WORKSHOP TO EVALUATE THE UTILITY OF INDUSTRY-DERIVED DATA FOR ENHANCING SCIENTIFIC KNOWLEDGE AND PROVIDING DATA FOR STOCK ASSESSMENTS (WKEVUT; OUTPUTS FROM 2022 MEETING)

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i Executive summary

The Workshop to evaluate the utility of industry-derived data (WKEVUT) aimed to assess the quality and potential of industry-derived data to enhance scientific knowledge and to provide data for stock assessments. WKEVUT provided an overview of fishing industry data provision initiatives and carried out comparisons of such initiatives with data from National Sampling Programs to assess the added value in terms of quality, ecological understanding and utility for stock assessments.

Industry self-sampling and co-sampling approaches have been increasing in recent years. Especially the Covid years have led to more catch sampling and survey programs utilizing a form of self-sampling or co-sampling. Self-sampling is here defined as a sampling strategy whereby the fishers are collecting and measuring the data on board, whereas co-sampling refers to the strategy whereby the fishers are collecting samples that will be processed on-shore, by research institutes.

Several industry-science joint initiatives have been presented during WKEVUT: 1) opportunistic acoustic data collection and estimation of stock abundance, 2) genetic sampling and stock identity, 3) gonad sampling on board of commercial vessels to contribute to egg surveys and the improved understanding of spawning cycles, 4) Remote Electronic Monitoring techniques for verification of self-reported catch compositions and 5) integrated fisheries management tools aimed at skippers and science.

Benefits and drawbacks for industry participation in data collection have been highlighted for the different types of data (Section 4). The documentation of self-sampling catch sampling can be improved by following the draft documentation template developed by the Working Group on the Governance of Quality Management of Data and Advice (WGQUALITY). An outline for a potential scientific publication following WKEVUT outcomes has been prepared (Section 6).

Participants highlighted the need for ICES to be able to understand the value of new data streams and what it implies for the processes to incorporate and apply them in future work. For this purpose, the group recommends to organize a second WKEVUT in 2023.

ii Expert group information

Expert group name	Workshop to evaluate the utility of industry-derived data for enhancing scientific knowledge and providing data for stock assessments (WKEVUT)
Expert group cycle	Annual
Year cycle started	2022
Reporting year in cycle	1/1
Chairs	Martin Pastoors, The Netherlands
	Els Torreele, Belgium
Meeting venue and dates	4-6 April 2022, Online, 29 participants

1 Introduction

1.1 Purpose and expected outcomes

The **Workshop to evaluate the utility of industry-derived data for enhancing scientific knowledge and providing data for stock assessments (WKEVUT)**, co-chaired by Martin Pastoors (PFA, Netherlands) and Els Torreele (ILVO, Belgium), will be established and will meet online, 4-6 April 2022, to:

(a) Compile an overview of previous, current rand planned industry self-sampling initiatives within the North Sea and Eastern Arctic Atlantic region (NS&EA) NE Atlantic and describe those initiatives in terms of aim, scope, sampling approach, guidelines, quality check, data reporting and data utilization for science and advice.

Participants are invited to provide working documents and/or presentations on specific case studies of industry-derived data. Inspiration for such a working document could be taken from the Commercial Catch Sampling Summary, developed by WGQUALITY 2022. Important elements to consider are also the governance of the program and the communication of results.

(b) Using specific case examples (e.g. herring, mackerel, demersal species and nephrops), compare industry self-sampling data with data collected from National Sampling Programmes for the purpose of understanding the added value in terms of quality, ecological understanding and utility for stock assessment and research.

Do participants have specific experiences with statistical techniques to evaluate consistency or differences between different sampling programs? If so, these could be presented as methodological working documents.

If participants have carried out specific comparisons between industry derived data and routine sampling programs (catch, surveys), these could be presented as case study working documents. It would be nice if the (summarized) data is available in a format that could be utilized in the course of the workshop.

(c) Mapping and assessing potential benefits and/or drawbacks of different types of self-sampling data (e.g. sensor data, scanner data, camera data, catch sampling data, bycatch data, biological data, environmental data) for utilization in ICES

Any experiences on utilizing different types of industry-derived data are welcome under this topic. During the course of the WKEVUT we will keep track of any benefits or drawbacks of different types of data, to end up in targeted recommendations.

(d) Write a scientific publication based on the analyses from ToR a and b.

An original research paper will be developed focusing on how to integrate data, information and knowledge contributions from the fishing industry in marine science in a way that delivers good quality information that is considered trustworthy within the constraints of established evidence-based decision-making processes. While we are witnessing a clear willingness by industry and growing interest in the scientific community for collaborative research, we also see challenges in relation to questions around conflict of interest, trustworthiness and reliability of industry contributions, hindering their integration in science in support of management. Our focus is explicitly on regions with well-developed scientific advisory systems because this is where issues about the transition in governance and participatory approaches in fisheries are matters of debate rather than necessity.

1.2 Terms of reference

WKEVUT looked into the following Terms of reference:

(a) Compile an overview of previous, current and planned industry self-sampling initiatives within the ICES regions and describe those initiatives in terms of aim, scope, sampling approach, guidelines, quality check, data reporting and data utilization for science and advice.

(b) Using specific case examples (e.g. herring, mackerel, demersal species and *nephrops*), to compare industry self-sampling data with data collected from National Data Collection Programmes for the purpose of understanding the added value in terms of quality, ecological understanding and utility for stock assessment and research.

(c) Mapping and assessing potential benefits and/or drawbacks of different methodologies in self-sampling data, e.g. sensor data, scanner data, camera data, catch sampling data, bycatch data, biological data, environmental data, for utilization in ICES i.e. where additional self-sampling for certain stocks is valuable (end-user need based). The output from the RCGs (i.e. ISSG on Regional overviews of fisheries and sampling) will be used to support this.

(d) Write a scientific publication based on the analyses and output from WKEVUT

1.3 Context

This workshop arose from a recommendation from the Workshop on Industry-Science Initiatives (ICES 2019). The purpose is to test the quality and utility of new data derived from industry-science data collection or sole industry initiatives by comparing it with existing data collected under national sampling programs and routinely used by ICES in stock assessment or for other research and advisory purposes. It is a high priority for ICES to be able understand the value of new streams and what it implies for the processes to incorporate and apply them in future work.

The purpose of the 2019 **Workshop on Science with Industry Initiatives** (WKSCINDI, ICES 2019) was to provide ICES with an up to date overview on the roles that industry can play in delivering scientific information relevant to ICES advice and marine research, and to develop a roadmap for taking measurable steps toward the inclusion and application of scientific data from industry. Key recommendations highlighted the need for actions that (1) establish standards and guidelines for industry data collection initiatives, their quality assurance process, and the pathway to making the data useful to ICES (WKDSG 2021), (2) evaluate the utility of self-sampling data from industry for enhancing scientific knowledge and providing data for stock assessments (WKEVUT 2022, this workshop), (3) provide a test case of the Regional Database and Estimation System using industry derived data, (4) consider specific applications of industry-derived data in current assessments and opportunities for continuous development of assessments based on new data streams.

The **Workshop on Standards and Guidelines for fisheries dependent data** (WKDSG, ICES 2021) convened to evaluate whether available documentation on Standards and Guidelines provides data-collectors and users with sufficient guidance on the requirements for quality assurance that should be applied to data used in supporting ICES advice. Particular focus was given to the need for guidance on data collection initiatives that fall outside of the scientific institutions that routinely participate in ICES, such as the fishing industry or other third-parties. This was motivated by recognition that participation of more (and different) data-collectors may provide new opportunities for ensuring that ICES advice is based on 'the best available data', and can assure its quality, credibility and legitimacy. Outputs from the workshop were used to draft the outline of a standalone document 'Overview of the principles and processes for quality control and assurance of data intended for use in ICES advice'. Management of conflicts of interest was identified as being an important issue that needs differentiated treatment between different data-collectors in order to reduce the risk that wider participation in data-collection compromises real or perceived legitimacy of advice.

The Working Group on the Governance of Quality Management of Data and Advice (WGQUALITY) met for the first time between 19 and 22 January 2022. The Working group is broadly tasked with Analysing existing ICES quality management processes within advice production and to operationalise the quality tools and processes that were proposed during the previous 3-year cycle of PGDATA. This resulted, inter alia, in a Commercial Catch Sampling Summary Template that was made available to WKEVUT for initial testing.

1.4 Terminology

During WKEVUT, it was concluded that the terminology around the sampling activities and roles that different people have, it not always clear. Therefore, WKEVUT worked towards preliminary definitions and descriptions of the following terms, in relation to commercial catch sampling.

Sampling activities

Self-sampling	The process whereby, e.g., fishers or fishing crew-members take samples from the catch and carry out measurements on those samples. Self-sampling programs may be led by research organization, by industry organizations, or both.
Co-sampling	The process whereby, e.g., fishers or fishing crew-members take samples from the catch and store or freeze these samples for later analysis at a research institute.
Observer-sampling	The process whereby researchers or research assistants affiliated with a research institute carry out catch and/or discard sampling, e.g., while at sea. The purpose of the sampling is to acquire scientific information. Note that there may also be observer programs that are aimed at enforcement of regulations. These programs are not part of the discussions within WKEVUT.

Roles

Observer	A person who goes out to sea with a commercial fishing vessel to carry out sampling activities and observe the composition of the catches, discards and bycatch. An observer is normally employed by a research institute (scientific observer) although observers may also be employed by fishery organizations (industry observer)
Researcher/Scientist	A person with a scientific training who is carrying out research activities in the context of sampling commercial catches. A researcher is normally employed by a research institute.
Industry scientist	Similar to above, but employed by a fishery organization
Fisher/skipper	The operator of a fishing vessel and responsible for the daily operations on the vessel.
Fishing crew-member	People on board of fishing vessels with tasks related to the fishing operations and potentially also related to sampling activities
Vessel-owner/operator	The owner and/or operator of a fishing vessel.

2 Overview of self-sampling initiatives

2.1 Catch sampling programs

2.1.1 Netherlands self-sampling and co-sampling approaches

The presentation gave a short overview about how different science-industry collaborative projects developed in the Netherlands (Figure 2.1) and introduced the Dutch shrimp self-sampling (co-sampling) programme. Various projects have developed with different degree of industry involvement: from commercial vessels used in a scientific survey with observers (scientists) sampling and processing the data (orange colour, Figure 2.1), to sampling by fishers themselves that follows the normal commercial fleet activity (blue colour, Figure 2.1). In many projects, both fisher and scientists are involved in data collection. For example, a self-sampling program validated by observer trips (blue with stripes, Figure 2.1) or observers joining a commercial vessel to take samples themselves (orange with stripes, Figure 2.1).

In general, an increase in collaborative science-industry projects and successful self-sampling programs can be seen. The main motivation for these collaborative monitoring programs are to gather information on data limited species (e.g. Norway lobster, turbot and brill programs), discard sampling (e.g. shrimp and DCF self-sampling) and testing and certifying technology (e.g. pulse monitoring, fly shoot knowledge). The projects are often demanded by the EU or ministry (e.g. to underpin the landing obligation exemption, DCF, monitoring requirement) or suggested by ICES (data limitation).

There are many potential benefits of using data collected by/with industry for management:

1. Cost-efficient way of increased coverage (temporal, spatial, more age classes),
2. Increased communication, transparency and trust between scientists and fishers (model and advice),
3. Increased proximity to practice of commercial fishing (management solutions of end-users: gear technology changes, landing obligation, real-time closures),
4. Including knowledge from all relevant actor groups (improving management solution and research performance).

However, it is often a challenge to integrate the collaborative data into advice. One main challenge is how to translate the fisheries dependent data into scientific research-based information? Does the strategy for data translation for advice depend on the degree of fisheries dependence? A quantification of fisheries dependence could be helpful.

The shrimp self-sampling program was introduced as an example for a self-sampling project. The shrimp self-sampling was assigned by the Dutch ministry (LNV), to collect data for the scientific evaluation of a de minimis exemption in the brown shrimp fishery in the North Sea. The bycatch of quota species in the shrimp fishery shall not exceed 6 % (in 2021/2022) and shall be reduced to 5 % in 2023 for an exemption to apply. The project was assigned for 2 years. 200 sampling trips per year are distributed over the reference fleet of 14 shrimp vessels. The sampling area is divided into 5 area and each area is sampled every month. There is much contact with vessel owners and the producer organisation in order to find every month the right vessels at the right location to take samples. The Sampling is done by the fishers themselves (self-sampling), and the analysis is done in the laboratory by WMR researchers (co-sampling). Where possible, the data is validated with observer trips from a different ongoing shrimp programme.

Sampling procedure: First the empty hopper volume is measured and translated into volume. During the chosen sampling trip, the fisher takes a 5 litre bucket of unsorted catch from each hopper, from 2 hauls (1 day, 1 night). The hauls can be chosen by the fisher. The fisher registers hauling time, total catch (in cm), cooked shrimp landings for every haul of the entire trip. In the WMR laboratory, the sample is sorted by species, measuring, weighing and counting is done. The data is "raised" from sample to fleet level (assuming a constant ratio and considering trip information from the trawl list and the logbooks filled in by fisher).

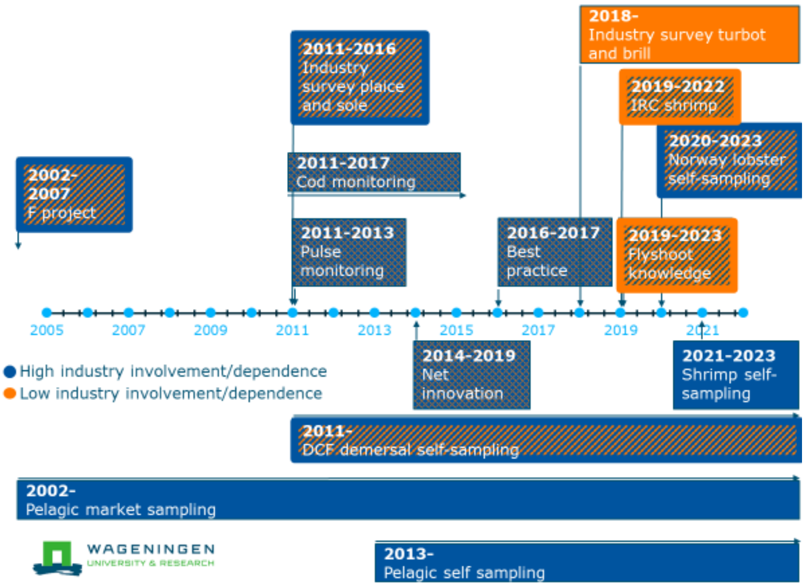

Figure 2.1 Dutch science-industry collaborative projects that involve long-periodic sampling on commercial vessels and show a varying degree of industry involvement depicted by the colour (orange: low industry involvement, blue: high industry involvement). Electronic monitoring is excluded.

Q&A:

- It is important to be clear on the backgrounds of the people involved. People may have different roles in the sampling program. For example, observer refers to a researcher employed by a national research institute who observes any part of the catching or sampling process. A researcher may be a person working at the research institute, or a person working within the fishing industry but trained as a researcher and having a research scope.
- What are the incentive for fishers to participate in the sampling programs? The research institute works closely with the fishery organizations who are advising on which fishers to invite. The fishing news magazine is also used to invite participation. In many projects, fishers receive a small compensation for their efforts but it is not clear whether this is actually an incentive. Most participants are interested in the project and the results.
- How is the diversity in the participation? There are some repeat vessels that have a track record and understand the working process. There are also quite a few people at WMR who have connections with the fishing industry and help to reach out to contacts.
- The shrimp project currently does not have a quality checking system in place. How can you make sure that there is no cheating with the sampling data? In this case, the ministry of fisheries has requested for this type of sampling, but did not allocated a budget to carry out quality control. Although, the sampling has way better coverage than previous procedures, the validation still needs to be done.
    - Could you perhaps verify the consistency of the vessels internally, by cross-comparisons?

- Could the selection of vessels lead to potential bias?
  - more ‘friendly’ vessels are invited; could lead to bias of vessel participation
  - Some vessels do not meet the ‘requirements’ to be included in the program; this may also lead to bias

2.1.2 Pelagic Freezer-trawler Association self-sampling approach

The PFA self-sampling program is an industry-initiated sampling program that is being carried out on freezer-trawler vessels from the Netherlands, UK, Germany, France, Poland and Lithuania. The program has been incrementally implemented during the years 2015–2017 and from 2018 onwards, all vessels in the association are participating in the self-sampling program. The program is designed in such a way that it follows as closely as possible the working practices on board of the different vessels and that it delivers the biological and fisheries information needed for the relevant scientific bodies (e.g. ICES, SPRFMO, CECAF), certification bodies (e.g. MSC) and as a feedback mechanism for the participating vessel crews.

The main elements in the self-sampling protocol are:

- Collection of haul information (date, time, position, weather conditions, environmental conditions, gear attributed, estimated catch and species composition)
- Collection of production (batch) information (total catch per batch, including variables like species, average size, average weight, fat content, gonads and stomach fill)
- Mechanism for linking batch and haul information (essentially a key of how much of a batch is caught in which of the hauls)
- Collection of length frequency measurements, initially either by batch or by haul, but since 2021 onwards only by haul)
- Collection of specific biological information for individual fishes (length, weight, sex, gonads, genetics, …)

The self-sampling information was initially collected using standardized Excel worksheets. From 2018 onwards, a transition is being made to dedicated data-recording soft-ware (M-Catch) with live synchronization to a shore-based system.

Quality control mechanisms are taking place in different stages:

- On data entry
  - Error detection in standardized Excel spreadsheets / dedicated software
- On data adding to database
  - Currently still Excel database, converted into RData files
  - Manual and automated checks on outlier values and potential errors
- On generating trip reports
  - Detecting any problematic or erroneous results in trip reports
  - Getting feedback from skippers/crew on spatial/temporal patterns
- On comparing with other sampling programs
  - With WMR market sampling
  - With WMR observer program
  - With SPRFMO observer program
  - Via new PFA-WMR working group (2022)

Within the program, standardized trip reports are generated using *Rmarkdown*. The trip reports are returned to the vessel immediately after ending of each trip.

The compiled data for all vessels is being used for specific purposes, e.g. reporting to expert groups, addressing specific fishery or biological questions and supporting detailed biological studies. The PFA publishes an annual report on the self-sampling program.

Q&A:

- Are the type of measurements in the CECAF area the same as in the Northeast Atlantic? Yes, in principle the same approach to self-sampling is carried out in the CECAF area. Although there is a formal EU observer program for the CECAF area, in practice this does not work because of the regulations in Morocco that require Moroccan control observers to be on the vessels.
- Is slipping behaviour a problem in this fishery? Although the self-sampling program does not have a control objective, there are no strong indications that deliberately slipping of parts of the catch is happening in the fishery. If slipping happens, this is probably rather exceptional and may be due to problems with the gear (e.g. due to net damage). In principle, it would be possible to compare species and length compositions between to assess whether slipping could be occurring.
- Is the batch information used in the stock assessments? Currently, this information is presented as additional information. It should be presented in a way that it is usable in stock assessment. One way would be by linking with the traditional sampling schemes with the self-sampling scheme.

2.1.3 Scottish pelagic self-sampling approach

The programme aims to establish and maintain long-term data collection; with the objective of providing data to ICES for use in stock assessment and scientific research.

Development of the current programme took place over a period of ~5 years, beginning initially in 2017–18 with a feasibility study which looked to identify opportunities for the Scottish pelagic industry to collect and contribute data (Mackinson *et al*., 2018). Following on from this, between 2018 and 2021, a pilot phase was carried out to develop and evaluate methods for data collection across the three main pelagic fisheries of herring, mackerel and blue whiting. Key elements of the pilot were: 1) ensuring that methods were both practical to work onboard a commercial fishing vessel and robust to provide quality data that could be trusted and accepted, 2) documenting processes and procedures, and 3) engaging with industry and science for the provision of transparent feedback.

As of 2022, the programme is fully established, with commitment from industry and science partners to long-term data collection (all SPFA member vessels participate voluntarily, representing 20 out of 21 Scottish pelagic vessels; and MoUs are being established between partners). The current programme comprises two elements:

a) **Self-sampling**, whereby vessel crew undertake length and weight measurements of samples from every haul, and record associated haul information (including date, time, location, and other environmental and operational parameters). For the length-weight sampling, a paired keypad-scale recording system was developed in the pilot phase to aid efficiency and facilitate paperless data recording.

b) **Co-sampling**, whereby vessel crew collect a frozen sample of fish from randomly selected trips, which is returned to scientists at laboratories for biological sampling of age, length, sex and maturity. 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. 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.

For more information:

- SPFA dedicated science webpage, with links to science and sampling information and documentation: https://scottishpelagic.co.uk/pelagic-self-sampling/
- SPFA YouTube channel, with videos detailing science involvement, data collection, and user guides on the paired keypad-scale recording system: SPFA Science - YouTube

Q&A:

- WGQuality should be able to play an important role in making self-sampling data feed into the ICES system. It is mainly about transparency and process control.
- The paired keypad is an interesting idea. Is it commercially available? Yes, it is. https://echomastermarine.co.uk/
- What are the incentives for participation and how did you increase the participation? Prior feasibility study combined with recruitment of Steve Mackinson as industry scientist, laid the groundwork. Started off with a few vessels and the success with those led others to join. Peer pressure and fairness issues were important too.
- What are the advantage of co-sampling with crew doing the sampling? All catches are available to be sampled because even those that land overseas are available to be sampled.
- Is there a financial cost involved and how are people on board designated to sample? The initial costs for the keypads was covered around 70% by EU project, 30% by SPFA. Vessels are responsible for any installation (cabling costs etc). Nominated samplers are designated by the skippers on the vessels, with one main contact point, although more than on persons are involved. Quality control is important. Immediate feedback is key to tackling any problems.
- How are hauls selected? Length -weight sampling is every haul. Co-sampling for frozen samples is random selection of trips using a daily coin-toss of those vessels on the water that day.
- Now that all the vessels are participating – maybe you are oversampling? The gold standard is every haul. Easy to go lower, but not go higher. Samplers say it is now part of routine. It is easier to implement if it is simpler and consistent. Different audiences – self-sampling is important information to replace the need for diaries. Maybe more scope to adapt the co-sampling if needed.

2.1.4 Scottish demersal onshore co-sampling approach

The Scottish Fishermen's Federation (SFF) has been running Observer schemes for more than a decade. Most of the data collection streams have been conducted under a joint scheme with Marine Scotland Science (MSS), sharing the same protocol and inputting data in the same database.

During 2021, a new phase of the project started taking the name of Independent Fisheries Science Support Scheme (IFSSS) and expanding its scope from the usual offshore sampling to a form of co-sampling. Due to the restrictions brought during the COVID-19 pandemic, offshore activities saw a huge reduction and the lack of data started to become an issue. It was at the time that a co-sampling pilot scheme was devised, still in collaboration with MSS, with the idea of increasing the collection by creating an alternative to shift the place and time of sampling, onshore and after landing.

The pilot run over ten months, but it took a couple of months to kick off due to difficulties of identifying the right kind of derogations needed to land fish “outside” the normal commercial quota.

If the pilot keeps evolving successfully, the co-sampling scheme will be kept operative beyond COVID-19 and will help to enrich the data collection and enhance the data coverage.

The aim of this pilot was to determine if onshore sampling of catches, using samples collected and provided by the fishing vessels, could yields results similar to an observed trip and to determine the feasibility in the future to collect this data in a statistically randomised manner that is compatible with the existing data collection programmes.

Data collected from this pilot, providing that meet the required criteria, are to be submitted for scientific use, including the stock assessment process, as well as informing other important work streams such as the Marine Stewardship Council sustainability certification.

The SFF and MSS took over different fleet segments. It was decided that SFF would cover the Whitefish (Areas IV and VI) and Offshore *Nephrops* vessels mainly operating in the Fladen grounds, and MSS the Inshore *Nephrops* fleet for all the Functional Units. The pilot started with a very limited number of vessels, but the intention is to scale up the programme once the protocols are consolidated. During the pilot the participation of the vessels was voluntary. A compensation for the time invested in retrieving and prepare the samples for the shipping/delivery is given to the boat (£50 pounds per sample).

As per sample collection, participating vessels are requested to collect samples according to different protocols that will need to be standardised. In case of Whitefish and Offshore Nephrops vessels the crew is required to provide 2 to 4 samples per trip, consisting of unsorted catches taken in day light and night-time, with the effort duplicated if a shift of fishing ground (hence species composition) happens during the trip. The sample should be collected from the hopper at different time points of the sort (beginning, middle and near the end) to counteract the effects of stratification within the hopper. The total quantity of fish that can be provided under the current derogation is <= 160Kg per trip. For the Inshore fleet the samples provided are of the unwanted component of the catch and the crew is instructed to operate as if there is an observer on board (Note for the Chairs: better details of this side of the protocol can be provided by the responsible persons at MSS).

For each trip, the skipper is asked to complete a Trip Summary sheet which will contain the relevant fields (Vessel Name, Vessel PLN, Vessel RSS, Skippers Name, Date Sailed, Date Landed, Target species (fish/*Nephrops*/squid), Gear type, Cod End Mesh Size, Total number of hauls for the trip)

For each haul where a sample is obtained during a *Nephrops* Offshore or Whitefish trip, the skipper is asked to complete a Haul Summary sheet with relevant information (Haul number, Time shot, Time Hauled, Latitude/longitude net is shot, Latitude/longitude net is hauled, Estimated weight (kg) of total catch (bulk) from sampled haul, Estimated weight (kg) of marketable fish/*Nephrops* from sampled haul, broken down to species landed where possible, Total number of hauls for the trip, Comments on any factors affecting the sample).

Once it arrives at the laboratory, the sample is processed by the observers as if they were on the trip (sorting, identifying, measuring, weighting, retrieving otoliths). Once this is done, the observer is required to complete, in addition to the usual data sheets, an Observer Haul Summary sheet for each sample, including relevant information (Trip ID, Observer name, Fleet segment, Vessel Name, Vessel PLN, Departure port, Port landed, Date sample collected, ICES areas fished in, Number of samples).

With the new funding stream, we hope to improve the scope of the pilot increasing the number of participating vessels, so that it will become significant of the various fleet segments operating in Scotland.

Q&A:

- Question Steve: more clarification: skippers, byers sample, … Keeping it simple is usually avoiding problems; future plan…
- How will you organise the feedback system? All data will be in a database from which reports can be produced. Participation is mostly on a voluntary basis. Best reason to be part of self-sampling programme is because there is a perceived gap between scientist information and what the industry is seeing. The 50 pound is probably not so important for fishermen.

2.1.5 French self-sampling and co-sampling approaches

In France, self-sampling of commercial fisheries are currently implemented in three different perspectives:

EU Data collection work programmes and sampling for blue whiting in the Atlantic North-East and for cod in ICES areas I and II; the objective is to provide length structures for assessment working groups because on-board observer would be too costly (long trips) and on-shore sampling impossible (fish processed on-board).

Industry initiatives on cod 7.b-k, anglerfish 7/8, haddock 7.b-k and common skate; The objective is to complement the existing data used in stock assessment

Scientific projects for pollock in ICES area 8 and crustaceans (lobster, red lobster and edible crab) with the objective of initiating a data collection on stocks with limited data available and improve scientific knowledge.

A fourth initiative occurred in 2021 when France started to implement a remote monitoring (CCTV) of by-catches of marine mammals on the gillnetters in the Bay of Biscay (ICES divisions 8.ab). The objective is to equip 20 vessels and monitor all the fishing operations to assess the impact of the fisheries on marine mammals.

All these initiatives are developed following *ad hoc* demands and are currently lacking a coordinated approach and shared tools. Some are well integrated in the data collection routine (blue whiting, gadoids Celtic sea), others are under development (cod, haddock) to eventually further integration. Moreover, the development of a specific application for the fishers is a crucial point since for both the centralisation in a common database and sharing the same tool but there is a reluctance to change fishers routine when they're used to Excel and as long as scientists eventually get the data.

Q&A

- In general, it would be nice to have a paper on the industry initiatives and where it contributes 60% or more of the information for stock assessment and has been tested against data from the observer programmes
- ObsCam-e refers to REM monitoring of marine mammal bycatch
- Development of a specific app for the fishers seems to be a crucial point because it can more easily feed into IFRMER database. However, people are reluctant to change the process when using excel and it is working OK.
- What is the vessel size? The co-sampling is done on 8–15m vessels in the Bay of Biscay and Obscam-e is equipped on a few larger offshore gillnetters (30–35m). There are attempts to get a representation of all components
- Is there feedback to vessel? Feedback with Pêcheurs de Bretagne (industry initiative sampling) and with the company owning the vessels targeting blue whiting in the Northeast Atlantic and cod in area 1,2 on a yearly basis. Feedback may also be on demand.

- If it is a private company that does the setup of the Cameras on boats with support from IFREMER for all the technical issues? The company having the contract for managing the cameras onboard and handling the data is bound to confidentiality. All the images are kept that correspond to an incident being recorded. 99.9% of the time there is nothing to see. The A metadata exchange format is under development to be imported on the IFREMER central database and will be further analysed within a dedicated research project starting in 2022.

2.1.6 Co-sampling programme for sole (*Solea solea)* – Belgium

In order to extend the spatial and temporal coverage of the classic observer programme for commercial beam trawl vessels targeting demersal species (TBB_DEF_>221kW), ILVO has initiated a co-sampling programme. The co-sampling programme is aiming at collecting additional catch information of *Solea solea* in area 7a and 8ab. Participation of the fishermen in the co-sampling programme is on a voluntary basis. During each co-sampling trip, fishermen work closely together with ILVO scientist and the collection of the data and samples is done partly by the fishermen and partly by ILVO. The crew of the fishing vessel is properly trained by ILVO to collect data and samples in a correct way.

During a trip, the crew of the fishing vessel is asked to collect trip and haul meta data. Furthermore, the fishermen document total catch weights of *Solea solea* by catch fraction and by haul and they are taking a 30 kg *Solea solea* discard sample (containing fish from at least 3 hauls spread out over the entire trip). The discard sample is stored on ice and brought ashore by the crew.

ILVO picks up the discard sample in the harbour for further analyses in the ILVO lab: the entire discard sample is measured and 5 fish per cm-size are randomly selected for estimation of biological parameters (age, individual weight, length, sex, maturity and gonad weight). Furthermore, the *Solea solea* landings from this particular trip are sampled by ILVO in the fish auction/harbour. A representative number of fish boxes is randomly selected from all *Solea solea* landings from the trip for length measurements. From this sample, 4 fish per cm-size are randomly selected for estimation of biological parameters (age, individual weight, length, sex, maturity and gonad weight) in the ILVO lab (reimbursement is provided for the shipowner). It should be noted that the *Solea solea* landings are sampled before the sorting process takes place in the auction.

The collected information of each trip is stored in the national Smartfish database and the data are submitted to an extensive ILVO quality procedure: data forms are checked for completeness and consistency, outliers at different levels are checked, the *Solea solea* discard rate and length frequency distribution of the co-sampled trip are compared to those of observer trips that took place with vessels that use similar gear and were active in similar regions and in the same season etc. Only when the data passes the quality checks, the trip information can be validated and the information is ready to be used for further analysis and extrapolation (e.g. for stock assessment purposes). Feedback on the quality of the collected information is provided to the crew of the fishing vessel. ILVO will further investigate the added value of this type of sampling in the upcoming years and would like to extend the co-sampling programme in the future.

Q&A:

- ILVO gives feedback to the vessel after a self-sampling trip took place and general feedback is provided via industry - scientist meetings called "the quota commissions". There is also an industry magazine ("de Rederscentrale") where feedback of the self-sampling project is provided to the industry.

- Quality Control program: checks are done based on common sense. Are there formal methods to check if these results out of expected range? The still needs to be implemented.

2.1.7 Swedish sampling of commercial catches of herring and sprat in the Baltic and North Sea

Since late 2019 Sweden has been improving its sampling of Baltic herring and sprat. That effort took place in the context of regional cooperation initiative initiated by Baltic Regional Coordination Group (RCG BA): the RCG BA Intersessional Subgroup on Small Pelagics. After a pilot phase (2020–2021), the new sampling scheme is now included in the Swedish National Work-Plan carried out under the EU Data Collection Framework (DCF NWP) and, from 2022 onwards sampling was extended also to the North Sea region.

The sampling is coordinated by the Swedish University of Agricultural Sciences (SLU) and counts with the collaboration of the Swedish Pelagic Federation (SPF PO) which vessels are involved in collecting the samples from the fishery. At the start of the year, logbook data from previous years is analysed by SLU to identify the main vessels involved in the fisheries. That information is then cross-checked with SPF PO for new additions and recent sales and the gathering of phone contacts. The final sampling frame contains a variable number of vessels (generally, 15 to 21) that include all the most significant vessels, accounting for, at least, 70% cumulative landings of sprat and herring in any Central Baltic subdivisions and 90% of cumulative landings of sprat and herring in the North Sea subareas, and Kattegat and Skagerrak subdivisions.

In 2022 the sampling frame was partitioned into three vessel strata: vessels that fished only in the Baltic, vessels that fished only in North Sea – Kattegat and vessels that fished in both of these regions. Weekly contact lists are being assembled at start of each quarter, with 2-5 vessels (depending on list) selected probabilistically for sampling each week. Each vessel is contacted by SLU and asked to collect one sample from each haul made in the 1st trip departing next week. A range of methods is used to communicate with the vessels, largely dependent on skippers' preference (e.g., phone calls, SMS, messenger). In the case of fishing for industrial purposes, skippers are asked to collect 3–5 kg of unsorted catch from each haul and freeze it. Larger samples are requested from human consumption fisheries and the North Sea. To facilitate sampling, a sampling kit is sent to skippers at the beginning of the year that includes, among other, 60 litre bags, writing material (pencils and markers) and labels with vessel name, departure date, haul number, haul start and stop date and times and subdivision. Landings frequently take place in Denmark, so after each trip, a pick-up point is arranged with skippers when vessels change crew or land in Sweden.

At the lab, samples are sorted, checked for details, registered and, when needed, subsampled (2 hauls per subdivision in the Central Baltic, 4 per subdivision/subarea in the North Sea). Lab procedures involve sorting of samples to species, then the weighing of each species separately, and finally the measurement and biological analysis of maximum of n = 50 (Baltic) and n = 75 (North Sea) random individuals per species and sample. For each individual, length, weight, sex, maturity with some additional variables (parasites, fat content, genetics) being collected for specific species*subdivisions combinations.

Feedback to vessels is given by means of an annual report that includes length and age frequencies of the samples they provided. To account for situations where sampling may not work or industry not collaborate, A fall back sampling scheme including quota sampling targets by species*quarter*subdivision is also included in the DCF NWP.

Q&A:

- Communicating is directly with skippers on vessels. Direct contact takes a lot of time but you get good and quick feedback.
- Subsampling takes place in the lab, are you not using certain samples? We communicate only about the samples that we analysed, we don't communicate the details of the sampling; more of an overall output is given.

2.1.8 Fishermen scientists: Self Sampling and Co-Sampling in Ireland

The fishing industry and the Marine Institute in Ireland have a long history of co-operation and active participation in collecting data that feeds into the stock assessment process. Fishing vessels have, since the early 1990s, facilitated scientific samplers aboard their fishing trips to collect data and samples at sea. In recent years the vessel selection has been conducted using a weighted random selection 4s sampling scheme where the vessels selected are contacted and trips arranged and/or refusal rates recorded. The duration of At Sea Sampling trips vary, with the average 5–6 days at sea.

In March 2020, the At Sea Sampling program was temporarily suspended in response to the Health & Safety guidelines associated with Covid-19. To plug the possible emerging data gap, the fishing industry along with the Marine Institute developed an At Sea Self Sampling Program where the vessel collects data and samples at sea and deliver to the Marine Institute on landing. Under this program the vessel collects data and samples on a subset of hauls (one haul per day) according to the standard operating procedure (SOP) developed. The data collected include haul metadata (start/stop lat, long, time, date) gear parameters, estimation of the bulk catch (i.e. total catch), landing by species and weight, any interaction with bycatch PET species. The vessel also collects a random box (40kg) sample of unwanted catch which is labelled appropriately and stored for collection ashore. To ensure standardisation and quality, prior to sailing each vessel is provided with a standard sampling pack which includes datasheets/ labels and the SOP, everything required bar the pencil. The skipper is contacted to issue a unique trip code and to advise on and run through the SOP. As a quality control measure each skipper is requested to send an image of the first recorded datasheet (via WhatsApp) to the Fisheries Liaison Officer where real time feedback is provided on any potential issues. Regular contact is maintained during the trip to offer assistance and arrange logistics for sample collection. On landing the samples and datasheets are collected by Marine Institute staff and the samples worked up for biological parameters. The data is stored in the catch sampling database and automated trip reports are extracted as feedback to skippers. The aggregated datasets are extracted as appropriate to answer data calls that feed into the stock assessment process. The experience with the At Sea Self Sampling has been very positive and the plan is to continue this as a second stream of data to augment the At Sea Sampling when it returns to full capacity post Covid-19.

The At Sea Self Sampling program is a specific program that collects a significant amount of ancillary data along with the samples collected. The Marine Institute also has less involved co-sampling programs with industry, i.e. samples collected from the *Nephrops* fleet and the herring fisheries, where the vessels simply collect samples at sea to be subsequently worked up ashore by MI staff. In Ireland there is also another aspect of industry science data collection where staff members in selected processing establishments are contracted to measure a selection of species from the landings. The data collected here include vessel details, area of operations, volume and the individual measurements.

All fisheries-science data collection is designed with end user in mind be that the traditional stock assessment process or the emerging uses in assessing bycatch PET species. Templates are standardised to work with existing datasets/data storage systems and to increase utility. The data are also available in aggregated format to potentially answer specific questions which the industry or state may have.

Additional information: in February 2019, the Marine Institute, Ireland, received the international accreditation of its Data Management Quality Management Framework (DM-QMF) by the (UNESCO) International Oceanographic Commissions (IODE) – International Oceanographic Data and Information Exchange program. The overall aim of the DM-QMF is to support continual improvement of the quality of the data, products and services delivered by the Marine Institute through assuring the quality of the processes and procedures used in the generation of data and products. All data products including those collected via fisheries self-sampling and co sampling programs are managed through the DM-QMF.

https://oar.marine.ie/bitstream/handle/10793/1589/Leadbetter2019_Article_Implementation-OfADataManagemen.pdf?sequence=1&isAllowed=y

Q&A:

- Advantages of new sampling approach? We were not reaching targets in number of sampled trips with previous approach. Using the new techniques, we are getting there.
- Feedback mechanism? Key thing is interaction, also communication is important. A trip report to send back to skipper. In addition there is also real-time communication with the skipper through WhatsApp.
- Assuming there is a fully operating camera system in place. Would you then give up on self-sampling? Prefers to continue with self-sampling because you generate more information. They are also collecting ETP information.

2.1.9 Norwegian co-sampling approach ("catch sampling lottery")

The Norwegian "catch sampling lottery" is a sampling program intended to provide data to describe the age and size structure of the Norwegian commercial catches in the pelagic fishery, which is input data to the stock assessment. The program is based on probabilistic sampling, where each haul in the fishery can be selected for sampling (almost 100% coverage of hauls). The practical sampling is done by the fishermen that freeze a (~15kg) sample upon request and deliver to a Norwegian processing plant which further ships the sample(s) to Institute of Marine Research (IMR) for processing. The decision on whether a haul should be sampled or not is done by a computer at IMR, and the size of the haul (in kg) determines the odds for being selected for sampling or not (unequal probability random sampling). We us the electronic logbook system, with some modifications, as the basis of communication with the vessel and for ordering samples. This means that when a vessel leave harbour for fishing, they send a departure message, stating target species for the trip (among other things). If the target species is one of the species included in the catch sampling lottery, they will automatically get a reply and asked to participate in the lottery this trip. Further, immediately after each haul an unofficial catch report message will be sent to IMR, and this message is going into the "lottery" and a return message is sent back to the vessel immediately. This message says whether that haul should be sampled or not. By using the size of the haul, or more precisely the fraction this haul is to the expected yearly catch (set equal to the total Norwegian quota), together with the number of samples we want for the whole year, we calculate an inclusion probability that is used in the selection process. In that way we can predetermine the number of samples ordered for a year, and spread the sampling effort in time and space, reflecting the fishery.

The catch sampling lottery was developed as a cooperation between IMR and Directorate of Fisheries and including the industry. It was implemented for herring from 1 January 2018 and has later been extended to include also blue whiting, mackerel, sprat, horse mackerel, sand eels, capelin, Norwegian pout and Argentines. From 15 January 2021, it was mandatory for the fishers to participate, and after that the participation rate increased to almost 100% on haul level. However, not every requested samples are taken. In average we received approximately 60% of the ordered samples in 2021. The rest are either not taken or may be forgotten somewhere on the way to IMR. Information and feedback to the industry is a necessity and a continuous process. We expect that the success will increase year by year when the industry will get more used to the system and the benefits for themselves through more precise stock assessment. The sampling program will be further described in an upcoming publication. We have also initiated an international project, CATSAM, in order to discuss and potential develop similar approaches in other European countries.

Q&A

- Suggestion to improve the website: click on the dots to make the length frequency distribution visible
- Could there be a bias in who are taking samples (friendly), who is not (unfriendly)? Most of the vessels are participating, but it is challenging to get this to 100%. It is not a perfect system, increased quality of sampling enormously
- It is required to use the logbook at haul level before participating in the project? Yes, it is required by haul. Previously the had to send the logbook in info before midnight

2.1.10 Norwegian use of grading machines

Estimating the size distribution of reported catches on-board factory vessels – issues with using data from the production process. High-grading is the practice of discarding lower value catches to make space for catches with higher value. It is necessary to understand the extent and variation in these unreported discards to improve stock assessments and management decisions. Where discards are not directly observed, a proposed methodology for estimating high-grading involves comparing size distributions of total catches (before sorting) and landed catches (after sorting), but we have yet to identify a suitable data source for the landed portion. This report presents data from two pilot studies exploring the suitability of data gathered during the onboard factory production process for describing the size distribution of reported catches. We received these data in a summarised report, where individual fish weights are aggregated into coarse, overlapping size grades. This summarised form results in a large loss of information. Applying the necessary statistical procedures to get a more detailed picture of fish size distributions would introduce even more uncertainty into an already uncertain estimation, potentially leading to non-significant results, and can introduce unknown biases. We conclude that it is necessary to use the raw data behind summarised reports which provide data on individual fish. To this end, we address the logistical and statistical issues posed by production data including individual fish observations.

Q&A:

- The studies were done on two fisheries: 1. Barents Sea trawl and longline fishery targeting cod and haddock; 2. North Sea trawl fishery for saithe.
- How were the individual measurements taken: length or weight? The weight of individuals (processed product) is measured. Weights are converted to lengths using a conversion factor. Additional data for that conversion factor could be obtained from the reference fleet.
- The overall conclusion is that the production reports (on the batches) are not useful to aggregate data, as the data are too coarse and categories are overlapping. There is no way to use these data in a scientific manner: also, not for estimating the amount of unreported catch.

2.2 Sensor data collection programs

2.2.1 Synthetic transect approach for interpretation of the acoustic data collected by fishing vessels

For many years already, acoustic data has been recorded on commercial fishing vessels of the Pelagic Freezer-trawler Association (e.g. Fässler *et al.*, 2016). Many terabytes of data are now available. The equipment is sophisticated, the echosounders are calibrated and the high fish density regions are visited during the fishing trips with extensive spatio-temporal coverage. But how can we derive meaningful metrics from the acoustic data collected by fishing vessels?

Currently a method is being developed and tested at Wageningen Marine Research to utilize acoustic data collected during commercial fishing operations for biomass estimation. The case study that is explored is the blue whiting stock during the spawning season in March–April. The International Blue Whiting Spawning Stock Survey west of the British Isles (IBWSS) is carried out annually during the spawning season. At the same time, the commercial fishery is taking place in that area. An overview of the available acoustic data from commercial fisheries is shown in Figure 2.2.

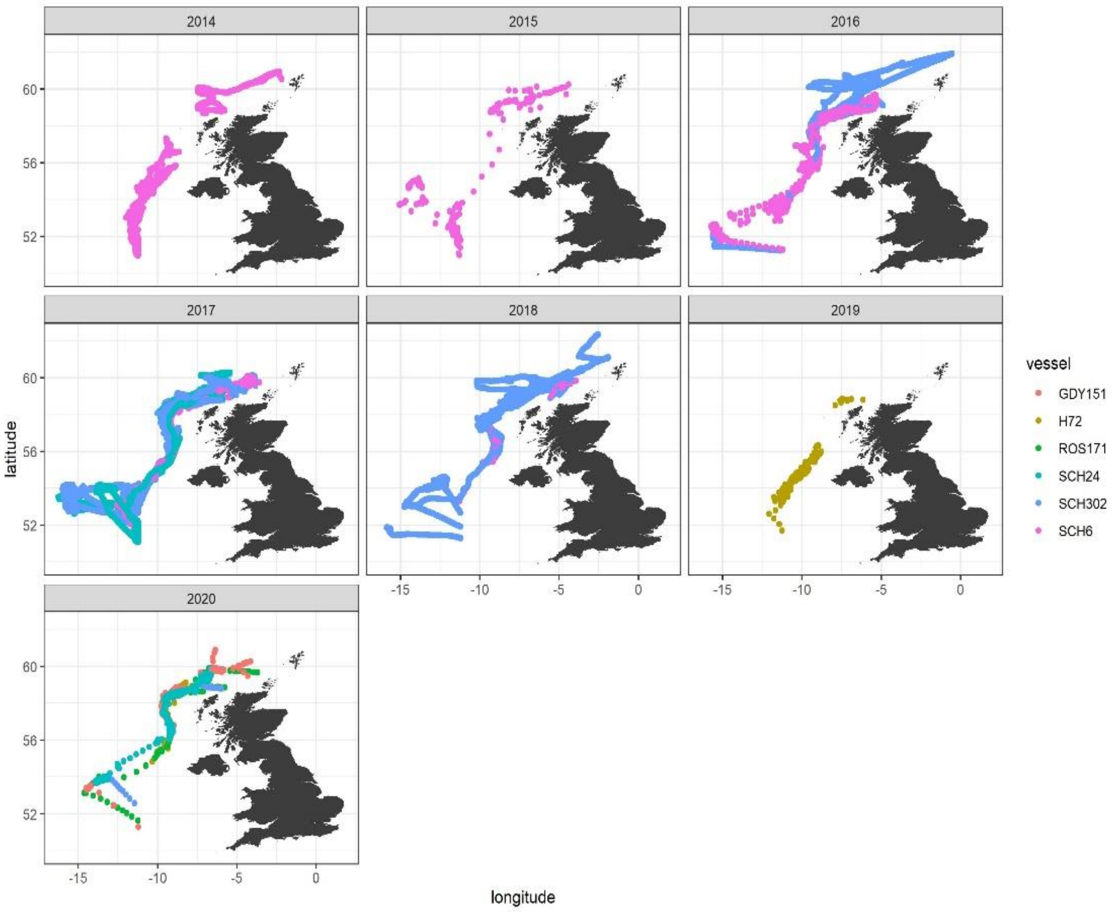

Figure 2.2 Overview of acoustic data for blue whiting collected on PFA freezer-trawlers

The acoustic observations during both, the scientific survey and the fishing trips have been processed using the same methods: cleaning noise, removing unwanted regions (e.g. surface and bottom reflections), manually drawn polygons that confine the backscatter regions that can be attributed to the blue whiting, and results exported as integrated acoustic backscatter per nautical mile.

The main difference between the survey and the fishing vessel observations comes from the patterns in the acoustic tracks. The fishing vessels observations comes from localised recordings from high density spots during the actual fishery. The biased property of the acoustic tracks of the fishing vessels makes it difficult to fit them into a statistically meaningful survey design. The method now being developed at Wageningen Marine Research is taking advantage of the good overlap between the commercial fishery and the scientific survey to develop a method to transform the targeted fishing vessel data into unbiased ‘survey-like’ estimates of abundance.

All commercial acoustic data is broken down into weeks for each fishing trip and polygons were generated around these weekly tracks. Next, synthetic transects were generated in a similar fashion to the survey transects with 1 nm. differences between the sampling units and with a predefined inter-transect distance. Acoustic values are assigned to the synthetic transects by taking the average of the acoustic observations within the search radius around each point on the transect.

The use of synthetic transects gives the possibility of interpreting the data from fishing vessels in a similar way as the survey procedures. However, there are two important parameters that needs to be determined to generate these synthetic transects: the distance between the transects, and the search radius around the points in the synthetic transects. We looked at the correlation between the survey data and the synthetic transect data with different transect spacings and search radiuses. The spacing of 0.2 degrees and search radius of 1.2 nautical miles gives a coefficient of determination of 0.94. This promising correlation encourages us to generate time series that can be used to generate trends independent from the survey data.

Length frequencies from the PFA self-sampling programme will also be incorporated into this workflow.

Q&A:

- In a year where the survey result is missing (example 2020 due to covid), can this approach be used to fill the gap? The approach is not developed enough to fill such gaps. The surveys are based on predefined strata, where the industry data are biased because they are transformed into ‘mini-surveys’. The magnitude of the data is not the same. That is why the results of the industry data is called a biomass proxy. The trends of this proxy need to be calibrated; we would need more data points (longer time series) to get confidence that the industry results follow the same trend as the survey results.
- There is potential to fill minor gaps in surveys, for instance when the research vessel has technical problems and a certain survey station cannot be covered. If there would be a fishing vessel in the right area on the right time, the acoustic data could be used to fill such minor gaps.
- One of the bottlenecks mentioned is the enormous amounts of data to be processed. A suggestion was to narrow down to specific areas or seasons to limit the amount of data you work with. At this point, the research focuses on one case study (blue whiting). Once the methods are thoroughly tested, it can be expanded to other case studies.
- The geographical scope of the fisheries is smaller than that of the survey. So compared to survey data, there is a gap in the fisheries data for the areas where there was no fishing.
- It is possible that the same fish return in the data several weeks in a row. How is that accommodated for? This has to be explored further. At the moment, the results of the

fisheries data are presented as boxplots, to show the range of values instead of one estimate.

- Suggestion to get in touch with French researchers that do a comparison between acoustic data from survey and fishing vessels in the Bay of Biscay. It is not clear whether there is use of opportunistic set-up (fishing vessels normal behaviour) or adapted design, where fishing vessels fish together with the survey vessel.

2.2.2 Danish pelagic acoustic data collection

The feasibility of an acoustic data collection project based on measurements from pelagic trawler vessels is currently investigated at the Danish Pelagic Producers Organization (DPPO). Representing the 11 largest Danish pelagic vessels, the DPPO is a key player and stakeholder in the management of fisheries, fish stocks and the marine environment. The DPPO-vessels account for more than one third of the total turnover in Danish fisheries and are equipped with advanced underwater acoustic measurements systems. With an average time at sea estimated around 196 days per year and per vessel, a systematic data collection effort would have the potential to provide extensive acoustic data for scientific and monitoring purposes. As there are currently no similar data collection programs in Denmark, the initial objective of this work will be to define a suitable methodology and to serve as a proof of concept for the collection of acoustic measurements from the fishing vessel of the DPPO. This work is expected to be carried out as part of an ongoing industrial PhD project in collaboration with the Danish Technical University (DTU).

Q&A:

- Do you compare the acoustic data with survey data or will the focus be on school formation?
- Collaboration may be required between different fleets. Would this require an expert group on industry acoustics?

2.2.3 VISTools - Fishing vessels as automatic data-gathering platforms

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A skipper of a fishing vessel has access to various sources of information that help him manage his work. Navigation instruments and sensors track the location (e.g., GPS/VMS), monitor any fishing activity (e.g., towing force, depth), fuel consumption and register landed catch (i.e., via an electronic weighing scale). These sensors gather valuable data, but none of that are of any use, if data are not integrated, stored or processed. By automating data collection from conventional on-board equipment, adding additional sensors (CTD, TBD) and coupling this information with economic parameters (e.g. fish prices and fuel prices), the VISTools projects achieved;

1. The hardware development of a central hub for the automatic data gathering on board of a fishing vessel (concentrator). This includes data from conventional on-board equipment (towing force, fuel consumption, catches, GPS and depth) and additional sensors fixed to the fishing nets (CTD) or other parts of the vessels (for instance, fish hold temperature)
2. The development of a business intelligence tool for fishers presenting the processed data in a simple and accessible way on graphs and maps, ready for in fisheries evaluation and planning (VISTools Analytics)
3. The groundworks for private and protected information exchange for research purposes.

4. The upscaling of the system to 5 vessels as part of the pilot study
5. The construction of data processing infrastructure that can offer services to the entire Belgian fleet (60 vessels)

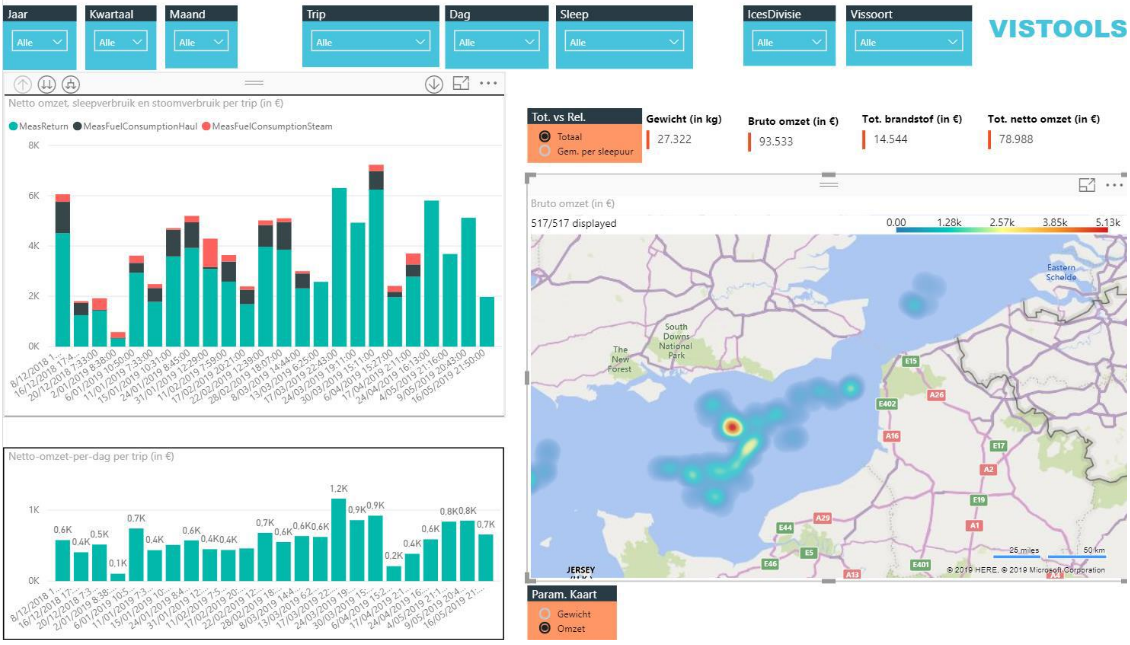

Figure 2.3 Example of VISTools visualization of results.

With this approach, fishers gain new insight in the economic performance of their fishery, while exchanging valuable high-resolution oceanographic data with research institutes. This is a fully automatic process that does not entail unnecessary burdens on the fishers themselves and has been fully operational on a fishing vessel for over a year.

This increased insight of fishing activities could trigger behavioural changes that increase the efficiency of the vessel and simultaneously reduce the impact on the environment. Additionally, the business intelligence tool incentivizes fishers to keep gathering information that have great scientific relevance, and share this information under clearly defined conditions. This data could open new research possibilities including catch prediction models, decision support tools, avoidance of sensitive areas, and real time closures. This high resolution of spatial information can also lead to better advice to fisheries management and governmental bodies (e.g., real time monitoring of quota usage).

The first results of this project have led to the development of a proof-of-concept business intelligence tool that logs the landings of a single test vessel and automatically tracks economic performance. With this tool, a vessel owner can evaluate the economic performance and catches of a vessel at haul level. Since all sensor data have a geographic component, all landings data can be tracked to a certain location and provide insights in the economic performance of the fishing grounds (heat map). The 1,5 years' worth of data have already proven to provide interesting insights for the skippers and vessel owner, and is very promising for scientific research. This proof of concept has been up-scaled to 4 more vessels between 2020–2022 and will make the VISTools platform ready for expansion to other vessels. The added value of this approach exceeds the usefulness for the individual fishermen if data of several vessel are combined and analysed together with oceanographic data from data bases such as Emodnet and Copernicus. This latter aspect will be the main focus of the ILIAD-project, a project where VISTools will contribute to constructing the digital twin of the ocean. The VISTools Analytics

Q&A:

- Is this real time? Nearly real-time, 5 min delay
- Costs? Small bits of data are saved. 12.000 euro for installation, 65 euro per month subscription for cloud and processing, a small monthly fee for using the application
- Is calibration of sensors needed? Calibration of sensors needed, the more complex sensor especially need calibration and sometimes send back to producer
- Is the species composition integrated? How is that data entered? Fish is sorted, afterwards when the box is filled, the fisher fills in the information himself (but not extra work, has to be done anyway)
- The data has incredible resolution. This would be useful for spatial management and management regulations. What is feedback by fishers on that? If it means that fisher can keep on fishing, fisher willing to share the information. 100% backing of vessel needed for this.
- Can this show this the most lucrative fishing ground (e.g. in terms of fuel efficiency). Yes, plan in one project to develop fuel model: Ratio steaming, hauling important. Another project: map most lucrative projects that in addition also avoid unwanted bycatch
- Can camera data for species recognition and other more complex data be integrated? Yes! E.g. turbidity, chlorophyll data etc. planned to be used, also automated recognition
- Maybe soon you don’t need the skipper at all for this information. Was there ever any situation where agreements were not met? Important to show value and how data is used and saved. Some vessels indeed did not agree. Trust indeed is important! Usefulness for skipper needs to be clear before using for others

2.3 Biological data collection programs

2.3.1 Genetic sampling of Herring for stock identification in ICES Divisions 6.a, 7.b-c

An overview of the industry involvement in a long-term project on the genetic stock identification of herring in ICES Divisions 6.a, 7.b-c was presented. This is a good example of an alternative form of industry input and industry derived data being used for enhancing the scientific knowledge and assessment input data. It also illustrates the potential for industry funded pilot studies to develop into fully funded research programmes and ultimately become incorporated into national DCF programmes.

Two stocks of Atlantic herring in ICES Divisions 6.a, 7.b-c are currently recognised by ICES and are subject to assessment and management. The 6.a.S, 7.b-c herring spawn off Donegal in northwest Ireland in winter (November to March) and the 6.a.N herring spawn off Cape Wrath in northwest Scotland in Autumn (September/October). The stocks are believed to form mixed feeding aggregations west of the Hebrides in summer, where they are surveyed by the Malin Shelf Herring Acoustic Survey (MSHAS), conducted annually by the Marine Institute (MI) and Marine Scotland Science (MSS). The MSHAS survey index is a primary input into the stock assessments of the two stocks. Up to now it has not been possible to separate the data from the MSHAS into stock of origin, therefore only a combined index was available and hence a combined assessment. Based on the combined assessment, ICES has provided combined advice for the two stocks and has recommended a zero TAC since 2016. The 2015 benchmark for these stocks (WKWEST) concluded that there was a clear need to rapidly develop robust methods of being able to identify individuals to their spawning population, both in the catches and surveys (ICES, 2015).

In response to the WKWEST (2015) report a programme of stock identification research was initiated by members of the Northern Pelagic Working Group of the European Association of Fish Producer Organisations (EAPO) and developed in close collaboration with the MI, MSS, scientists from University College Dublin (UCD) and the Pelagic Advisory Council (PelAC). The programme initially relied on industry and national institute funding (2016-2018) before the European Commission's Executive Agency for Small and Medium-sized Enterprises (EASME) funded a 36-month project (2018–2020) entitled 'Herring in Divisions 6.a, 7.b and 7.c: Scientific Assessment of the Identity of the Southern and Northern Stocks through Genetic and Morphometric Analysis'.

At the start of the project there was a quick realisation that existing surveys could not provide the necessary samples for developing genetic baselines for the stocks as they were not conducted at spawning time. Further there was a need to continue the collection of fisheries catch data to ensure that gaps were not left in the catch series due to the zero-catch advice issued by ICES since 2016. Therefore, a scientific monitoring TAC was introduced to ensure sufficient sample coverage and two new acoustic series were initiated (see Mackinson *et al.*, 2021). The 6.a.N industry spawning surveys (6aSPAWN) were conducted on Scottish RSW and Pelagic Freezer Trawler Association (PFA) vessels and were designed to locate and survey spawning aggregations of herring in 6.a.N. The survey design has been adapted over the past six years to focus on core areas considered to represent the 6.a.N autumn spawning stock. Industry and MSS scientists process biological samples on board for length, weight and otoliths before freezing the fish whole for later genetic processing.

In 6.a.S, 7.b-c the survey design was different due to the inshore aggregating behaviour of the herring prior to spawning. The survey is conducted by MI scientists on commercial vessels and initially used larger vessels so both the inshore and offshore areas could be covered. The design has evolved in recent years into a series on mini surveys focussing on the inshore areas in Donegal Bay, Lough Swilly and Lough Foyle using inshore boats with portable acoustic equipment that can be moved between vessels. No samples are collected during the surveys and instead the samples come from the monitoring fishery which takes place at the same time. All vessels participating in the fishery are required to provide representative catch samples to the MI, which are then processed for biological data and genetic samples. Industry knowledge has been essential in identifying previously unsampled later spawning components in the area, which have now been genetically sampled.

The significant industry involvement ensured focussed, effective and comprehensive sampling, which was critical for the success of the project. The results were compiled into a final project report (Farrell *et al*., 2021), which was reviewed by the ICES Stock Identification Methods Working Group (SIMWG) who concluded that 'the study should serve as an example of good practice for optimal use of existing resources and result reproducibility'. The results have also recently been incorporated into the benchmark assessment (WKNSCS) of these herring stocks (O'Malley *et al*., 2022) and the genetic methods have been included in Irelands DCF programme for 2023 onwards.

Q&A:

- soleDNA project ongoing at ILVO, we ask observers to bring samples in plastic bags. This presentation could bring things to a new level.
- How quickly did the crew pick up the system? Not really by crew. Equipment is operated by researchers.

2.3.2 NEA Mackerel gonad sampling approach

An important challenge in the international triennial mackerel and horse mackerel egg survey, is the estimation of potential fecundity of mackerel. The challenge is mostly due to the difficulties research vessels have with catching sufficient mackerel immediately prior to spawning.

In February and March 2022, an industry-employed researcher joined a pelagic fishing vessel for two three-week mackerel fishing trips with the aim to collect a large number of mackerel gonad samples. During the two trips, the mackerel migrated south and continued developing their gonads. In total, 2200 mackerel were measured and assessed, of which 379 were in the right stage for gonad sampling to be used for estimating potential fecundity. The samples were processed in two different ways:

- The standard micro-pipette samples were taken from the gonads and stored in formalin. These samples will be processed in the standard way for egg surveys according to the protocols of WGMEGS.
- The gonads were shock frozen for later analysis at the lab. This will allow comparison between fresh samples and frozen samples. If these two types of samples would yield the same information, then in the future we may collect more frozen samples directly from fishing vessels.

Utilizing commercial vessels for collecting gonad samples of mackerel provides an opportunity to collect many more samples of fish compared to survey vessels that often need to follow specific transects. Knowledge about location and behaviour of target species are deeply embedded in the fishing community. Working on a pelagic trawler gave us the opportunity to use this knowledge for research purposes. For these kinds of research projects to succeed, a high level of mutual trust and transparent sharing of information is required so that both science and industry are benefitting from the collaboration.

Q&A

- How was work received by crew, did they want to do it themselves? Might be too complicated to take these kinds of samples. Was a positive response by crew? In different survey crew does take out gonads and freeze them as a whole, but taking a sample from that is too much work.
- Impressed by size of working station. Is this typical for these kinds of collaboration? Even another station for quality master. However, evolved over time: at first trip not own scale and had to share space with quality master.
- Many new Belgium commercial vessels have foreseen extra space for research station and even a cabin. So, industry does recognize the value and future of this type of sampling themselves.
- What information from frozen (existing sampling) and what from fresh gonad samples (new sampling)? Part of the study is to compare these results.

2.4 Electronic Monitoring programs

2.4.1 USA EM approaches

NOAA Fisheries works with fishers, Regional Fishery Management Councils (Councils), and other partners to improve the timeliness, quality, cost effectiveness, and accessibility of fishery-dependent data by integrating technology into monitoring programs. Electronic monitoring (EM) has clear potential to meet many of these challenges by incorporating cameras, gear sensors, and electronic reporting (ER) into fishing operations. To date, seven commercial fisheries have implemented EM programs in U.S fisheries, including the Atlantic Highly Migratory Species (HMS) pelagic longline fishery, and six programs in Alaska. NOAA Fisheries and our partners are on track to implement seven more EM programs including two in the Northeast (herring mid-water trawl and multispecies groundfish fisheries), four programs in groundfish fisheries along the West Coast (whiting and non-whiting midwater trawl, fixed-gear, and bottom trawl) and the pollock trawl fishery in Alaska. Across the implemented programs and those under development, there are approximately 600 vessels in the U.S. running EM systems in commercial fisheries. However, because the purpose and goals of any monitoring program can vary across fisheries, the use of EM varies too. Some programs use EM as a tool for monitoring compliance with catch retention requirements, others are using EM as a way to validate data reported in a vessel logbook, and in one case, EM is deployed for a direct accounting of discards as a way to augment observer coverage.

Given the different uses of EM and different stages of implementation, EM programs are in varying stages of evaluating the quality of EM data compared with reporting programs that have a much longer time-series, such as data collected by logbooks, observers, vessel monitoring systems (VMS), and other sampling programs. Additionally, EM programs have built different tools for evaluating EM data, based on the purpose for the program, but the following summary captures the general process for how most of the EM programs are evaluating the quality of EM information.

An EM service provider collects the raw EM data from the vessels, it gets reviewed and analysed based on guidance and review protocols developed in collaboration with NOAA Fisheries. The agency establishes the data collection priorities and associated data elements, defines data format(s), and standards, and establishes the method of data (summarized data) submission for the EM service provider. The summary EM data is transmitted to NOAA Fisheries through an application programming interface (API), which provides an initial quality check on the information, based on some established data standards and other control measures. Additionally, in many of these EM programs, the fishing vessels are required to independently submit an electronic logbook with much of the same data (e.g., trip information, estimates of discards) through a separate API. EM programs designed with these requirements then use the summarized EM data to validate the logbook data, while the EM service provider retains the original raw EM data. Based upon the results of that comparison, each program has a series of business rules that dictate which data source(s) will be used for management and/or in a fishery stock assessment, such as the logbook data as submitted, logbook data that has been adjusted based on the EM data validation, the summary EM data submitted by the EM service provider, or even some other source (e.g., federal observer deployed on a trip).

It is important to highlight that there is often a direct benefit to individual fishers reporting as accurately as possible, usually with some process of reducing video rates (i.e., reduced need to analyse video for that vessel) in an industry-funded monitoring program. However, in order to promote and support better reporting in EM programs, it is equally important to provide feedback to captains and crew, especially when the data quality is poor. Near real-time validation to the vessel is critical, in terms of how well they operate on deck with the EM system, adhere to catch handling protocols, and more generally have feedback on how to improve data quality.

Q&A:

- Can EM be used as a validation tool? Or more to look at compliance? Is it replacing fisheries observers? There are three categories of EM programmes in the US:
  - under regulation: 6 EM programmes– all in Alaska region
  - Exploratory phase – piloting long-term programmes
  - Pilot phase – just a few boats

  Around 600 vessels involved at the moment
- EM in validation of reported discards by fishers:
  - NE groundfish fishery
  - Validation of Tuna logbook data
  - Alaska Pollock

  The hope is that as the accuracy of the reporting gets better, less video will have to be watched
- It may be required in the future that the crew run the catch over a measuring board so the species can be identified
- There are still mismatches in the data; e.g. hauls in EM that do not exist in the logbooks, and vice-versa
- Sending feedback to skippers is critical for EM. You need to get info to the fishers fast (for example if a coat is hanging over the camera, they need to know immediately)
- Other case: fisheries company contracts a private company that collects and processes the data, sending a summary data product to NOAA; with a validation scheme [some videos analysed to make sure the private contractor is doing things correctly]. There is an API to detect issues ahead of upload to NOAA - data validation checks ahead of data entering NOAA.
- Alaska fixed gear programme. When fishers were not cleaning lenses or not reporting correctly, letters were sent to the fishermen ("you need to get the data quality improved or you are removed from the programme"). That has led to improvements in the data quality
- Who is paying for the reviews and validation of the videos? If there is a regulation – they expect the industry to pay for that equipment, and data acquisition. The 2nd review is kept to a bare minimum because it falls on the institute itself.
- How do you select what to review? Based on logbook information. Whether is a % of trips or a % of hauls it varies between programmes.
- Any other type of feedback? NOAA provides the basic, but the manager may provide them with other types of data products; sometimes they also inform about different forms of quality issues (what went wrong? Were there camera outages? Some other aspects that went wrong?)
- What are you getting out of the programmes? In some cases, you can get species and the size – but that requires a lot of work and that impacts data quality. EM is not a one size fits all – in some cases it may be that it is only useful as a validation tool but not for measurements because it requires quite a bit of additional work from the crews.
- Do you have data quality indicators associated to the summary data you get? We get a lot of other data (positioning, amount of other species, coverage in minutes, etc)

2.5 Discussion

Industry self-sampling and co-sampling approaches have been increasing in recent years. Especially the Covid-years have led to more catch sampling and survey programs utilizing a form of self-sampling or co-sampling. The workshop identified the need to better define the different catch sampling categories:

Self-sampling	The process whereby fishers or fishing crew-members take samples from the catch and carry out measurements on those samples. Self-sampling programs may be carried out by industry organizations alone or joint efforts of industry organizations and research organizations.
Co-sampling	The process whereby fishers or fishing crew-members take samples from the catch and store or freeze these samples for later analysis at a research institute. Upon return of the vessel, the samples are transferred to the research institute for analysis and measurements.
Market-sampling / Factory-sampling	The process where catches are sampled once they have been offloaded in an auction or factory. The sampling is normally carried out by researchers from research institutes
Observer-sampling / At-sea sampling	The process whereby researchers or research assistants join fishing vessel trips to carry out catch and/or discard sampling while at sea. The purpose of the sampling is to acquire scientific information. Note that there may also be observer programs that are aimed at enforcement of regulations. Such programs are not part of the discussions within WKEVUT.

When selection certain vessels for co-sampling or self-sampling, is there an explicit way of dealing with potential bias? What methods are being used for selecting vessels for specific sampling activities? How to deal with systematic exclusion of certain fishing vessels from sampling?

Recommendation: The suggestion was made to present the frequency of fishing vessels participating in different projects and sampling activities.

The case studies presented during WKEVUT demonstrated that the use of self-sampling or co-sampling data is dependent on different situations. In many instances, co-sampling has been a long-established methodology of getting catch samples from fisheries that are not easy to sample in auctions. In those case, crew-members have been instructed to take predefined samples and to take those samples back to port where they will be analysed by research from a research institute. For example, the Dutch pelagic sampling has been using this methods for over 40 years already. Co-sampling approaches have generally been set up by research institutes who then ask for collaboration from the fishing industry. In those cases, the results from the sampling efforts are directly used in the stock assessments.

Voluntary, industry-initiated self-sampling programs are currently not yet directly used for stock assessments, although the results do get to be presented at assessment working groups. In most cases, self-sampling is not aiming at generating age distributions of the catches, but rather focus on length-distributions and potentially other biological variables (e.g. length-weight relationships, fat content, gonad development).

Recommendation: Length-weight relationships and non-standard biological information collected during self-sampling programs should be published and made available to working groups. Such relationships are most useful if they have sufficient spatio-temporal resolution.

An important element of self-sampling and co-sampling approaches is to organize the feedback systems to the participating fishers. Timely, efficient and effective feedback mechanisms, may generate a long-lasting engagement of fishers with science and scientists with fisheries. Recent experiences have shown that immediate feedback to participating skippers (e.g. after each trip) is a powerful mechanism of maintaining commitment.

Recommendation: Collate and distribute examples of feedback methods between fishing industry and science.

A recent trend seems to be towards combining self-sampling activities (e.g. aimed at length and weight) with more traditional co-sampling activities (aimed at generating age compositions).

Most of the sampling initiatives presented are national but some (e.g. PFA self-sampling) are focused on multi-nation fisheries. This may require a possibility to bring information to ICES using a regional approach.

The Catch lottery system developed in Norway is a powerful example of a co-sampling approach in combination with a strong statistical approach. This is expected to allow for truly random sampling from the commercial fleet, assuming that the willingness to bring samples back to port is not associated certain behavioural aspects in the fishery.

Recommendation: WKEVUT supports the wider application of catch lottery systems to improve random sampling of fisheries catches while at the same time achieving higher engagement and feedback between science and industry.

On board of a fishing vessel various sources of information are available to manage the fishing activity. Navigation instruments and sensors track the location, monitor any fishing activity and register landed catch. These sensors gather valuable data, but none of that are of any use, if data are not integrated, stored or processed. By automating data collection from conventional on-board equipment, adding additional sensors and coupling this information with economic parameters the Belgian VISTools projects achieved;

- The hardware development of a central hub for the automatic data gathering on board of a fishing vessel (concentrator). This includes data from conventional on-board equipment and additional sensors fixed to the fishing nets or other parts of the vessels
- The development of a business intelligence tool for fishers presenting the processed data in a simple and accessible way on graphs and maps, ready for in fisheries evaluation and planning (VISTools Analytics)
- The groundworks for private and protected information exchange for research purposes.

This project shows the power of data already collected on board of commercial vessels and which could be used as well for the benefit of the (commercial) fishing activity, as for the benefit of science, i.e. in the ecosystem-based management approach.

Recommendation: WKEVUT supports the wider application of the VISTools system to improve the individual fishing activity management, the fishing activity management of a fleet based on the ecosystem-based approach.

Collecting opportunistic acoustic data from pelagic fishing vessels has been a long-standing ambition in pelagic fisheries (see Section 2.2.1 and 2.2.2). The acoustic equipment on pelagic vessels is sophisticated and the echosounders can be calibrated similarly to how this is done on survey vessels. The vessels cover many of the high-density regions during the fishing trips with extensive spatio-temporal coverage. Organizing the logistics of collecting the acoustic data from fishing vessels is challenging in certain aspects (e.g. number of hard disks, size of the files) but overall this appears to be manageable. However, the two bigger challenge are: 1) how to process the raw data that has been recorded, and 2) how to interpret the acoustic signals for vessels that are targeting fish aggregations.

For scientific surveys, the processing of raw acoustic data is done by semi-automatic and manual scrutiny. For fishing vessels, especially if several vessels are recording data, this becomes a very time-consuming activity. Several developments are currently ongoing aimed at machine-learning techniques that could be used to process large volumes of acoustic data.

Making use of the acoustic data from fishing vessels as potential estimates of abundance of fish or as add-on to existing surveys, requires a method for compensating for the targeting behaviour of the fishery. An example of such an approach has been presented in section 2.2.1 based on direct comparisons of between survey transects and synthetic transects that have been generated from the fisheries data. Some examples of analytical tools for using industry acoustics have also been presented in the context of the SPRFMO Science Committee (Alegría & Sepúlveda, 2022).

Recommendation: WKEVUT emphasizes the need to develop 1) automatic processing techniques for industry-collected acoustic data and 2) tools to convert industry-acoustic indicators into useable stock indicators.

3 Comparison of self-sampling to regular sampling programs

3.1 Simulation approach to assessing bias in a fisheries self-sampling program

The hierarchical structure and non-probabilistic sampling in fisher self-sampling programmes make it difficult to evaluate biases in total catch estimates. While so, it is possible to evaluate bias in the reported component of catches, which can then be used to infer likely bias in total catches. We assessed bias in the reported component of catches for 18 species in the Barents Sea trawl and longline fisheries by simulating 2000 realizations of the Norwegian Reference Fleet sampling programme using the mandatory catch reporting system, then for each realization we estimated fleetwide catches using simple design-based estimators and quantified bias. We then inserted variations (e.g. simple random and systematic sampling) at different levels of the sampling design (sampling frame, vessel, and operation) to identify important factors and trends affecting bias in reported catches. We found that whilst current sampling procedures for fishing operations were not biased, non-probabilistic vessel sampling resulted in bias for some species. However, we concluded this was typically within the bounds of expected variation from probabilistic sampling. Our results highlight the risk of applying these simple estimators to all species. We recommend that future estimates of total catches consider alternative estimators and more conservative estimates of uncertainty where necessary.

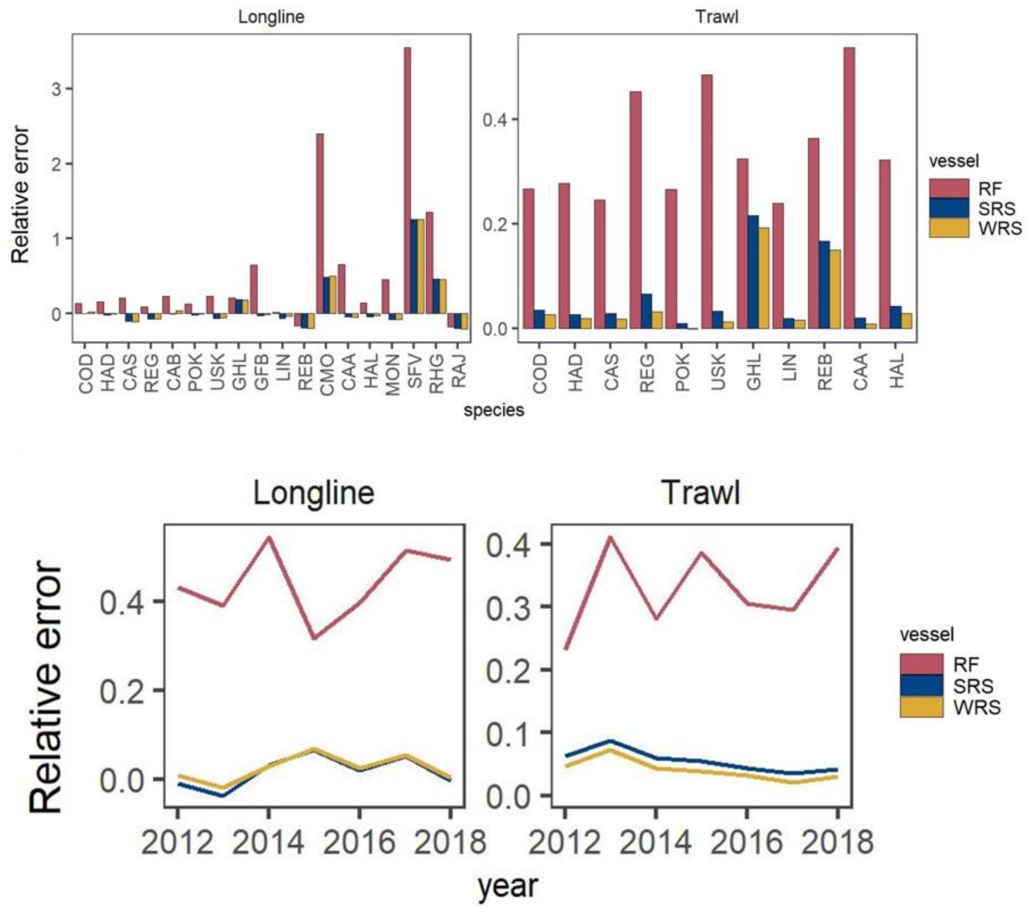

Figure 3.1 Top: Partial dependence plots from the random forest models, showing the marginal effect of species on relative error. Bottom: Partial dependence plots from the random forest models, showing the marginal effect by year on relative error.

Q&A:

- A short exchange followed about the issue with vessel selection in relation to the sample design. The vessel selection for the reference fleet appears not to be so bad, but when you compare it to a design where vessels are randomly selected or weighted randomly selected, then there are situations where the reference fleet set-up does not perform that well. The take home message is that if you think you have a good set-up, you should not stop studying whether it keeps on performing well over the years. Wrong vessel selection will affect bias in your estimates.
- In the two plots (Figure 3.1) of the relative error (1) by species and (2) over time, there seems to be a lot more variation in the figure by species. The explanation is that in partial dependence plots, the data are split up by species, causing more variation. In time plots the data are aggregated over species, so only variation between years show.

3.2 Comparison SPFA self-sampling and MSS onshore sampling data

In order to examine data collected through the Scottish Pelagic Industry Data Collection Programme, comparisons were carried out between industry self-sampling data (Section 2.1.3) and MSS onshore factory sampling data. The MSS onshore factory sampling collects data on age, length, sex and maturity, and has been carried out since ~1970s as part of the national data collection programme. For industry self-sampling, vessel crew undertake length and weight measurements of samples from every haul, and record associated haul information.

- Comparison of sampling distribution (Figure 3.2): With full participation of the fleet, full spatial and temporal coverage of the fishery can be achieved, enabling greater reach of the self-sampling data compared to the MSS onshore sampling programme, including sampling of landings abroad. Industry data can be further resolved with individual haul locations (not shown here).
- Comparison of sample length distribution (Figure 3.3): Where trip sampling coincided from the two sampling programmes, length data were compared, with similar distributions observed.
- Comparison of sample length-weight relationship (Figure 3.4): The mean weights-at-length from the self-sampling data were compared with the predicted weight-length relationship used by MSS, with the observed self-sampling weight data indicating a greater weight-at-length than factory sampling data predicts. Sampling both lengths and weights provides valuable additional data – not currently collected by MSS onshore factory sampling – allowing for monitoring of changes in fish growth.

The data comparisons demonstrated the coverage and quality of industry collected data, showing that the industry programme can be used to obtain biological data on commercial catches, offering opportunities for the provision of data collection to stock assessment and ICES advice.

For more information: Working Document WGWIDE 2021: Overview of the Scottish Pelagic Industry Self-Sampling Programme with potential data opportunities relevant to stock assessment

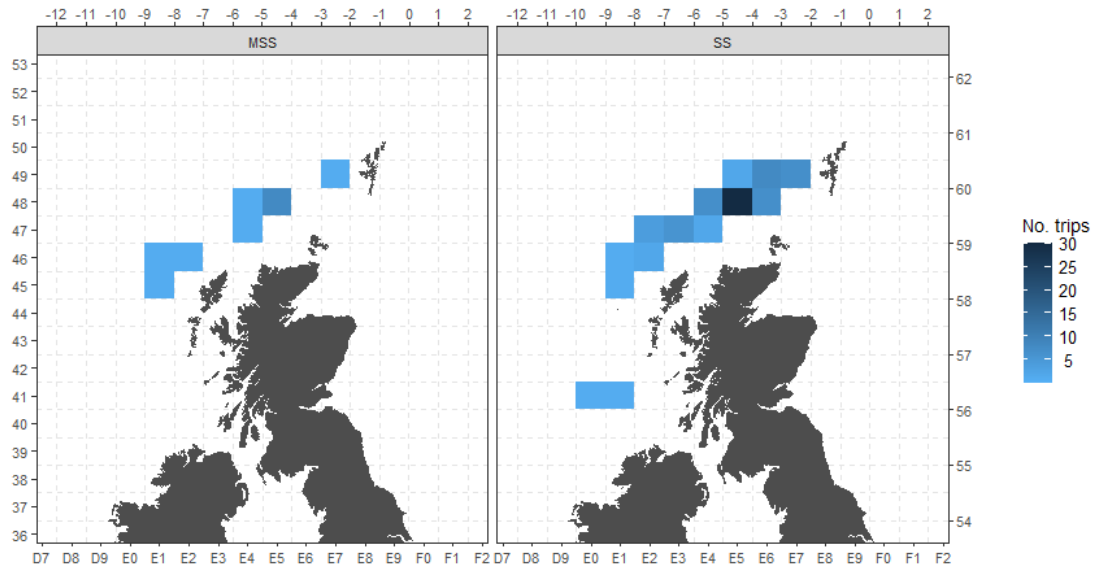

Figure 3.2 Sample locations from industry self-sampling (SS, right panel) and Marine Scotland Science sampling (MSS, left panel) for winter mackerel 2021. Number of trips per ICES rectangle, mapped by dataset.

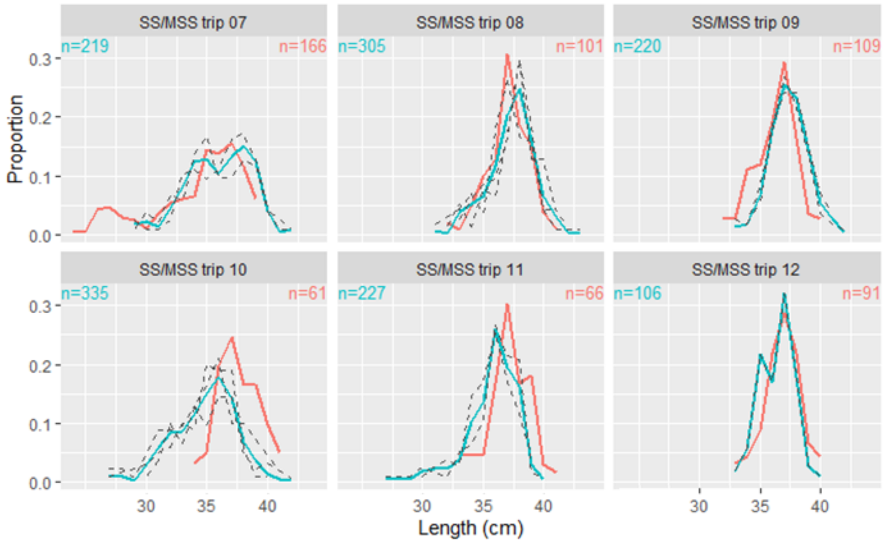

Figure 3.3 Length distribution from industry self-sampling (SS, blue line) and Marine Scotland Science sampling (MSS, pink line) for winter mackerel 2021. Length distribution of fish by trip where data coincides from each dataset. For the self-sampling data, the blue line shows the length distribution across all hauls in a single trip, while the dotted black line shows the length distribution for each haul within a trip.

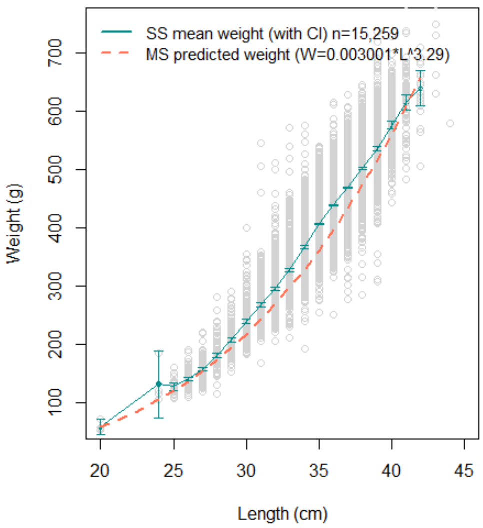

Figure 3.4 Fish length-weight relationship for winter mackerel 2021. MS = Marine Scotland Science sampling (predicted weight-at-length), and SS = industry self-sampling (mean weight-at-length, with confidence interval [CI] and raw data [grey circles]).

3.3 Comparison of PFA self-sampling with observer data and co-sampling data

Self-sampling for science is known to increase the engagement between industry and science. However, there are regular concerns expressed on whether self-sampling be trusted for science. Here we compared industry self-sampled data, generated by the Pelagic Freezer-trawler Association (See Section 2.1.2 for description of the program) with 1) the EU observer program in the

South Pacific and 2) the regular co-sampling program carried out by Wageningen Marine Research.

The comparison of the EU observer program In the South Pacific with the self-sampling program, demonstrated that the self-sampling covered more trips, more hauls and more catch. The number of overall length measurements was slightly less in the self-sampling. In general, we find good alignment of length-frequencies per trip between self-sampling and observers. Notable exceptions were the trip were the scientific observer unknowingly carried out a non-random sampling from the conveyor belt and self-sampling trips where the number of sampled hauls was too low to provide a robust estimate of the length composition. When length-frequencies were raised to the total catches by year and quarter, large differences in estimates occurred due to certain fisheries not being covered in the scientific observer program. This demonstrated that a combination of self-sampling and the observer program would be useful way forward, with sufficient quality control on the length frequencies from the self-sampling, while achieving the benefit of full coverage.

An initial comparison of self-sampling and market sampling of the pelagic fisheries in the Netherlands has been carried out just prior to WKEVUT. This work is intended to be part of the joint WMR-PFA working group on sampling. The WMR co-sampling approach consists of fixed number of Dutch and UK (England) vessels taking samples according to a pre-agreed protocol. The self-sampling approach covers approximately 12 vessels measuring length distributions, from 5 different countries. Data from co-sampling and self-sampling have been made available for the period 2017–2021. Comparing number of length-sampled hauls per species resulted in the following percentages of co-sampled hauls relative to the self-sampled hauls:

arg	her	hom	mac	whb
7%	11%	19%	8%	8%

A spatial comparison of number of length measurements in the two sampling programs (Figure 3.5) showed relatively good agreement for the North Sea herring, the horse mackerel and mackerel fisheries, but relatively lesser coverage of the blue whiting and Atlanto-scandian herring fisheries.

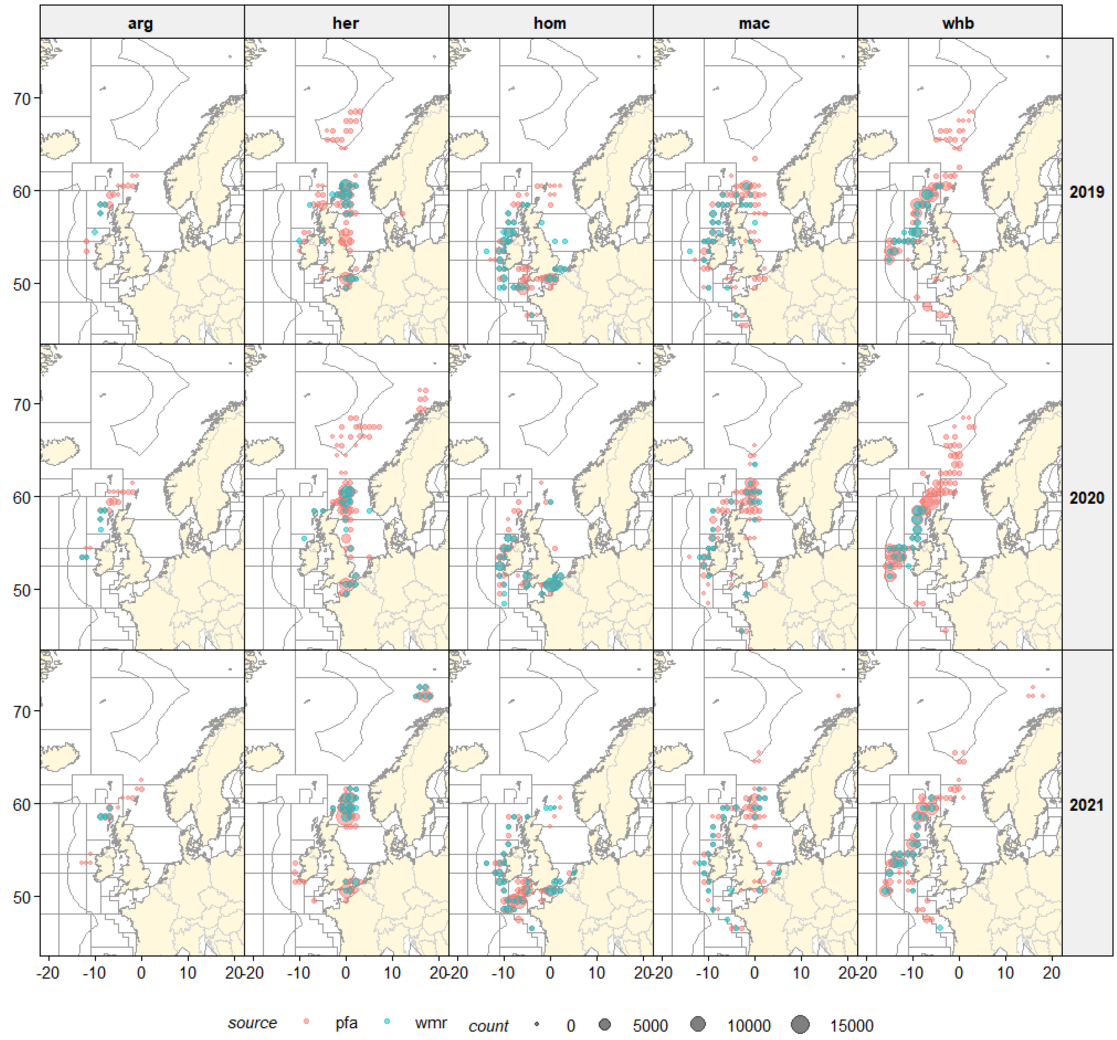

Figure 3.5 Comparison of number of length measurements in WMR co-sampling (green blue) and PFA self-sampling (red).

As an example, a comparison is presented of the herring length-frequency distributions by divisions in 2021 (Figure 3.6) demonstrating both overlap and differences. These comparisons will require some more in-depth analysis to actually compare the two sampling programs.

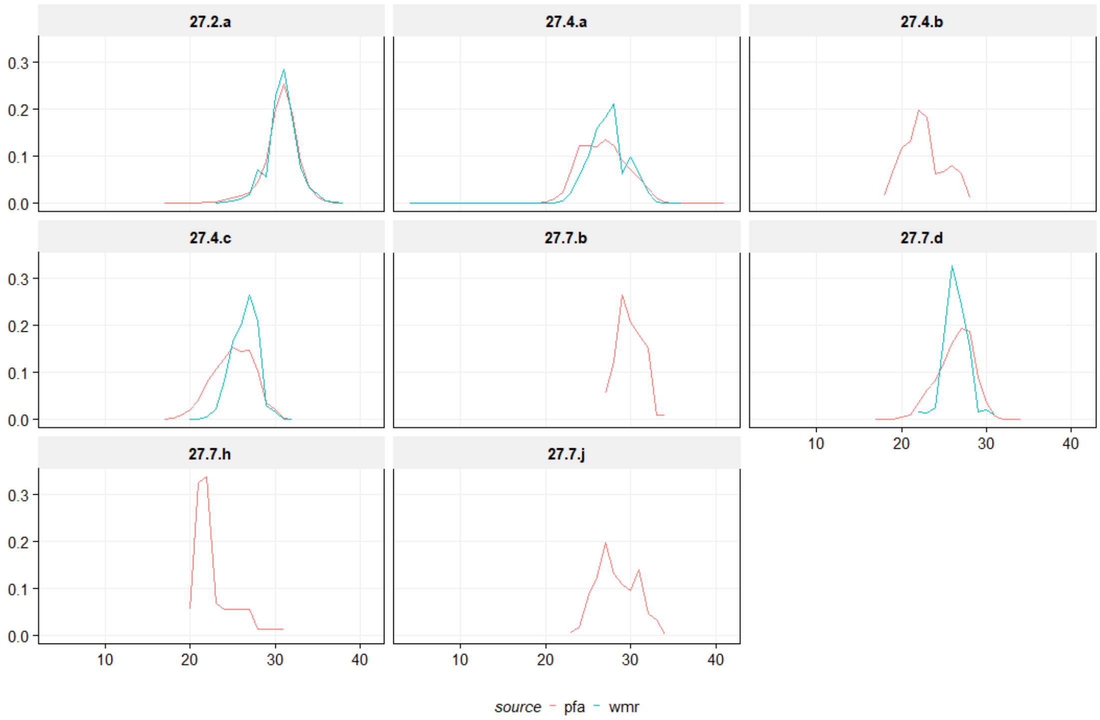

Figure 3.6 Comparison of 2021 herring length-frequencies by division in the PFA self-sampling program (red) and the WMR co-sampling program (green blue).

Because the combined data has only been available since March 2022, only initial comparisons could be shown at WKEVUT. More thorough comparisons will be carried out by the upcoming WMR-PFA working group in the course of 2022.

3.4 Detecting erroneous length metrics in PFA self-sampling data

Self-sampling for length-frequency distributions on board of PFA freezer-trawlers has recently shown to have a specific challenge. Because the vessels operate in different oceans (Northeast Atlantic, West Africa, South Pacific) where different length metrics are required, and because on board of the vessels, the default (commercial) length metric used is the Standard length (SL), there may be a mix-up in the data collected between the three length metrics (Figure 3.7). The issue is further complicated by changes in crew members, vessels and fishing areas.

This situation may give rise to two potential problems:

1. The wrong length metric has been used for the specific area (e.g. using SL when TL is required).
2. The wrong length metric has been written down (e.g. TL was used where SL was written down).

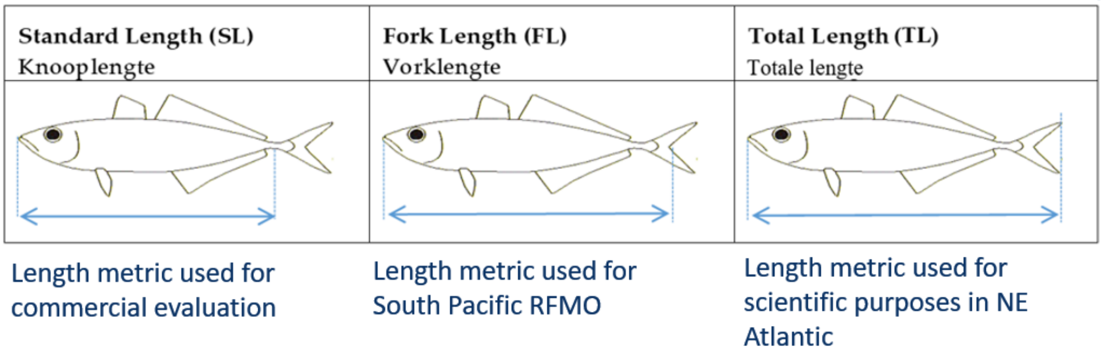

Figure 3.7 Different length metrics used in different circumstances of freezer-trawlers.

If the wrong length metric has been used for the specific area (e.g. using SL when TL is required), this was initially remedied by applying a conversion factor from the length metric used to the length metric required. The downside of the method is that 'holes' were created in the length compositions due to rounding down to whole centimetres. Since 2022, a new length-length-keys method has been implemented based on Hansen *et al.* (2018). Data on different length metrics (and weight) of individuals fish has been collected as part of the PFA self-sampling program and other research activities (currently, around 4000 fish, across 7 species). These data were used to generate length-length keys in different directions. The length-length keys are currently deployed in the processing of the PFA self-sampling data when the wrong length metric has been used.

The more challenging part is where the wrong length metric has been written down (e.g. TL was used where SL was written down). How can we identify trips where a problem exists in the length metric? The current attempt has been to select rectangle-week combinations where multiple vessels have carried out length measurements, and where length-frequencies by haul or by trip within those rectangle-week combinations can be compared. An example is shown in Figure 3.8 for some example cases of herring in 2021, demonstrating some probably wrong SL metrics being used (29/50F0, 30/49F0) and some probably right length metrics (31/46E9, 31/47E9, 33/47E9 and 35/46E9). Additional comparison methods are currently being explored.

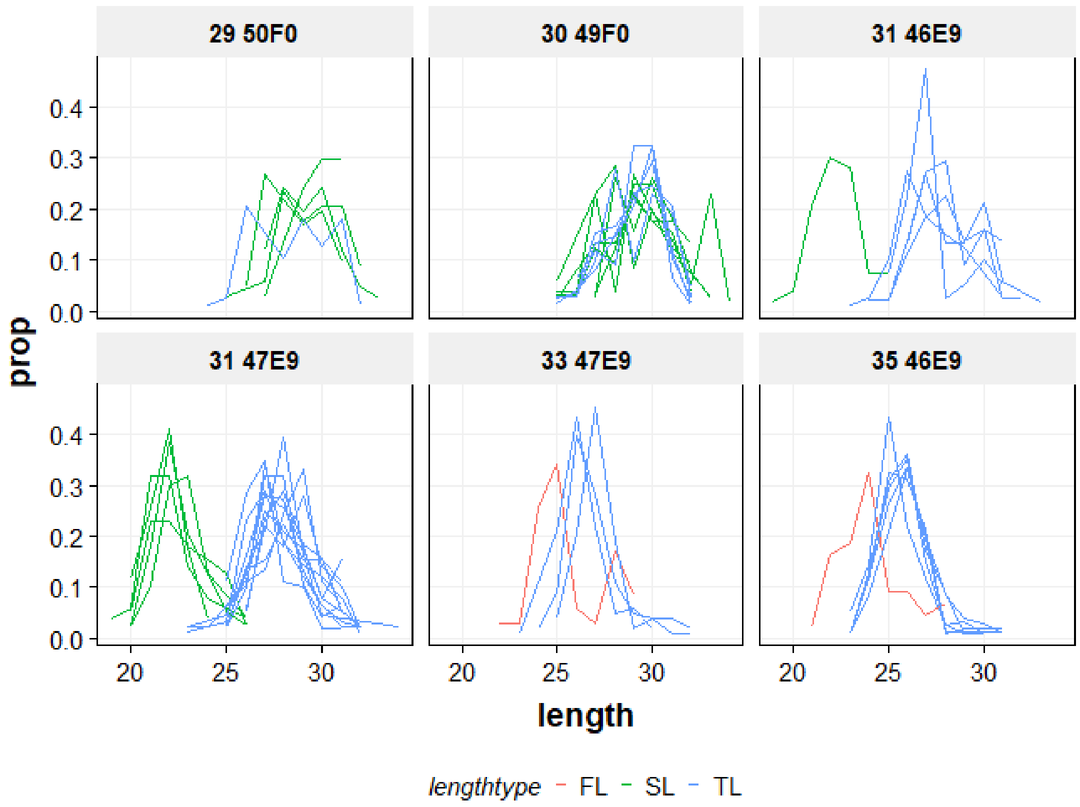

Figure 3.8 Haul based comparisons by week and rectangle combinations in 2021.

Q&A:

- Where, when was the problem identified? The problem was identified when working on the length-length conversion methods. Since then there is a regular check going on. Could be an idea in the future to use cameras on top of the measuring system.
- A suggestion was made to right away send a picture of a fish being measured with the filled in form.
- A suggestion was made to treat the entry as a conditional entry. Compare among vessels for example with a survey. Maybe market sampling could be used although rectangle association might still be tricky (because of variability within rectangles).
- Ideally one would also have individual weight measurements. That could even be used as validation, when fishermen would be asked to measure and weight at least a few individuals.

3.5 Discussion

The work presented by Clegg *et al*. (2022) highlighted that self-sampling and co-sampling programs could be biased due to the vessels being included in such programs on a voluntary basis.

Several approaches have been presented to compare self-sampling programs with traditional factory-based sampling or with co-sampling. While such comparison generate insights in the overlaps and differences in outcomes (mostly spatial distributions and length distributions), they do not yet provide a statistically robust methodology of comparing different programs that are characterized by different aspects (e.g. high space-time resolution and may be less-precise length measurements with lower space-time resolution and high precision length measurements). Application of statistical tools for program comparison should be developed. This could link to the work presented with simulation models for sampling (see: Clegg *et al*., 2022).

4 Benefits and drawbacks of different methodologies in industry-collected data

4.1 Self-sampling approaches for catch composition, length and weight

Benefits	Drawbacks
High space-time resolution (e.g. by haul)	Potentially many different crew members that carry out measurement
Optimal coverage of the whole fisheries	Potential imprecision in measurements
Possible to do inter-calibration between vessels at high resolution	Difficult to validate measurements
Wide engagement of fishing industry with science	Does not directly generate age estimates (otolith extraction not feasible)
Also covers trips where landings take place in other countries (e.g. Scottish fishery landing in Norway)	Needs to be fitted/feasible in the workflow on the vessels.
	Potential bias in catch estimates due to voluntary participation in self-sampling programs

e.g. this could also be organized as a reference fleet.

4.2 Co-sampling approaches for age, length and weight

Benefits	Drawbacks
Proven methodology in several different fisheries (e.g. Dutch pelagic fleet)	If a limited number of vessels is used, this could generate bias due to vessel selection
Sampling activity follows the activity of the fleet (to a certain extend).	Difficult to validate whether samples are truly random samples of the catch
Could generate engagement between fishing industry and science if well organized.	Some challenges may arise in handling the samples after the fishing trips

4.3 Catch-lottery approach for age, length and weight

Benefits	Drawbacks
Statistically sound and robust technique for generating random samples from the fisheries	Biases could arise if not all vessels are actually bringing samples for analyses
High/sufficient space-time resolution (e.g. by haul)	Difficult to validate whether samples are truly random samples of the catch
Could generate more engagement between fishing industry and science, if well organized.	Important challenges may arise in handling the samples after the fishing trips (logistics)
Reduction of costs of sampling, because smaller and more targeted samples can be collected	Requires close interaction between electronic logbooks and random sample generator. On an international level, this may be non-trivial to organize.
	Requires haul-by-haul data entry on fishing vessels (while current standard is mostly once per 24 hours).

4.4 Acoustic data from fishing trips

This is acoustic data from routine fishing operations which is being recorded for informing on stock abundance.

Benefits	Drawbacks
Relatively low cost for collecting data	Data processing can be costly (especially if scrutinizing is a manual job). Requires development of automated processing tools
Potentially high space-time resolution (all pelagic vessel and many demersal vessel have echosounder equipment)	Compensating for fisheries targeting behaviour is difficult (although some approaches have been presented recently)
Could generate engagement between fishing industry and science if well organized.	If data collecting is by hard disks, this requires a complex logistic process.
Could fill in on surveys, if certain years/areas cannot be covered with survey vessels	Calibration of industry vessels is challenging (time, availability). Possibly using bottom-calibration instead?
	Checking on acoustic recording settings may be challenging.

4.5 Biological data or sample collection on fishing vessels

Opportunistic or dedicated biological data or sample collection on fishing vessels may be used to collect information on e.g. genetics, fat content, gonads and stomach contents.

Benefits	Drawbacks
Relatively easy to collect data or samples from many vessels simultaneously	Instructions to crew members need to be very clear, possibly with one-to-one instructions
Improves communication between industry and research	Only samples collected where the fishery is actually taking place (i.e. no full coverage or areas/seasons)
Possibility to do year-round sampling for specific purposes (e.g. gonad development)	Handling samples that are being landed in different ports and by different vessels is challenging
Possibility to do ad-hoc collection of samples from vessels in specific locations/seasons	
Possibility to send scientific observers on specific fishing trips to collect technically challenging samples (e.g. with gonad sampling)	

4.6 REM data

Remote Electronic Monitoring (REM) has received relatively little attention during WKEVUT 2022. The only example that was presented was from the US. More information on REM can be found in the report of the ICES Working Group on Technology Integration for Fishery-dependent Data (WGTIFD 2021, 2022)

4.7 Environmental data

Environmental data (e.g. temperature, salinity, pH) may be collected from regular equipment of fishing vessels (e.g. net sounders) or from dedicated measuring devices that are deployed during fishing operations.

Benefits	Drawbacks
Potentially may different sampling platforms with frequent sub-surface measurements	Regular equipment of fishing vessels is difficult to calibrate and there are many different brands and data formats
Measurements can be taking throughout the year and covering many areas	Dedicated measuring devices should not interfere with the fishing operations (e.g. in handling)
Information collected can be both useful for skippers and science	Dedicated measuring devices still require calibration and maintenance
Potentially develop catch predictor tools based on the collected data (thereby lowering fuel consumption)	Data storage and transfer needs to be organized from many different platforms

5 WGQUALITY documentation of (catch) sampling programs

The ICES Working Group on the Governance of Quality Management of Data and Advice (WGQUALITY) met from 19–22 January 2022 (ICES, *forth.*). The WG recognised that documentation of commercial catch sampling programmes that currently feed data into the ICES advisory process, or might do so in the future, is an important feature of a quality management system. The WG recommended that WKEVUT should encourages the participants to document their self-sampling or co-sampling programmes using the newly developed "commercial catch sampling summary template" (Annex 2).

WKEVUT applied the catch sampling summary template to four (randomly) selected cases during the workshop, with the main aims of starting to document the sampling programs and providing feedback to WGQUALITY. Detailed feedback to WGQUALITY is provided in Annex 2. The main conclusions are:

- WKEVUT underlines the importance of providing structured and comprehensive descriptions of any sampling program that is contributing to the generation of scientific advice. Of course, this also applied to the self-sampling and co-sampling approaches presented in WKEVUT.
- WKEVUT identified the need to better define the different catch sampling categories and it would be useful to have these definitions used in the template.
- Overall, the catch sampling summary template is covering the main areas that would require documentation.
- More work may be needed to clearly specify what types of answers are expected to the different questions. Apparently, the background of the experts drafting the template is in the development of the Regional Database and Estimation System (RDBES) and the terminology associated with that. Several questions in the template are difficult to answer if people are not familiar with the RDBES terminology or with the ICES terminology in general. A list of terms and definition would be very helpful.
- A section with the roles of all involved in the catch sampling programme would be beneficial
- Would there be scope to also include feedback mechanisms in the WGQUALITY template? E.g. in how to provide feedback to participating fisheries stakeholders on the outcomes of sampling.

6 Scientific publication on WKEVUT outcomes

ToR d Write a scientific publication based on the analyses from ToR a and b.

Steven Mackinson gave a short introduction to special issue in Frontiers of Marine Sciences: "Co-creating knowledge with fishers: integrating fishers knowledge contributions into marine Science". The intention was to target the special issue with a publication from WKEVUT. This has not materialized, so this section is outlining the potential topic and approach, but no longer targeted at the Frontiers Special Issue.

There are challenges about how to utilize self-sampling approaches in a way that delivers good quality information that is considered trustworthy within the constraints of established evidence-based decision-making processes. We want to contribute to the question of how to integrate industry knowledge contributions into scientific advisory systems and what it means for how the future of fisheries science is best conducted in the emerging frameworks for responsible research and innovation. Dilemmas in using fisher knowledge contributions and what it means for how the future of fisheries science is best conducted in the emerging frameworks for responsible research and innovation (RRI).

Questions

- Do we have examples from the case studies presented that clearly demonstrate the trade-offs in using self-sampling data for science? How has Covid (or other necessities) been catalyst for change and what has this mean for industry and for science institutions? Use examples to demonstrate how to make it happen. Show how the work that has been done conforms to best practice. What are the roles of ICES WGs and RCGs to achieve this?
- The Norwegian reference fleet and the Belgian sole case study are initiated by research institutes rather than fishing industry. A distinction should be made off co-sampling and self-sampling. There are close parallels with citizen-science and the participatory approach. Can we derive lessons from these disciplines? Data quality is a key focus. Concern that citizen-science is used so loosely that it lack credibility. Is participatory science more 'rigorous'? Fisheries-Science partnerships way above citizen science.
- Is ICES always aware or informed about the data that is or could be available from the fishing industry? What data can be collected by industry that adds value beyond current?
- There is currently no single, go-to platform at ICES for industry derived data. MIACO[1] and MIRIA[2] meetings provide opportunities to get feedback on the advice process so that it is fit-for purpose. Some participants have the feeling of sitting outside of the ICES system. What communication channels are required to match initiative with need and the mechanics of providing relevant information to platforms such as the RDBES.
- Match-making on data opportunities with data needs could be organized, showing where value can be added and how. Where does the self-sampling go? Sometimes there is no formal need expressed so lost on how to include such initiatives. What is the process for including such information – need to shed light on how to do this. There appears to be a contradiction between need and initiative.
- Need to demonstrate the added value on industry science programmes and to constantly demonstrate the quality of the data. How should this be done? What metrics and

[1] MIACO = Annual Meeting between ICES, Advisory Councils and other Observers

[2] MIRIA = Annual Meeting between ICES and Requesters of ICES Advice

processes? Can WKEVUT provide the guidance on how this should be done? And in doing so provide the guidance that people are looking for. This could be a proof of concept approach.

- How is data/ information quality judged, by whom and what process is required for application in ICES under the new Quality Assurance Framework. What existing tools are available to assess the quality of industry? And in what part of the ICES process would this happen. For example – starting with the Catch data template descriptions of the programme. How is information quality evaluated and by whom? What process is required for application in ICES under the new Quality Assurance Framework? The current documentation on the process for data inclusion is not transparent. What is required to pass muster and how should feedback be given?
- Use of information related to evolution of the fishery and what this means for regular sampling programmes.
- Sole in Belgium – 7a surveys informed by fishers' knowledge on where sole is. Data collection was adjusted accordingly. What were the implications of changing this data stream?
- Implications of changes in data streams –How to evaluate and decide.
- Can self-sampling be used to address a Case study? How has Covid (or other necessities) been catalyst for change and what has this mean for industry and for science institutions
- rea-misreporting and identification of where fish are actually caught?
- What are the implications for the fishing vessels themselves, if they will be deployed as sampling platforms?
- Acknowledge the lack of knowledge and confidence on the scientific end-users of the data, because it is new territory for them too.

Themes for a potential publication:

- Current and future needs – examples can industry data help? E.g. Novel – industry acoustic. Match-making, sensor for environmental data
- Catalysts and triggers – e.g. covid, frustration leading to take own initiative, bottom up approach of regulation (e.g. cameras triggering sector to collect data) e.g. VIStools
- Implications of changes in data streams – for surveys (e.g. Belgium sole), and time series for assessment. How to evaluate and decide. Guidelines for data comparisons are required– what can be used from what exists and how should it evolve.
- Operational 'structures' needed in the future from industry and science. Forethought. Costs and value.
- Trade-offs between investing in fancy tools vs involving people in data collection. Automation vs engagement.
- Motivation – What's in it for me? How to organize the feedback
- **How to evaluate the quality and added value of fisheries dependent data from co-sampling and self-sampling initiatives (in the ICES framework)**
    - **Define what added value means – for whom?**
    - **Provide the 'methodology' as general principles / guideline / good practice**
    - **Use of case studies from WKEVUT as applied demonstrations**
    - **Eligibility issues – including minimum requirements and checkpoints**
    - **Feedback and Improvement plan**
    - **References to WGCATCH and predecessors for criteria for evaluation of sampling schemes.**

7 Recommendations

Addressed to	Description of the recommendation	Timeframe
WGQUALITY	**Recommendation:** To provide a list of definitions and terms used in the Catch data template. **Background:** The background of the experts drafting the template is clearly in the ICES system and i.e., in the development of the Regional Database and Estimation System (RDBES) and the terminology associated with that. Several questions in the template are difficult to answer if people are not familiar with the RDBES terminology or with the ICES terminology in general. A list of terms and definition would be very helpful	January 2023
WGQUALITY	**Recommendation:** WKEVUT identified the need to better define the different catch sampling categories and it would be useful to have these definitions used in the template. **Background:** During WKEVUT, it was concluded that the terminology around the sampling activities and roles that different people have, it not always clear. Therefore, WKEVUT worked towards preliminary definitions and descriptions of the following terms, in relation to commercial catch sampling. Self-sampling: The process whereby fishers or fishing crew-members take samples from the catch and carry out measurements on those samples. Self-sampling programs may be carried out by industry organizations alone or joint efforts of industry organizations and research organizations. Co-sampling: The process whereby fishers or fishing crew-members take samples from the catch and store or freeze these samples for later analysis at a research institute. Upon return of the vessel, the samples are transferred to the research institute for analysis and measurements. Market-sampling - Factory-sampling: The process where catches are sampled once they have been landed in an auction or factory. The sampling is normally carried out by researchers from research institutes.	January 2023
WGQUALITY	**Recommendation:** To review, adjust and insert in the template a section on the roles of all involved in the catch sampling programme. **Background:** During WKEVUT, it was concluded that the roles that different people have, is not always clear. Therefore, WKEVUT worked towards preliminary descriptions of the following terms, in relation to commercial catch sampling Observer (scientific): A person who goes out to sea with a commercial fishing vessel to carry out sampling activities and observe the composition of the catches, discards and bycatch. An observer is normally employed by a research institute although observers may also be employed by fishery organizations Researcher/Scientist: A person with a scientific training who is carrying out research activities in the context of sampling commercial catches. A researcher is normally employed by a research institute. Industry scientist: Similar to above, but employed by a fishery organization	January 2023

Addressed to	Description of the recommendation	Timeframe
	Fisher/skipper: The operator of a fishing vessel and responsible for the daily operations on the vessel. Fishing crew member: People on board of fishing vessels with tasks related to the fishing operations and potentially also related to sampling activities. Vessel-owner/ operator: The owner and/or operator of a fishing vessel.	
WGCATCH	**Recommendation:** To discuss where and how to present the frequency of fishing vessels participating in different projects and sampling activities, i.e. those vessels selected for self-sampling or co-sampling. **Background:** When the selection of certain vessels for co-sampling or self-sampling is done, how is there dealt with the potential bias? What methods are being used for selecting vessels for specific sampling activities? How to deal with systematic exclusion of certain fishing vessels from self-sampling and co-sampling?	November 2023
WGBIOP **WGCATCH**	**Recommendation:** Length-weight relationships and non-standard biological information collected during self-sampling programs should be published and made available to working groups. Such relationships are most useful if they have sufficient spatio-temporal resolution. WGBIOP/WGCATCH are requested to provide feedback on the key requirements for including such self-sampling data to improve biological understanding. **Background:** The case studies presented during WKEVUT demonstrated that the use of self-sampling or co-sampling data is dependent on different situations. In many instances, co-sampling has been a long-established methodology of getting catch samples from fisheries that are not easy to sample in auctions. In those cases, crew-members have been instructed to take predefined samples and to take those samples back to port where they will be analysed by research from a research institute. For example, the Dutch pelagic sampling has been using this method for over 40 years already. Co-sampling approaches have generally been set up by research institutes who then ask for collaboration from the fishing industry. In those cases, the results from the sampling efforts are directly used in the stock assessments. Biological data from voluntary, industry-initiated self-sampling programs are currently not yet directly used for stock assessments, although the results do get to be presented at assessment working groups. In most cases, self-sampling is not aiming at generating age distributions of the catches, but rather focus on length-distributions and potentially other biological variables (e.g. length-weight relationships, fat content, gonad development). Therefore, self-sampling programs could be used to ameliorate existing (co-) sampling programs.	2023–2024
WGCATCH **WGQUALITY** **ACOM Leadership** **ICES Secretariat**	**Recommendation:** To collate and distribute examples of feedback methods between fishing industry and science. **Background:** An important element of self-sampling and co-sampling approaches is to organize the feedback systems to the participating fishers. Timely, efficient and effective feedback mechanisms, may generate a long-lasting engagement of fishers with science and scientists with fisheries. Recent experiences have shown that immediate feedback to participating skippers (e.g. after each trip) is a powerful mechanism of maintaining commitment.	2023 and beyond

Addressed to	Description of the recommendation	Timeframe
RCGNANSEA **RCG Baltic** **WGCATCH**	**Recommendation:** WKEVUT supports the wider application of catch lottery systems to improve random sampling of fisheries catches while at the same time achieving higher engagement and feedback between science and industry. RCG NANSEA and RCGBaltic and WGCATCH are requested to look into the introduction of the catch lottery as used in Norway, and the eventually possible improvement on the at random sampling **Background:** A recent trend seems to be towards combining self-sampling activities (e.g. aimed at length and weight) with more traditional co-sampling activities (aimed at generating age compositions). Most of the sampling initiatives presented are national but some (e.g. PFA self-sampling) are focused on multi-nation fisheries. This may require a possibility to bring information to ICES using a regional approach. The Catch lottery system developed in Norway is an powerful example of a co-sampling approach in combination with a strong statistical approach. This is expected to allow for truly random sampling from the commercial fleet, assuming that the willingness to bring samples back to port is not associated certain behavioural aspects in the fishery	June 2023
ACOM	**Recommendation:** To organise in 2023 a second workshop on evaluation of the utility of industry-derived data for enhancing scientific knowledge and providing data for stock assessments (WKEVUT2) **Background:** It is a high priority for ICES to be able understand the value of new streams and what it implies for the processes to incorporate and apply them in future work A workshop, WKEVUT, was organised in April 2022 with the purpose to test the quality and utility of new data derived from industry-science data collection or sole industry initiatives by comparing it with existing data collected under national data collection programs and routinely used by ICES in stock assessment or for other research and advisory purposes. The output of WKEVUT show clearly that this process is not finished yet and further work and follow-up of the process, the quality of the data from these sources, feedback mechanism to the fishing industry, etc is needed.	December 2022

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Annex 2: Feedback to WGQuality 2022

WKEVUT applied the WGQUALITY catch sampling summary template to four (randomly) selected cases during the workshop, with the main aims of starting to document the sampling programs and providing feedback to WGQUALITY. General conclusions are report in section **Error! Reference source not found.**.

A1.1 Commercial Catch Sampling Summary Template

The commercial catch sampling template used during WKEVUT consisted of the following elements:

Document created date:	
Most recent document review date:	
Contact name:	
Contact email:	

1. Purpose and scope of this document

2. Programme overview

2.1. Program name
2.2. The objective of this commercial catch sampling program
2.3. Spatial coverage and temporal resolution
2.4. Stocks targeted
2.5. Known quality issues
2.6. Time-series

3. Sampling design
3.1. Organisations conducting the sampling
3.2. Sampling scheme type
3.3. ICES Regional Database & Estimation System (RDBES) Upper Hierarchy
3.4. Target population
3.5. Sampling frame
3.6. Under coverage of the sampling frame
3.7. Sampling units
3.8. Stratification of Primary Sampling Units (PSU)
3.9. Effort allocation
3.10. Selection methods
3.11. Recording of non-responses and refusals
3.12. Risks and mitigations
3.13. Further information on sampling design

4. Biological sampling protocols
4.1. Species selection strategy
4.2. Sub-sampling procedure
4.3. Length sampling
4.4. Fish weight sampling
4.5. Age sampling

4.6. Other biological parameters measured
4.7. Further information on biological sampling protocols

5. Data storage
5.1. Programme data storage
5.2. Further information on data storage

6. Data quality checks and validation
6.1. National data checks
6.2. International data checks
6.3. National data flow
6.4. Further information on data checks ad validation

7. Estimation procedure
7.1. Estimation procedures
7.2. Further information on estimation procedures

A1.2 Feedback from application of Catch Sampling Template (based on the specific cases)

Overall

- Is the template only applicable to catch sampling or is there also a scope for acoustic sampling?
- It could be tricky to fill in by people less familiar with the ICES terminology
- Definitions are needed. A clear list would be useful (self-sampling, co-sampling, etc)
- Very useful. It would be good to have an completely filled out example to guide the readers.

By item

- Item 2.2 (*objective of this commercial catch sampling program*). It would be useful to list the possible end-users. End-users may be wider than just stock assessors Add: is self-sampling or co-sampling voluntary or regulated?
- Item 2.3 (*Spatial coverage and temporal resolution*): would numeric coverage be useful?
- Item 2.4 (*stocks targeted*). Is it about the target of the fishery or the target of the programme analysis?
- Item 2.5 (*known quality issues*). It is not clear what is required here. In the example provided, what would make the discard data not useful? Should include the degree of randomization
- Item 3.1 (*organisations conducting the sampling*). Should the funders be mentioned? Would be good to have a section with the roles of all those involved
- Item 3.2 (*sampling scheme type*). Is it the selection process of samples or the person who samples? No separation between the samples taken and biological analyses.
- Item 3.3 (*ICES Regional Database & Estimation System RDBES*). The link should be more direct to the hierarchies (now is too general)
- Item 3.4 (*target population*). Is this the target population of the fishery or of the programme?
- Item 3.5 (*sampling frame*). Please explain what is meant with sampling frame.

- Items 3.7 and 3.9. Some duplication of information (on sampling effort)
- Item 3.11 (*recording of non-responses and refusals*). Would be good to have some level of standardization in the codes (avoid too much details) Is there a list of definitions of non-responses and refusals available. If so, please add a link. More details needed.
- Item 6.1 (*national data checks*). Does this refer to data checks on raw data entry or on the analysis/aggregation level?
- Item 6.3 (*national data flow*). The schematic should not be optional. If one has it, it should be provided
- Overall: if people filling in the template are not within ICES/RDBES, it is important that you join in with national scientists that are familiar with the relevant terminology.