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Role	Name	Organisation	Date	File suffix[2]
Authors/ Task Leaders	Karim Erzini	CCMAR	30/10/2018	KE
Author	Kim Stobberup	CCMAR	30/10/2018	KS
Author	Nina Mikkelsen	UIT	30/10/2018	NM
Author	Vincent Lucas	SFA	30/10/2018	VL
WP leader	Karim Erzini	CCMAR	30/10/2018	KE
Coordinator	Jónas R. Viðarsson	MATIS	31/10/2018	JRV
Administrative Coordinator	Oddur M. Gunnarsson	MATIS	31/10/2018	OMG

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Deliverable D2.4

Templates and protocols for self-sampling

31/10/2018

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Executive Summary

In the EU, the Data Collection Framework (DCF) applies to all fisheries carried out by EU vessels, including those fishing outside EU waters under Sustainable Fisheries Partnership Agreements (SFPA). Although observer coverage of up to 100% has been achieved through collaboration with industry in some SFPA fisheries, the observer coverage in many others SFPAs is low. Lack of data for stock assessment and management of many stocks and species is a global problem. In this context, self-sampling schemes have been implemented in a wide range of commercial and recreational fisheries worldwide as a supplement to data collected by observers. Studies in the EU have shown that self-sampling can be a valuable and cost-effective method of data collection, with the added benefit of involving fishers in the scientific process of assessment and management of their fisheries. In EU fisheries, much of the self-sampling in recent years has been driven by the Common Fishery Policy (CFP) landings obligation (discards ban), where reference fleets (selected representative vessels chosen for the self-sampling scheme) apply self-sampling of catches and discards, with samples of the latter usually brought back to land for processing by fisheries scientists. Although not common, some self-sampling schemes have used fishers to collect samples for age and growth studies and even stomachs for analysis of diets.

Self-sampling schemes require volunteer fishers who are motivated and willing to carry out the extra work. Often, an incentive (e.g. financial, more days at sea, more quota) is required to guarantee fisher collaboration. Successful self-sampling programmes are based on mutual trust building between scientists and fishers, and discussion of the goals of the research, the data/sample collection methods and how the collected data/samples will be used. Data collection protocols must be followed, with clearly written instructions and forms used. Fishers need to be adequately trained in collecting data and biological samples in a consistent and standardized way and they should be provided with all the necessary material for the sampling.

Observer coverage of FarFish CS SFPA fisheries is variable, reaching up to 100% in some fisheries, with the level of coverage depending on the RFMO, the SFPA context and the national legislation of the third country. Implementing self-sampling in the FarFish CS was discussed with the industry (Spanish operators and LDAC) in the FarFish Workshop in Vigo (26-27 June 2018). The industry representatives were not favourable to implementing self-sampling in their fleets. Consequently, no sampling templates or protocols for the FarFish CS are proposed at this stage. This issue should be taken up with the CS leaders and industry representatives.

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Abbreviations

ANABAC	National Association of Tuna Freezer Vessels Shipowners
AZTI-Tecnalia	Centro Tecnológico Experto en Innovación Marina y Alimentaria (Spain)
CECAF	Fishery Committee for the Eastern Central Atlantic
CEN	European Committee for Standardization
CFP	Common Fisheries Policy (EU)
CNR	Consiglio Nazionale delle Ricerche (Italy)
CWA	CEN Workshop Agreements
CS	Case Study
DCF	Data Collection Framework
DFO	Department of Fisheries and Oceans (Canada)
DG MARE	Directorate-General for Maritime Affairs and Fisheries
DTU Aqua	National Institute of Aquatic Resources (Denmark)
EU	European Union
FAO	The Food and Agriculture Organization of the United Nations
FDF	Fully documented fisheries
FPA	Fisheries Partnership Agreement
FRS	Fisheries Research Services (Scotland)
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICES	International Council for the Exploration of the Sea
IEO	Spanish Institute of Oceanography
ILVO	Institute for Agricultural and Fisheries Research (Belgium)
IMARES	Institute for Marine Resources and Ecosystem Studies (Netherlands)
IMR	Institute of Marine Research (Norway)
INDP	Instituto Nacional de Desenvolvimento das Pescas (Cape Verde)
IOTC	Indian Ocean Tuna Commission
IPMA	Portuguese Institute for the Ocean and Atmosphere
IRD	French Institute for Research for Development
ISDEP	Irish Sea Data Enhancement Pilot (Ireland)
LDAC	Long Distance Fleet Advisory Council
MS	Member State
NEFOP	Northeast Fisheries Observer Programme
NMFS	National Marine Fisheries Service (USA)
OPAGAC	Organización de Productores Asociados de Grandes Atuneros Congeladores
ORTHONGEL	Organisation des Producteurs de Thon Tropical Congelé et Surgelé
OSF	Institute for Baltic Sea Fisheries (Germany)
PFA	Pelagic Freezer-trawler Association
QM	Quality Manager
REM	Remote Electronic Monitoring
RFMO	Regional Fisheries Management Organisation
SEAFO	South East Atlantic Fisheries Organisation
SFI	Sea Fisheries Institute (Poland)
SFPA	Sustainable Fisheries Partnership Agreement
SPRFMO	South Pacific Regional Fisheries Management Organisation
STECF	Scientific, Technical and Economic Committee for Fisheries
SUYS	Send us your skeletons (Australia)
VMS	Vessel Monitoring System
WP	Work Package

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1 Introduction and context

Collection of data on commercial catches by scientists is costly and time consuming, requiring observers on-board commercial vessels. In most fisheries part of the catch, consisting of undersized or juvenile commercial species, quota limited species, unwanted species and damaged individuals is discarded at sea. Consequently, landings do not represent catches in terms of species composition and size and age structures and therefore sampling at landing sites or ports does not provide all the fisheries-dependent data that is required for stock assessment. Minimizing the problem of discarding is at the heart of 'Landing obligation' of the new Common Fisheries Policy (EU Regulation 1380/2013). Self-sampling by commercial and recreational fishers is widely recognized to be a practical and cost-effective way to collect data for stock assessment purposes and for assessing spatio-temporal patterns in discarding (ICES 2008).

FarFish WP2 (Advancing biological knowledge and evaluation of current stock assessment models) focuses on the biological and ecological status of resources within the selected Case Studies (CS). Of primary interest are data and data availability, particularly in data-limited scenarios such as those of the CSs. WP2 aims to advance biological and ecological knowledge in the CSs by compiling and making available information that has been gathered by other sources but is not readily available. In addition, given the high costs associated with gathering fishery independent data for stock assessment, FarFish aims to use the EU fleet to gather data by means of self-sampling that can be used to contribute to improved stock assessment and management.

Initially, FarFish considered to use self-sampling by the European fleet to collect data on a number of biologically and ecologically relevant issues, including for example, temperature, depth, weather, plankton, catch composition, size and weight of catch samples, stomach content, and otoliths. FarFish WP2 also proposed to develop templates for the self-sampling which would be tested and improved within the project and the data would be made available in the FarFish database. The data would then be incorporated into the management tools developed in WP6. FarFish industry partners and LDAC would assist with the pilot testing and give feedback on the applicability of the self-sampling programme and associated templates. The templates would then become a part of the CEN Workshop Agreements (CWA) developed in WP3.

This document (deliverable 2.4) reviews self-sampling programmes and protocols from around the world, with emphasis on two specific examples: Cape Verde and the EU Pelagic Freezer trawler Fleet. It provides guidelines for designing self-sampling, evaluates the advantages and disadvantages of self-sampling, and provides examples of templates and protocols. EU observer and data collection programmes are also reviewed in light of the self-sampling objectives of FarFish.

2 Review of existing systems for using fishers for sampling

The International Council for the Exploration of the Sea (ICES), an intergovernmental organization established in 1902 that includes the USA and Canada, coordinates and promotes scientific knowledge and provides advice that best guarantees the sustainability of the marine environment. ICES has a key role in producing advice for international organizations and commissions including, among others, the EU Commission. Several ICES workshops have been held on fishers sampling (ICES 2007, ICES 2008). ICES (2008) provides an overview of self-sampling in 13 European countries, Canada and the USA. Table 1 summarizes the self-sampling systems existing in 2008.

Table 1: Summary of existing (2008) self-sampling systems (ICES, 2008).

Country	Fishery / species / stock	Self-sampling
Belgium	Western Waters	Involvement in the EU project "Joint data collection between the fishing sector and the scientific community in Western Waters"; design and implement pilot programmes to obtain information from the fishery industry.
	National	ILVO looking at potential to include self-sampling programmes in National Data Gathering Programme.
Canada	Lobster	Logbooks to 15-20% of license holders; fishers record numbers of commercial sized animals, berried females, non-commercials and any v-notched animals each day the traps are hauled. Detailed instructions on logbook and at-sea sampling data entry provided by DFO staff.
	Herring (Gulf of St. Lawrence)	Logbooks and sampling with multi-mesh gillnets.
	Silver hake (Maritimes region)	Industry samples length distributions.
Denmark	Baltic salmon	Volunteers (60% of fleet) record effort, landings and discard data.
	Sand eel (North sea)	Reference fleet of 15-20 vessels; fishermen take approximately 400 samples per year.
	Sand eel larvae (North sea)	2 vessels paid to take 60 samples (500 euros per sample)
	Sole (Kattegat)	Private logbooks with catch and effort (by haul) data
	Cod (Kattegat-Skaggerak)	Pilot study initiated in 2008 using 6 trawlers and gillnetters; participants get additional quota.
	Cod (Baltic)	Reference fleet of 5 trawlers record catch data in logbooks on haul by haul basis since 2007, with length distribution and discard information collected since 2008.
	Cod in Øresund (sport fishing)	Plan to initiate daily catch data collection with a reference fleet in 2008.

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	Non-commercial fishing with passive gears (not sport fishing)	93 fishers provide monthly catch data since 2002; paid with free gear.
	Herring and sprat (Baltic)	Industry samples landings in three harbours.
Germany	Trawl and gillnets (Baltic)	Participation of the Institute for Baltic Sea Fisheries (OSF) in the EU project JOIFISH/Lot8 (Joint data collection between the fishing sector and the scientific community in the Baltic Sea); 4 trawlers and 4 gillnets collect haul by haul data (effort, catch composition (landings and discards) and biological characteristics of the catch (samples of cod). Fishers paid 50 € per sample.
Iceland	Cod	Fishers paid to sample cod, collect and freeze the stomachs.
Ireland	Irish Sea (VIIa) trawl fishery	Two-year Irish Sea Data Enhancement Pilot (ISDEP) conceived in 2006 to obtain landings and discards data from Irish trawlers.
	Irish Sea demersal trawl and seine fisheries	Pilot programme initiated in 2007; 4 *Nephrops* and 1 whitefish vessel participating on a semi-regular basis by January 2008.
	Norway lobster (Irish Sea West, Porcupine Bank, Aran Grounds, Ireland SW and SE Coast, Celtic Sea)	Voluntary self-sampling programme for *Nephrops* landings and discards; about 15 vessels per year; samples are paid. Catch sample: 1 box, random sample of unsorted bulk catch, Discards sample: random sample (1 box) of discards.
Latvia	Coastal fishery	Reference fleet and self-sampling system since 1993: 20 to 30 fishers and fishing enterprises per year; record information on catches, bird and mammal by-catch and Chinese mitten crab. In some areas all salmon and sea trout measured, weighed and scale samples taken. Length measurements taken for cod and flounder in some areas.
Malta	Surface and bottom longliners	7 surface and 3 bottom longline vessels making at least 25 trips per year paid 700 € per year to record seabird, turtle and shark by-catch.
Netherlands	Dutch demersal fleet	Self-sampling (about 20 vessels) since 2004; sample of catch and discards % (volume) of plaice recorded twice a week. Cod discards also recorded since 2006.
Norway	High seas and coastal fishing vessels	Reference fleet (17 high seas and 22 coastal vessels) paid to measure subsamples of fish and on a less regular basis collect otoliths, stomachs, genetic and other biological samples for IMR. Also provide information on fleet behaviour and technological developments influencing efficiency and effort.

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	Tourist sea fishing	Collaboration of IMR with owners of fishing resorts; diaries for recording daily catch and effort data distributed to anglers.
Poland	Baltic coastal fisheries and offshore fisheries; salmon, sea trout, whitefish and cod.	Baltic cod fisheries: special haul information forms; landings and discards recorded. Salmonids and whitefish: selected fishers (paid) trained and equipped to collect length, weight, sex and maturity data and scales from 70-85% of the catch. Fykenet fishery in Vistula lagoon: fishers authorised to fish in prohibited areas; obliged to provide all information requested by SFI. Hook and line fleet self-sampling: length and other data recorded.
Spain	Recreational tuna fishery	Volunteer tag and release programme since 2001. Anglers trained; fish measured, tagged and released. Spatial information (catch and effort recorded).
Sweden	Vendace fishery, Bothnian Bay	Self-sampling programme since 2001; all vessels (36 in 2007) voluntarily sample each trawl haul (weight by species data collected).
Northern Ireland	M. Irish fleet (mainly *Nephrops* trawl)	Self-sampling programme initiated in 2008: log-book data for each haul including bulk catch and discards estimated in boxes/baskets. Subset of vessels provide biological samples. Incentives: monetary compensation and additional days at sea.
Scotland	Demersal fleets	Pilot study carried out by FRS in 2004 on the <10m sector; samples of unsorted catch brought to land.
	Pelagic fisheries	Pilot study (herring fishery) in 2008 to test and develop sampling protocols.
United States	Northeast	"Study fleets" used in two pilot studies to evaluate accuracy of fishery-based data: 32 and 20 vessels.

The review carried out by ICES (2008) shows that even within Europe there was a wide variety of self-sampling schemes, from volunteer to paid or compensated contributions. Self-sampling was used mainly to collect data on catch and discards, but in some fisheries other data were obtained, including size distributions, otoliths, scales and stomach contents.

Over the past two decades, self-sampling schemes have become an important part of national data collection programmes throughout the EU. In Denmark, self-sampling by part of the gillnet fleet is a component of the Danish Sea Sampling Programme (Storr-Paulsen et al. 2012). The vessels involved are mainly the smaller ones where the use of observers is difficult. A selected group of vessels are requested by the National Institute of Aquatic Resources (DTU Aqua) to bring all discards to land on randomly chosen days. An observer is sent on-board one of the fishing vessels to serve as a reference. The data from self-sampling and at-sea sampling by observers is entered into a national data base before being transferred to the international Regional Database (RDB-FishFrame, http://www.fishframe.org), where it contributes to estimation of discards by providing data on landings and effort.

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In the Netherlands, the self-sampling programme was initially an industry-driven initiative (Dutch Fish Product Board, 2004-2008), but since 2009 the Institute for Marine Resources and Ecosystem Studies (IMARES) has run a programme with a reference fleet with trained crew members who sample two random and pre-determined hauls on specified trips (Uhlmann, 2013; Uhlmann et al., 2011, 2013; Van Helmond et al, 2012). The samplers are provided with written instructions and all the necessary sampling equipment (van der Reijden et al., 2014). The samples consist of two boxes of approximately 40 kg each of discards that are processed in IMARES laboratories (species composition, size and age structures). The crew members also record additional haul-specific information including catch, landings, geographic position, depth, and sea and wind conditions. In 2013 for example, a reference fleet of 23 vessels was used for self-sampling nine different metiers: beam trawler (3), otter trawler (3), Scottish seiners (2) and Eurocutter (van der Reijden et al., 2014).

In the Shetlands, Napier (2015) evaluated self-sampling as a means of obtaining data on discards from seine net, single trawl and twin trawl vessels. The self-sampling methodology followed that used in Dutch fisheries (van Helmond et al., 2012; Kraan et al., 2013; Uhlmann et al., 2013). The Shetland Fishermen's Association identified crews willing to participate. The crews were given a briefing, provided with sample record sheets and asked to bring two boxes of discards from each tow to take back to port. Only some of the vessels consistently provided discards samples. However, the results were generally positive, with estimates of discard composition similar to those made by fishermen on similar vessels through the SFA's discard tally-book scheme, no significant differences in overall discard rates with those estimated from the SFA discard tally-book scheme, and no significant differences between the size distributions recorded by observers.

A similar approach was taken in the Italian bottom trawler fishery operating in the Strait of Sicily to self-sample landings and discards (Milsenda et al., 2017). Volunteer skippers and fishers were trained by Consiglio Nazionale delle Ricerche (CNR) staff and provided with sampling protocols and forms. One form was for registering dates of departure and return, fishing-ground and depth range per trawl tow, the number of tows and the landings composition by species and commercial categories. The fishers were also requested to take samples of approximately 25 liters of discards for analysis by CNR technicians and to record the volume of the total discards in a selected haul in a second form. The combined information was used to estimate the species composition and abundance of the total discards (kg) of the haul and the total discards for the trip, based on the number of tows (Milsenda et al., 2017).

In Alaska, the trawl industry provides species-specific landings data (Faunce et al., 2015). A joint study by the NMFS and the industry compared observer and industry estimates of landings of three trawl fisheries and found that although there were no significant differences between observer and industry estimates overall, there were some differences for the shallow-water trawl fishery (Faunce et al., 2015).

In Nigeria, a self-sampling programme for the Niger Delta artisanal fishery was implemented using 40 fishermen chosen based on the following criteria: literacy, membership of economic / cooperative group, level of fishing activity, gear type, craft type, quantity and size of catch (Abohwehere, 2011).

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The fishermen were trained by scientists to record date of fishing, identifyfish species, weight of fish per species, total weight of catch, length frequency of fish sample, total price of fish per species, total price of catch, place of fishing, time of setting out, time of return, number of crew on-board, type of canoe, type of engine, and HP of engine. They were provided with equipment for the sampling, including a fish identification chart and given a small stipend for their work. The programme proved highly cost effective and provided valuable baseline information that was used to calculate indicators such as catch-per-unit-effort (CPUE) and length frequency distributions (Abohwehere, 2011).

In west Australia, a citizen science programme, *Send us your Skeletons* (SUYS), enlists recreational anglers to donate the skeletons of fish they had caught (Fairclough et al., 2014). The skeletons are used to obtain age and size structures for stock assessment. SUYS has proved cost effective and useful, allowing the acquisition of samples that would be difficult and expensive to acquire with traditional scientific sampling programmes based on research surveys of market sampling. The data has been used for stock assessment and an additional benefit of the SUYS programme is that it contributed to greater involvement of stakeholders and collaboration with the scientists and managers (Fairclough et al., 2014).

In Norway, a reference fleet provides important data on species composition in commercial catches as well as age and length data for stock assessment of commercial species and information on the spatial distribution of coastal cod and Northeast Arctic cod (IMR, 2014). The offshore reference fleet, established in 2000, consists of 14 large offshore vessels while the coastal reference fleet (established in 2005) consists of 24 smaller coastal vessels, that are carefully selected based on reputation and concern for the fisheries resources. Sampling and data handling procedures are similar to those carried out on research vessels of the Institute of Marine Research (IMR), with fishers trained to carry out biological sampling, including length, otoliths, genetic samples, stomachs, contaminants, tagging (IMR, 2014).

Also in Norway, a self-sampling programme for tourist anglers renting accommodation in 445 registered businesses was implemented by IMR (Vølstad et al., 2010). A two-staged sampling design was used where a stratified sample of businesses were first selected, followed by a random systematic sub-sampling of reporting weeks (every 6th week) for which recreational anglers were requested to fill out diaries. Reliable data on catch composition and catch per unit effort was obtained for this recreational fishery.

3 Specific case studies

Good examples of ongoing self-sampling programmes that are relevant for FarFish CSs are in Cape Verde and within the Pelagic Freezer-trawler Association (PFA). Following is an overview of these programmes and discussions on the lessons learned from those examples.

3.1 Developing an observer programme and self-sampling in Cape Verde

The EU and Cape Verde have had in place a bilateral Fisheries Partnership Agreement (FPA) since 2006, which provides fishing possibilities exclusively for highly migratory species for EU vessels fishing in Cape Verde waters. This Agreement has been renewed twice for periods of 5 years, the latest in 29 March 2017. The current Protocol to the Agreement stipulates fishing opportunities of 5,000 ton (negotiable and not a maximum limit) per year for tuna and other highly migratory species in three fishing categories: 28 tuna seiners, 30 surface long liners and 13 pole-and-line vessels (EU 2018). It is important to note that the EU longline fisheries in Cape Verde target swordfish and pelagic sharks; blue shark (*Prionace glauca*) and mako (*Isurus oxyrinchus*) being the main commercial species of which blue shark is the primary target.

Following the recent reform of the EU Common Fisheries Policy (CFP), these fisheries agreements have changed name to Sustainable Fisheries Partnership Agreements (SFPAs), where the EU gives financial and technical support in exchange for fishing rights, generally with southern partner countries (EU 2018). More than a quarter of the fish caught by EU vessels are actually taken outside EU waters and around 8 % of EU catches (2004-06) are made under fishing agreements with countries outside the EU.

Considering the greater emphasis on sustainability and the need to develop the scientific basis for management, the EU is contributing to efforts in this area with the DGMARE Framework Contract MARE/2012/21 on the 'Scientific advice for fisheries beyond EU waters' with participation of scientists and experts. Within the framework of this contract, a specific contract no. 7 dealt with the provision of advice on the conservation of pelagic sharks associated to fishing activity under EU Sustainable Fisheries Partnership Agreements in the Atlantic Ocean. The main purpose of this project was to provide advice to the EU Commission on the conservation of pelagic sharks associated to the fishing activity conducted under EU SFPA in the Atlantic Ocean, specifically for the geographical area of the Cape Verde Archipelago.

3.1.1 Developing data collection and self-sampling

Within the project (specific contract no.7), several tasks were carried out, such as 1) designing an observer programme, 2) designing and implementing a tagging programme, 3) analysing the potential local depletion of sharks and impacts to the ecosystem in the region; 4) identifying biological and ecological sensitive areas in Cape Verde and neighbouring waters; and 5) coordination and communication (Coelho et al., 2017).

In the following, focus is placed on Task no. 1 which concerns an observer sampling programme for the fleets capturing sharks in the Cape Verde EEZ, as well as the development of a self-reporting scheme. The outputs included:

a) Identification guides: identification guides to be used by the observers, as well as dichotomous identification keys, previously developed for the EU longline fleet observer programmes were presented and provided to the local focal point of the project. Those guides were also used during the capacity building activities that took place in Cape Verde during the project. These identification guides and dichotomous keys do not only cover shark species, but also other taxa commonly caught in the area that are of interest to the observers, such as tunas, billfishes and sea turtles (see Annex 1).

b) Forms to collect observer data: data forms developed by EU observer programmes were adapted to ensure the collection of data on target and by-catch species, including sharks. The forms provided include specific forms regarding the collection of (see Annex 2 & 3):
    - Fishing gear characteristics
    - Longline set data (including geographical position, effort, bait and additional oceanographic data such as sea surface temperature, wind and sea condition)
    - Catch and by-catch data (for individual specimens, including species identification, fate, status at haulback, size, sex and maturity stage)
    - Discard data (including tunas, sharks, billfishes, other fish, turtles, etc.)
    - Biological samples, such as vertebra, genetic tissue and spines.

c) Development of a self-reporting scheme: this sampling scheme is complementary to the data collected on-board by the observers, consisting of a dedicated electronic logbook to be filled in by skippers in trips when scientific observers are not present. Those forms enable skippers to self-report a wide variety of data (including fishing gear characteristics, longline set information, catch composition and size/weight of retained and discarded catch), and enables the estimations of live and processed weight of the retained catch. A manual of procedures has been produced to help skippers to fill in the logbook and self-report their fishing activity including the retained and discarded catch (see Annex 4).

d) Development of a relational database: this database was developed by Instituto Nacional de Desenvolvimento das Pescas (INDP) in consultation with Consortium scientists and is property of INDP. The database was developed to store all the logbook and observer data collected, including from both the EU and other fleets that operate in the Cape Verde waters. Queries were prepared and can be further developed as appropriate and needed, as well as protocols for data entry and accessibility/confidentiality. A specific module of the database is dedicated for storage of fishing activity and catch reported by foreign fleets operating in the Cape Verde EEZ under past and current international fisheries agreements.

e) For the observer training component of the project, a training course was provided for 18 local technicians and 5 fisheries inspectors from Cape Verde in 2014. Additional observer training was conducted at INDP in April 2015 (5 days), in which 9 students (7 technicians and 2

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inspectors) received formation on general aspects of species identification, biology, data analysis and reporting. This course was focused on fisheries and biology of highly migratory tuna and tuna-like species, exploited by local fisheries and/or caught within the scope of SFPAs. Of those 9 students, additional formation specific to longline fisheries data collection, onboard sampling and reporting was provided to 4 technicians, as those were indicated by INDP as the ones likely to start as observers in the Cape Verde observer programme.

3.1.2 Lessons learned

The project produced materials and training for establishing an on-board observer programme, including manuals, sampling protocols and a self-sampling programme protocol, with the respective data collection forms, in cooperation with Cape Verde scientists to train technicians. It is important to point out that these forms are currently used in EU national observer programs. Furthermore, a relational database was developed in cooperation with INDP in Cape Verde to store current and historical fisheries data, both from the EU and other, non-EU, fleets operating in the Capo Verde region, thus facilitating data storage, processing and compilation.

However, there is no provision for observers in the Cape Verdean legislation, the country does not have an observer programme in place and does not participate in the ICCAT Regional Observer Programme. Several attempts at training and establishing such an observer programme have taken place but with no success so far, and key factor is the lack of provisions in the fisheries legislation.

Implementation is recommended as a two-step process. In the short term, a pilot project could be developed to start the implementation and testing phase of the observer programme. For the long-term, funds will need to be secured in order to guarantee the long-term stability and viability of the programme and the maintenance of a continuous time series of data that can be used in future stock assessments.

Implementation of the self-sampling program depends on the collaboration of skippers and crews in both domestic and foreign vessels. Efforts must be made by Cape Verde authorities and scientists to promote this and secure the participation of the sector. The project has created the conditions to receive and compile data from electronic logbooks and self-sampling currently being applied on EU vessels, but this should ideally cover all industrial and semi-industrial fisheries in Cape Verde through possible incentives and awareness-raising.

Comprehensive and reliable fisheries data on catches of commercial species, as well as by-catch and discards is needed to improve knowledge and the scientific basis for the management of fisheries. As a member of ICCAT, Cape Verde has responsibilities in relation to shark data collection consistent with ICCAT Recommendations on reporting Task I and Task II data (Art-IX in ICCAT Convention, Rec. 05-09 and Res. 66-01), as well as by-catch and discard data (ICCAT Rec. 11-10). This observer programme could cover fleets fishing in Cape Verde waters under license agreements and eventually a Cape Verde domestic fleet.

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3.2 Self-sampling in the EU Pelagic Freezer-Trawler Fleet

The Pelagic Freezer-trawler Association (PFA) represents the interests of nine European pelagic freezer-trawler companies, which fish for human consumption. These are family-run companies, mostly going back to the late 19th century, who benefit from several generations of fishing experience, and operate a combined fleet of 19 vessels (as of 2018). They are vertically integrated companies involved in the catching, processing, distribution and export of pelagic fish. The association currently has members in France, Germany, Lithuania, the Netherlands and the UK and its main office is in the Netherlands (https://pelagicfish.eu).

PFA vessels use pelagic (or mid-water) trawl gear to catch the shoals of pelagic fish and the main target species are herring, mackerel, horse mackerel, sardinella, blue whiting and silver smelt, which often migrate over long distances. The main fishing grounds are found in European waters including the North Sea, the waters west, north and south of Ireland, England and Scotland, in the English Channel and in the Bay of Biscay. About 80 % of the total catch has come from European waters and the North Atlantic.

PFA vessels have also fished for sardine, horse mackerel, mackerel and sardinella, in the waters off western Africa (FPAs with Mauritania and Morocco). Up to 20 % of the PFA catch came from these waters in the past. However, a new agreement between the EU and Mauritania (2012) has set technical conditions that now make commercially viable fisheries very difficult and PFA vessels have hardly been active in Mauritanian waters since 2012.

Another fishing ground for PFA vessels is in the South Pacific. Since the end of 2005, these vessels have been targeting the Southern Pacific jack mackerel, while operating outside the Chilean EEZ. This high-seas fishery is famous for the large catch volumes during the 70s and 80s, taken mostly by the Soviet fleet. When the Soviet Union collapsed, its fleet left the area and other fleets entered into the fishery, albeit in a smaller extent. The PFA is one of them.

3.2.1 Development of self-sampling

An important characteristic of freezer-trawlers is that they process and freeze their catches directly at sea. As part of the Quality Control programme (Pastoors, 2018), most vessels have a Quality Manager (QM) on-board who is responsible for the monitoring and documentation of the catch. Traditionally, the monitoring is primarily aimed at the sales process.

Since the beginning of 2015, the PFA has extended the ongoing monitoring programme to a self-sampling programme that aims to collect, analyse and share fisheries and catch information on-board of pelagic freezer-trawlers. The programme essentially adds to the quality monitoring, the information on haul-by-haul basis and regular length-frequency measurements of the catch. The PFA self-sampling programme somewhat resembles the Norwegian Reference Fleet, although in the PFA programme the initiative and coordination lies with within the PFA and the aim is both to inform the fishing industry and fisheries science (Pastoors, 2018).

By the end of 2016 around 11 PFA vessels had participated in the self-sampling programme, more than half of the freezer-trawler fleet at that time. The total catch of self-sampled vessels was 252,000 tonnes in 2016. Although the programme does not consist of a random selection of vessels, the overall fishing pattern appears to represent the fisheries of the PFA vessels.

One of the main drivers behind the use of self-sampling was the recent reform of the EU Common Fisheries Policy (CFP) which introduced a land-all catch policy in EU waters with a requirement for full reporting of fishing and on-board processing activity. There has been focus on remote electronic monitoring (REM) systems that can be utilized in fully documented fisheries (FDF), but other technologies and approaches such as a reference fleet and self-sampling have been used to contribute to delivering FDF. Another issue in distant-water fisheries is that it can sometimes be difficult to place observers on vessels (e.g. lack of available, experienced observers; logistics; costs, etc.). This was for example the case for PFA vessels operating in the South Pacific (Wójcik and Corten, 2017).

3.2.2 Self-sampling strategies

Data collection is carried out through standardized Excel spreadsheets that have been developed and adapted during the course of the self-sampling project (Pastoors, 2018). The explicit aim was to standardize the type of observations and to define unique and well-described units for the observations. This development resulted in a standardized Excel template in which different options could be either switched on or off, but without changing the overall lay-out of the data in the spreadsheet. The main worksheets of the spreadsheet are:

- Haul information e.g. haul number, date, shoot time, haul time, shoot position, haul position, temperature, depth, gear attributes, catch (see Annex 5).
- Batch or 'Merk' information e.g. total catch per batch - production unit, species, size category, biological attributes, quality attributes.
- Haul and Batch - coupling of haul and batch: how much of a batch is caught in a certain haul.
- Length - length frequency per species and per sample (see Annex 6).

A major feature of the PFA self-sampling programme is that it is tuned to the capacity of the vessel-crew to collect certain kinds of data. Depending on the number of crew and the space available on the vessel, certain types of measurements can or cannot be carried out. That is why the programme is essentially tuned to each vessel separately. It is important to bear in mind that vessels may be providing more or less complete data, and that this should be considered when processing and compiling data.

3.2.3 Sampling protocols

The following is the defined protocol in Pastoors (2018) for length sampling which is applicable to vessels: Cornelis Vrolijk, Afrika, Carolien, Maartje Theadora, Margiris, Annelies Ilena, Alida, Willem van der Zwan.

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How often to sample: ideally, every haul would be sampled. However, this is not always practical or achievable. Please follow the following guidelines:

- If the catches are very similar between hauls, it would be sufficient to take one sample per day, preferably during different times of day and night, e.g. the first sample at 12:00 on day 1, the second sample at 21:00 at day 2 and the third sample at 4:00 on day 3 etc.
- If the catches are highly variable between hauls or between day and night, it is important to sample more often and as a minimum to sample during different parts of the day or the night.

Taking a random sample: it is important that a random sample of the catch is obtained. Dependent on the lay-out of the vessel, the type of fishery and the time available for sampling, different options are available for obtaining a random sample:

- Holding a (open) bucket or orange fish basket under the fish water separator.
- Stopping the conveyor belt built for a quick moment and collecting the fish from a certain region of the conveyor belt over all lanes. It is important to make sure that the fish area collected in an equal share of all lanes until the sample is large enough.
- Scooping fish from the hopper before it goes on the conveyor belt (mostly difficult to achieve nowadays)

Don't take a sample at the start of the production from the pumping system or from the fish tank, but rather when the pumping or tank emptying has been going on for some time already.

Determining the size of the sample: in principle we would want a sample of around 100 fish, because that is expected to give a reliable length distribution. This includes all species in the sample.

- When the sampling is of big fish (e.g. mackerel), you will probably need to sample around 20-25 kg. If it is small fish like pilchard, anchovy or sprat, it could be that 2-5 kg may be sufficient.
- If you find that with a certain weight, you are sampling too many fish or too few fish, perhaps you could adapt the next sample to be somewhat smaller or bigger. The most important thing is that you write down the sample weight!!

Handling the sample: when the sample has been taken, the following steps need to be taken:

1. Sort the sample into the different species
2. Weigh each of the species fractions and note down the weight of each species fraction
3. Measure each of the fish of each of the species and generate a tally sheet ('turf list')

Measuring the fish: there are three different ways of measuring fish:

- Standard length (SL)
- Fork length (FL)
- Total length (TTL)

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All measurements are taken to the cm below. Preferably, the following measurements would be used:

- Northeast Atlantic Ocean and West of Africa: Total length
- South Pacific Ocean: Fork length

Please make sure (always) to indicate which measurement type has been used.

Protocols are yet to be defined in relation to roe sampling which takes place during the winter herring fishery (in 2018). When additional biological sampling is required (e.g. during survey work on commercial trawlers), the manual indicates that Martin Pastoors should be contacted (Pastoors, 2018).

Entering the data: this should be carried out through standardized Excel spreadsheets that have been developed. The standardized Excel template includes different options that can be either switched on or off, but without changing the overall lay-out of the data in the spreadsheet. There are a number of worksheets that summarize and quality control the data that were entered.

- Cell protection: to avoid accidental errors in the input to the spreadsheet or in the handling of the formulas in the spreadsheet, the spreadsheet is automatically protected whenever it is opened. The worksheet protection will make sure that formulas cannot be overwritten or deleted and that settings for different cells are maintained and enforced.
- Hidden worksheets: the self-sampling spreadsheet is designed so that only the relevant worksheets to each vessel are shown. All other worksheets are simply hidden from view. The hidden worksheets can only be made visible when the work-sheet protection has been lifted.
- Utility pages: there are a number of utility pages included, to allow for species definitions, area allocations, maps and checks.
  a) Lists: contains list of species, vessel names etc. If you cannot enter a species on one of the other worksheets, it is probably because that species has not been entered in the species list yet. You can simply add that species in the row below the other species and it will then be possible to select the species on the other worksheets.
  b) Rect: contains information on coastline, ICES rectangles and ICES areas
  c) Check (in some versions only): checks the consistency of the catch per mark and catch per haul.

There are a number of hidden worksheets in the spreadsheet that are specifically aimed at the conversion of the information to the format of the PFA database. This applies to the hidden worksheets L1 (converts the length information to a table) and the S1 and S2 worksheets (converts the species compositions to a table). These hidden worksheets are not needed for the standard operator of the spreadsheet. Furthermore, R-code has been developed to read the data from the Excel worksheets, to store the data in R-Data files and to generate the standardized reports and dedicated analyses.

3.2.4 Lessons learned

The PFA self-sampling programme has been developing since 2015 and can still be considered in building-up phase, the collected data and information has shown its value in contributions to scientific understanding of the relevant ecosystems and the compositions of the catches (e.g. ICES, SPRFMO, also expected in FAO/CECAF). A general finding is that self-sampled data provide a more extensive impression of the catches throughout the fishing season, when compared with the scientific observer data that is limited to only a small number of trips.

There is an aim to achieve a level of standardization and harmonization across fisheries and vessels. However, given the difference between different fisheries and seasons, a full harmonization of methodologies has not yet been achieved. This is because during the design of the programme, the intention was to stay as close as possible to the standard operations that are carried out on-board specific vessels. Additional data requirements have meant placing extra burdens on the crew of the participating vessels, but these extra efforts are minimized as much as possible.

The self-sampling does not consist of a random selection of vessels, although overall fishing pattern does appear to represent the fisheries of the PFA vessels. However, it is not yet possible to make an overall comparison between the catches of all the PFA vessels and the catches of the subset of self-sampling vessels. Efforts are being made to address this and next steps will also include a more thorough analysis of the biological variables (e.g. fat content, mean weight) that are measured in the standard operations on the vessels.

Overall the self-sampling programme has demonstrated the feasibility of self-documenting catches of this fleet and providing links between environmental parameters and catches. Feedback to participating crews and vessels is a key element of the programme. Maintaining engagement with the fishermen at sea is an essential requisite for the programme to continue to work. Direct communication involves an almost instantaneous return of the trip report after finishing a trip. By investing in standardized procedures, the response time back to the vessel is usually well below one week.

Self-sampling provides wider sample coverage than observers and has been shown to produce high-quality data that is consistent with observer sampling. However, self-sampling programmes have generally been voluntary leading to concerns about sampling frame bias and short natured with declines in enthusiasm over extended periods. Concerns have also been raised about potential bias or non-adherence to protocols (e.g. random sampling of fish, falsification of data). While such problems are not unique to self-sampling, such concerns are significant when considering self-sampling as a possible approach to fleet-wide discard sampling for full documentation of individual vessel's catch. It is thus important to introduce some means of verification of the accuracy of the catch gathered through self-sampling. Also, self-sampling in itself does not appear to work well for monitoring contentious, rare or protected species (Mangi et al., 2013).

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4 Guidelines for designing self-sampling programmes

Self-sampling is a participatory research activity where fishers are given full responsibility for data and/or sample collection. The GAP and GAP2 projects (Bridging the gap between science, stakeholders, and policy makers. Phase 2 (Integration of evidence-based knowledge and its application to science and management of fisheries and the marine environment) focused on participatory research in fisheries and produced a Good Practice Guide for Participatory Research in Fisheries Science where self-sampling is considered as one of the examples where fisheries scientists and managers can benefit from stakeholder participation (Mackinson et al., 2008, 2015). The Good Practice Guide outlines seven key principles for successful participatory research: 1) inclusivity, 2) effective facilitation, 3) joint ownership of knowledge, 4) overcoming institutional barriers, 5) prioritising communication, 6) planning participative, and 7) battling participation fatigue. Mackinson et al. (2015) stress the importance of preliminary preparatory activity where scientists and fishers discuss the goals of the research, the data/sample collection methods and how the collected data/samples will be used. Fishers need to be trained in data collection and biological sampling following a protocol so that data is collected in a standard and consistent manner. The need for mutual trust is essential in any participatory process where stakeholders are responsible for collecting data and samples. Trust building, long-term funding and good training of fishermen were highlighted as prerequisites for a successful implementation of a reference fleet and for the successful collection of data that could be included in stock assessments (Grohsler and Steppanis, 2009).

Lordan et al. (2011) stressed that in addition to clarity and transparency with regard project objectives, differences in expectations between industry and scientists and managers should also be carefully taken into consideration. Of particular relevance are differences between stakeholders and scientists and managers in the time-horizon and expected outcomes, with most stock assessment methods requiring relatively long time series of data. Such differences in expectations may influence the motivation of self-sampling participants from the industry.

The most important considerations for designing a self-sampling programme are summarised in Table 2 (adapted from ICES, 2008).

Table 2: Important considerations for designing a self-sampling programme

Aims	Clearly define the aim(s), mutually agreed and communicated to all participants.
Survey design	1) Preliminary analysis of existing or similar sampling programmes (e.g. observer surveys, harbour samples) to understand expected sources of variance and to evaluate sampling needs. 2) Define optimal temporal and spatial coverage and stratification. 3) A reference fleet of representative fishing vessels is recommended in many cases, especially when the number of vessels and metiers is large (van Helmond et al., 2012).
Financing	Financing can be done in a number of ways, including by direct payment of fishers (industry, national programme or DCF), access to extra quota for participants, fishing grounds or more days at sea). Fishers should be motivated to participate not only by financial means but also by participatory meetings to show and discuss data, look at trends over time and compare data collected by different fishers and observers.
Confidentiality	Data collected by fishers should be confidential.
Training	Participants need to be properly trained in sampling and data collection, with regular training courses and training on-board fishing vessels by observers / scientists. Fishers should be provided with clear sampling and data protocols and guidelines, as well as the necessary equipment and forms.
Quality	Data quality should be evaluated by cross checking with VMS data, logbook information, observer data and also for consistency (variability within each fishing vessel and between different fishing vessels).

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5 Advantages and disadvantages of self-sampling

Three types of data are required by fisheries scientists (Stebbins et al., 2009): 1) Catch: species composition and biomass of retained or discarded, 2) Fishing gear and effort, including location, gear characteristics, amount of gear and deployment times, and 3) Biological data: length distributions and samples for reproduction, feeding ecology (stomach contents) and age and growth studies (scales, otoliths and vertebrae). Most self-sampling programmes focus on the first two types of data as the collection of biological data beyond simply taking whole fish samples back to port is time consuming and requires specialized training. Nevertheless, in some fisheries from different parts of the world, fishers have been successfully used to collect all kinds of data and samples for biological studies as a complement to observer or scientist collection. The advantages and disadvantages have been discussed in a number of studies and publications. Table 3 summarizes the potential advantages and disadvantages of using observers and self-samplers (fishers) to sample discards on-board fishing vessels (Napier, 2015).

Table 3: Summary of potential advantages and disadvantages of using observers and self-sampling by fishers on-board commercial vessels for discards studies

Observers	Self-sampling
High level of control over sampling protocol.	Low level of control over sampling protocol
Requires sea-going staff (capable of working at-sea on-board commercial fishing vessels).	Does not require sea-going staff.
Observer can only sample one vessel at a time.	Same staff can process samples from multiple vessels.
Limit on the amount of time that an observer can spend at sea / number of vessels that can be covered. Limited	Limited only by the number of vessels willing to undertake sampling, and the availability of onshore staff.
Observers are occupied fulltime.	Staff only required part-time.
Observer can sample all (or most) tows made during a trip.	Samples can probably only be collected from a few of the tows made during a trip.
Observer can analyze all (or a high proportion) of a catch.	Only a sample of the catch is available
Observers' priority is to collect samples / data.	Fishermen have other priorities that may interfere with sample collection

In general, it can be stated that self-sampling allows less intensive sampling of a much larger number of vessels compared to costly, but more intensive sampling of a smaller number of vessels by research technicians or observers (Napier, 2015). Self-sampling may offer greater spatial coverage than research surveys of the use of a limited number of observers on-board commercial vessels. Furthermore, as research vessels availability is often limited and expensive, ad-hoc investigations of unexpected events such as the occurrence of large numbers of juveniles in some areas can be sampled by self-samplers on-board reference fleet vessels (Grohsler and Steppanis, 2009).

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6 EU Observer Programmes and Data collection

6.1 The EU Data Collection Framework (DCF)

A framework for the collection and management of fisheries data has been in place since the early 2000s with modifications and reforms during this time (ICCAT 2018, IOTC 2017). Under this framework the Member States (MS) collect, manage and make available a wide range of fisheries data needed for scientific advice, including fisheries that take place in distant waters. The data is collected on the basis of National Programmes in which the MS indicate which data is collected, the resources they allocate for the collection and how data is collected. MS must report annually on the implementation of their National Programmes and the Scientific, Technical and Economic Committee for Fisheries (STECF) evaluates these Annual Reports (https://datacollection.jrc.ec.europa.eu/).

These data collection activities are co-financed between the EU and the Member States and implemented by the relevant research institutes and ministerial departments in each EU Member State. A complete set of information pertaining to the fleets (catch and effort as well as biological and economic indicators) is compiled. To ensure a harmonised and coherent collection of the information, scientists of the different EU Member States carry out coordination meetings during which sampling schemes are fine-tuned and, where possible, some tasks are shared. This coordinated approach is particularly important when reporting to the relevant RFMOs, where the EU represents its members.

The DCF applies to all fisheries carried out by EU vessels inside and outside EU waters. However, we concentrate on EU MS such as France, Portugal, and Spain in the following to give an overview of data collection activities that are most relevant to the case studies. Other EU countries such as Ireland, Italy, UK and the Netherlands have or have had vessels operating in the CECAF, ICCAT and IOTC areas, but the same objectives of the DCF apply. There are differences between countries in terms of approaches used, but the overall goal is the same.

6.2 Scientific Observers Programmes

The EU national scientific observers cover the main fisheries in which the EU is involved in the CS areas such as tuna purse seine and longline fisheries, small pelagic trawl fisheries, demersal trawl and longline fisheries. These observer programmes have to comply with the requirements of DCF as well as the relevant RFMOs where the fisheries take place. The information collected concerns all target and not-target species and, where possible, the collection of data is extended to cover turtles, seabirds and marine mammals. The type of data collected refer to catch, discards, by-catch, vessels and fishing gear characteristics as well as biological parameters such as length, weight, sex, maturity and growth.

It is important to point out that producer organizations representing EU tuna purse seiners, in France (ORTHONGEL) and Spain (ANABAC and OPAGAC), have gone further and developed, in collaboration with the French Institute for Research for Development (IRD), the Spanish Institute of Oceanography (IEO) and AZTI-Tecnalia (Spain), a Voluntary Observing Programme to ensure 100% coverage of fishing activities through on-board observers and electronic means of surveillance.

6.3 Surface longliners (tuna, swordfish & sharks)

As an example, the Portuguese Institute for the Ocean and Atmosphere (IPMA) has developed a scientific observer programme for the mainland based pelagic longline fishery operating in the ICCAT and IOTC Convention areas. This observer programme collects all catches that interact with surface longliners, both as target and by-catch, retained or rejected (species/non-retained size data) and the scientific observers record a substantial amount of fisheries data, including species-specific incidental shark catches. The data collection currently includes, among other, the following information: Gear characteristics; Fishing regime (hook style and ganglion type) and effort (number of hooks); Catch composition (retained and discarded) and fate at species level; Size data for mandatory and major by-catch species (retained and discarded); Sex data for major species (including sharks). Additionally, a voluntary self-sampling scheme by skippers has been put in place for a number of years, as well as, the recovery of historical data from skipper's personal logbooks.

Another example concerns the longline fleet targeting swordfish in association with tuna; i.e. the Reunion-based longliners. The observation program is based on-boarding the larger vessels of the fleet and is supplemented by self-sampling activities carried out by the crew under the supervision of IRD scientists. The coverage rate of the fishing activity, measured in number of hooks, reached 3.77% in 2014 and 3.37% in 2015 and 2.93% in 2016 when considering only the share corresponding to the data collected by the observers on-board. This increased to 13.66% in 2014 and 14.30% in 2015 and 14.84% in 2016 when including the results of self-sampling activities conducted by the crew (IOTC, 2017).

6.4 Tuna Purse Seiners

In the case of tuna purse seiners, logbook data, including estimates of catches, are systematically cross-referenced with satellite positioning data of fishing vessels (VMS data), information from sales notes and information recorded by observers in their reports such as those from landings sampled in key ports of the Indian Ocean (Port of Victoria) and Atlantic Ocean (Dakar, Abidjan). The processing and consolidation of these data from EU purse seiners is done on the basis of shared procedures between EU research institutes, including IRD, IEO and AZTI-Tecnalia. These findings are reported to the relevant tuna RFMO and shared with several institutions of the coastal states with which the EU is bound by an SFPA.

6.5 Overview of applicable observer programmes

The following table (Table 4) attempts to provide an overview of the observer programmes that EU vessels/operators must implement, depending on the fishery and the fishing ground. This was constructed with a focus on CS areas, thus including the CECAF, SEAFO, ICCAT and IOTC conventions areas and the applicable requirements. Note however that EU vessels are currently not fishing in the SEAFO Convention Area and the reported catches for FAO Area 47 are presumably taken in the EEZs of coastal countries (Eurostat). Although EU vessels have fished in the SEAFO Convention Area in the past, primarily Spanish and Portuguese vessels, this has ceased for a number of years (SEAFO, 2017a).

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During 2017, only four fishing vessels from Japan and Namibia were active in the SEAFO area (SEAFO 2017b).

It is important to note that EU fleets are covered by the DCF, which implies that all fisheries taking place in distant waters are covered by observer programmes with a coverage of roughly of 10% (Table 4; EC 2018). This is defined in the context of DCF, where sampling should strive to achieve representative data. This concerns also fisheries taking place in the Southwest Atlantic for which there is no functioning RFMO, where IEO observer programme has achieved a good coverage of about 13% on average during the period 1989-2008 (Vilela-Pérez, 2013). Observers are also placed on EU vessels fishing for demersal and small pelagics in Northwest Africa, meaning that the self-sampling scheme implemented by the PFA (section 3.2) is an additional voluntary initiative to strengthen data collection.

The same applies to the observer programmes specified in the context of RFMOs and SFPAs in that there can be additional requirements, sometimes reaching up to 100% coverage in some fisheries. In the case of EU vessels operating in the waters of third countries, the level of coverage depends on what has been agreed upon in the context of the SFPA, which also takes into account the national legislation of that third country. This includes for example demersal trawlers and longliners operating in Mauritania and Senegal. It is also important to bear in mind that EU vessels sometimes operate under private agreements and charter agreements, which can add further complexity on observer requirements, but this appears not to be relevant in the case studies.

Table 4: Overview of the observer programmes in place for specific fisheries and areas. The specified coverage should be seen as a target level, not necessarily what has been achieved (modified and extended from Caillart et al. 2016)

Framework	Fisheries	Target	Type	Coverage
ICCAT	Tuna	Longline supply vessels	Control	100%
ICCAT	Tuna	All fishing vessels	Scientific	5%
ICCAT	Tuna	All tuna surface gears during moratorium	Mixed	100%
IOTC	Tuna	Longline supply vessels	Control	100%
IOTC	Tuna	All fishing vessels	Scientific	5%
SEAFO	All except tuna	All fishing vessels	Scientific	100%
SFPAs	All fisheries specified in SFPA	All EU fishing vessels	Mixed	Variable, up to 100%
EU National Programmes	All EU fisheries according to DCF	All EU fishing vessels	Scientific	Roughly about 10%
Coastal State National Programmes	All fisheries	Industrial vessels	Mixed	Variable, up to 100%
Private initiatives	Tuna purse seiners	All EU vessels and other associated with the ISSF	Scientific + best practices	100%

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In the case of EU purse seine vessels operating in the eastern Atlantic, five different observer programmes are applicable, each with different prescriptions regarding entity responsible for the programme (Flag State or Coastal State), observer mandate (scientific / enforcement / both), coverage rate (from 5% to 100%) and data ownership (Table 4). The situation of this fleet in relation is further complicated by the fact that these vessels can exploit both the high sea and the waters under jurisdiction of third countries during a same fishing trip. For other fleets, like the small pelagic freezer trawlers and demersal trawlers, the situation is simpler with two to three applicable programmes, and fishing area located exclusively in waters under jurisdiction of third countries.

In terms of coverage, tuna purse seiners are generally well covered by observers, which is further reinforced by the industry-led voluntary scheme on full coverage. This is not necessarily the case for surface longliners where coverage is variable and generally lower than the stipulated target of 5%. This is linked to the operations of these vessels, which fish in remote areas and pay rare visits to ports, making it difficult and costly to send observers on-board. Although some fleets achieve good levels of coverage (e.g. Portugal has achieved an average of 9% in the Indian Ocean), the average level fluctuates about 1-3%. In such cases, the use of electronic reporting (e-logbooks), which is compulsory on EU fishing vessels, becomes a key tool to obtain data on fishing activities. The use of self-sampling schemes in combination with observer data has provided valuable information and strengthened coverage (e.g. Portugal, Reunion), but consultations with Spanish operators indicate that these are reluctant to use such an approach (FarFish Workshop in Vigo, 26-27 June 2018). The view is that this would add further to the work load of the crew and that IEO has well-functioning observer programmes, albeit the data collected is not being used to its full potential.

In order to improve on the current situation in relation to purse seiners, French and Spanish shipowner associations are promoting the development of a common, single and permanent regional fisheries observer programme onboard their vessels to be implemented in partnership with Coastal states. This is being promoted both in the Atlantic and Indian Oceans. These associations would have the responsibility of training fisheries observers, forming a common pool of observers from the EU and Coastal States, who could be deployed on their vessels with a mandate which cover all mandatory and voluntary data collection programmes that apply during a specific fishing trip, either in waters under jurisdiction of Coastal States or in the high seas. This appears to be an ideal solution to facilitate implementation and make this more effective, but there is a need for support and agreement from Coastal States.

7 Conclusions and discussion

Self-sampling has been widely implemented in fisheries around the world to supplement fisheries-independent data and data collected by observers on-board commercial fishing vessels. Studies to evaluate the effectiveness of self-sampling compared to other methods have been advocated for long time (ICES, 2010). The fact that self-samplers have a stake in the outcome raises issues of reliability and is another reason for the need for comparison and validation studies (Uhlmann, 2013).

Most studies have concluded that the majority of self-sampling programmes are beneficial, contributing valuable data for stock assessment. In the groundfish fisheries of the north-eastern USA, Roman et al. (2011) compared self-sampling with a study fleet with other sources of data such as the Northeast Fisheries Observer Programme (NEFOP) and reported that effort and length-frequency data were better than logbook data and could be used for assessment of some data-deficient stocks. The reference fleet self-samplers were able to report catch and discards for each haul and their data did not differ significantly from fisheries-independent data.

Hoare et al. (2011) compared self-sampling with national data collection programmes in the Irish Sea Data Enhancement Pilot (ISDEP) and concluded that the programme was efficient and cost-effective, and the data were robust and had more precision. They concluded that the main benefits were in terms of increased quantity of discard data obtained and greater involvement of fishers in the assessment process. Hoare et al. (2011) stressed the need for incentives to maintain good levels of fisher participation and that it was preferable to involve fewer vessels with a good record of self-sampling than many vessels with variable participation.

In the northern Adriatic Sea, Mion et al. (2015) compared 3,588 self-sampled hauls recorded in electronic logbooks with 249 observer monitored hauls and found good agreement between the two. The self-sampling contributed to greatly enhance temporal resolution with the added benefit of greater involvement of the fishers in the scientific process.

In the context of the FarFish CS fisheries, observer coverage, required under the DCF, together with data collection under the framework of RFMOs and national third country requirements, is up to 100% in some cases. Trained observers record catch and effort data as well as undertake biological sampling. In such cases, where self-sampling is not required; it is difficult to see significant additional benefit to implementing a self-sampling programme on top of existing observer programmes. Given the reluctance of the industry to participate in the implementation of self-sampling programmes in the FarFish CS fisheries (FarFish Vigo meeting, 26-27 June, 2018), implementing self-sampling programmes in FarFish CSs does not seem to be viable at this time. For this reason, no specific protocols or templates have been developed. However, this review has identified guidelines for successful implementation of self-sampling programmes and provides a number of examples of such programmes, with examples of data sheets and protocols. Therefore, if necessary, it would be a simple matter to prepare protocols and templates for FarFish CSs. Implementation on the other hand would require the collaboration of industry and funding for training and maintaining the self-sampling programme.

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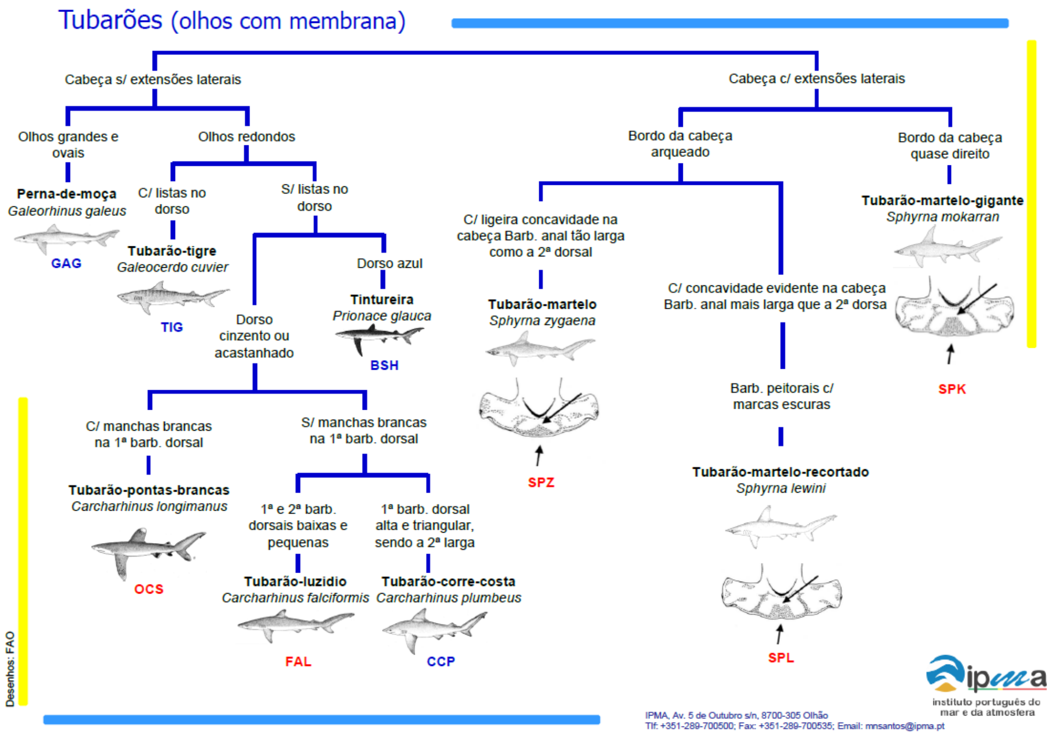
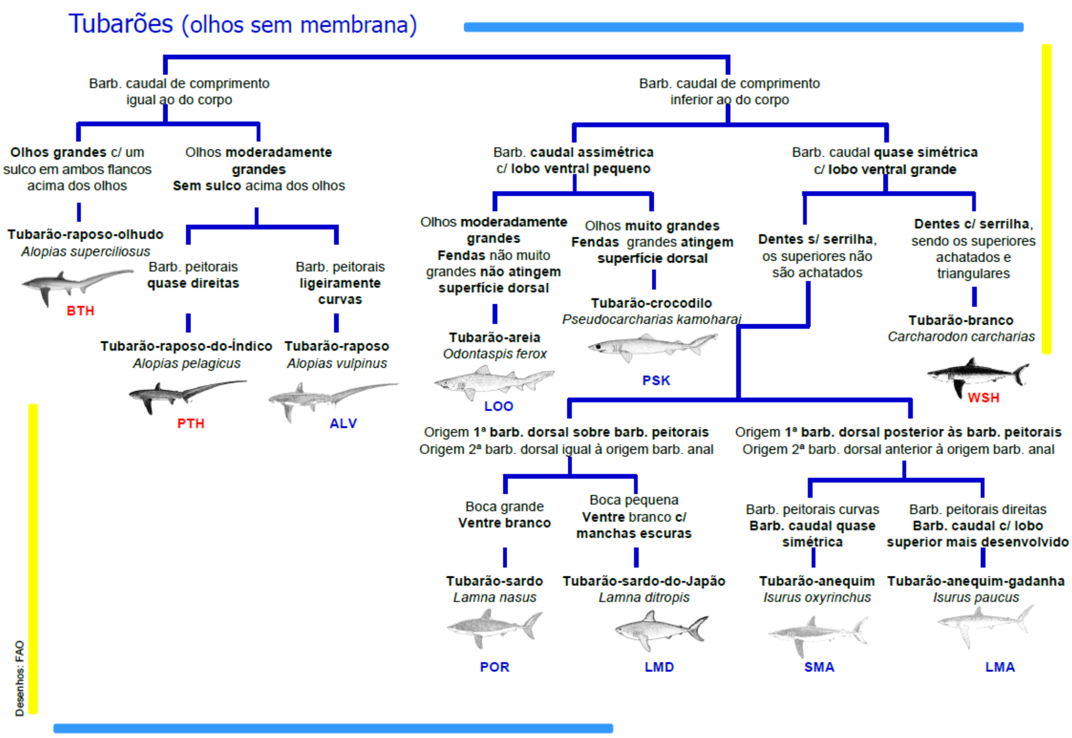
Annexes

Annex 1. Example of an identification key for sharks (with and without eye membranes) produced by the project. Additional keys for guides and summaries were produced tunas, billfish, and turtles, as well as characteristics of target and bycatch species.





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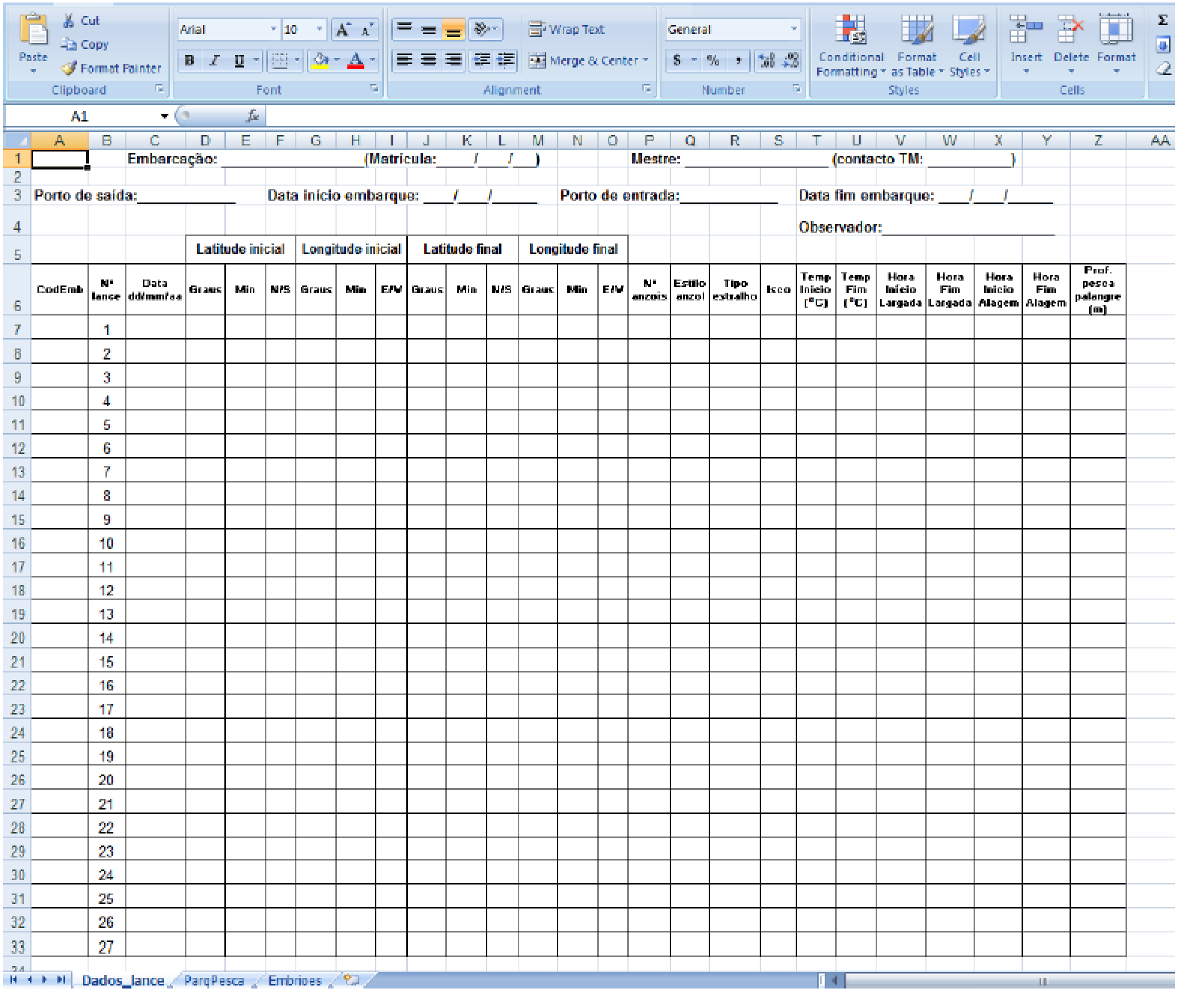
Annex 2. Form developed for collecting haul information to be entered in the Observer database developed at INDP.



Embarcação: ____________________ (Matrícula: ____/____/____) Mestre: ____________________ (contacto TM: ____________)

Porto de saída: ____________ Data início embarque: ____/____/______ Porto de entrada: ____________ Data fim embarque: ____/____/______

Observador: ____________________

			Latitude inicial			Longitude inicial			Latitude final			Longitude final													
CodEmb	Nº lance	Data dd/mm/aa	Graus	Min	N/S	Graus	Min	E/W	Graus	Min	N/S	Graus	Min	E/W	Nº anzois	Estilo anzol	Tipo estralho	Isco	Temp Inicio (°C)	Temp Fim (°C)	Hora Início Largada	Hora Fim Largada	Hora Inicio Alagem	Hora Fim Alagem	Prof. pesca palangre (m)
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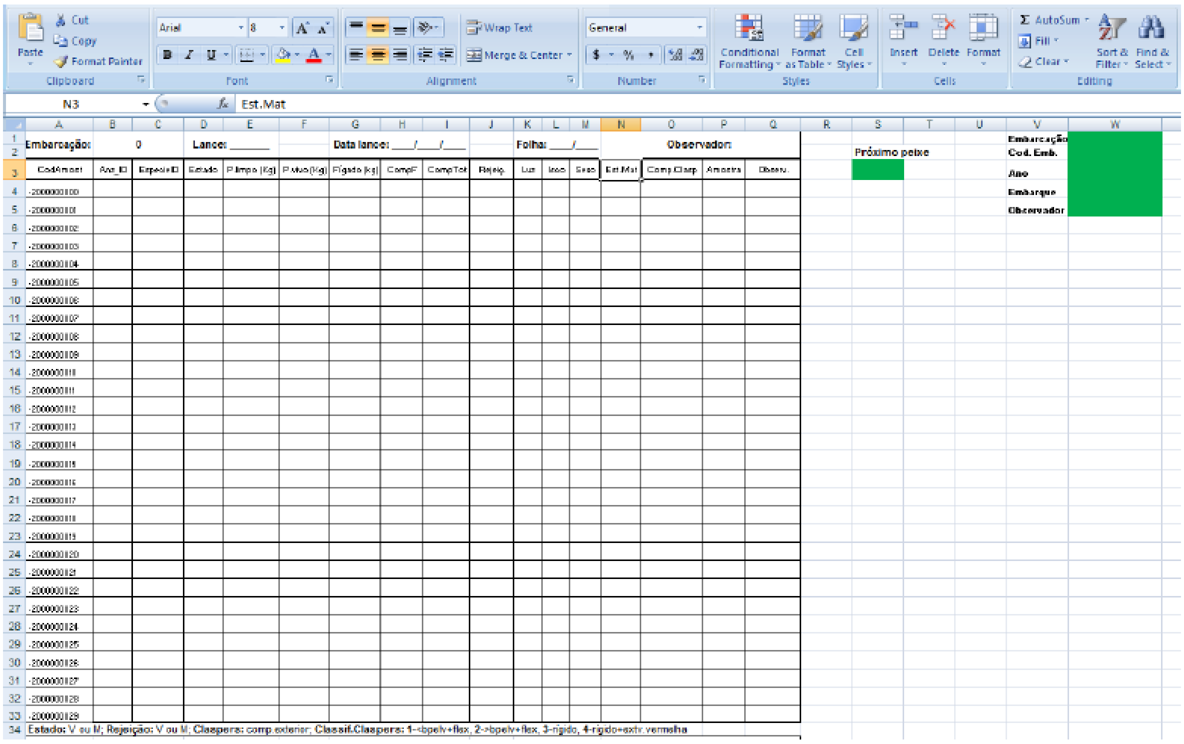
Annex 3. Form developed for collecting biological information to be entered in the Observer database developed at INDP.



Para cada exemplar capturado, devem-se preencher os seguintes dados:

- Código da amostra: número sequencial único pré-programado para refletir o código da embarcação, o código da missão e o número sequencial de exe3mplares capturados durante a viagem;
- Identificação do anzol;
- Identificação da espécie, usando dos códigos de 3 letras da FAO;
- Estado no momento de captura: V=vivo, M=morto;
- Peso limpo, vivo e do fígado (kg);
- Comprimento furcal e total (cm);
- Estado no caso de ser rejeitado: V=vivo, M=morto;
- Luz no caso de terem sido usados lanternas nos anzóis;
- Tipo de isco usado;
- Sexo do exemplar: M=macho e F=fêmea;
- Estado de maturação (*ver detalhes na secção seguinte*);
- Comprimento dos claspers: para os elasmobrânquios machos;
- Recolha de amostras: especificar se foram recolhidas amostras biológicas, por exemplo vértebras, tecido para genética, espinhos, etc.
- Observações: outras observações relevantes que possa ser registadas durante o processo de pesca, incluindo a presença de parasitas, marcas de acasalamento emarcas de predadores.

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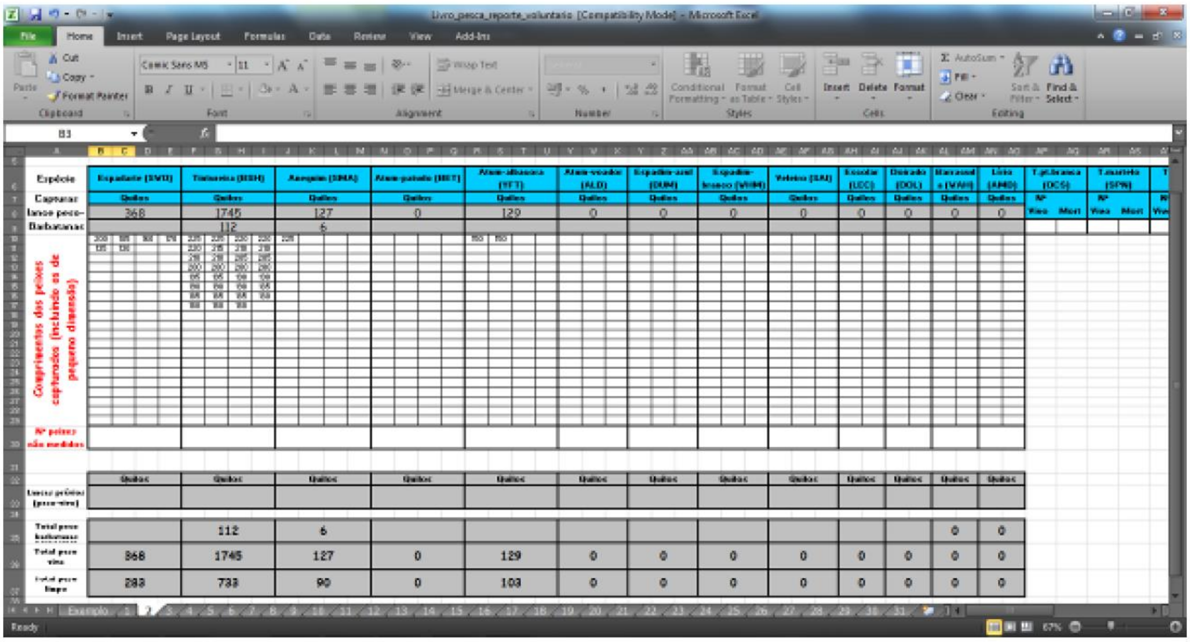
Annex 4. Form developed for the Self-sampling scheme to register data on catch and bycatch by haul in the longline fishery. The project provides a detailed guide on how to install the Excel workbook and its configuration as well as the data to be entered. There are 31 sheets, one for each daily haul in a month.



Annex 5. Example of haul information obtained from PFA self-sampling.

vessel	trip	haul	date	shoot time	haul time	shoot lat	shoot NS	shoot long	shoot EW	haul lat	haul NS	haul long	haul EW	surface temp	headline temp	Wind direction	Windforce (Bft)	headline depth	water depth	mesh size	vert opening	horz opening	netcode	number meshes	catch
BX791	201701	1	23/11/2017	00:55	07:45	55°39'	N	009°18'	W	55°45'	N	009°14'	W	11.5		n	6.0		150	44	40	130	6400		14.4
BX791	201701	2	23/11/2017	10:45	15:50	55°38'	N	009°00'	W	55°33'	N	008°51'	W	11.5		n	4.0		90	44	30	120	5600		35.2
BX791	201701	3	25/11/2017	03:00	04:50	52°35'	N	012°04'	W	55°28'	N	012°01'	W	12.5		nw	5.0		300	44	40	130	6400		4.8
BX791	201701	4	25/11/2017	06:30	18:55	52°28'	N	012°01'	W	52°31'	N	012°06'	W	12.5		nw	5.0		300	44	40	130	6400		54.2
BX791	201701	5	26/11/2017	09:10	19:15	52°27'	N	012°01'	W	52°40'	N	012°03'	W	12.4		w	5.0		260	44	40	130	6400		32.4
BX791	201701	6	26/11/2017	22:20	05:15	52°43'	N	012°01'	W	52°35'	N	012°01'	W	12.4		w	5.0		250	44	40	130	6400		1.2
BX791	201701	7	27/11/2017	10:30	18:55	52°46'	N	012°06'	W	52°42'	N	012°06'	W	12.3		nw	6.0		260	44	40	130	6400		15.6
BX791	201701	8	28/11/2017	04:00	05:20	53°39'	N	010°48'	W	53°44'	N	010°47'	W	11.6		n	5.0		150	44	40	130	6400		-
BX791	201701	9	28/11/2017	10:50	14:15	54°24'	N	010°47'	W	54°27'	N	010°27'	W	11.5		n	5.0		140	44	40	130	6400		-
BX791	201701	10	29/11/2017	05:00	09:05	55°47'	N	009°09'	W	55°53'	N	009°06'	W	11.0		n	5.0		140	44	40	130	6400		3.6
BX791	201701	11	29/11/2017	10:25	18:25	55°52'	N	009°08'	W	56°00'	N	009°07'	W	11.0		n	5.0		160	44	40	130	6400		68.4
BX791	201701	12	29/11/2017	23:05	08:15	56°08'	N	009°03'	W	56°18'	N	009°06'	W	10.9		n	5.0		160	44	40	130	6400		58.8
BX791	201701	13	30/11/2017	10:25	18:30	56°12'	N	009°05'	W	56°10'	N	009°04'	W	10.9		n	5.0		170	44	35	115	6400		55.1
BX791	201701	14	30/11/2017	22:40	07:50	55°51'	N	009°14'	W	55°53'	N	009°14'	W	11.0		n	4.0		180	44	40	130	6400		57.5
BX791	201701	15	01/12/2017	10:30	17:50	55°55'	N	009°12'	W	55°58'	N	009°08'	W	11.0		n	3.0		180	44	40	130	6400		35.9
BX791	201701	16	02/12/2017	10:50	11:50	55°40'	N	008°58'	W	55°44'	N	008°59'	W	10.9		nw	5.0		110	44	35	115	5600		59.9
BX791	201701	17	02/12/2017	16:30	18:55	55°56'	N	009°08'	W	55°59'	N	009°10'	W	11.0		nw	5.0		180	44	40	130	6400		-
BX791	201701	18	04/12/2017	10:40	11:15	52°46'	N	012°05'	W	52°42'	N	012°04'	W							44	40	130	6400		-
BX791	201701	19	06/12/2017	01:00	01:05	50°05'	N	001°03'	W	50°05'	N	001°02'	W	13.0		s	3.0		50	44	25	85	5600		53.8
BX791	201701	20	06/12/2017	04:35	04:45	50°03'	N	000°40'	W	50°03'	N	000°41'	W	13.0		s	3.0		50	44	25	85	5600		23.9
BX791	201701	21	06/12/2017	06:30	06:40	50°04'	N	000°40'	W	50°04'	N	000°43'	W	13.0		s	3.0		50	44	25	85	5600		43.1
BX791	201701	22	06/12/2017	11:15	11:20	50°05'	N	000°39'	W	50°05'	N	000°38'	W	13.0		sw	4.0		50	44	25	85	5600		64.6
BX791	201701	23	06/12/2017	13:55	00:00	50°05'	N	000°39'	W	50°05'	N	000°37'	W	13.0		sw	4.0		50	44	25	85	5600		45.4
BX791	201701	24	06/12/2017	17:23	17:46	50°01'	N	000°32'	W	50°01'	N	000°30'	W	13.0		sw	5.0		50	44	25	85	5600		12.0
BX791	201701	25	06/12/2017	19:10	19:30	50°01'	N	000°29'	W	50°00'	N	000°32'	W	13.0		sw	5.0		50	44	25	85	5600		44.3
BX791	201701	26	07/12/2017	00:10	00:30	50°01'	N	000°31'	W	50°01'	N	000°27'	W	13.0		sw	6.0		50	44	25	85	5600		59.8
BX791	201701	27	07/12/2017	03:30	03:45	50°00'	N	000°31'	W	49°59'	N	000°33'	W	13.0		sw	6.0		50	44	25	85	5600		33.5
BX791	201701	28	07/12/2017	07:55	08:05	50°02'	N	000°24'	W	50°02'	N	000°25'	W	13.0		sw	7.0		50	44	25	85	5600		19.1
BX791	201701	29	07/12/2017	12:50	13:25	50°01'	N	000°28'	W	50°03'	N	000°23'	W	13.0		sw	8.0		50	44	25	85	5600		29.9
BX791	201701	30	07/12/2017	16:10	16:35	50°00'	N	000°23'	W	50°01'	N	000°26'	W	13.0		sw	7.0		50	44	25	85	5600		25.1
BX791	201701	31	07/12/2017	18:55	19:30	50°01'	N	000°30'	W	50°01'	N	000°28'	W	13.0		nw	5.0		50	44	25	85	5600		80.1
BX791	201701	32	07/12/2017	23:25	23:40	50°00'	N	000°28'	W	50°01'	N	000°25'	W	13.0		nw	6.0		50	44	25	85	5600		58.6
BX791	201701	33	08/12/2017	02:50	03:10	50°02'	N	000°26'	W	50°02'	N	000°23'	W	13.0		nw	5.0		50	44	25	85	5600		87.3
BX791	201701	34	08/12/2017	10:35	10:45	50°01'	N	000°27'	W	50°01'	N	000°26'	W	12.6		nw	7.0		50	44	25	85	5600		65.8
BX791	201701	35	08/12/2017	15:22	15:50	50°01'	N	000°31'	W	50°01'	N	000°28'	W	12.8		nw	7.0		50	44	25	85	5600		56.2

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Annex 6. Example of length information obtained from PFA self-sampling.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	vessel	BX791	BX791	BX791	BX791	BX791	BX791	BX791	BX791	BX791	BX791	BX791	BX791	BX791
2	trip	201701	201701	201701	201701	201701	201701	201701	201701	201701	201701	201701	201701	201701
3	merk	HOM 008	HOM 009	HOM 010	MACP 011	HOM 012	SQU 013	HOM 014	HOM 015	HOM 016	HOM 017	HOM 018	HOM 019	MACK 020
5	species	HOM	HOM	HOM	MAC	HOM	SQU	HOM	HOM	HOM	HOM	HOM	HOM	MAC
6	sampleWeight	23.0	23.1	23.1	23.0	23.1	25.0	23.1	23.1	23.0	23.04	23.09	23.0	23.0
7	date	23/11	23/11	23/11	23/11	25/11	25/11	26/11	27/11	30/11	30/11	30/11	30/11	02/12
8	lengthType	TTL	TTL	TTL	TTL	TTL	TTL	TTL	TTL	TTL	TTL	TTL	TTL	TTL
28	20									3				
29	21	1								8				
30	22	1								57				
31	23	36								104	28			
32	24	121								36	73			
33	25	48			5					11	64			
34	26		3		43					6	10	7		
35	27		18		53						3	20		
36	28		43		47							45		
37	29		34		9							35		
38	30		25	8	6		4					14	2	10
39	31		8	18		3	6	1					2	23
40	32			23		9	9	3					17	29
41	33			21		14	6	12	1				18	16
42	34			8		16	10	21	12				21	7
43	35			7		11	12	11	21				7	1
44	36			1		8	18	16	18				4	
45	37					4	12	2	8				2	
46	38					1	14		1					
47	39					1	17		1					
48	40						16							
49	41						10							
50	42						8							
51	43						7							
52	44						3							
53	45													

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Annex 7. Example of the Sample Record Sheets issued to skippers. Discards self-sampling sheets carried out in partnership with the Shetland Fishermen's Association (SFA). Source: Napier (2015).

NAFC Marine Centre
University of the Highlands and Islands

Port Arthur, Scalloway, Shetland, ZE1 0UN, Scotland, UK

Tel: 01595 772000

Email: info@nafc.uhi.ac.uk
Web: www.nafc.ac.uk

Ian: 077 869 711 87 Leslie: 077 866 563 98

Discards Self-Sampling

See over for information

Vessel:	
Skipper:	

PLN:	

Trip Start Date:		**End Date:**	

Haul to be Sampled:	

Hauls:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Haul Information

Haul No.	
Date:	
Tow Duration:	
Haul Time:	

ICES Square:	
Fishing Ground:	

No. of Boxes Kept:		**No. of boxes Discarded:** (including sample)	

Sample Information

	Box 1	Box 2	
SFPA Tag No:			

Please write any comments or other information in the space below:

continue on the back if necessary

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Further Information

- Please collect a sample consisting of two boxes of discards from the specified haul.
- If you are unable to sample the specified haul please sample the next one.
- Fill three boxes at intervals with whatever is being discarded from the catch.
- Please ensure that the samples include all the fish being discarded as they come off the end of the belt (do not just pick out certain species or sizes of fish).
- Space the samples out so that the discards from all parts of the catch are sampled (for example, fill one box after 1/3 of the catch has been processed and one box after 2/3).
- Put NAFC Sample labels in each box.
- Attach an SFPA tag to each box and record the tag numbers on the front of this sheet.
- Ice the boxes and store them in the hold.
- The sample should not be recorded in your log book.
- If you are using the SFA's Discard Tally Book please record the sampled catch in the tally book as normal, and mark that the catch was sampled.
- Please let us know when you will be landing your catch.
- When you land please place your sample separately from the rest of your catch.

If you have any queries, please contact:

Ian R. Napier (01595 772308, ian.napier@nafc.uhi.ac.uk)

or **Leslie Tait** (01595 772232, leslie.tait@nafc.uhi.ac.uk)

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Annex 8. Instructions for self-sampling of Dutch gillnetters (after Uhlmann, 2013).

Naast het invullen van de vangst op het logboek, dienen nu ook de discards genoteerd te worden.
• Discards moeten onderscheiden kunnen worden van aan te landen soorten. Dit doen we door voor de soortnaam een **D** op te schrijven. (zie voor de meeste soorten lijst onderaan)
• Discards zijn al die vissen en krabben die de visser normaal overboord zou gooien of in zijn net zou laten zitten, dus ondermaatse commerciële vissen, krabben en vis die wel gevangen is maar niet aangeland wordt.
• Per vis-sessie worden **3 stukken net van 100m** bemonsterd, 1 aan het begin, 1 in het midden en het laatste stuk van het net. Bij het binnenhalen van het net wordt dus meteen bemonsterd.
• Als er zeer veel discards in zitten (bijvoorbeeld omdat er 'in de schar gelopen' is) kan volstaan worden met 3x50 m net te tellen. Als er niet zoveel discards zijn dan 3x100 m net. Dit besluit wordt genomen tijdens het tellen in het eerste stuk net. GEEF DIT DAN AAN MET '50m' BIJ OPMERKINGEN IN HET LOGBOEK. Als dat er niet staat gaan we uit van 100m net.
• De discards moeten opgeschreven worden **in aantallen**, dus niet in kilo's. Tel het aantal stuks in het net, turf ze per soort en noteer het totaal aantal stuks op het logboek.
• LET OP: alle interacties met bruinvis moeten ook opgeschreven worden!

Translation:
In addition to filling in the catch on the logbook, the discards must now also be noted.
• Discards must be able to be distinguished from species to be landed. We do this by writing a **D** for the species name. (for most types of list see below)
• Discards are all those fish and crabs that the fisherman would normally throw overboard or leave in his net, so undersized commercial fish, crabs and fish that are caught but not landed.
• Per fish session **3 x 100m sections of net** net are sampled, 1 at the beginning, 1 in the middle and the last part of the net. The sampling of the net is therefore immediately sampled.
• If there are a lot of discards in it (for example because there is 'a mess'), it is sufficient to count 3x50 m net. If there are not so many discards then 3x100 m. This decision is taken during counting in the first piece of net. PLEASE NOTE THIS WITH '50m' IN REMARKS IN THE LOGBOOK. If that is not there, we assume 100m net.
• The discards must be written down **in numbers**, not in kilos. Count the number of pieces in the net, sort them by species and note the total number of individuals on the log.
• ATTENTION: all interactions with porpoises must also be written down!

Vis / benthos soort	Code vissoort	Discards
Makreel	MAC	DMAC
Tarbot	TUR	DTUR
Bot	FLE	DFLE
Griet	BLL	DBLL
Tong	SOL	DSOL
Kabeljauw	COD	DCOD
Wijting	WHG	DWHG
Schol	PLE	DPLE
Schar	DAB	DDAB
Zwemkrab	CAD	DCAD
Strandkrab	CAN	DCAN
Noordzeekrab	NCAD (CRE)	DNCAD
Bruinvis		PHO
Zeehond		SEAL

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Annex 9: Pound net haul protocol. Source: Gröhsler and Stepputtis (2009).

Pound net – haul form	Ship:	Captain:	Ship code:	Filled in from:

Position	Latitude	Longitude	Water depth
	° ' N	° ' E	m

Net	Typ	Number of meshes	Direction to coast

Haul-Nr.	Date	Time (Start)	Time (End)	Wind		Weather	Cod < 20 cm		Cod 20 - 38 cm		Cod (sized)		Comment (e.g. Discard, Specials, Frost sample, etc….)
	(dd/mm/yy)	(hh:mm)	(hh:mm)	Direction	Force	Code	Number (p.)	Weigth (kg)	Number (p.)	Weigth (kg)	Landing (kg)	☐ vmK ☐ amK	
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													

Contact: Institute for Baltic Sea Fisheries: Ronny Weigelt, ronny.weigelt@vti.bund.de; 0381/8116126; Daniel Stepputtis, daniel.stepputtis@vti.bund.de; 0381/8116136

Explanatory notes to pound net haul protocol for fishermen. Source: Gröhsler and Stepputtis (2009).

windforce	wind speed				wave height (m)	
in bft	m/s	km/h	mph	kn	deep sea (Atlantic)	shallow sea (North and Baltic Sea)
0	0,0 – <0,3	0	0 – <1,2	0 – <1	–	–
1	0,3 – <1,6	1 – 5	1,2 – <4,6	1 – <4	0,0 – 0,2	0.05
2	1,6 – <3,4	6 – 11	4,6 – <8,1	4 – <7	0,5 – 0,75	0.6
3	3,4 – <5,5	12 – 19	8,1 – <12,7	7 – <11		
4	5,5 – <8,0	20 – 28	12,7 – <18,4	11 – <16	0,8 – 1,2	1
5	8,0 – <10,8	29 – 38	18,4 – <25,3	16 – <22	1,2 – 2,0	1.5
6	10,8 – <13,9	39 – 49	25,3 – <32,2	22 – <28	2,0 – 3,5	2.3
6	13,9 – <17,2	50 – 61	32,2 – <39,1	28 – <34	3,5 – 6,0	3
8	17,2 – <20,8	62 – 74	39,1 – <47,2	34 – <41	more than 6,0	4
9	20,8 – <24,5	75 – 88	47,2 – <55,2	41 – <48		
10	24,5 – <28,5	89 – 102	55,2 – <64,4	48 – <56	till 20,0	5.5
11	28,5 – <32,7	103 – 117	64,4 – <73,6	56 – <64	more than 20,0	–
12	>32,7	>118	>73,6	>64		

weather	
0	clear, cloudless
1	partial cloudy
2	closed cloud cover
3	sand-,dust- or snow storm
4	fog or heavy smoke
5	drizzel
6	rain
7	sleet or snow
8	show er
9	no notice

fishing gear type	
OTB	Otter Traw l Bottom
PTB	Pair Traw l Bottom
TTB	Tw in Traw l Bottom
OTM	Otter Traw l Midw ater
PTM	Pair-Traw l Midw ater
GNS	Gill Net Set
GND	Gill Net Drift
LLS	Longline Set
FPN	Uncovered Pound Net
FYK	Fyke Net
FPO	Fish Pot

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Annex 10: Sampling periods and catch durations for each site. Periods are coloured, catch durations are given in hours at heaving days. Dates of laboratory sampling are illustrated in the outermost column. Question marks indicate samplings with unknown catch durations (those catches are not used in the analyses). Source: Gröhsler and Stepputtis (2009).

Date	Funen			Lolland			northern			Fehmarn	southern	southeastern		frozen samples (n)
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	
2008-09-11														
2008-09-12											24	24	24	
2008-09-13														
2008-09-14											48	48	48	
2008-09-15											24			
2008-09-16											24	48	48	
2008-09-17														
2008-09-18														
2008-09-19											72	72	72	
2008-09-20														
2008-09-21												48	48	37
2008-09-22							96		72		72			
2008-09-23											24	48	48	
2008-09-24											24	24	24	
2008-09-25							72		72		24			
2008-09-26							24		24		24	48	48	
2008-09-27														
2008-09-28												48	48	
2008-09-29							72		72	24	72			
2008-09-30												48	48	52
2008-10-01							48	48	48	48	48			
2008-10-02														
2008-10-03							48	48	48		48	72	72	
2008-10-04										48				
2008-10-05				?	?	?								
2008-10-06				24	24	24	72	72	72		72	72	72	39
2008-10-07				24	24	24				48				21
2008-10-08				24	24	24					48	48	48	
2008-10-09				24	24	24					24			
2008-10-10						24	96	96	96	48	24	48	48	23
2008-10-11				48	48	24								
2008-10-12											48			
2008-10-13	?	?	?	48	48	48	72	72	72	48	24	72	72	
2008-10-14														
2008-10-15														
2008-10-16							72	72	72		72	72	72	
2008-10-17				96	96	96						24	24	25
2008-10-18	120	120	120							24				
2008-10-19				48	48	48					72	48	48	
2008-10-20	48	48					96	96	96		24			71
2008-10-21				48	48	48					24	48	48	
2008-10-22			96	24	24	24				24				
2008-10-23	72	72		24	24	24					48	48	48	
2008-10-24				24	24	24	96	96	96		24			
2008-10-25				24	24	24				24				
2008-10-26											48	72	72	
2008-10-27	96	96	120	48	48	48								
2008-10-28							96	96	96		48	48	48	
2008-10-29	48	48		48	48	48					24	24	24	
2008-10-30										24				
2008-10-31	48	48	96	48	48	48	72	72	72		48	48	48	33
2008-11-01														
2008-11-02							48	48			48	48	48	
2008-11-03	72	72	72	72	72	72				24				
2008-11-04							48	48	96	24	48	48	48	
2008-11-05												24	24	
2008-11-06			72	72	72	72								
2008-11-07							72	72	72		72	48	48	26
2008-11-08	120	120		48	48	48				24				
2008-11-09														
2008-11-10	48	48												
2008-11-11			144	72	72	72				24	96	96	96	
2008-11-12							120	120	120					
2008-11-13										24		48	48	
2008-11-14				72	72	72					72			
2008-11-15														
2008-11-16							96		96			72	72	
2008-11-17				72	72	72				24	72			
2008-11-18											24			
2008-11-19														
2008-11-20												96	96	40
2008-11-21					96	96	120		120	24	72			
2008-11-22					24	24								
2008-11-23											48	72	72	
2008-11-24														
2008-11-25							96		96	24	48			
2008-11-26														
2008-11-27														
2008-11-28							72		72		72		120	
2008-11-29										24				
2008-11-30														
2008-12-01														
2008-12-02														
2008-12-03														
2008-12-04														
2008-12-05													168	
2008-12-06										24				36
2008-12-07														
2008-12-08											96			22
2008-12-09														
2008-12-10														
2008-12-11										24	96			80

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