PFA
PELAGIC FREEZER-TRAWLER ASSOCIATION

REPORT

Report on 2019 research projects

M.A. Pastoors

Pelagic Freezer-trawler Association (PFA) /
Redersvereniging voor de Zeevisserij (RVZ)

Louis Braillelaan 80
2719 EK Zoetermeer
The Netherlands
www.pelagicfish.eu

Please cite as:

Pastoors, M.A. (2020) Report on 2019 research projects. PFA report 2020/01

© 2020 Pelagic Freezer-trawler Association

Contents

Executive Summary

This reports documents the use and outcome of research projects in 2019 based on scientific catches allocated to members of the Redersvereniging voor de Zeevisserij. Although the scientific catches that has been used for the projects mentioned in this report have been allocated by the Netherlands, the reports is in English to allow for international dissemination of results.

In 2019, pelagic scientific catches has been allocated to the following projects:

- Industry acoustic survey and genetic research in 2018 and 2019 for herring in 6a North
- PelAcoustics using acoustics of PFA vessels
- Species Identification using acoustics
- Year of the Mackerel
- Self-sampling of the PFA fleet
- Fish condition research
- Other research activities

Main results can be summarized as follows:

Industry survey on 6a herring	Successfully executed the 2018 and 2019 industry acoustic surveys on herring in 6a (and 7bc). Results have been presented to ICES Planning Group on Surveys (WGIPS) in 2019 and 2020 and will be presented to the Herring assessment working group 2020 (HAWG). International reports are available.
PelAcoustics	The PelAcoustics project is looking to develop methodologies to utilize acoustic information from pelagic trawlers as supporting information for stock assessment and surveys. The focus in 2019 has been on implementing the OceanBox (now available on 5 trawlers) and the testing of tools to estimate overall biomass. In addition, we are exploring the overlap in length compositions of the blue whiting acoustic survey and the commercial catch compositions.

SpeciesID	Two different approach to species identification are being followed. 1) using multi-frequency acoustic data in combination with machine learning techniques to assess the probability of encountering certain species in certain areas/seasons. Main focus has so far been on fish-mapping technique. 2) exploring the use of new acoustic equipment (e.g. SeaPix) for species identification. Unfortunately, no concrete results have been obtained so far.
Year of the Mackerel	The Year of the Mackerel is a large, dedicated research effort to monitor the gonad development of Northeast Atlantic mackerel through the year 2019 based on sampling undertaken by a number of PFA vessels. Samples have been processed and are now being analysed to generate the final results.
Self-sampling	The self-sampling on PFA vessels has been rapidly expanding over the past years and is now covering all vessels. Dedicated reports are produced for each of the relevant expert groups. The development of software for self-sampling has been a major focus. The software has moved from trial to production state and is now being utilized on 5 trawlers and trialled on another 4 trawlers.
Fish condition	In collaboration with Wageningen Marine Research, an exploratory study has been set up to gain insight into the condition of fish in the catches of pelagic trawlers from the moment the fish comes on board until the end of the catch processing process. A specific monitoring protocol has been developed and is currently being implemented on a test vessel.

Other research activities

Improving the assessment of Greater Silver Smelt

This research project aims to improve the assessment of Greater Silver Smelt by utilizing this additional information in the assessment. As part of this work, a comparison has been carried out between the PFA self-sampling and the WMR standard monitoring research. The WMR calculated catch at age has been reviewed and checked and is available for the stock assessment. And the the Scottish deep-water survey has been made available for the stock assessment. The efforts are geared towards the benchmark of Greater Silver Smelt that is going to be held in February 2020.

Fat content research

A PhD student has been jointly funded by the University of Aberdeen, Scottisch Pelagic Fisheries Association and the PFA. The PhD student will look into the use of fat content data collected by thye fishing industry to assess the overall body condition of fish. Food availability and temperature are two environmental factors which are known to affect the body condition of fish. A Dutch internship is currently making the Dutch fatcontent data available for the research project.

Nederlandse samenvatting

In dit rapport wordt het gebruik en de uitkomsten van onderzoeksprojecten in 2019 beschreven op basis van wetenschappelijke vangsten die zijn toebedeeld aan de leden van de Redersvereniging voor de Zeevisserij. Hoewel het wetenschappelijk vangsten voor deze projecten zijn toebedeeld door Nederland, is het rapport in het Engels geschreven om internationale verspreiding van de resultaten mogelijk te maken.

In 2019 zijn pelagisch wetenschappelijk vangsten toegekend voor de volgende projecten:

- Industrie akoestisch onderzoek en genetisch onderzoek in 2018 en 2019 voor haring in 6a North
- PelAcoustics met behulp van akoestiek van PFA-schepen
- Soortidentificatie met behulp van akoestiek
- Jaar van de Makreel
- Zelfbemonstering van de PFA-vloot
- Visconditieonderzoek
- Andere onderzoeksactiviteiten

De belangrijkste resultaten kunnen al volgt worden samengevat:

Industrie survey van haring in gebied 6a	De industrie-akoestische surveys van 2018 en 2019 met betrekking tot haring in gebied 6a (en 7bc) zijn met succes uitgevoerd. De resultaten zijn gepresenteerd aan ICES Planning Group on Surveys (WGIPS) in 2019 en 2020 en zullen worden voorgelegd aan de Herring assessment werkgroep 2020 (HAWG). Internationale rapporten zijn beschikbaar.
PelAcoustics	Het PelAcoustics-project is op zoek naar methoden om akoestische informatie van pelagische trawlers te gebruiken als ondersteunende informatie voor bestandsschatting en surveys. De focus in 2019 lag op de implementatie van de OceanBox (nu beschikbaar op 5 trawlers) en het testen van tools om de totale biomassa te schatten. Daarnaast onderzoeken we de overlap in lengtesamenstellingen van het blauwe wijting akoestische onderzoek en de commerciële vangstcomposities.

SoortID	Twee verschillende benaderingen voor soortidentificatie worden gevolgd. 1) multi-frequentie akoestische gegevens gebruiken in combinatie met *machine-learning* technieken om de waarschijnlijkheid te bepalen dat bepaalde soorten in bepaalde gebieden / seizoenen worden aangetroffen. De belangrijkste focus is tot dusverre bezig geweest met het in kaart brengen van visverspreiding. 2) onderzoek naar het gebruik van nieuwe akoestische apparatuur (bijvoorbeeld SeaPix) voor identificatie van soorten. Helaas zijn er tot nu toe geen concrete resultaten verkregen.
Jaar van de Makreel	Het Jaar van de Makreel is een grote, toegewijde onderzoeksinspanning om de ontwikkeling van de geslachtsorganen van Noordoost-Atlantische makreel gedurende het jaar 2019 te volgen op basis van bemonstering uitgevoerd door een aantal PFA-schepen. Monsters zijn verwerkt en worden nu geanalyseerd om de definitieve resultaten te genereren.
Self-sampling	De zelfbemonstering op PFA-schepen is de afgelopen jaren snel gegroeid en dekt nu alle schepen. Specifieke rapporten worden geproduceerd voor elk van de relevante expertgroepen. De ontwikkeling van software voor zelfbemonstering is een belangrijk aandachtspunt geweest. De software is van proef naar productiestatus gegaan en wordt nu gebruikt op 5 trawlers en getest op nog eens 4 trawlers.
Vis conditie	In samenwerking met Wageningen Marine Research is een verkennend onderzoek opgezet om inzicht te krijgen in de toestand van vis in de vangsten van pelagische trawlers vanaf het moment dat de vis aan boord komt tot het einde van het vangstverwerkingsproces. Een specifiek monitoringprotocol is ontwikkeld en wordt momenteel geïmplementeerd op een testschip.

Overige onderzoeken

Verbetering van de beoordeling van Grote Zilversmelt

Dit onderzoeksproject heeft tot doel de beoordeling van Grote Zilversmelt te verbeteren door deze aanvullende informatie te gebruiken bij de beoordeling. Als onderdeel van dit werk is een vergelijking gemaakt tussen de PFA-zelfbemonstering en het WMR-standaardmonitoringonderzoek. De door de WMR berekende vangst op leeftijd is herzien en gecontroleerd en is beschikbaar voor de voorraadbeoordeling. En de Schotse diepwatersurvey is beschikbaar gesteld voor de stock assessment. De inspanningen zijn gericht op de benchmark van Grote zilversmelt die in februari 2020 zal worden gehouden.

Vetgehalte onderzoek

Een promovendus is gezamenlijk gefinancierd door de universiteit van Aberdeen, Scottisch Pelagic Fisheries As-sociation en de PFA. De promovendus onderzoekt het gebruik van vetgehaltegegevens die door de visindustrie zijn verzameld om de algehele lichaamsconditie van vissen te beoordelen. Voedselbeschikbaarheid en temperatuur zijn twee omgevingsfactoren waarvan bekend is dat ze de lichaamsconditie van vissen beïnvloeden. Via een Nederlandse stageplaats worden de Nederlandse vetgegevens momenteel beschikbaar gemaakt voor het onderzoeksproject.

1 Introduction

For many years already, the Pelagic Freezer-trawler Association (PFA) has been an active player on the interface between industry, science and management. PFA members have all contributed to data collection initiated by scientific institutes (observer trips, catch sampling, logbook information). In addition, the PFA has initiated and commissioned several scientific research projects, for example on stock structure of horse mackerel, on the improvement of the knowledge base for horse mackerel, catch sampling in Mauritanian waters etc.

In 2014, the PFA has developed their Science and Knowledge strategy 2015-2018 (PFA 2014) that provides for strategic foresight on the directions of research. Important themes in the strategy are:

1. documenting of catch and effort
2. using vessel acoustics for stock trends
3. improving selectivity
4. assessing impacts

The utilization of scientific catches provides an important avenue to facilitate the research ambitions of the PFA. That is why we are submitting an integrated request for scientific catches (by year) and that is why we are also reporting on the outcomes in the integrated results document that you have in front of you.

2 Research projects

2.1 Industry survey for herring in 6a-north (2018 and 2019)

This project combines the research efforts towards assessing the state of the 6a herring stock(s) and developing the tools to separate between 6a north and 6a south-7bc herring. The research has been carried out together with Wageningen Marine Research, member companies of RVZ/PFA and international partners. The 2018 and 2019 surveys are the third and fourth iteration of the survey.

Previously, the collection of acoustic data from commercial vessels had been discussed for a long time (e.g. FAO 2012; ICES 2007; Melvin and Power 1999), but real applications in European waters had been very limited. However, in 2016, the first industry acoustic and genetic survey for herring in ICES area 6.a has been carried out (Mackinson et al. 2017). During 2017, the second iteration of the integrated acoustic and genetic industry survey for herring in ICES area 6.a has been carried out and

2.1.1 Results of 2018 industry acoustic survey on 6a-7bc herring

2018 was the third industry-led survey of herring in 6a/7bc. Industry and scientific institutions from Scotland, Northern Ireland, Netherlands, Ireland, and England successfully carried out scientific surveys with the aim to improve the knowledge base for the herring spawning components in 6aN and 6aS, 7bc, and submit relevant data to ICES to assist in assessing the herring stocks and contribute to establishing a rebuilding plan (Mackinson et al. 2019).

Three industry vessels were used for acoustic surveys in 6aN and one in 6aS/7b. The vessels used in 6aN were each equipped with a calibrated Simrad EK80 transceiver using the ship's hull-mounted transducer. One industry vessel was dedicated to taking samples for morphological and genetic analyses in 6aN, and two others were directed to searching and fishing in specific areas so as to maintain comparability with previous commercial catch data.

In 6aN, each vessel undertook an acoustic survey in sequence, covering four known pre- spawning/ spawning areas. This was planned to coincide with the known spawning period, but spawning in 2018 was two or more weeks later than during previous surveys. In particular, the first two acoustic surveys were considered too early because no spawning ready/ spawning fish were found during the survey and because commercial fishing occurring at the end of September/ early Oct saw considerably more herring in areas where they were largely absent during the acoustic surveys. For example, in the area east of Cape Wrath. A notable feature of the 2018 survey was the recording of a good abundance 0-age group herring in the

Minches, generally mixed with similar sized sprat. The main concentration of mature herring found during the acoustic survey in 6aN was aggregated in Area 3 – North Minch, (same as 2017). 0-age group mackerel (10-15cm) were found in abundance distributed throughout the area, being caught in almost every haul. Sprat were also common again, distributed throughout the area in surface schools. Close attention was given to distinguishing these from herring schools during classification of the acoustic data. Total biomass estimates of herring recorded during the survey in 6aN was 118 000 t.

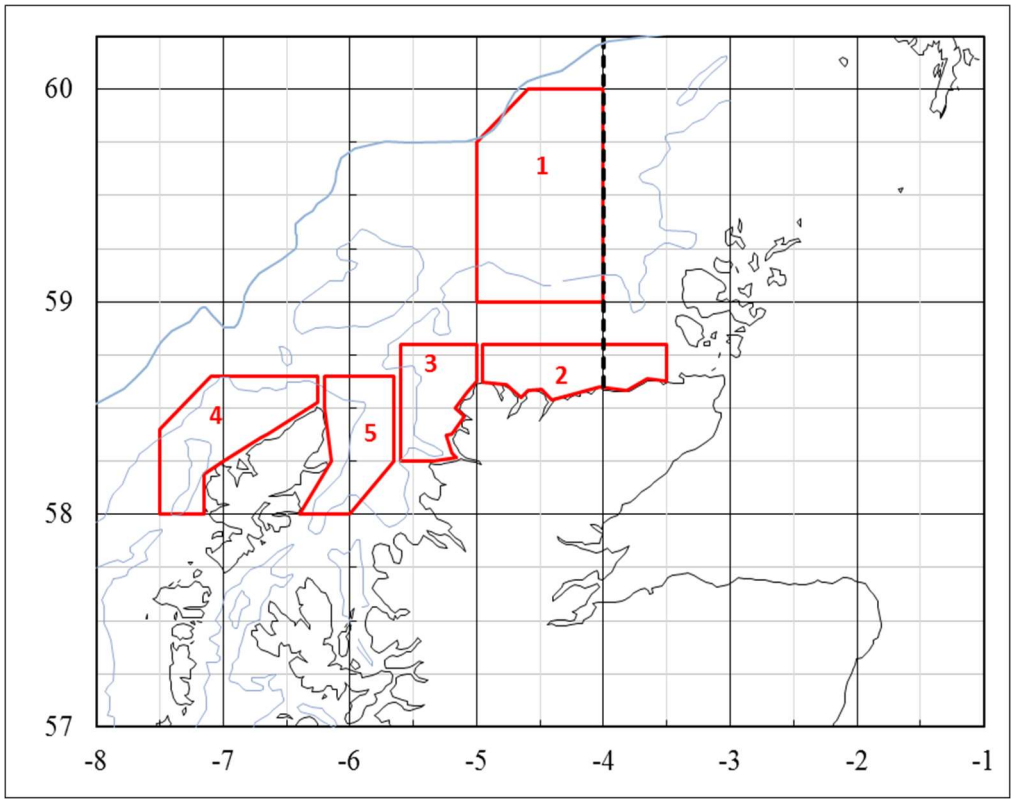


Figure 2.1. Survey areas used in the 6aNorth surveys. Area 1- North pre-spawning mixing area, Area 2 -East of cape Wrath, Area 3 – The Minch, Area 4 – Outer Hebrides, Area 5 – east Minch.

2.1.2 Results of 2019 industry acoustic survey on 6a-7bc herring

2019 was the fourth industry-led survey of herring in 6a/7bc. Three industry vessels were used for acoustic surveys in 6aN and one in 6aS/7b (Mackinson et al. forth). Two vessels used in 6aN were each equipped with a calibrated Simrad EK80 transceiver. FV Pathway used the ship's hull-mounted transducer, while FV Dirk Dirk deployed a towed body transducer. A different industry vessel was dedicated to taking samples for morphological and genetic analyses in 6aN, and another directed to searching and fishing in specific areas so as to

maintain comparability with previous commercial catch data. In 6aS/7b biological, genetic and morphometric samples for were collected by numerous inshore vessels.

In 6aN, the acoustic survey vessels were deployed in sequence, covering four known pre-spawning/ spawning areas. Timing was planned to coincide with the known spawning period, but the presence of adult herring marks was notably lower than in previous years and only one biological sample contained spawning-ready fish. Technical difficulties with the towed body transducer on FV Dirk Dirk followed by a malfunctioning hull transducer and significant disruption due to poor weather resulted in the Dirk Dirk data only being fit only to use as information on acoustic mark identification and fish distribution. No biomass calculations were possible.

The main distribution of acoustic marks that could be confidently identified as herring was concentrated in survey Area 3 (North Minch) in the same locations as previously recorded. No spawning marks were seen in Area 2 (East of Cape Wrath), where significant spawning marks have been seen in the past. Similar to 2018, a notable feature of the 2019 was a predominance in Area 5 (East side of Lewis) of young herring mixed with sprat. Horse mackerel were also recorded again, often in close proximity with herring marks and mixed diffuse aggregations of sprat. Mackerel were found in abundance distributed throughout the area, being caught in every survey haul. An aggregation of blue whiting (which were close to spawning) was located off Stornoway. Total biomass estimates of herring recorded during the survey in 6aN was 76, 000 t.

Coinciding with the 2019 International Herring Acoustic Survey, a one-off 10-day acoustic survey was carried out by FV Grateful in July. The first objective was to undertake a detailed survey of the Minch to address the question whether the limited coverage in the Minch by the International Survey might be missing herring aggregations outside of the survey track. The second objective was to try and identify the species responsible for strong acoustic marks associated with outcroppings on rocky ground. The acoustic survey did not record any herring marks, and trawl samples found very few herring that were mixed in with catches dominated by other species. Drop-camera work was successful in identifying that the acoustic marks on rocky ground are most likely produced by juvenile gadoid species and zooplankton concentrations.

2.1.3 Results of herring genetic research

TO BE UPDATED ~~Together with Ed Farrell and Jens Carlsson at University College Dublin and with the other pelagic industries in Europe, we have invested in the building up of knowledge around the genetic make-up of herring stocks in the North Sea and Western waters. The focus is on the development of new~~

~~genetic markers that could be used for immediate screening of individual fish. To achieve that goal we need to first establish the baseline of what the genetic profile of a herring from a certain spawning location is. A final report on the genetic work on herring is foreseen in 2018.~~

2.2 PelAcoustics

How could acoustic information collected by commercial fishing vessels be used as an addition or alternative to traditional acoustic surveys for estimating biomass of different fish species? This is the core question for the PelAcoustics project. The project looks at the mechanisms of collecting the acoustic data from trawlers and at the methods of generating biomass estimates.

2.2.1 Oceanbox as data-collector and integrator

In 2017 a new angle has been taken to develop the work on acoustic data recording on pelagic trawlers. Whereas the earlier programme focussed on the process of calibration and manual analysis of acoustic recordings of a limited number of vessels, the new programme is instead refocussing that attention towards automatic data capture and data processing on board of many trawlers at the same time. To achieve this ambition a collaboration has been developed between RVZ and Sustainovate (www.sustainovate.com) and several other partners.

The OceanBox is the key mechanism for collection and integration of sensor data onboard of commercial fishing vessels. The OceanBox is a system that collects, integrates and analyses data automatically and is easy to install and to manage. Based on the customer needs the OceanBox can have a live link with shore and can hold additional storage for raw (acoustic) data.

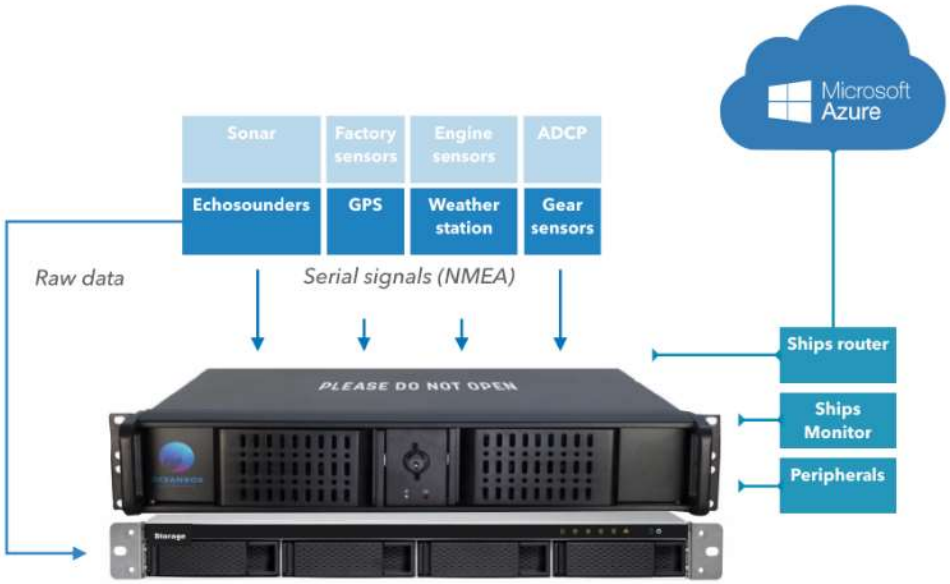


Figure 2.2. OceanBox systems design

The OceanBox was first installed onboard H72 Frank Bonefaas (December 2018), followed by the SCH6 Alida, SCH302 Willem van der Zwan, GDY151 Annelies Ilena and ROS171 Maartje Theodora (March/April 2019). The OceanBox systems have been in operation and recording since installation. An example of the recorded tracks and biomass estimates is shown in the figures below.

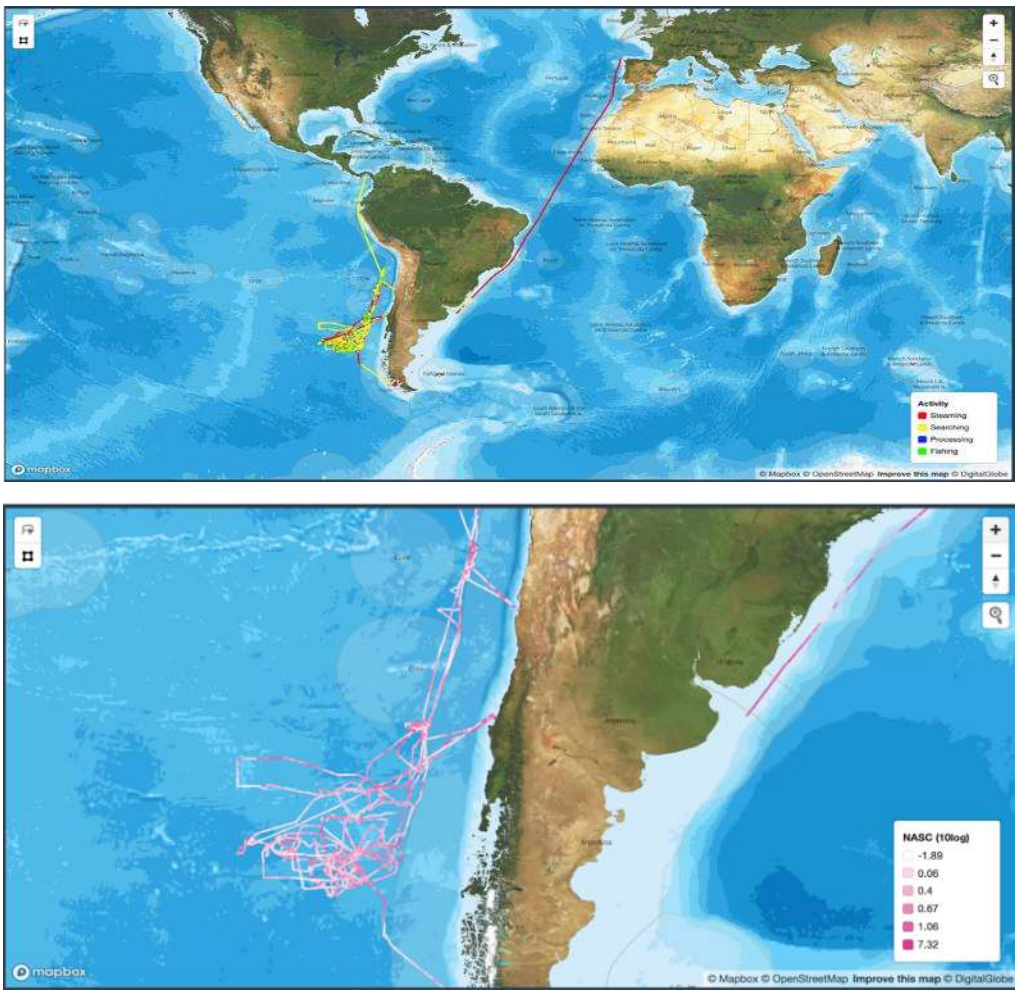


Figure 2.3. Example tracks (top) and biomass estimates (bottom) recorded with the OceanBox in 2019.

While the system for recording, integration, automatic analysis and transfer works according to plan, two technical issues still need to be resolved in order for the information to be fully useable for biomass estimation: 1) bottom detection and 2) EK80 support. These activities are currently ongoing and close to being finalized.

2.2.2 Biomass estimation

Can acoustic data from commercial trawlers be used to generate biomass estimates of commercially important fish stocks? The is the main question for the second part of the PelAcoustics project. A trial has been set up using acoustic recordings from pelagic trawlers during the herring fishery in 2017. During

the fishing period the herring stock moves relatively little and does not mix with other species. Furthermore, the scientific survey on North Sea herring gives a reliable indication of the relative biomass and can thus be used as a comparison.

The data from both the scientific survey and the fishery data used for the comparative study cover the same geographic area south-east of the Shetland Islands during the July 2017. To make the two data sets qualitatively comparable, they are both interpolated and calibrated. Because the commercial observations were in a more restricted area than the survey observations, the commercial observations needed to be extrapolated. Two different methods were used for the extrapolation of commercial observations to a larger area: 1) purely statistical method, 2) using a fish-distribution model that is based on machine learning. Results indicate that the statistical method approach for extrapolation has the tendency to overestimate stock biomass whereas the machine learning approach appears to provide a promising approach for converting commercial observations to overall stock biomass (Ybema and Johannsen 2020).

2.2.3 Comparison of blue whiting survey and commercial data

Blue whiting (Micromesistius poutussou) aggregates in one particular region around west of Ireland for spawning during the early spring. The commercial fishing effort overlap with ICES coordinated international scientific survey in area and time. The scientific survey protocol requires representative fish samples collected throughout the survey area with pelagic trawl nets. In adition to the verification of the species composition the samples are necessary also for obtaining lenght composition as well as other biological data such as age, sex and maturity stage.

Because of the spatio-temporal overlap between the survey and fishing effort, the commercial vessels may have hauls in the vicinity of the survey transects which can provide samples to be used for scientific purpose. For instance, the data coming from self-sampling database may be directly usable for this purpose. A first step towards the use of commercial length frequency data for survey index calculation consists of investigating the potential difference between survey and commercial length frequency data, and understand the origin of such differences. This analysis is being carried out by WMR and will be finalized early in 2020.

2.3 Species ID – developing tools for species discrimination

Acoustic species recognition has long been a very desirable goal for pelagic fishing. Over a long period of time and during multiple research projects, a search has been made for a way to recognize with acoustic equipment (echometers, sonars) which fish is swimming under or in front of the ship. An important principle here is that the selectivity in pelagic fishing is largely determined by the choice of whether or not to go fishing at a certain fishing school. Pre-identifying unwanted species therefore has a clear added value in avoiding unwanted species (or sizes).

2.3.1 Multi-frequency approach to species identification

When the 'SEAT II' project on multi-frequency species identification was completed (2015-2017), it was concluded that the techniques for acoustic data collection and analysis have been greatly improved thanks to the project and that in a number of cases species recognition worked well (Sustainovate 2018). However, there were also regular cases where SEAT could not be used for species recognition, for example because the acoustic fingerprints between species were too similar or where there was too much variation in the fingerprints over time and space. Main improvements were expected in: 1) using additional information from the acoustic data such as school shape and acoustic density and 2) excluding species in certain areas and seasons based on a habitat preference model. This model takes as an input historic catches and environmental conditions and provides real-time 'fish presence probability maps' for any species identification tool to use. The fish-mapping work is is currently in a final phase and the result are expected within the first months of 2020.

2.3.2 ixBlue SeaPix

Another recent development is that a number of other producers of acoustic equipment (e.g. ixBlue, Furuno) have introduced systems that claim to make species recognition possible. As part of the SpeciesID project, and in collaboration with Wageningen Marine Research and IxBlue we are exploring the potential utilization of the SeaPix system for species identification. Data for the analysis has been collected during 2018 and a preliminary analysis has been carried out during 2019. Final results are expected in the first half of 2020.

2.4 Year of the mackerel

The stock of Northeast Atlantic mackerel has raised a lot of attention over the last number of years. The expansion of the area of distribution of mackerel has been very conspicuous, with mackerel now being caught much more westerly and northerly compared to the past. In recent years also changes in spawning are apparent, with changes in timing and centre of gravity of spawning. Dealing with a stock with such a wide area of distribution from the west of Portugal all the way to the Norwegian Sea is providing a continuous challenge to attempt to monitor the development of this stock. One approach, that is followed here, is to improve our understanding of how mackerel gonads develop and when and where mackerel spawn. This information could affect the design of the mackerel egg survey and possibly also how spawning stock biomass is calculated from the stock in numbers within the stock assessment model.

The fishing industry has been getting involved in providing data on mackerel through different means, such as the mackerel tagging program and providing vessels to conduct the swept-area survey and the mackerel egg survey. In all cases, understanding the spatial-temporal patterns of mackerel is key to making these sources reliable indicators for stock assessment. The overall aim of the Year of the Mackerel project is to gain insight in the gonad development of female and male mackerel throughout the year in order to better understand the spawning strategy.

On a monthly basis male and female mackerel have been collected by the pelagic industry throughout the distribution area of mackerel. Wageningen Marine Research and partner institutes have prepared histological sections of the gonads. Each gonad will be analysed to identify which development stages of oocytes and spermatozoa are present in the gonad. This will allow to follow the gonadal development over time and determine the timing when mackerel is ready for spawning.

An overview of the samples taken by quarter is shown in the figure below.

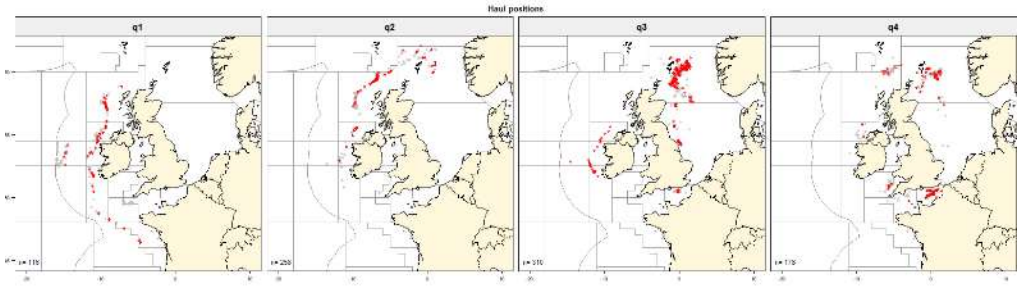


Figure 2.4. Mackerel samples taken by quarter during 2019.

The general approach to the processing of the gonad samples is explained in the figure below.

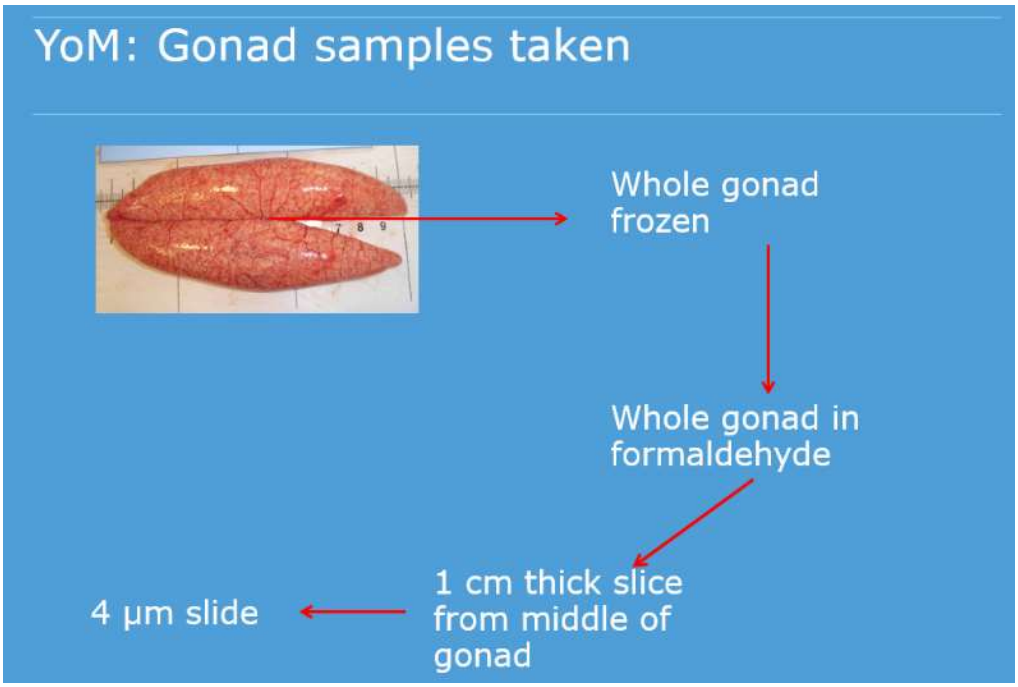
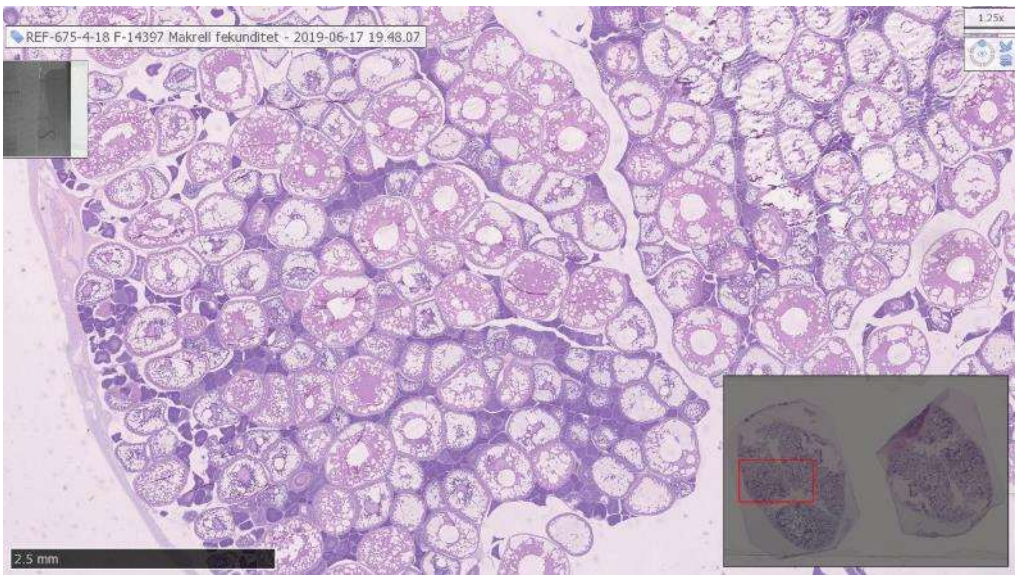


Figure 2.5. Processing of the Year of the Mackerel gonad samples.

The processing of the samples by WMR has largely been completed and the slides have been sent for specialized photographic digitalization. Examples of the digital representations at different magnification are shown below.



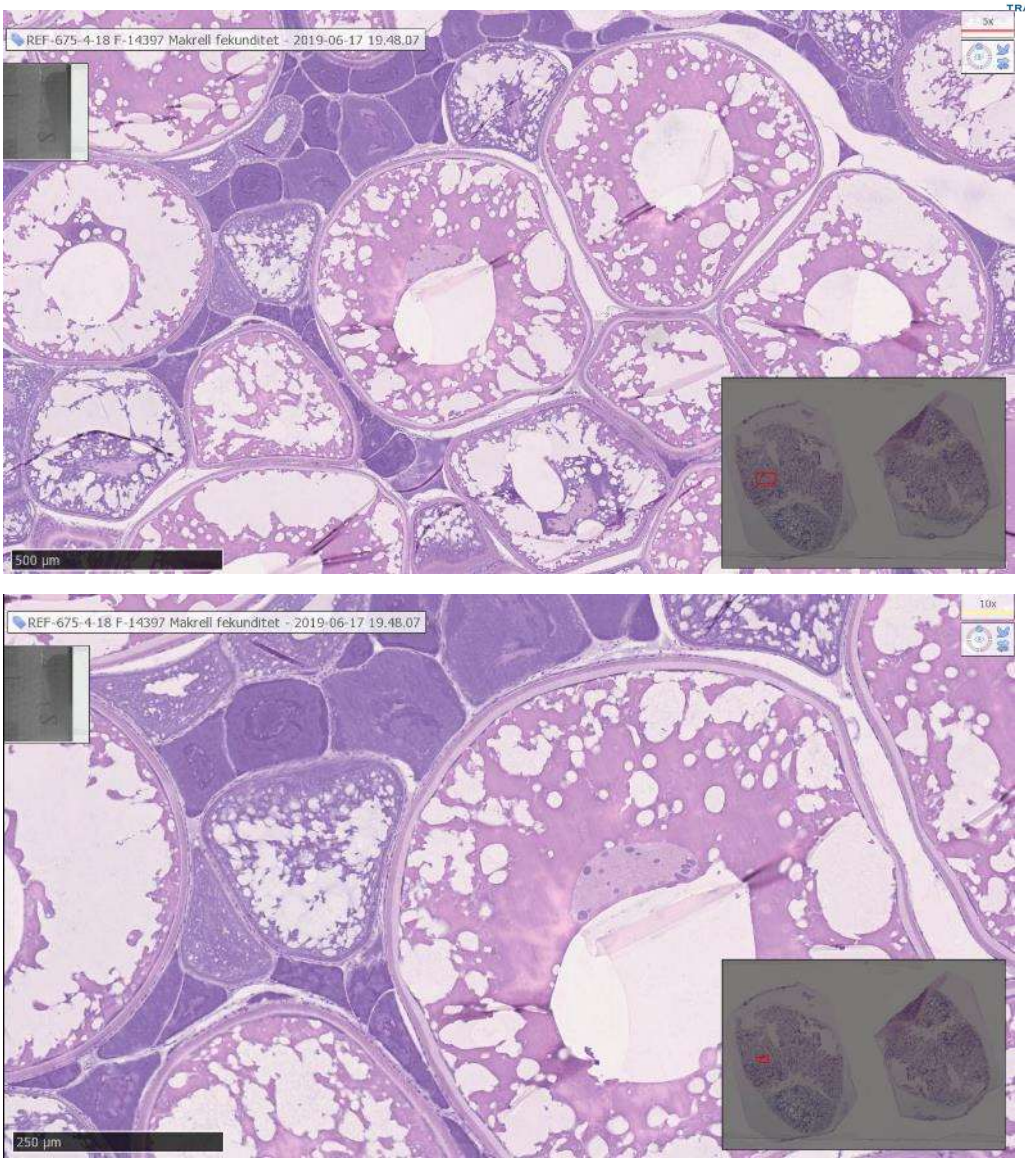


Figure 2.6. Examples of mackerel gonad cells at different magnification.

The results of all the samples and analysis is expected to be finalized in the second quarter of 2020.

2.5 Self-sampling the pelagic fleet

The self-sampling program in pelagic fishing was launched in 2014 and now forms a solid basis for the role of pelagic fishing in scientific research. The self-sampling data is now widely used for various applications (stock assessment, MSC, spatial-temporal occurrence of different types).

2.5.1 Catch compositions of PFA trawlers

An overview in number of vessels , trips, number of days, total catch of self-sampled vessels and number of length measurements is presented in the text table below.

year	nvessels	ntrips	ndays	nhauls	catch	nlength
2015	8	43	762	1,739	136,353	127,547
2016	11	98	1,539	4,067	302,860	179,883
2017	15	122	2,038	4,951	390,184	305,365
2018	16	161	2,542	6,050	478,289	347,782
2019	17	156	2,656	6,549	437,833	296,804
(all)		580	9,537	23,356	1,745,519	1,257,381

Details by large FAO area (27, 34 and 87) are below.

area	year	nvessels	ntrips	ndays	nhauls	catch	nlength
27	2015	7	34	584	1,360	107,380	120,083
27	2016	10	74	1,124	2,852	252,238	142,967
27	2017	14	98	1,511	3,475	328,819	203,855
27	2018	16	145	2,214	5,179	443,948	285,411
27	2019	16	136	2,067	4,759	377,355	211,459
27	(all)		487	7,500	17,625	1,509,740	963,775
34	2016	3	20	320	1,046	40,337	29,989
34	2017	4	14	250	861	31,712	80,681
34	2018	4	11	198	635	24,105	57,679
34	2019	4	17	504	1,628	48,362	77,665
34	(all)		62	1,272	4,170	144,516	246,014
87	2015	2	9	178	379	28,972	7,464
87	2016	1	4	95	169	10,284	6,927
87	2017	2	10	277	615	29,652	20,829
87	2018	1	5	130	236	10,234	4,692
87	2019	1	3	85	162	12,114	7,680
87	(all)		31	765	1,561	91,256	47,592
(all)	(all)		580	9,537	23,356	1,745,512	1,257,381

The large majority of self-sampling activities are taking place in the Northeast Atlantic (FAO area 27). However, all trips in FAO areas 34 and 87 are also fully covered by the self-sampling program. Results of self-sampling are summarized in an annual report (Pastoors 2019a) and in specific reports targeted at different scientific groups (Pastoors 2019b; Pastoors 2019c; Pastoors 2019d; Pastoors 2019e; Pastoors 2019f).

2.5.2 Development of a standardized catch-handling system

The self-sampling program is still largely carried out through Excel spreadsheets and processing in the statistical programming language R. In 2016, we also started developing an integrated knowledge-information system M-Catch that can be linked to the electronic logbooks. In 2016 the basis was laid for a version of M-Catch that gives an overview of the catches per species, per area and per day (*M-Catch portal*). A further development was initiated in 2017, recording the data of fishing activities, productions and biological sampling (M-Catch production app).

In 2019 we move from a testing phase of the M-Catch production app to a application phase. The M-Catch databases have been converted into separate database instances for the different participating companies (Cornelis Vrolijk BV, Parlevliet en van der Plas BV en Willem van der Zwan BV). Currently, the M-Catch production app is being utilized on 5 trawlers with additional trials being carried out on 4 trawlers. It is anticipated that in 2020 the production app will be extended to include detailed sampling capabilities and being utilized by all trawlers.

2.6 Fish condition

In 2018 the Dutch Council for Animal Affairs (*Raad voor Dieraangelegenheden*) issued a vision document on the welfare of fish, in which it stated that "the welfare and integrity of fish are still insufficiently taken into account when dealing with fish." Specifically for commercial fishing, the Council recommended more attention to the catching and handling of fish. The PFA has therefore initiated an exploratory study to the condition of pelagic fish as they are caught in pelagic fisheries.

In collaboration with Wageningen Marine Research, an exploratory study has been set up to gain insight into the condition of fish in the catches of pelagic trawlers from the moment the fish comes on board until the end of the catch processing process. Factors that can be taken into account are the fish species and conditions at sea such as water temperature, depth, wind force and wave height.

Specific equipment has been developed to allow for assessment of Fish condition on board.

Figure 2.7. Fish condition monitoring tubs developed specifically for the research project. Each of the tubs contain flowing sea-water where fish can be held until vitality assessments can be carried out.

WMR has generated a fish condition monitoring protocol (Molenaar and Schram 2019) which has been applied in the December 2019 herring fishery in the Channel. Further trials are foreseen in the first part of 2020.

2.7 Other research activities

2.7.1 Argentines data and assessment

ICES advice for silver melt (Argentina silus) is currently largely based on changes in the temporal trend of the Faroese (summer) survey. The stock is therefore currently in ICES Stock Assessment Category 3. However, catch at age information from the EU fleet, data from different surveys and CPUE series could also be made available for the stock assessment. This research project

aims to improve the assessment of Greater Silver Smelt by utilizing this additional information in the assessment.

The research project is carried out by PFA and Wageningen Marine Research (WMR).

A comparison has been carried out between the PFA self-sampling and the WMR standard monitoring research.

The WMR calculated catch at age has been reviewed and checked and is available for the stock assessment.

The Scottish deepwater survey has been made available for the stock assessment.

Support is being supplied by PFA and WMR to the benchmark of Greater Silver Smelt that is going to be held in February 2020.

2.7.2 Fatcontent of herring and mackerel

The fat content of fish is a good indicator of overall body condition, which influences important traits such as its survival, growth, and reproduction. Therefore condition has an impact on stock productivity and availability to fisheries. Thus understanding drivers of variation in fat content is important for fisheries management. A joint research project with the University of Aberdeen, Scottisch Pelagic Fisheries Association and the PFA is looking into the utilization of industry data to elucidate these questions.

The PhD student Susan Kenyon has been jointly funded by the University of Aberdeen, Scottisch Pelagic Fisheries Association and the PFA. She started her PhD research by the beginning of 2019. Food availability and temperature are two environmental factors which are known to affect the body condition of fish. However these interactions have not been formally investigated within Atlantic herring and mackerel, two commercially-important species within the North-East Atlantic.

The PhD studentship is working with fish processing factories and vessels which measure the fat content of herring and mackerel to harmonise and standardise their historic data, producing a new database. We will then compare the fisheries data with a scientific data source in order to validate the novel database. We will then investigate trends in herring and mackerel fat content across time and space, identifying periods and hotspots of low or high condition. Links between these trends and prey populations (such as zooplankton) and temperature will be made in order to determine causes of these trends in fat content.

An internship has been opened up at the PFA to make the Dutch fatcontent data available for the PhD research project. The internship is being fulfilled by Jorn School for the period November 2019-March 2020.

3 Acknowledgments

A research programme like described in this report can only be carried out with a sustained commitment of many persons within the fishing industry and the research community. The skippers, officers and the quality managers of the participating vessels are investing a lot of time and effort in making the self-sampling work and other research projects become a reality. A special word of thanks to the strong support by the fleet-managers, project-officers and quality managers on shore. Many thanks also to the skippers and crew of the participating vessels for their warm welcomes whenever I came on board and for the thought-provoking discussions and the sharing of deep knowledge and insight in fishing strategies and fish behaviour.

4 References

FAO (2012). Fishing vessel execution of acoustic surveys of deep-sea species: main issues and way forward. FAO Fisheries and Aquaculture Circular. **No. 1059**.

ICES (2007). Collection of Acoustic data from Fishing Vessels. W. A. Karp, ICES. **Cooperative Research Report no. 287**.

Mackinson, S., M. A. Pastoors, S. Lusseau, E. Armstrong, S. M. M. Fassler, D. de Haan, R. Kleppe, M. O'Malley, A. Campbell, M. Clarke and A. Wiseman (2017). Report on the 2016 industry-science survey of herring in the Western British Isles (ICES Divisions 6a, 7bc)**:** 82 pp.

Mackinson, S., M. A. Pastoors, S. Lusseau, S. O'Connell, S. Sakinan, B. Berges, A. McClean, J. Forbes-Birnie, A. Wiseman, M. O'Malley and E. D. Farrell (2019). Report on the 2018 industry-science survey of herring in the Western British Isles (ICES Divisions 6a, 7bc)**:** 104 pp.

Mackinson, S., M. A. Pastoors, S. Lusseau, S. O'Connell, S. Sakinan, B. Berges, J. Forbes-Birnie, M. O'Malley and E. D. Farrell (forth). Report on the 2019 industry-science survey of herring in the Western British Isles (ICES Divisions 6a, 7bc).

Melvin, G. D. and M. J. Power (1999). A proposed acoustic survey design for the 4WX herring spawning components. **DFO Can. Stock Assess. Sec. Res. Doc. 99/63:** 15 pp.

Molenaar, P. and E. Schram (2019). Protocol Catch Welfare Assessment, WMR.

Pastoors, M. A. (2019a). PFA self-sampling report 2015-2018, PFA. **2019_03**.

Pastoors, M. A. (2019b). PFA selfsampling report for WGDEEP 2019, PFA. **2018/06**.

Pastoors, M. A. (2019c). PFA selfsampling report for HAWG, 2015-2018, PFA. **2019/04**.

Pastoors, M. A. (2019d). PFA selfsampling report for WGWIDE, 2015-2018, PFA. **PFA report 2019_12 / WGWIDE WD 2019_06**.

Pastoors, M. A. (2019e). PFA selfsampling report for JSC EU-Mauritania, PFA. **PFA 2019_14**.

Pastoors, M. A. (2019f). PFA selfsampling report for SPRFMO, 2015-2019 (v3), PFA. **PFA 2019_13 / SPRFMO SC7-JM07**.

PFA (2014). Research and Knowledge Strategy 2015-2018. **18 December 2014**.

Sustainovate (2018). Improved selectivity of small-pelagics in the North Sea & North Atlantic using SEAT classification software. Oslo, Sustainovate A.S.

Ybema, M. S. and K. Johannsen (2020). Fish abundance estimates. A big data approach. Phase II - Pilot North Sea herring comparison. Oslo, Sustainovate.