Report on 2017 research projects

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## Executive Summary

This report documents the use and outcome of research projects in 2017 based on scientific catches allocated to members of the Redersvereniging voor de Zeevisserij. Although the scientific catches that have been used for the projects mentioned in this report have been allocated by the Netherlands, the report is in English to allow for international dissemination of results.

In 2017, pelagic scientific catches have been allocated to the following projects:

- Industry acoustic survey and genetic research for herring in 6a North
- Self-sampling of the PFA fleet
- PelAcoustics on using acoustics of PFA vessels
- AutoMeasure on the development of an automatic measuring device
- Horse mackerel research
- Improving selectivity for hake

In addition, scientific catches have been granted for the SEAT project to the company Willem van der Zwan BV (WZ). This will be documented in a separate report by WZ.

Main results can be summarized as follows:

<table>
<thead>
<tr>
<th>Project</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry acoustic survey and genetic research on 6a herring</td>
<td>Successfully executed the second industry acoustic survey on herring in 6a (and 7bc). Results have been presented to ICES Planning Group on Surveys 2018 (WGIPS) and will be presented to the Herring assessment working group 2018 (HAWG). An International report is available. Genetic baselines for herring have been successfully established. Apparently mostly a divide between northern stocks and southern herring stocks. Northern stock genetics very similar to North Sea herring.</td>
</tr>
<tr>
<td>Self-sampling</td>
<td>The self-sampling on PFA vessels has been rapidly expanding, covering close to 400 000 tonnes of catch in 2017 and up to 15 participating vessels. The self-sampling gives information on biological properties of the catch in time and space and in relation to the ambient environmental parameters. The self-sampling has been applied as the basis for the stock assessment in the South Pacific and to address specific questions in the Northeast Atlantic.</td>
</tr>
</tbody>
</table>
A dedicated report on the self-sampling activities will be published in the beginning of 2018.

Catch reporting software is under development now that the NL and UK vessels are using eCatch as their electronic logbook software. A dedicated platform for creating overviews of catch information has been created (mCatch). The modules for Individual Transferable Quota (ITQ) management and production information are under development and close to finishing.

| **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 2017 has been on re-starting the acoustic data collection and on developing new tools to automatically summarize the acoustic information. |
| **AutoMeasure** | The automeasure project has commissioned the developed of a new device that will allow automatic measurement of weight and length of individual fish. A first version of the device has been delivered in September 2017. Tests have been hampered by an unexplained damage to the device. Towards the end of 2017 first real tests have been carried out which show promising results although some alterations to the device are still needed. Three student projects have been carried out on automatic species recognition and automatic sorting techniques. The projects established the feasibility of fast and automatic length calculations from photos and species recognition based on body parameters. |
| **Horse mackerel research** | This project has widened to include all horse mackerel stocks or components caught by the PFA fleet. Focus is on stock identity and on development of indicators of abundance. For the genetic work on stock identity, additional genetic samples of horse mackerel in different parts of their distribution area have been collected in 2016 and 2017. In addition, historical catch rates of horse mackerel have been collected and preliminary analyses have |
been carried out and presented to the ICES benchmark workshop on widely distributed stocks in 2017. More work on the analysis of the historic data is foreseen for early 2018.

### Improved selectivity for hake

During 2017 trials have been carried out with a new selective device (grid) aimed at reducing the bycatch of hake in the fisheries for blue whiting and horse mackerel. The trials have shown that the grid has potential to reduce the bycatch of hake, although modifications were required to the design to circumvent certain unwanted behaviour of the initial grid. The techniques for monitoring the behaviour of fish within the net have been improved.
Nederlandse samenvatting

In dit rapport wordt het gebruik en de uitkomsten van onderzoeksprojecten in 2017 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 2017 zijn pelagisch wetenschappelijk vangsten toegekend voor de volgende projecten:

- Industrie akoestische survey en genetisch onderzoek van haring in gebied 6a
- Self-sampling
- PelAcoustics
- AutoMeasure
- Horsmakreel onderzoek
- Verbetering selectiviteit heek

Daarnaast werd opnieuw een verzoek worden ingediend voor het SEAT-II project. Deze aanvraag is gedaan door Willem van der Zwan BV (WZ), maar wel in afstemming met de RvZ.

De belangrijkste resultaten kunnen al volgt worden samengevat:

| Industrie akoestische survey en genetisch onderzoek van haring in gebied 6a | Succesvolle uitvoering van de tweede industrie akoestische survey op haring in 6a (en 7bc). Resultaten zijn gepresenteerd aan de ICES Planning Group on Surveys 2018 (WGIPS) en worden gepresenteerd aan de Haring assessment werkgroep 2018 (HAWG). Een internationaal rapport met resultaten is beschikbaar. |
| Self-sampling | Genetische 'baselines’ (standaarden) voor haring zijn vastgesteld. Het ziet er naar uit dat er vooral een onderscheid is tussen noordelijke en meer zuidelijke haringbestanden. Weinig onderscheid tussen noordelijke bestanden en het Noordzee bestand. |
| De self-sampling op PFA schepen is snel toegenomen en beschrijft bijna 400 000 ton vangst in 2017 |
en tot 15 deelnemende schepen. Door de self-sampling is informatie beschikbaar in tijd en ruimte en in relatie tot lokale omgevingsvariabelen. De self-sampling is toegepast als basis voor de toestandsbeoordeling in de Stille Oceaan (South Pacific) en om specifieke vragen te beantwoorden in de Noordoost Atlantische oceaan. Een rapport over de self-sampling resultaten zal worden uitgebracht in begin 2018.

Vangst registratie software is in ontwikkeling nu wel de NL als VK schepen eCatch gebruiken voor rapporteren van vangsten. Een toegesneden platform is ontwikkeld voor het maken van overzichten (mCatch). Nieuwe modules voor koppeling met quota (ITQ) en voor productie-informatie en wetenschappelijke informatie is in een test-fase.

**PelAcoustics**

In het PelAcoustics project worden methodes ontwikkeld om akoestische informatie van bedrijfsschepen in te kunnen zetten als aanvullende informatie voor stock assessment en surveys. De nadruk in 2017 heeft gelegen op het opnieuw opstarten van de gegevensverzameling en op het ontwikkelen van nieuwe hulpmiddelen voor het genereren van automatische samenvattingen van de akoestische information.

**AutoMeasure**

Het automeasure project heeft opdracht gegeven een nieuw apparaat te ontwikkelen dat het mogelijk maakt om automatische metingen te doen van lengte en gewicht van individuele vissen. Een eerste versie van het apparaat is opgeleverd in september 2017. Helaas is het testen van het apparaat gehinderd doordat een onverklaarde schade aan het apparaat is opgetreden. Tegen het einde van 2017 zijn alsnog de eerste testen uitgevoerd die veelbelovende resultaten laten zien hoewel er ook nog wat aanpassingen aan het apparaat nodig zijn.

Drie studenten projecten van Wageningen Universiteit zijn uitgevoerd naar automatische soortherkenning en automatische sorteertechnieken. De projecten hebben laten zien dat het haalbaar is om
snel en automatisch lengte te berekenen van gefotografeerde vissen en soortherkenning mogelijk is op basis van lichaamsparameters.

**Horsmakreel onderzoek**


**Verbetering selectiviteit heek**

In 2017 zijn testen uitgevoerd met een nieuw selectie mechanisme (grid) om bijvangst van heek in de visserij op blauwe wijting en horsmakreel te verminderen. De proeven hebben laten zien dat het grid de potentie heeft om bijvangst van heek te verminderen of vermijden. Er zijn nog wel aanpassingen nodig om kinderziektes van het huidige ontwerp te verbeteren. De technieken voor het observeren van het gedrag van vis in het net zijn verbeterd tijdens deze proeven.
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 acoustic survey and genetic research for herring in 6a-north

This project combines the research efforts towards assessing the state of the 6a herring (via an industry acoustic survey during spawning time) and the stock separation between 6a north and 6a south-7bc herring. The research has been carried out together with Wageningen Marine Research, University College Dublin and the member companies of RVZ/PFA.

While the collection of acoustic data from commercial vessels has been discussed for a long time already (e.g. FAO 2012; ICES 2007; Melvin and Power 1999), real applications in European waters have been very limited. However, in 2016 the first industry acoustic and genetic survey for herring in ICES area 6.a has been carried out. This idea was first sparked at the industry workshop on acoustics (2015) and further developed during a dedicated meeting on 6a herring in Edinburgh, 10/9/2015 (PELAC 2015). The survey has been carried out in August-September 2016 and results (Mackinson et al. 2017) have been presented to the ICES International Pelagic Surveys working group (ICES 2017a) and the ICES Herring Assessment Working Group (ICES 2017b).

During 2017, the second iteration of the integrated acoustic and genetic industry survey for herring in ICES area 6.a has been carried out.

Aims

• Contribute to an internationally coordinated industry acoustic survey for herring in 6a and 7bc, with the aim to give minimum biomass estimates of the spawning components in 6a North (August-September 2017) and 6a South-7bc (November-December 2017).
• Develop a genetic stock identification tool to enable rapid and cost effective splitting of survey samples and commercial catches of herring in 6aN and 6aS & 7bc into stock of origin.

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

In 2017 the second industry-led survey of herring in 6a/7bc has been carried out. Industry and scientific institutions from Scotland, Netherlands, Ireland and England successfully carried out scientific surveys with the aim to improve the knowledge base for the herring spawning components in 6a.N and 6a.S, 7b-c, and submit relevant data to ICES to assist in assessing the herring stocks and contribute to establishing a rebuilding plan.

With the agreement on a monitoring fishery TAC of 5800t (EU 2017/127), the scientific survey was designed based on ICES advice for the timing, location and
number of samples required to collect assessment-relevant data from the monitoring fishery (ICES 2016).

In 2017, Four industry vessels were used for acoustic surveys in 6aN (Wiron 5-6, Sunbeam and Lunar Bow) and two in 6aS/7bc (the pair trawlers Eilean Croine and Sparkling Star). All vessel used calibrated scientific echosounders (Simrad EK60 or EK80) either using the ships transducers or a transducer on a towed body. Two other industry vessels (Dirk and Antares) were dedicated to taking samples for biological, morphological and genetic analyses in 6aN, whilst in 6a/7c samples were collected by numerous inshore vessels.

Biological samples taken during the survey and subsequent commercial catches were used to construct a catch-at-age supplied to the ICES 2018 stock assessment (HAWG 14-20\textsuperscript{nd} March 2018). Acoustic survey data on the biomass of the spawning components were review by ICES International Pelagic Surveys working group (ICES 2017a) and found to be reliable to be considered as data points in a possible future time series. Morphometric and genetic data from spawning fish is providing the new baseline data required to assess separately the stocks in 6aN and 6.aS, 7b-c. This information would be considered in a future benchmark assessment.

Following ICES advice on the need for a stock recovery plan for herring in 6a/7bc (ICES 2016b), a draft recovery plan is under development under the auspices of the Pelagic Advisory Council.

With provision made for 5800t monitoring fishery in 2018 (EU 2018/127), plans are underway for third survey to be held in 2018.

2.1.2 Results of herring genetic research

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.
Figure 1 relative migration network of herring stocks in the Northeast Atlantic. Areas are indicated by numbers (1: 6a south, 2: Celtic Sea, 3: Irish Sea, 4: 6a North, 5: West of Hebrides, 6: North Sea and 7: Baltic Sea). Source: Farrell, E.D & J. Carlsson. Presentation to Pelagic AC, 4/1/0/2018.
2.2 Self-sampling of the PFA fleet

Documentation of catch and effort of the pelagic freezer-trawlers fleet is a key focus for the PFA research programme. The activities are capitalizing on the sampling that is already being undertaken on most of the freezer-trawler vessels and provides for efficient techniques for collecting robust information. In 2017 the self-sampling programme has been extended to more vessels and better reporting.

2.2.1 Self-sampling results

Self-sampling of freezer-trawler vessels started in 2014, but really became established from 2015 onwards. Self-sampling has been carried out in the North-east Atlantic (FAO area 27), in West-African waters (FAO area 34) and in the Southern Pacific (FAO area 87). An overview of the self-sampling 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.

Table 1: summary of PFA self-sampling activities 2015-2017.

<table>
<thead>
<tr>
<th>year</th>
<th>nvessels</th>
<th>ntrips</th>
<th>ndays</th>
<th>nhauls</th>
<th>catch</th>
<th>nlength</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>8</td>
<td>43</td>
<td>758</td>
<td>1,727</td>
<td>134,804</td>
<td>122,315</td>
</tr>
<tr>
<td>2016</td>
<td>11</td>
<td>98</td>
<td>1,539</td>
<td>4,065</td>
<td>302,089</td>
<td>157,365</td>
</tr>
<tr>
<td>2017</td>
<td>15</td>
<td>122</td>
<td>2,037</td>
<td>4,946</td>
<td>388,507</td>
<td>291,458</td>
</tr>
<tr>
<td>(all)</td>
<td></td>
<td>263</td>
<td>4,334</td>
<td>10,738</td>
<td>825,400</td>
<td>571,138</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>year</th>
<th>catch/trip</th>
<th>catch/day</th>
<th>catch/haul</th>
<th>broken fish%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>3,134</td>
<td>177</td>
<td>78</td>
<td>1.8</td>
</tr>
<tr>
<td>2016</td>
<td>3,082</td>
<td>196</td>
<td>74</td>
<td>1.1</td>
</tr>
<tr>
<td>2017</td>
<td>3,184</td>
<td>190</td>
<td>78</td>
<td>1.3</td>
</tr>
<tr>
<td>(all)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note that during 2017 the self-sampling programme has been extended to also include the data that has been collected during the SEAT project (Sustainovate 2017). This meant that by the end of 2017, self-sampling data has been collected on board of 15 out of the 19 freezer-trawlers that belong to the members of the PFA. With the self-sampling programme, the PFA can monitor the distribution (spatial, temporal) and the composition (length, weight, fat content) of the catches of a large part of the fleet of freezer-trawlers.

The distribution of self-sampling activity by major FAO area and year is shown in table 2 below.

---

1 Note that the same vessel may have been active in multiple areas.
Table 2: area-specific summary of PFA self-sampling activities 2015-2017.

<table>
<thead>
<tr>
<th>area</th>
<th>year</th>
<th>vessels</th>
<th>trips</th>
<th>days</th>
<th>hauls</th>
<th>catch</th>
<th>length</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>2015</td>
<td>7</td>
<td>34</td>
<td>580</td>
<td>1,349</td>
<td>106,936</td>
<td>114,851</td>
</tr>
<tr>
<td>27</td>
<td>2016</td>
<td>10</td>
<td>74</td>
<td>1,124</td>
<td>2,850</td>
<td>251,521</td>
<td>120,531</td>
</tr>
<tr>
<td>27</td>
<td>2017</td>
<td>14</td>
<td>98</td>
<td>1,510</td>
<td>3,470</td>
<td>327,180</td>
<td>190,168</td>
</tr>
<tr>
<td>27</td>
<td>(all)</td>
<td>.</td>
<td>206</td>
<td>3,214</td>
<td>7,669</td>
<td>685,637</td>
<td>425,550</td>
</tr>
<tr>
<td>34</td>
<td>2016</td>
<td>3</td>
<td>20</td>
<td>320</td>
<td>1,046</td>
<td>40,283</td>
<td>29,989</td>
</tr>
<tr>
<td>34</td>
<td>2017</td>
<td>4</td>
<td>14</td>
<td>250</td>
<td>861</td>
<td>31,674</td>
<td>80,461</td>
</tr>
<tr>
<td>34</td>
<td>(all)</td>
<td>.</td>
<td>34</td>
<td>570</td>
<td>1,907</td>
<td>71,957</td>
<td>110,450</td>
</tr>
<tr>
<td>87</td>
<td>2015</td>
<td>2</td>
<td>9</td>
<td>178</td>
<td>378</td>
<td>27,868</td>
<td>7,464</td>
</tr>
<tr>
<td>87</td>
<td>2016</td>
<td>1</td>
<td>4</td>
<td>95</td>
<td>169</td>
<td>10,248</td>
<td>6,845</td>
</tr>
<tr>
<td>87</td>
<td>2017</td>
<td>2</td>
<td>10</td>
<td>277</td>
<td>615</td>
<td>29,652</td>
<td>20,829</td>
</tr>
<tr>
<td>87</td>
<td>(all)</td>
<td>.</td>
<td>23</td>
<td>550</td>
<td>1,162</td>
<td>67,804</td>
<td>35,138</td>
</tr>
</tbody>
</table>

In the Northeast Atlantic the self-sampling programme has monitored the fisheries for blue whiting, horse mackerel, mackerel and herring and the most important bycatch species. There have also been some fisheries for pilchards and anchovy, mostly in the southern North Sea. West of Africa the main catches are sardines and horse mackerel and in the South Pacific mostly Jack Mackerel.
More on the self-sampling results will be available in the dedicated research report on self-sampling that will be issued February 2018.

2.2.2 Development of catch reporting software

The current self-sampling programme is still mostly carried out using dedicated Excel spreadsheets to collect the information on board of the vessels. As part of the ambition to harmonize and facilitate the data entry on the vessels, we have been working towards an extension of the electronic logbook software,
by adding a number of features that are not part of the mandatory logbook requirements but that are very important for the companies and that could facilitate the self-sampling programme.

During 2016 and 2017 a contract between RVZ and eCatch lead to the development of:

1. a pelagic fisheries version of the eCatch onboard electronic logbook system
2. a dedicated mCatch portal that can be used to generate the required trip reports (LAN, SAL) for the government, but also to supply insight and overviews on the performance and catch history of the vessels
3. a quota module to monitor the utilization of ITQs over time (beta version) and
4. an onboard production recording app (mCatch production) that interfaces with the mCatch portal. The production app is intended to take over the current Excel based versions of production recording by the companies and the ones used for self-sampling.

The development of the mCatch production app had reached the testing stage in September 2017 and is currently being trialled by the Zeeland (SCH123). The mCatch ITQ module is ready for testing and is expected to be trialled in the first half of 2018.
2.3 Pelacoustics - using vessel acoustics for stock trends

Collecting relevant scientific information from commercial vessel acoustics is a long-standing ambition of the PFA. Since the acoustic equipment on many of the vessels is comparable or very close to scientific standards, making use of commercial vessels for additional data collection next to the regular scientific surveys would be an efficient way to improve the robustness of the knowledge base.

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). Sustainovate has been the project leader on the SEAT project that aimed to develop acoustic techniques for species recognition based on multi-frequency acoustics. As part of this work, they have implemented acoustic recording and transmission systems that would be very useful for the Pelacoustics programme. The year 2017 was intended to re-start the calibration and recording on board of a number of pelagic trawlers and the development of the automated summaries of the acoustic data.

Acoustic data is currently being recorded on board of the three vessels participating in the SEAT project and the RealFishEcho broadband project (SCH6 Alida, SCH302 Willem van der Zwan and SCH24 Afrika). In addition, acoustic data has been recorded with the SeaPix systems on the PH1100 WIRON5 and the H171 Cornelis Vrolijk. Although data recording has so far been focussed on acoustic species recognition, the data may also be used to test-drive the development of automatic processing capacity. While the data collection has made progress during 2017, unfortunately, the development of the automated processing capacity has not lead to tangible results yet.
2.4 **AutoMeasure: the development of automatic measurements and species recognition**

The PFA/RVZ self-sampling programme and the routine measurements that take place in the cold-stores both rely on manual registration of length and sometimes semi-automatic registration of weight. However, weight and length (and species) are not jointly recorded. The joint recording of these variables would be very useful for scientific research and understanding growth patterns by area and season. Therefore, the PFA/RVZ is keen to contribute to the development of an automatic measuring and weighing device, if possible also with species recognition. During 2017 the PFA/RVZ has commissioned the development of an automated weight-length measurement device. In addition several student projects on this subject have been finalized in 2017.

2.4.1 **Automeasure device**

After initial contacts were established between HAKON ([www.hakon-weegapparatuur.nl](http://www.hakon-weegapparatuur.nl)), WPL ([www.wpl-industries.com](http://www.wpl-industries.com)) and RVZ in 2016, a first conceptual model for a combined weight-length measurement device was developed in August 2016. After a number of sessions with quality managers at the different companies, a final contract between WPL/HAKON and RVZ was signed in April 2017. Delivery of the first version of the device was in September 2017 (figure 3).

After a successful first test, unfortunately we experienced a major set-back in the project. When starting up for the second trial, it was discovered that the machine was full of water, so that the computer elements were all damaged and had to be replaced. This lead to a long-lasting insurance procedure to find out who was responsible and how the damage should be attributed to the different partners. This has only been resolved in the beginning of 2018.

In November 2017, we did manage to carry out more extensive trials with the device using both manually and automatically weighed and measured fish. From these trials we established that the weight distributions by batch were very similar, but also that the length measurements had a substantial deviation. This probably has to do with the technique of length measurement which uses a light sensor on the side of the conveyor belt. In many cases, the light sensor either misses the head or the tail of the fish, dependent on the orientation of the fish as it moves over the conveyor belt.

Additional trials are foreseen in 2018 to fine-tune the behaviour of the automeasure device.
Figure 3 Automeasure device that automatically weighs and measures fish, developed by WPL/HAKON.
2.4.2 Student projects on species recognition and measurement

Results of three MSc student projects of Wageningen University (Farm Technology Group) on automatic species recognition and automatic sorting were finalized and presented in 2017.

- Andries van der Meer worked on the development of vision algorithms to identify different fish species and to carry out length measurement (Van der Meer 2017).
- Teun van de Weijer worked on the application of vision algorithms and body morphometry to different fish species from actual catches (Van de Weijer 2017), and
- Marnix van Koeveringe worked on the mathematical simulation of onboard fish sorting processes (Van Koeveringe 2017).

Results of the student projects were presented to fishing industry representatives in the summer of 2017. General conclusions were that it is possible to calculate length from photographs with a mean relative error of less than 2% (total length, standard length) and 5.5 % (fork length). Length measurement at the lowest resolution took 41 ms. Species recognition was found to be mostly determined by body shape parameters, especially the tail-height ratio. Impressions of the photo and analysis setup are on the next page.
2.5 **(North Sea) horse mackerel research**

The knowledge base for the assessment and advice of horse mackerel is weak in general and for the North Sea component it is even weaker. The project aims to improve the knowledge base for the Western and North Sea stocks by providing genetic samples from horse mackerel in different parts of its distribution area and by developing new indicators of abundance based on commercial fisheries data.

2.5.1 Collecting genetic samples of horse mackerel throughout their distribution area

In 2015 the Pelagic Freezer Trawler Association (PFA), through IMARES, funded University College Dublin (UCD) and IMARES to undertake a pilot study to develop a method of genetic stock identification for discriminating North Sea and Western Horse mackerel (Brunel et al., 2016). The aims of the pilot study were:

1) To develop and validate at least 24 polymorphic microsatellites markers in horse mackerel.
2) To screen spawning fish collected in 2015 from the Western and North Sea stocks to establish a genetic baseline of the spawning stocks and test the presence of population structure.

Sampling was organised between UCD, the Marine Institute, IMARES and the PFA. The primary focus of sampling for the genetic analysis was collection of spawning fish (Figure 1). This was to ensure that samples could be considered to provide a valid baseline as the definition of the Western and North Sea stocks is based on the spatial separation of spawning. Recently developed Next Generation Sequencing (NGS) and Genotyping by Sequencing (GBS) based approaches, which were developed during UCD projects on cod (*Gadus morhua*), boarfish (*Capros aper*) and 6a/7bc herring (*Clupea harengus*) were used for marker development and screening of spawning samples (Carlsson et al. 2013; Farrell et al. 2016; Vartia et al. 2014; Vartia et al. 2016).

Although the pilot study successfully identified a large number of novel microsatellites, the initial data analyses were confounded by a poor quality sequencing run and as such the discrimination power between the western and North Sea sample was low. In order to improve the statistical power and increase the geographical scope of the analysis it was suggested that the sampling area should be widened to include the southern stock and outlier stocks (e.g. Mauritania and Mediterranean samples). During 2016 and 2017 horse mackerel samples have been obtained from many fisheries both in the North Sea, around the British Isles and along the continental shelf, all the way down to Mauritania (figure 3).
For all samples, DNA extractions have been carried out. During 2018 the analysis of the data will be carried out.

2.5.2 Compiling historical catch and effort data

During 2016, the PFA initiated the collection of fisheries data from personal logbooks of skippers of six vessels that have been operating under Dutch, German and English flag. In those personal logbooks, skippers noted down the haul, date, time, position, environmental variables, fishing gear characteristics, estimated catch and in most cases also an indication of species composition. The oldest logbooks were from 1998 and the newest from 2016.

The historical catch data can provide an important source of information to help improve the knowledge base for fisheries management, especially in the case of data-poor stocks like horse mackerel or Greater argentines. Because the information is spatially and temporally resolved, this information could also provide clues on the behaviour of fish under different circumstances (area, depth, tide, temperature, etc).
Results of the data collection and subsequent analyses have been presented at the ICES Benchmark for widely distributed stocks (WKWIDE 2017). Unfortunately the analyses could not be fully completed prior to the benchmark which means that some work will still need to be done. In the beginning of 2018, Esther Beukhof, PhD student at DTU Aqua, Copenhagen, will attempt to finalize the analysis of the historical catch record data.
2.6 Improved selectivity for hake

Hake is a species that is sometimes caught during the pelagic fishery for horse mackerel or mackerel, mostly to the west of Scotland and Ireland. The bycatch of hake is unwanted, as the vessels do not hold quota for hake and the processing plants in the vessel have a difficult time to process large fish such as hake. Therefore, a programme has been initiated to attempt to reduce or eliminate the bycatch of hake in pelagic fisheries.

A first attempt to avoid catching hake with the so-called Vónin grid was trialled in the fishing of mackerel, blue whiting and argentines in 2015. The results of that study were disappointing because the relatively small openings at the bottom of the grid were too small for hake to escape. This left so many hake in front of the grid, that the grid was pressed out of the net. A second attempt was carried out in the beginning of 2016, using a grid where the unwanted bycatch would escape from the top of the net. Unfortunately, the results of this study were also disappointing.

In the beginning of 2017 a new type of grid has been developed by Nordsøtrawl, Denmark. The new grid was designed after the lessons from the earlier experiments which showed that hake was very passive in the net. That is why the exit has now been made in the bottom of the net. The first trials were carried out during 10 days in May 2017 (. Results were promising but not yet conclusive (Van Rijn et al. 2017). The conclusion was that the design should be slightly modified to achieve a better selection for hake. Main alterations were that the grid sections needed to be all the way down to the bottom of the net (instead of have a small net section under the net). It was noted that the trawlcamera was able to record useable footage even at large depths, but that the light on the camera had a strong attracting effect on some species (notable mackerel) which often prevented a view on the grid itself.

Furthermore, a need was identified to better measure what is going on within the net during the trials. Additional measurements are needed on the water-flow within the net (to assess whether the tension in the net is sufficient for the grid to open up) and on the fish biomass measured before and after the grid (to assess the quantity of fish lost through the hole under the grid section). In addition, a new netcamera has been developed by JT Electric (Faroe Islands) that allows for short recording pulse, interspaced by periods without light.

New trials with a modified grid design are now foreseen to be taken up during the first part of 2018.
Figure 6 Testing the hake grid on board of SCH72 Frank Bonefaas (May 2017). Top: mounting the netcamera within the grid section. Bottom: a view down the grid section. Middle left is a hake caught against the grid.
3 Conclusions

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 form of this integrated results document. The conclusions on the different projects are summarized below.

Industry acoustic survey and genetic research on 6a herring

- Successfully executed the second industry acoustic survey on herring in 6a (and 7bc).
- Genetic baselines for herring have been successfully established.

Self-sampling

- The self-sampling on PFA vessels has been rapidly expanding, covering close to 400 000 tonnes of catch in 2017 and up to 15 participating vessels.
- The self-sampling gives information on biological properties of the catch in time and space and in relation to the ambient environmental parameters.
- The self-sampling has been applied as the basis for the stock assessment in the South Pacific and to address specific questions in the North-east Atlantic.
- A dedicated platform for creating overviews of catch information has been created (mCatch). The modules for Individual Transferable Quota (ITQ) management and production information are under development and close to finishing.

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 2017 has been on re-starting the acoustic data collection and on developing new tools to automatically summarize the acoustic information.

AutoMeasure

- The automeasure project has commissioned the developed of a new device that will allow automatic measurement of weight and length of individual fish.
- A first version of the device has been delivered in September 2017. Tests have been hampered by an unexplained damage to the device. Towards the end of 2017 first real tests have been carried out which
show promising results although some alterations to the device are still needed.

- Three student projects have been carried out on automatic species recognition and automatic sorting techniques. The projects established the feasibility of fast and automatic length calculations from photos and species recognition based on body parameters.

**Horse mackerel research**

- The project has widened to include all horse mackerel stocks or components caught by the PFA fleet.
- For the genetic work on stock identity, additional genetic samples of horse mackerel in different parts of their distribution area have been collected in 2016 and 2017.
- Historical catch rates of horse mackerel have been collected and preliminary analyses have been carried out. More work on the analysis of the historic data is foreseen for early 2018.

**Improved selectivity for hake**

- During 2017 trials have been carried out with a new selective device (grid) aimed at reducing the bycatch of hake in the fisheries for blue whiting and horse mackerel.
- The trials have shown that the grid has potential to reduce the bycatch of hake, although modifications were required to the design to circumvent certain unwanted behaviour of the initial grid.
- The techniques for monitoring the behaviour of fish within the net have been improved.
4 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 have invested 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.
References


