Atlantic mackerel and Horse mackerel egg survey 2016

Dutch participation on board FV Atlantic Lady: May

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Summary

From 10 till 25 May 2016 IMARES carried out a mackerel and horse mackerel egg survey on board the FV Atlantic Lady. This survey was part of the international mackerel and horse mackerel egg survey coordinated by ICES. The Redersvereniging voor de Zeevisserij (RVZ) asked IMARES to carry out this survey.

Thanks to the excellent weather circumstances during the survey, it was successful, in the way that we managed to sample fish eggs and larvae and collected ovary samples. This proves that a plankton survey can be carried out on a fishing vessel. It should however be noted that the stability of the vessel is limiting the plankton sampling in case of bad weather circumstances. Also the possibility of sorting and analysing the plankton samples is limited by the weather circumstances.

Of the 89 planned plankton stations 85 were sampled. Due to one day of bad weather, sampling time was lost and 4 stations could not be sampled. That same day it was also not possible to sort or analyse any plankton samples. During the survey it was possible to sort and analyse all samples on board. Also a first check of sorting of the samples was carried out. Further quality control will be carried out upon return.
Twice it was tried to catch adult mackerel and horse mackerel with rods. However this was not successful. Instead four fishing hauls with the trawl were carried out and these catches delivered the required adult mackerel and horse mackerel.

Numbers of mackerel eggs in the samples were low, lower compared to previous surveys. Most mackerel eggs were found along the 200m depth contour of the continental slope. Most of the adult mackerel had running or newly developing (in between batches) gonads. Few mackerel had gonads which were spent.

Numbers of horse mackerel eggs were extremely low. A few horse mackerel eggs were found along the 200m depth contour on the most southern transects. Adult horse mackerel caught had running or newly developing gonads.

At some stations blue whiting larvae were caught.

During the survey we collected all fecundity, atresia and genetic samples which were planned.

This survey was part of the international mackerel and horse mackerel egg survey, therefor it is not possible to conclude anything on the current size of the mackerel and horse mackerel spawning stocks based on this report alone because it only presents the Dutch May survey results..

1 Introduction

Every three years an international Atlantic survey is carried out by various European institutes, to monitor the spatial and seasonal distribution of Atlantic mackerel (*Scomber scombrus*) and horse mackerel (*Trachurus trachurus*). During this international survey 1) mackerel and horse mackerel eggs are sampled using a plankton sampler or bongo nets and 2) adult mackerel are sampled to estimate fecundity and atresia. The survey covers the whole spawning area and season. It starts along the Portuguese coast in February and continues until August when the waters west of Scotland and Ireland are sampled.
The mackerel and horse mackerel egg survey is coordinated by the ICES working group for mackerel and horse mackerel egg surveys (WGMEGS).

England and France started the egg survey in the western area in 1977. The Netherlands participates since 1983. Nowadays participating countries and sampling area have expanded. In 2016 the following countries participate in this survey: Faeroe Islands, Germany, Iceland, Ireland, Portugal, Scotland, Spain and The Netherlands.

The method used to estimate mackerel spawning stock biomass is the so-called Annual Egg Production Method (AEPM). The theory behind this method is simple: estimate the total number of eggs produced during the entire spawning season. Dividing the total egg production by the numbers of eggs produced by a single female gives an estimate of the female spawning stock biomass. The ratio between female and male mackerel gives an estimate of the total spawning stock biomass. This method is simple but requires an accurate estimate of the total fecundity (total number of eggs produced by a single female in one spawning period) of a female. Total fecundity can only be estimated for determinate spawners, spawners which develop all oocytes prior to spawning. But horse mackerel and very probably mackerel are indeterminate spawners (the females keep recruiting new oocytes after spawning has started). Hence part of the oocytes are already spawned while others are still recruited and it is therefore impossible to estimate total fecundity.

In 2016 we will also attempt to carry out a the Daily Egg Production Method (DEPM) for both mackerel and horse mackerel. This method requires an accurate estimate of the daily egg production at the peak spawning period and batch fecundity estimates in order to estimate the numbers of eggs which a single female produces per day. But for the DEPM also an estimate of the daily spawning fraction is needed. Hence this method requires a more intensive sampling of the adult fish. But the DEPM can be used for both determinate and indeterminate spawners.

1.1 Background

Results of the 2010 and 2013 egg surveys showed that the start of the spawning season of western mackerel was probably missed in both years. In those years the start of the survey was probably too late.
In winter 2014-2015 four collaborative science-industry surveys were carried, where the marine institutes of Ireland (MI), Scotland (MSS), Denmark (DTU) and The Netherlands (IMARES) cooperated with the pelagic industries of those countries. These surveys were carried out to determine the start of the spawning of western mackerel. Results showed that the egg survey would need to start earlier in 2016 to cover the whole spawning season.

Despite the need to start the survey earlier, the survey could not be finished earlier either because of the spawning of horse mackerel. Moreover, Norway withdrew as survey participant. Due to these circumstances, financial gaps appeared such that four trips in the international survey could not be filled by the standard financing of the research institutes. The pelagic industry was asked if they could help with finances and vessels for these four cruises. It was agreed during the 2015 planning meeting

of WGMEGS that the four countries and institutes involved in the winter surveys would try to carry out the four cruises. The Redersvereniging voor de Zeevisserij (RVZ) applied for scientific quota for one cruise and asked IMARES to carry out the survey on board the FV Atlantic Lady.

2 Aim of the project

The purpose of this project is to monitor the spatial distribution and seasonal patterns in the appearance of mackerel and horse mackerel eggs in the Eastern Atlantic. IMARES, on board the 'FV Atlantic Lady', sampled the Celtic Sea and northern part of the Bay of Biscay in May 2016, using a Gulf VII plankton sampler to sample fish eggs. Additionally, jigging and pelagic trawl hauls were carried out to collect adult mackerel and horse mackerel to estimate fecundity. These data will be combined to provide a fisheries-independent estimate of the spawning stock biomass of western mackerel and horse mackerel by the ICES working group on widely distributed stocks (WGWIDE).

This report contains the cruise report and preliminary results of the Dutch participation in the international mackerel and horse mackerel egg survey during May 2016. The results will be finalised at the next WGMEGS meeting in 2017.

3 Materials and Methods

3.1 Sampling gears

Egg sampling was performed with a "Gulf VII", a High Speed Plankton Sampler (Fig. 3.1; Nash et al., 1998), referred to as 'plankton sampler' in the remainder of the report, with a plankton net with 280 µm mesh size. A small Scripps depressor (25 kg) was attached to the plankton sampler for stabilisation of the sampler in the water. The volume of water filtered during each haul was measured using an internal General Oceanics mechanical flowmeter mounted inside the nosecone.

On top of the plankton sampler two Marport depth sensors and an altimeter is mounted to monitor in live view the depth of the plankton sampler in the water column and the bottom depth under the plankton sampler. A Valeport CTD on top of the plankton sampler measures temperature and salinity during deployment.

Adult fish samples were sampled using fishing rods or with a pelagic trawl.

Figure 3.1 *Gulf VII high speed plankton sampler with Marport depth sensors and General Oceanics flowmeter in the nosecone.*

3.2 Fishing method

Sampling is done according to the WGMEGS manual (ICES, 2016).
This survey is carried out on board the 'FV Atlantic Lady' (Fig. 3.2). The speed during fishing with the plankton sampler is 4-5 knots through the water. At each station a 'double oblique' haul (a V-shaped haul through the water column is performed. The plankton sampler is lowered, with a speed of 10 m/min through the water column, to 5 m above the sea floor and, at stations deeper than 200 m, to 200 m depth maximum. To ensure enough water is filtered during the haul, haul duration should at least be 15 minutes. At stations with shallow depth a double 'double oblique' is performed without the plankton sampler breaking the surface of the water. In this way each 10 meters of the water column

are sampled twice, 1 minute going down and 1 minute going up. It is not possible to monitor temperature during the plankton hauls, hence it is not possible to detect thermoclines. Thus at stations with a thermocline the plankton sampler is still lowered to maximum depth for plankton sampling.

A set of calibration hauls were carried out to calibrate the flowmeters. During the calibration the plankton sampler without the codend is lowered to 30 m depth. The codend is removed to ensure free flow of water through the sampler. The plankton sampler is hauled at constant depth for 30 minutes at a speed of 4-5 knots through the water. During this haul the flowmeter revolutions, water track and bottom track are registered. This is repeated in the exact opposite direction in order to rule out any influence of water and tidal currents on the calibration.

Figure 3.2 *The FV Atlantic Lady.*

When markings were visible on the echo sounder a jigging or trawl haul was carried out to try and catch adult mackerel and horse mackerel. A total of 45 mackerel gonads were planned to be collected for oocyte development and fecundity analysis.

3.3 Sampling grid

Following the request by WGMEGS, IMARES sampled the Celtic Sea and Northern part of the Bay of Biscay in May 2016 (period 5 of the international egg survey; Annex 1). Ideally in the sampling area a plankton sample should be collected within each half ICES rectangle. As the whole area is too large to cover in two weeks with the FV Atlantic Lady the sampling area is covered in east-west transects one degree apart. On each transect at each half ICES rectangle a plankton sample was taken (Annex 1). On the way back the remaining transects at the half degree were filled in along the 200 m depth contour, where the highest egg production is expected (ICES, 2016).
Five pelagic trawl hauls were planned in the spawning area (Annex 1). A pelagic jigging or trawl haul was performed when fish were visible on the echo sounders.

3.4 Sample processing on board

3.4.1 Plankton samples

As soon as the plankton sampler is back on board the vessel, the sample (Fig. 3.4) is brought to the 'hydrographic lab' or the improvised wet lab, where plankton samples were fixed and then sorted for fish eggs and larvae (Fig. 3.5).

Figure 3.4 *The codend with the plankton sample.*

The fresh sample is immediately fixed in 4% buffered formaldehyde. After at least 24 hours of fixation, the fish eggs are separated from the other plankton using the 'spray method' (Eltink, 2007). The sample is sprayed and checked multiple times until few eggs remain in the last spray. Then the whole remaining plankton sample is sorted manually to check for remaining eggs and collect fish larvae.

Figure 3.5 *The improvised wet lab for fixing and sorting the plankton samples.*

Eggs are photographed and identified to species level using image analysis (Fig. 3.6). The image analysis is carried out in ImageJ (Rasband, 1997-2008) with the ObjectJ macro StampFishEggs (version 0.3) ***stampfisheggs.html***. All eggs are counted, measured and identified to species. For mackerel and horse mackerel eggs at least one hundred eggs per species per sample are measured and the development stage is determined. The remaining mackerel and horse mackerel eggs are counted. If the sample contains a lot of eggs these are all sorted from the sample, and then subsampled using a 'Folsom'-splitter ensuring at least 100 mackerel and horse mackerel eggs are staged.

Figure 3.6 *Mackerel eggs in different development stages in a plankton sample.*

For quality assurance the sample sorting results are checked. At least 5 samples from each scientist are checked for remaining eggs. If > 5% of the total number of counted eggs have remained in their samples, all samples of this scientist were checked. Numbers of eggs in these sample were then adjusted by adding the number of the remaining eggs found in the quality check.

WGWIDE has requested WGMEGS to also collect information on the distribution of blue whiting (*Micromesistius poutassou*) larvae to increase knowledge of blue whiting spawning areas. Therefor all fish larvae collected in the plankton samples were also checked for the presence of blue whiting.

3.5 Adult fish samples

3.5.1 Fecundity and atresia

In principal all the fish are sorted for species and all mackerel and horse mackerel are collected from the catch. If the catch is large a random sample of 4 baskets of mackerel and 1 basket of horse mackerel is selected. This subsample is raised to the total catch weight. Total weight of mackerel and horse mackerel is measured.
One hundred mackerel and 10 horse mackerel are taken randomly from the catch. If less than 100 are caught all are measured. Of each individual length, weight, sex, maturity and otoliths are taken.
From the 100 mackerel, females in development stage 3 to 6 are collected. In total 45 female mackerel are sampled divided over all the trawl hauls. Of each female, length, weight, maturity, age and ovary weight is collected. Of the ovary one whole lobe is put in 3.6% formaldehyde for atresia sampling. From the other lobe 2 25 µl and 2 100 µl pipette samples are collected and put in 3.6%

formaldehyde. Also a teaspoon full (2-3 g) of oocytes is collected for histological confirmation of the maturity stage.
Of 1 mackerel ovary 10 100 µl pipette samples are taken for a ring test between analysing institutes.

3.5.2 Genetic samples

Genetic samples of horse mackerel were taken of 50 individuals by taking a tissue sample from behind the dorsal fin.

3.6 Sample processing in the lab upon return from the survey

3.6.1 Plankton samples

Plankton samples need to be further checked for sorting and identification of eggs and larvae. A quality check of the data is necessary before the data can be finalised and sent to the survey coordinator.

3.6.2 Adult fish samples

Upon return to the laboratory, screening and fecundity samples will be sent out immediately to the analysing institutes. IMARES screening samples will first be checked with histology for spawning markers. If no spawning markers are visible the samples will be analysed for fecundity. If spawning markers do occur, this sample will be analysed for atresia.
After fixation for at least 14 days in 3.6% formaldehyde the ovary lobes for atresia estimation are ready to be cut. From each lobe one or two whole sections (depending on the size of the ovary) of 0.5 cm thickness will be put in individual cassettes and sorted in 70% alcohol. The atresia samples will then be sent to the various analysing institutes.

3.7 Calculation of the number of eggs

The total number of eggs in the water is calculated using the below formulas.
The volume filtered is obtained from the formula:

$$Volume\ \ filtered \quad = \quad \frac{area\ of\ \ mouth\ opening\ (m^2)*efficieny\ \ \ factor*flowmeter\ \ revolutions}{flowmeter\ \ calibration\ constant}$$

The number of eggs per square metre at each station can be calculated as:

$$n/m^2 = \frac{eggs\ \ per\ \ sample\ (n)*sampler\ \ depth\ (m)}{volume\ \ filtered\ \ (m^3)}$$

4 Survey

4.1 Date and time

From (harbour)	Date	Time (UTC)	To (harbour)	Date	Time (UTC)
Scheveningen	10-05-2016	15:30	Concarneau	20-05-2016	15:00
Concarneau	21-05-2016	14:30	Scheveningen	25-05-2016	12:00

4.2 Scientific crew

- Cindy van Damme (cruise leader)
- Dirk Burggraaf
- Thomas Pasterkamp
- Ineke Pennock
- Hanz Wiegerinck

4.3 Deviations from the proposed sampling grid

Due to changes in the weather circumstances and the need to go into a harbour to fuel up, the planned sampling grid (Annex 1) was changed multiples times during the survey. Of the 89 stations planned 85 were sampled (Fig. 4.1). However two stations needed to be sampled multiple times to get a valid sample. Four stations on the western part of the 47.45°N transect could not be sampled due to the bad weather circumstances.

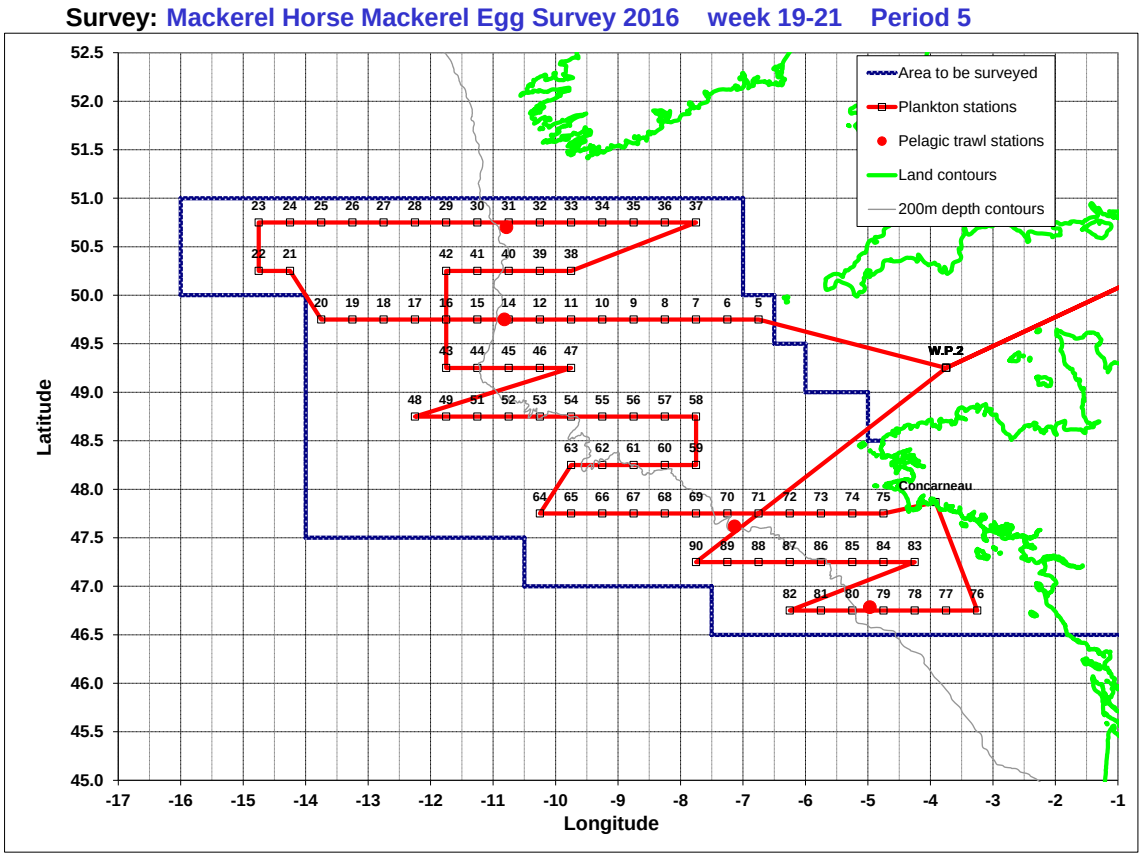


Figure 4.1 *The sampled station grid.*

4.4 Damage to sampling equipment

One flowmeter was damaged when it hit the vessel during setting of a haul on Tuesday 17th May. No other damage occurred to the sampling equipment during this survey.

4.5 Survey

On Monday 9th May at 6:00 am the Atlantic Lady left Stellendam to steam to Scheveningen. On board were two IMARES technicians to setup the Gulf VII plankton sampling on board. The setup was prepared and ready for a test haul. Meanwhile the Marport system with sensors and hydrophone was prepared by the crew. A first test haul was carried out on that afternoon in the Dutch coastal area. This was a successful test and all other preparations were setup and carried out to start with the mackerel and horse mackerel egg survey on the following day.

On Tuesday 10th May at 8:00 the IMARES scientific crew came on board the Atlantic Lady to setup the dry and wet labs and the data collection systems on the bridge. Meanwhile the fishing crew prepared the vessel for departure. At 15:30 the Atlantic Lady left Scheveningen harbour to steam to the sampling area.

On Wednesday 11th May calibration hauls were carried out in the English Channel to calibrate the flowmeter. The first haul could not be used for calibration, as the speed of the winch for setting and hauling was not clear, and the speed of setting the plankton sampler was too low. Also during this first haul the laptop running the IMARES Haul Information Programme (IHIP) failed and shut down. Thus two other calibration hauls were carried out which were successful.

On Thursday 12th May we arrived at the first plankton station at 49.45°N 6.45°W at 8:25. During the first plankton haul the depth sensors were not working properly, and we could not get the plankton sampler down to the desired depth. Maximum depth was 64m. Furthermore we did not know the exact speed of the winch, as the winch has no fine precise speed adjustment. Speed # 2 (0.5m/s) was too slow, but speed # 3 (0.83m/s) was definitely too fast and also seemed to be too fast for the Marport depth sensors and hydrophone connection. When the plankton sampler was back on deck we downloaded the CTD file and got evidence that the sampler had not been beyond 64m depth.
For the second haul we replaced the one Marport depth sensor with altimeter with another one that should have fully loaded batteries. We got the same result. At the start of the haul we received information from the depth sensors, but when going deeper there seemed to be no connection anymore. The sampler went down slowly and could not go beyond 75m. As this haul was invalid we left the sampler at 75m and tried to change the position of the hydrophone. Changing the position seemed to improve the receiving of the data from the depth sensors. When the sampler was at depth the cable in the water seemed to be very flat and not at a straight angle. This and the problem to get the plankton sampler to greater depth seemed to point at the fact that there is not enough pull from the plankton sampler on the Dyneema cable and the cable is floating up.
After the second haul we got into contact with Radio Holland to get more information on the Marport sensors.
Since the test haul on the first day had been carried out at shallow depth in Dutch coastal waters, the cable of the depressor had been shortened to 1m. For the third plankton haul on Thursday we increased the length to 2m to increase the pull of the sampler on the cable. Also the position of the hydrophone was changed so its frame pointed straight down. We received data from one depth sensor and also the altimeter. But the second sensor was still not sending data. The extra pull of the depressor ensured that the plankton sampler went deeper, but not beyond 80m. The floating of the cable seemed still the problem.
As a last test we added a second chute (standard the plankton sampling is carried out with one chute behind the plankton sampler) behind the plankton sampler for extra pull. This did not result in a greater depth. The only conclusion could be that the Dyneema cable was preventing the plankton sampler from going down.
We decided to cut half of the trawl sensor cable to use this for the plankton sampler. The second chute was removed from the plankton sampler. With the trawl sensor cable we could get the plankton

sampler to the right depth. At 17:00 we were happy with the plankton sample and could continue the plankton sampling.
On day 5, Friday 13th May we arrived at the deeper stations around the continental slope. It turned out that we could not get the data from the depth sensors at these great depths. As this was the first deep stations we also did not know how much cable should be veered to get the plankton sampler to 200m. As a result the plankton sampler was hauled too early and we needed to redo the sample.
When the plankton sampler was back on board the depth sensors on it were replaced. First one sensor was on top and the second one was on the side. Now both sensors were on top one above the other.
While we were waiting for the sensors to be replaced we decided to try a fishing haul with the rods. This however was not successful and no mackerel or horse mackerel were caught.
We redid the plankton sample and this time we did receive depth data to be able to lower the sampler to 200m. However the update speed of the depth sensors was very low. The depth sensor position was changed slightly over the next hauls to get the best position on the plankton sampler. We could continue to sample plankton over the deep hauls.

Figure 4.2 *Angling for mackerel.*

On 13th May we carried out a fish haul with the pelagic trawl. We caught lots of horse mackerel and mackerel.

On the 14th and 15th of May the weather was excellent and the plankton sampling went well. On the 15th we also carried out a second trawl haul. This time we again had a good mackerel and horse mackerel sample.

On the 16th and 17th the weather remained fine and we continued the plankton sampling. On the 17th the sampler hit the vessel during setting and hauling and the flowmeter was damaged and needed to be replaced. However on the 18th the weather turned worse and the plankton sampling was problematic. We were steaming against the wind but the sampling could not be done against the wind. At each station the vessel was turned and the sampling was carried out with the wind. This caused us to lose much time and some samples at the west part of the 47.45°N needed to be omitted.
The weather improved on the 19th and we continued sampling and finish the 47.45°N transect.

On 20th May at 06:00 two calibration hauls were carried out to calibrate the new flowmeter. After that we steamed to the harbour of Concarneau. On our way there we had a visit of the French fisheries inspection. After a thorough inspection they left us with the statement that the French permit

requested us to contact the French authorities not only when entering the French waters but every 48 hours when in French waters. At 15:00 we arrived in the harbour of Concarneau.

In Concarneau harbour we continued to sort and analyse plankton samples. Finally we found some horse mackerel eggs in the samples as well. We also started the check on the plankton sample sorting. Most plankton samples were sorted by the IMARES plankton experts. Of each 5 samples were checked. In the samples none or one or two eggs were left (see chapter 7 for results). We left Concarneau harbour 21st May at 14:30. We arrived at the first plankton station at 21:00, to continue the plankton sampling.

On 22nd May at 06:00 a fishing haul was carried out on the most southern transect. The catch consisted of blue whiting and boarfish, without mackerel or horse mackerel. After that the plankton sampling was resumed.

On 23rd May at 13:55 the last plankton station was sampled. After that we steamed back and when crossing the 200m depth contour we carried out a final fishing haul at 17:44. The catch consisted of boarfish, but also contained just over 100 mackerel and some horse mackerel. We were able to collect the last mackerel ovary samples needed.

On the 24th we sorted and analysed remaining plankton samples. On the 25th of May 2016 at 12:00 we returned to Scheveningen.

4.6 Sample-IDs

Plankton hauls 2016.5000151 - 2016.5000245
Fishing hauls 2016.5000141 – 2016.5000144

4.7 Samples and data

During the survey a total of 90 plankton stations with CTD measurements, 4 fishing hauls and 5 calibration tows were carried out covering the whole of the proposed sampling area. At each plankton station a double oblique haul was performed and minimum sampling time was 15 minutes.

The 90 plankton stations included 5 invalid hauls due to failure of the depth sensors or not being able to lower the plankton sampler to the desired depth when using the Dyneema cable.
Of the 5 calibration tows the first was invalid due to failure of the laptop running the IHIP programme.

4.8 Remarks for next survey

We had a successful survey but there are still some points that could be improved for a future plankton sampling survey on board a fishing vessel:

- Hydrophone in the hull, instead of towed hydrophone. During this survey the towed hydrophone was deployed at each station, but in bad weather situations this limits the depth range of the sensors.
- The vessel should have a plankton winch, or have the plankton sampler cable on the jomper winch, or a 10mm winch cable connected to the fish cable on the main winch. The downside of using the main winch is the long time it takes to change from fishing mode to plankton sample mode and back.
- The plankton winch line should be a 10mm steel armoured cable. The cable used in this survey, a Dyneema 10mm, was not a success, because the line floats, and at a certain point the plankton sampler does not descend further.
- The line of descending of the plankton sampler is not a straight line but bends to horizontal when getting into deeper water.

- A line length counter should be available on the winch in case the depth sensors do not give any data.
- Use of the trawl sonar winch is possible, if the tension system can be overruled to manual speed, then the cable end should have an underwater connector to connect to the depth sensors and/or CTD on the plankton sampler.
- A limiting factor is the stepwise adjustment of the winch speed, speed settings were 2=0.5m/s, or 3=0.83m/s. Speed of the winch should be freely adjustable to arrange a constant descent /ascent speed of the plankton sampler.
- The setup used with the hydrophone and depth sensor is a sensitive situation, the angle of the depth unit must be around 12 – 15 degrees upward, the sensors and depressor were adjusted many times to get the sensors active beyond 200m. Mostly the sensors stopped working around 170-180m depth. In that case the altimeter was essential to see the plankton sampler distance to the bottom.
- Good weather conditions increased the range of connection to the depth sensors. However this range decreases quickly in bad weather circumstances.
- Acoustic sensors with a minimum refresh rate of 1 per second should be available. Preferably two units, one depth sensor and a combined altimeter/depth sensor (trawleye).
- Two of each sensors should be on board, so they can be exchanged in case of low battery and charged in a dry area. During this survey charging needed to be done on the aft deck, in wet conditions which is dangerous with 220 volt plugs.
- If available, an ITI Simrad system this would be preferred. This system also gives information about depth and the distance of the plankton sampler to the vessel. However, one should keep in mind that the communication of an ITI works on a different frequency compared to the Marport or Scanmar depth sensors.
- A NMEA connection with GPS and Marport or Scanmar depth data, speed through the water by a Doppler log would give the possibility to monitor the exact speed of the plankton sampler through the water. This survey there was no way of estimating the speed through the water and as it turned out the length of the cable set varied a lot at the 200m depth stations and thus line length is a not a reliable parameter.
- The data flow on board is arranged by connecting a plug to a laptop on the bridge to download the CTD data, and at the same time ensure power supply for the batteries of the CTD sensor. On the bridge there should be space for two people to work with laptops.
- The plankton sampler should be deployed with a crane from the hekgalg or from the side of the vessel, this way the risk of the plankton sampler hitting the vessel is minimised.
- Seawater on the deck is necessary for cleaning the plankton sampler net.
- A 'wet lab' working space with seawater should be available for fixing and sorting the plankton samples and collecting the fish samples. The current wet lab was workable but had limitations with low work space. More preparation time before the survey could help to improve the ergonomic work situation.
- The plankton and fecundity samples are fixed in formaldehyde solutions. There should be proper refreshing of the air in the wet lab space to avoid formaldehyde fumes.
- In the wet lab four different solutions are used for fixing and analysing plankton and fecundity samples. However, only three taps for pouring fluid from the containers were available. Further surveys should at least have four taps, preferably with some spare ones.
- A waterproof, dry workspace ('dry lab') of at least 122x244cm for laptop and microscope, fixed table with 220 Volt power with uninterrupted power supply (UPS) is necessary for the analyses of the plankton samples.
- UPS should be available for survey equipment
- Rs232 cables should be available for the Marport / Scanmar equipment, LAN, NMEA splitter and GPS (Furuno)
- IHIP read routine should be checked. The programme in the current survey gave too much errors and shut down multiple times.
- LAN cables and switches should be arranged to create a local network of the sampling equipment.
- At the current survey two general IMARES laptops were used. However these turned out to be not updated and very slow and caused many failures during the survey causing loss of survey data. Instead a dedicated (CF-53 Panasonic) laptop should be available to ensure the hardware is capable of handling the data flow

- A chart plotter with depth charts of the area, aids the planning of the station grid.
- A stopwatch should be available to measure haul duration in case IHIP or the laptop running IHIP fails.

5 Results

5.1 Plankton

In total 85 samples were sorted and analysed for fish eggs and blue whiting larvae. On the two most northern transects some samples contained lots of phyto- and zooplankton. This was seen in the low volume of water filtered at 10 stations of these northern transects (Fig. 5.1).

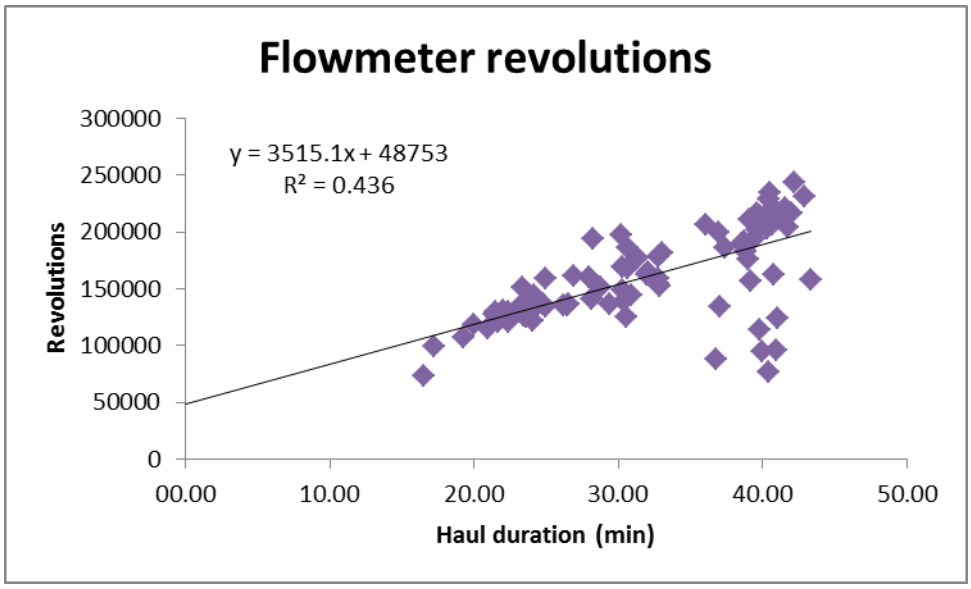


Figure 5.1 *Flowmeter revolutions per haul.*

Most eggs in the samples were of pearlsides (*Maurolicus muelleri*), mackerel, lesser argentine (*Argentina sphyraena*), dragonets, rocklings, pilchard (*Sardina pilchardus*) and horse mackerel. Most fish eggs were found west of the continental slope (Fig. 5.2).

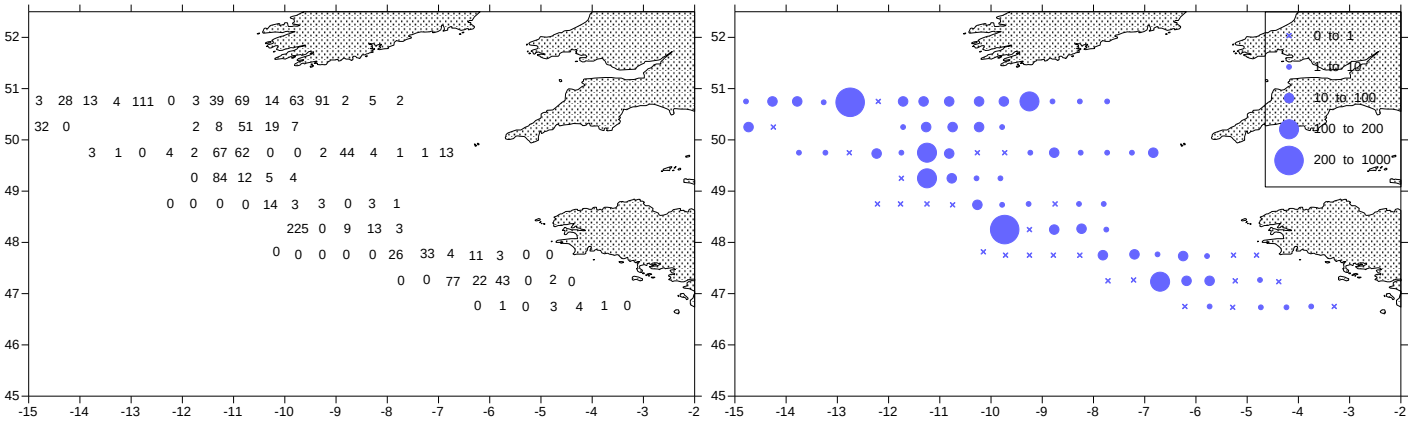


Figure 5.2 *Number of fish eggs found in the samples (left) and fish eggs per m2 (right).*

5.1.1 Mackerel eggs

Mackerel eggs were found from north to south along the 200m depth contour of the continental slope (Fig. 5.3). However numbers were lower compared to previous surveys IMARES carried out in the same area in May (ICES, 2011; ICES, 2014).

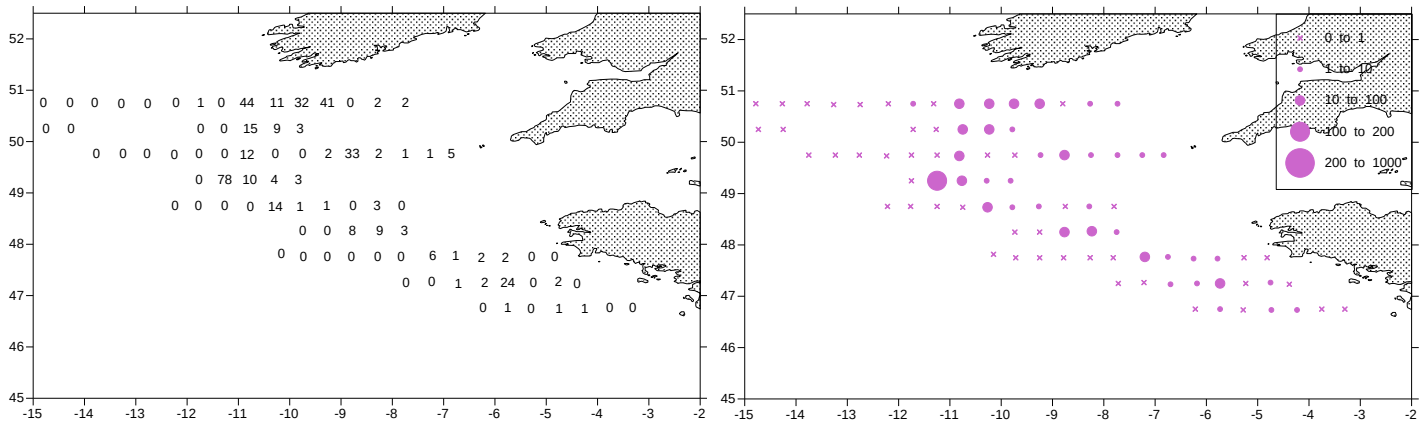


Figure 5.3 *Number of stage 1 mackerel eggs found in the samples (left) and number of stage 1 mackerel eggs per m2 (right).*

5.1.2 Horse mackerel eggs

Numbers of horse mackerel eggs in the samples were very low. Horse mackerel eggs were only found in the most southern transects along the continental slope (Fig. 5.4). Numbers were lower compared to previous surveys (ICES, 2011; ICES, 2014).

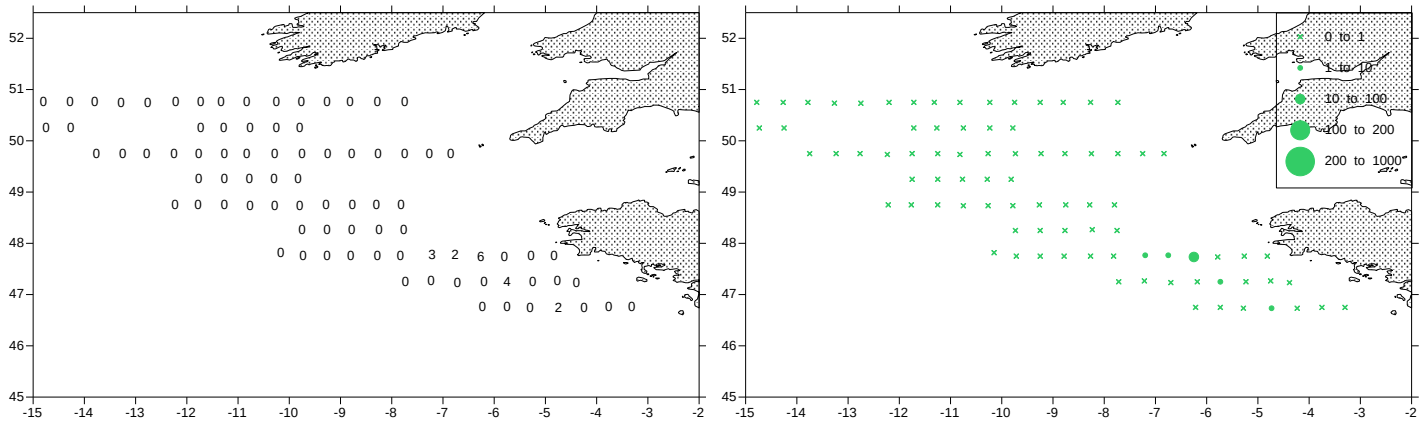


Figure 5.4 *Number of stage 1 horse mackerel eggs found in the samples (left) and number of stage 1 horse mackerel eggs per m2 (right).*

5.1.3 Blue whiting larvae

Numbers of blue whiting larvae in the samples were low and were only found in a few samples (Fig. 5.5).

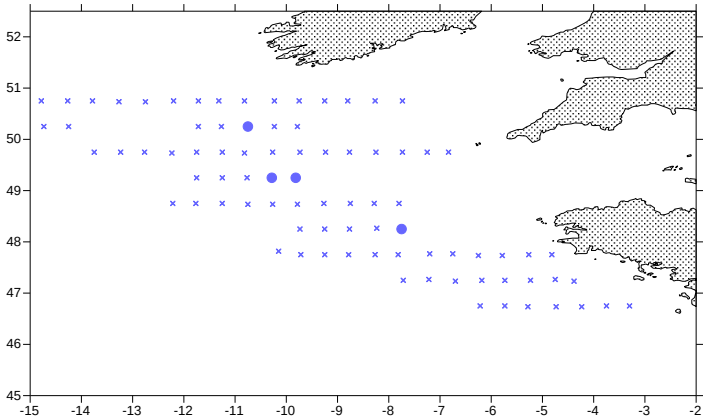


Figure 5.5 *Presences of blue whiting larvae in the samples.*

5.2 Adult fish samples

5.2.1 Fecundity samples

Four fishing hauls were carried out during the survey. In three hauls mackerel was caught. All required biological measurements (see par 3.5.1) were taken. In the first two hauls, male-female ratio was 1:1, but the last haul contained many more males than females. Almost all males and females were in maturity stage 4 or 5 (Walsh scale).
Of 45 females, fecundity, atresia and screening samples were collected. Of one female 10 extra ringtest samples for batch fecundity analyses were collected. These samples will be analysed in the laboratory upon return.

5.2.2 Genetic samples

In three hauls horse mackerel were caught. Like mackerel, horse mackerel were also in maturity stage 4 or 5 (Walsh scale). Of 40 adults tissue samples were collected for genetic analyses.

6 Conclusions

The mackerel and horse mackerel egg survey on board the FV Atlantic Lady was a successful survey, in the way that we managed to collect fish egg and larvae from plankton samples and ovary samples for fecundity analyses. Of the 89 planned stations 85 were sampled. It should however be noted that, except for one day, the weather during the survey was excellent. The stability of the vessel is not high and this limits the possibility of plankton sampling and plankton sample analyses in deteriorating weather circumstances. Wind force 6 is already limiting the plankton sampling and makes the analyses of the samples impossible.

The crew were very helpful and made the work pleasant, even though the working circumstances in the lab spaces were not ideal.

Numbers of mackerel and horse mackerel eggs found in the samples were low, lower compared to previous surveys in the same area. However, it is not possible to conclude anything on the size of the mackerel and horse mackerel spawning stocks from this survey alone. Any conclusions on the spawning stocks can only be taken when the data of the whole international mackerel and horse mackerel egg surveys are available.

During the survey we collected the fecundity, atresia and genetic samples that were assigned to this trip. Preliminary results will be made available for the WGWIDE meeting in August 2016. Finalised fecundity and atresia results will be ready for the WGMEGS meeting in 2017.

7 Quality Assurance

7.1 Check on the sorting of plankton samples

For quality assurance the egg and larvae sorting of the individual scientists were checked. During the survey, of each expert plankton-'sprayer' at least 5 samples, with different total amounts of plankton, were checked if eggs were properly sorted (Table 7.1). The inexperienced scientists only sorted a few samples to learn the analyses. Of the inexperienced 'sprayers' all samples were checked. The eggs remaining in the samples were mostly over 5% (Table 7.1). However, the number of eggs remaining in the samples sorted by the experts never exceeded 3. Due to the low number of eggs in the total sample this low number of remaining eggs still leads to a high percentage left (Table 7.1). However, as the actual numbers of mackerel (one of the target species) eggs remaining in the experts' samples after the spraying was low, it was decided there is no need to do the quality check on all the samples. For the inexperienced sprayers higher numbers of eggs were left in the sample. It is clear from this that experience in spraying is necessary to properly sort eggs from the samples.
Remaining eggs which were collected in the control spray were also identified, counted and staged in case of mackerel and horse mackerel eggs. The original results were corrected with the results of the control spraying for all the samples.

Table 7.1 Eggs remaining in the sample after the original spraying (in brackets: standard deviation)

Sprayer	Experience	Average eggs remaining in the samples (%)	Average mackerel eggs remaining in the samples (%)
1	Expert	4.9 (3.3)	6.4 (5.8)
2	Expert	17.3 (16.7)	0.0 (0.0)
3	Novel	15.5	15.9
4	Novel	17.9 (11.9)	18.8 (12.1)

7.2 International calibration of egg identification and fecundity and atresia analyses

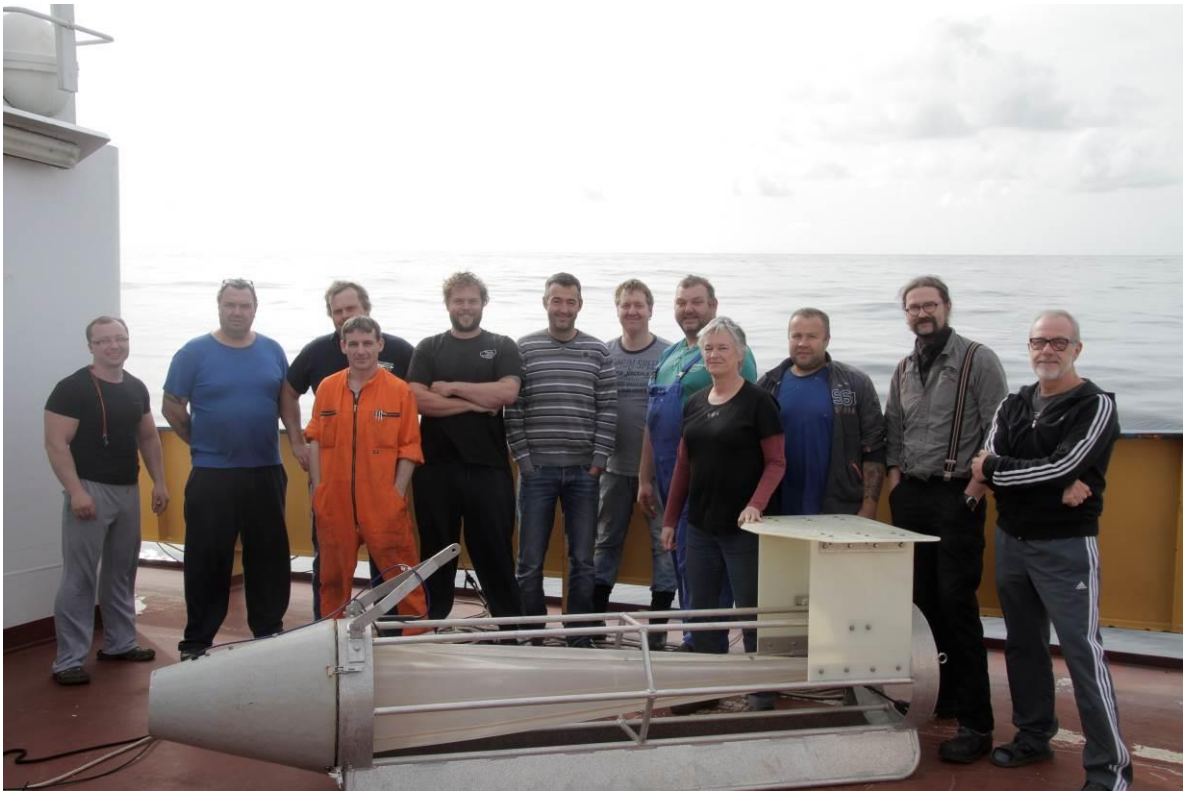
Before the Atlantic mackerel and horse mackerel egg survey international workshops, Workshop on Egg staging, Fecundity and Atresia in Horse mackerel and Mackerel (WKFATHOM), are held in October and November 2015 to calibrate (1) egg species identification and egg staging and (2) to calibrate fecundity and atresia estimation. Four IMARES specialists participated in these workshops in 2015 and participated in the 2016 mackerel and horse mackerel egg survey. Results of the 2015 workshop are described in the WKFATHOM report (ICES, 2015).

7.3 ISO qualification

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 187378-2015-AQ-NLD-RvA). This certificate is valid until 15 September 2018. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V.

Acknowledgements

We would like to thank the crew of 'FV Atlantic Lady' for their help and commitment for the mackerel and horse mackerel egg survey. Without their help we would not have been able to carry out this survey. Their interest in the survey created a good atmosphere to work in.



From left to right: Boris, Frans, Cors, Graig, Jakob, Thomas, Dirk, Henk, Ineke, Ton, Dirk & Hanz.

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Justification

Report C077/16
Project Number: 4316100060

The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of IMARES.

Approved: Christine Röckmann
Scientist

Signature:

Date: 22 July 2016

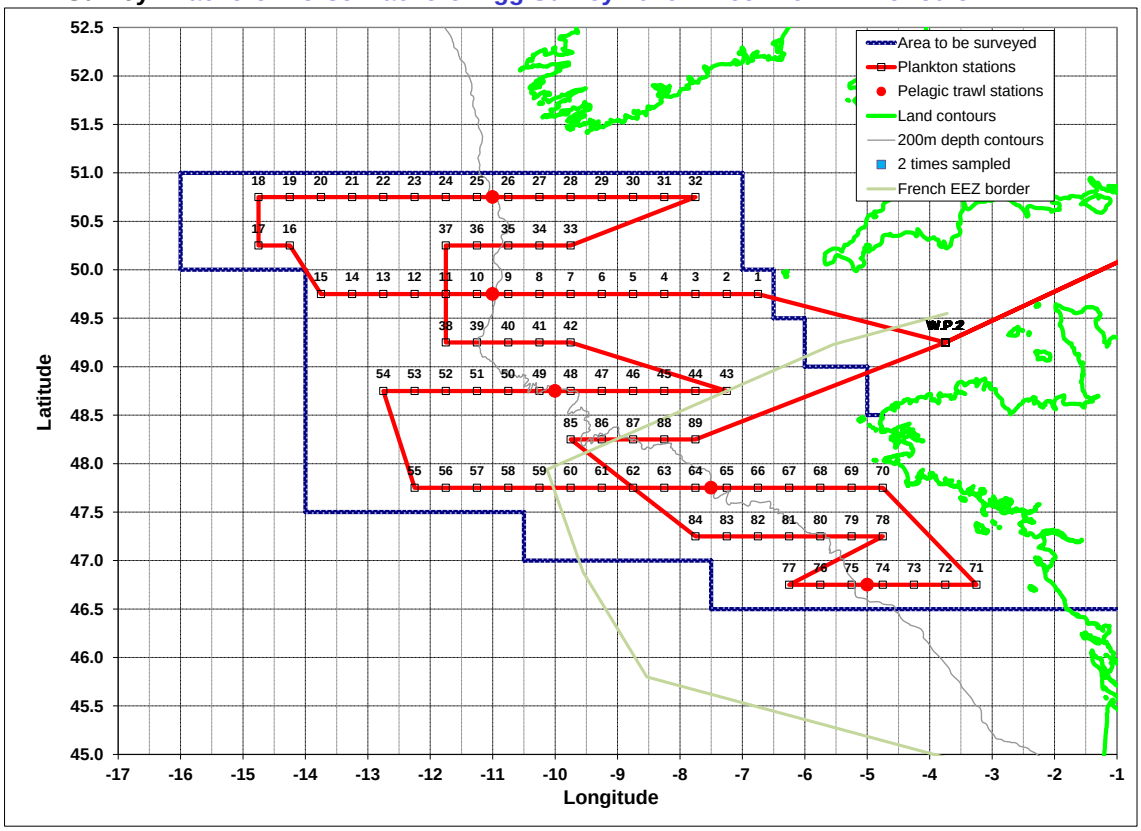
Approved: Jakob Asjes
Manager Integration

Signature:

Date: 22 July 2016

Annex 1 Planned station grid

Survey: Mackerel Horse Mackerel Egg Survey 2016 week 19-21 Period 5



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