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Regulation (EU) 2017/1004 of the European Parliament and of the Council of 17 May 2017

on the establishment of a Union framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the common fisheries policy and repealing Council Regulation (EC) No 199/2008 (recast).

Commission Implementing Decision (EU) 2019/909 of 18 Feb 2019

establishing the list of mandatory research surveys and thresholds for the purposes of the multiannual Union programme for the collection and management of data in the fisheries and aquaculture sectors

Commission Delegated Decision (EU) 2019/910 of 13 March 2019

establishing the multiannual Union programme for the collection and management of biological, environmental, technical and socioeconomic data in the fisheries and aquaculture sectors

Commission Implementing Decision (EU) 2016/1701 of 19 August 2016

laying down rules on the format for the submission of work plans for data collection in the fisheries and aquaculture sectors.

Commission Implementing Decision (EU) 2018/1283 of 24 August 2018

laying down rules on the format and timetables for the submission of annual data collection reports in the fisheries and aquaculture sectors.

German Annual Report for data collection in the fisheries and aquaculture sectors

2020

Version 1.0 – May 2021

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CONTENTS

Text Box 1C: Sampling intensity for biological variables

General comment: This box fulfils paragraph 2 point (a)(i)(ii)(iii) of Chapter III, Chapter IV of the multiannual Union programme and Article 2, Article 4 paragraph 1 and Article 8 of the Decision (EU) 2016/1701. This box is applicable to the Annual Report.

General remarks regarding all regions:
Several reasons imply that the collection of biological parameters from commercial fisheries is best handled by sampling-at-sea. This is due to

- the necessity to sample on board of freezer trawlers and trawlers with processing units. This is the case in the fishery for pelagic species, as these are landed in frozen packages. The same is true for landings of demersal species from waters off Norway and Greenland which are landed as partly processed products.
- monitoring discarding. It would be highly ineffective not to sample the landings and other biological data at the same time.
- providing the possibility to sample at the same time landings, discards and other catch fractions (related to the Landing Obligation) and to take otoliths and samples for sex and maturity.
- discards of species listed in Table 1D of Commission Decision 2016/1251 as by-catch in fisheries directed towards other species that can only be recorded on board.
- 68%, 73% and 69% of the landings in 2018, 2019 and 2020, respectively, having occurred in foreign countries.

Due to the reasons mentioned above, Germany prefers to sample catches at sea in the North Sea and North Atlantic. This is still the case with the Landing Obligation in force in parts of the fleet. In the Baltic Sea, there is at-sea, self-sampling and harbour sampling.

The status of a scientific observer on board of a German fishing vessel still is a guest status. Article 12.2 of Reg. 2017/1004 stipulates that *"the masters of Union vessels shall accept on board scientific observers and cooperate with them"*, which did however not improve this situation. The possibility for biological sampling depends on the hospitality of vessel owners and companies. Based on the present situation, random sampling of the fleet is difficult and might be not optimal in future (even if a new legal basis for on board sampling is in place), since some reluctance regarding observers will still remain for several fisheries.

Data are gathered in connection with sampling of commercial sources (observer trips, harbour and self-sampling) and on scientific surveys. Data are sampled on a yearly basis. Table 1C provides an overview on the species by region/fishing ground/area/stock that were sampled during 2020. Note that for some species (e.g. redfish and Greenland halibut), otoliths were only taken but not read due to lacking consensus on age reading methodology and validity.

The indications of the planned minimum numbers of individuals to be measured for the different variables are based on experiences with the German sampling scheme and survey catches. Even with the possibilities to adjust the numbers within the updates for the programme, it is not always possible to predict accurately if these planned numbers are reachable and realistic. In the following, the most common reasons for over- and undersampling are listed:

Reasons for oversampling:
For most of the fish stocks and brown shrimp, the number of length and age measurements well exceeded the planned and requested minimum number of measurements. As most of the measurements are taken on observer trips, the reason for "oversampling" is often that all fish of a once randomly chosen subsample have to be measured in order to calculate the retained and discarded fraction of the whole catch. Another reason is that once an observer is onboard, the entire trip is being sampled (i.e. sampling does not stop after a few hauls or fishing days, but lasts until the end of that trip). The sometimes very high numbers for weight@length (=individual weights) are taken to obtain reliable weight-length relationships.

Reasons for undersampling:
In several cases, the planned sample sizes have not been achieved. In some cases, this is due to the general rule for observers to collect stock-based variables of 10-12 fish per length class and area. If only very few

length classes occur during a fishing trip, this rule can lead to undersampling in terms of the planned numbers.

Although Germany was able to cover most of the stocks, the COVID-19 pandemic interfered with the sampling programmes in many ways. It was not always possible to place observers onboard because of missing hygiene standards or national regimentations prohibited the crossing of borders to bring staff into the harbours.

For surveys, no minimum numbers are given in Table 1C. Here, the survey manual stipulates the target of the survey in terms of fishing method, spatial and temporal coverage. Surveys are mostly not aiming to catch high numbers of a certain species but to get a standardized overview on the abundance and distribution of fish species.

Further explanations by region:

Baltic Sea:

1. Evidence of data quality assurance

All data quality assurance measures for the commercial and the recreational fisheries sampling programme are given in Table 5A.

2. Deviations from the Work Plan

The work plan for the Baltic Sea defines six stratum ID codes. In 2020, deviations occurred in three of these sampled strata.

Over-achievement:

Baltic passive 2224 (+263%): This metier contributes significant amounts to the total landings, especially of Western Baltic cod (>30%) but also for flatfishes. Despite this importance, there is a lack in biological data from this metier, not only regarding length and age distributions, but also in the discards. Thus, our sampling fills an important gap in the stock assessment input data. Moreover, this fleet involves a great proportion of the German fishing vessels in the Baltic Sea with considerable variations in species composition, gear settings, temporal and spatial extent, which was not fully recognised when the Work Plan was designed. Finally, potential bycatch issues exist (marine mammals and sea birds) and more intensive sampling was initiated to fulfil national and international requirements.

Moreover, due to low quota and the COVID-19 pandemic, the proportion trips with passive gear increased (see comment below) and additional self-samples were purchased from the passive-gear demersal fleet in 2020.

Baltic sprat (+400%): In 2012, a self-sampling cooperation was initiated with the two main trawlers targeting sprat and has been successfully continued since 2013. Improved work organisation in the lab enabled efficient work-up of samples without causing additional costs.

Under-achievement:

Baltic active 2224 (only 77% achieved): Quota and catch options for cod in the western Baltic were historically low in 2020 so that the possibility to obtain trips and samples from the fishery was also reduced. Due to COVID-19-related restrictions, the fishery was temporarily shut down; and even if fishing took place, observers could not enter the vessels; larger vessels, which require larger catches to be profitable, reduced the number of trips because larger catches were difficult to sell. The passive-gear fisheries was less affected, as these are usually have smaller catches, and their catch size can be adjusted more easily, are operated by one or two persons only and thus had less problems (e.g. with testing or quarantine measures).

Baltic herring active 2224 (only 53% achieved): The planned number of 30 PSUs sampled per year is a false entry (see below under Deviations from the work plan, Text Box 4A). In addition, the further reduced national quota shortened the fishing season and hence the number of samples that could be collected.

Baltic active 2532 (only 10% achieved): In 2020, Eastern Baltic cod could only be fished as a bycatch species with a bycatch quota. Despite the introduction of the landing obligation in 2015, discard rates of Eastern Baltic cod are still relatively high so that observer trips are difficult to arrange. So, not only the total number of PSUs in the sampling year was historically low so that the sampling reflected the minor fishing activities; also COVID-19 restrictions further aggravated conducting observer trips.

Salmo salar and *Salmo trutta*: No salmon or sea trout were obtained from the collected self-samples. Thus, no sex and individual weight data could be collected.

3. Actions to avoid deviations

Conservative planning leads to exceeding the sampling plan, which results in so-called 'oversampling'. However, oversampling may not be the right term, as for statistical purposes, the sampling intensities in terms of trips are usually not too high. Given the relatively low coverage, any additional, statistically sound sampling data are useful and desirable, especially if they come with no additional costs – as in our case. Since our sampling is proportional to the fishing activities, the under-achievement in the strata "Baltic active 2224" and "Baltic active 2532" just reflect the reduced number of fishing trips in 2020 and the lower availability of sampling opportunities due to COVID-19 restrictions.

North Sea and Eastern Arctic:

1. Evidence of data quality assurance

   See Table 5A. The sampling design and protocols follow the outcomes of sampling expert groups and/or the national standards. Sampling procedures and analysis are described and documented (see e.g. http://www.dcf-germany.de/fileadmin/sites/default/downloads/Beprobungsanleitung_2011-12.pdf). Data quality is checked by national routines. Germany is participating in relevant age reading and maturity workshops in order to ensure international agreement. Presently, we do not evaluate bias and precision of our data. A routine tool is still not available for such estimates on a national level. Furthermore, bias and precision should be evaluated on a regional level within the Regional Coordination Groups in order to assess the sampling levels on a broader coverage. Germany is participating actively in the Regional Coordination Group for the North Sea and Eastern Arctic, now combined with the North Atlantic group.
2. Deviations from the Work Plan

   Oversampling and undersampling of the planned minimum number of individuals of a certain species are explained in the general remarks at the beginning of this paragraph.

   Specific explanations are given for 0 measurements:

   0 measurements of saithe in ICES 3a: Catches in the Skagerrak are belonging to the same saithe stock as in the northern North Sea, targeted by the same fishing metier. As fishing activities in the Skagerrak occur only irregularly, the stock is sampled mainly in the North Sea. As the sampling possibilities were additionally restricted due to the COVID-19 pandemic, no observer could be placed on a trip covering this area.
3. Actions to avoid deviations

   Achieved sampling intensities higher than the planned values are explained above. For statistical reasons, the achieved sampling intensities cannot be considered too high. The occurrence of oversampling rather reflects conservative planning.

North Atlantic and NAFO:

1. Evidence of data quality assurance

   See Table 5A. The sampling design and protocols follow the outcomes of sampling expert groups and/or the national standards. Sampling procedures and analysis are described and documented (see e.g. http://www.dcf-germany.de/fileadmin/sites/default/downloads/Beprobungsanleitung_2011-12.pdf). Data quality is checked by national routines. Germany is participating in relevant age reading and maturity workshops in order to ensure international agreement. Presently, we do not evaluate bias and precision of our data. A routine tool is still not available for such estimates on a national level. Furthermore, bias and precision should be evaluated on a regional level within the Regional Coordination Groups in order to assess the sampling levels on a broader coverage. Germany is participating actively in the Regional Coordination Group for the North Atlantic now merged with the North Sea and Eastern Arctic RCG.
2. Deviations from the Work Plan

   Oversampling and undersampling of the planned minimum number of individuals of a certain species are explained in the general remarks at the beginning of this paragraph.

   Specific explanations are given for 0 measurements:

   Missed sampling of herring in ICES Div. 6a/6aN/6aS, 7bc/7a/7j: This herring is only bycatch in the pelagic fisheries targeting other species. In 2020, this was not the case, no landings were recorded therefore no sampling could be conducted.

   Undersampling of horse mackerel in ICES Div. 2a, 4a, 5b, 6a, 7a-c, e-k, 8abde/10. As the sampling possibilities were restricted due to the COVID-19 pandemic, no observer could be placed on a trip targeting this species.

3. Actions to avoid deviations

   Achieved sampling intensities higher than the planned values are explained above. For statistical reasons, the achieved sampling intensities cannot be considered too high. The occurrence of oversampling rather reflects conservative planning.
   Germany is always aiming to fulfil all its sampling obligations. However, in case of some fisheries with a very low number of trips and very long duration (e.g. up to 3 months), it is not always possible to place observers.

Other regions:

1. Evidence of data quality assurance
   A multilateral sampling agreement for the CECAF area exists since 2011. For the SPRFMO area, a similar agreement is in force since 2015. Table 7A provides details on these agreements, and the national portal website (dcf-germany.de) contains copies of the agreements. Sampling procedures are described in separate documents accompanying the multilateral agreements (https://www.dcf-germany.de/sampling). Germany is participating actively in the Regional Coordination Group on Long Distance Fisheries.
2. Deviations from the Work Plan
   not applicable
3. Actions to avoid deviations
   not applicable

Text Box 1D - Recreational fisheries

General comment: This box fulfills paragraph 2 point (a) (iv) of Chapter III of the multiannual Union programme and Article 2, Article 3 and Article 4 paragraph 1 of the Decision (EU) 2016/1701. This box is applicable to the Annual Report. This box is intended to provide information on the design, implementation and analysis of all components of sampling schemes/ surveys that are listed in Table 1D.

1. Description of the target population

Offsite: Effort of German households (all fishing methods & species)

Onsite: CPUE All (resident, nonresident and foreign anglers | all fishing methods & species)

Salmon: PSU trolling boat

2. Type of survey

To collect recreational fisheries data, the following surveys were conducted:

(i) Telephone diary survey (effort – 2014/2015)
(ii) Multiannual on-site access point survey (CPUE – annual)

(iii) Remote camera survey + random on-site intercept survey (catch + effort – annual)

3. Data Quality

Precision estimates are caluclated and documented, see Strehlow et al. 2012 and Weltersbach et al. 2021.

4. Data Analysis and processing

Data processing and imputation procedures are documented (Strehlow et al. 2012; Weltersbach et al. 2021). The estimation procedure follows the survey design. In the case of cod data, no annual precision estimates are calculated, as for assessment purposes, this is not a requirement. For salmon, confidence intervals for catches are calculated.
In general, a detailed documentation from the pilot study has been prepared, which includes full documentation of methods, imputation procedures and bootstrapping of catch estimates (Weltersbach et al. 2021 – German language & English summary).
Germany follows a multiannual, multistage survey to collect recreational fisheries data. This includes an off-site telephone diary survey to estimate effort (number of anglers + angling days) and an on-site stratified random access point intercept survey to estimate catch rates. Onboard sampling of charter vessels is conducted annually to obtain length distributions of both kept and released components.
The off-site telephone survey follows a random digit dialling approach screening the German population followed by a one-year diary survey. A representative computer-assisted telephone survey (CATI) was carried out in 2014/2015 generating 358,411 telephone numbers yielding a gross sample of 73,213 valid telephone numbers. Of these, a net random sample of 50,200 telephone interviews were realized and 562 German marine anglers identified. Respondents were asked to keep a catch diary for one year. Of these, 348 anglers agreed to keep a diary. The survey aimed to identify marine anglers in the German population. A marine angler was defined as a person who had fished in the last 12 months or who planned to go fishing in the coming 12 months. Quarterly follow-ups were used to remind participants and obtain data. Diarists were asked to report every single angling day regarding fishing area, platform, target species, and numbers of fish caught, kept, and released. The survey is documented in Weltersbach et al. (2021), containing an English summary of 8 pages. The subsequent effort survey was launched in 2020 and contacted 150,000 German households, yielding a gross sample of 2774 anglers. This survey is still ongoing.

The on-site stratified random access point intercept survey is conducted annually and covers all 12 months. The coastline is divided into spatial strata for sampling, with harbours and beaches as access point mixed with days as primary sampling units (PSUs). It is designed to estimate catch rate. A random sample from 87 access points and dates is drawn, yielding 30 sampling assignments per month along the German Baltic coast. Sampling effort is increased for sea-based fishing methods and for weekends and holidays. Data is stratified into shore fishing, boat fishing and charter boat fishing. A survey agent conducts interviews to obtain socio-demographics, fishing characteristics, and catch rates (harvest + release) from complete fishing days. This information is then raised to the total angling population and the number of angling days. In 2020, 1,141 on-site angler intercepts were realized.

STREHLOW, H. V, SCHULTZ, N., ZIMMERMANN, C. & HAMMER, C. (2012). Cod catches taken by the German recreational fishery in the western Baltic Sea, 2005-2010: implications for stock assessment and management. ICES Journal of Marine Science, 69, 1769-1780.

WELTERSBACH, M. S., RIEPE, C., LEWIN, W.-C., STREHLOW, H. V. (2021). Ökologische, sozial und ökonomische Dimensionen des Meeresangelns in Deutschland. Braunschweig: Johann Heinrich von Thünen-Institut. Thünen Report 83. https://doi.org/10.3220/ REP1611578297000.

Pilot Study 1: Relative share of catches of recreational fisheries compared to commercial fisheries

General comment: This box fulfils paragraph 4 of Chapter V of the multiannual Union programme and Article 2 and Article 4 paragraph (3) point (a) of the Decision (EU) 2016/1701.
General comment: This box is applicable to the Annual Report. This box is intended to provide information on the results obtained from the implementation of the pilot study.
Resume 2017-2019 and outlook The pilot study was performed as planned by Germany within 2017-2019 and will be continued as regular data collection. The pilot study conducted during 2017-2019 revealed that for some areas and species, marine recreational fisheries (MRF) catches represented a significant proportion of the total removals and thus should be collected regularly to underpin European fisheries management. This was the case for cod, salmon and sea trout in the Baltic Sea. In the case of cod, the comaprison between the off-site 1-year-telephone-diary survey and the on-site stratified random access-point-intercept survey revealed that a national population survey is required at regular intervals (3-5 years) to quantify fishing effort and that an annual on-site intercept survey proves valuable to detect rapid and quick changes in catch rates (CPUE). The onboard sampling during charter boat trips was used to collect biological catch composition data (length measurements) for all caught and released species during the sampled trips of this sector. This survey component is indispensable to obtain unbiased length distriutions of caught and released MRF catch compositions. We will therfore continue with our annual on-site access-point-intercept survey in 2020 and beyond, as well as regular onboard sampling of MRF catches to obtain length distributions. As there have been substantial changes in MRF management regulations in recent years (introduction of a bag limit for cod), which also affect anglers' behaviour and thus exerted fishing effort, we are planning to conduct a large nationwide telephone survey in 2020/2021 to yield updated data on fishing effort in recreational fisheries. This survey shall also cover freshwater/inland fisheries to yield estimates on freshwater eel catches in Germany. Social indicators will be included to correct for angler heterogeneity in data collection and stock assessment. In the case of salmon, the 1-year-telephone-diary survey revealed that this survey does not adeqautely cover the MRF for salmon in the Baltic Sea. We therefore invented a new dedicated salmon-camera survey to obtain near-census effort estimates from relevant salmon harbours and in association with stratified random angler-intercepts in those harbours to obatin catch rates and biological data (length distribution). MRF salmon catches proved to have a large interannual variability suggesting to conduct this dedicated survey on an annual basis. We will thus continue this remote camera survey with regular angler intercepts in 2020. In the case of sea trout, the 1-year-telephone-diary survey could be used to obtain effort estimates for the MRF sea trout fishery. This survey was however not sufficient to yield annual variability and length distributions. Currently, the plan is to continue to use national population surveys for this specialized fishery and use the same data for intermittent years. The planned nationwide telephone survey in 2020 will provide updated data for sea trout catches in the Baltic Sea. Altogether, the conducted pilot study (MRF surveys) was adequate to fullfill the DCF requirements and the continuity of it will satisfy the following end-users of the MRF data: ICES WGRFS, WGBFAS and WGBAST; DG MARE; EP; RCGs; PGECON; national governments and regional fisheries authorities, international and national angling bodies, national and local businesses and journalists.
Achievement The main objective of the pilot studies was the collection of representative data on the number, fishing effort, catch-per-unit-effort and total catches (harvest and releases) of German marine anglers in the North and Baltic

Sea including the brackish lagoon waters (Bodden) of Mecklenburg-Western Pomerania considering all relevant species.

Duration of pilot study:

Pilot study	Duration	Inclusion into regular sampling
1.1 Telephone diary survey	2017-2021	Yes, every 5-7 years
1.2 On-site access point intercept survey	2017-2020	Yes, annually
1.3 Remote camera survey	2017-2021	Yes, annually

The first pilot study comprised an off-site telephone diary survey. A representative telephone screening survey (CATI) of the general population in Germany was conducted from May to October 2014 to identify marine anglers in the German population. During the screening survey, sociodemographic parameters of the German marine angler population were collected and participants were recruited for a one-year diary study. The diary study aimed to provide detailed spatial-temporal data on recreational fishing effort and catches for all species over a twelve-month period. The diary survey ran between May 2014 and October 2015. The analyses and documentation of the results were conducted in the framework of the pilot study between April 2017 and January 2021. A main goal of the off-site survey was the collection of fishing effort data that can be used together with catch rate data from the on-site survey (pilot study 1.2) to calculate recreational harvest and releases for stock assessment purposes. Based on the experiences and lessons learned from the pilot study similar off-site surveys are planned every 5-7 years (due to cost constraints) to update recreational fishing data, in particular fishing effort. These surveys will also include all freshwater recreational fisheries in Germany to obtain also catches of diadromous species during their freshwater phase. However, with the exception of eel, freshwater catches for these species are expected to be negligible. A subsequent off-site telephone diary survey targeting German marine and freshwater anglers from all over Germany (screening of 150,000 German households) has been already initiated in 2020 and will run until 2022.

The pilot study 1.2 comprised a stratified random on-site access point intercept survey conducted between 2017 and 2020. The on-site survey follows a multi-annual survey design and collects information based on completed fishing days on socio-demographics of anglers, fishing characteristics and catch rates for stock assessment purposes, in particular for western Baltic cod (*Gadus morhua*), even though all species are considered (Strehlow et al., 2012). The survey is conducted annually and will continue in the future.

The pilot study 1.3 comprised a remote camera survey supplemented with an on-site access point intercept survey to monitor the highly specialized recreational salmon (*Salmo salar*) trolling fishery in the Baltic Sea around the Island of Ruegen (ICES SD 24). The survey is conducted annually since 2017 and will continue in the future.

Onboard sampling during charter boat trips was used to collect biological catch composition data (length measurements) for all caught and released species during the sampled trips of this sector.

All objectives of the pilot sudy were reached.

Incorporation of results from pilot study into regular sampling
See Table above.

Text Box 1E: Anadromous and catadromous species data collection in fresh water

General comment: This Box fulfills paragraph 2 points (b) and (c) of Chapter III of the multi-annual Union programme and Article 2 of this Decision.

Eel (*Anguilla anguilla*)

As required by Decisions 2019/909 and 2019/910, the data collection in all German Eel Management Units (EMUs) will be organised as follows:

- Biological variables (age, length, sex, maturity)
  - Sampling of silver eels from commercial catches
  - Timing and frequency of sampling commercial fisheries potentially affects catch composition (i.e. length and/or age composition) and will thus introduce a bias to the collected data. To proceed towards a sound sampling scheme, multiple samplings over an extended time period will be conducted in one EMU (Ems) to analyse seasonal variations in the catch composition. It is thus necessary to conduct additional age readings in this EMU and therefore no further age readings will be conducted in other EMUs.
  - Spawner quality assessed in sub-samples (e.g. contamination status, fat content, parasite infestation)
- Annual catch quantities in EMUs as reported by fishers
- Recruitment
  - Natural recruitment: regional (non-DCF) glass eel monitoring /ICES time series
  - Stocking: number of glass eels and elvers, as reported in national stocking statistics
  - Larval surveys in the spawning area of the European eel
- Abundance of standing stock and silver eel escapement
  - calculated via German Eel Model III (Oeberst & Fladung 2012)

Salmon (*Salmo salar*)

Salmon stocks in Germany are extirpated and in those rivers with re-introduction programs (Rhine, Elbe, Ems and Weser) abundance of salmon is very low. German stocks of *Salmo salar* do currently not contribute to (and are not further considered in) stock assessment by ICES WGNAS. For the given reasons, active data collection within the German DCF data collection is considered not feasible. However, available data and information from regional authorities from re-introduction programs are collected annually and regularly provided to relevant end-users, in order to ensure regular updates on the state of German salmon populations.

References

Oeberst, R. & Fladung, E. 2012. German Eel Model (GEM II) for describing eel, *Anguilla anguilla* (L.), stock dynamics in the river Elbe system. Inf. Fish. Res. 59: 9-17. DOI: 10.3220/Infn59_09-17_2012

Were the planned numbers achieved?

Partly achieved regarding the sampling of commercial catches. Planned numbers were fully achieved in the EMU Schlei/Trave, while in the other EMUs, silver eel sampling will be completed in 2021.

Fully achieved regarding the multiple sampling of silver eels over an extended time period in the River Ems. Eel sampling started in September 2020 and will be continued until December 2021. Biological variables of 926 eels were assessed between September and December 2020 and a subsample of otoliths was prepared for age reading. Restrictions of laboratory operations due to the COVID19-pandemic caused a delay in age readings. However, the planned number of otoliths was sampled in 2020 and age readings will be finalized by the end of 2021.

Partly achieved regarding the spawner quality assessment. Where available, sub-samples from EMUs were collected for contaminant analysis and the analysis of fat content and *Anguillicola crassus* infestation. Due to technical problems, the contaminant analysis could not be conducted as planned (please see separate study report for details). However, sampling, fat analysis and *A. crassus* screening will be completed in 2021.

Data collection on eel catch quantities, eel recruitment and stocking are collected annually, but data from 2020 will be available only later in 2021. An annual update on these data is provided in the ICES data call on eel and available to end-users. Data on the silver eel escapement from EMUs and abundance of standing stock is reported in the Eel Management Plan progress reports on a three-year basis. The next report is due in August 2021.

Two EMFF-supported studies were conducted in 2020, aiming 1) to assess the feasibility of environmental DNA analysis to quantify the abundance of migrating silver eels in rivers and 2) to investigate the contaminant burden of eels in German EMUs. Detailed information on progress, results and difficulties of these studies are provided in separate study reports (Annex 2).

In addition, a telemetry study was conducted in the Baltic Sea with migrating silver eels from two German EMUs (Schlei/Trave, Oder). In total, 101 eels were caught during downstream migration, tagged with acoustic transmitters and released in coastal waters nearby. Detections from acoustic receivers installed in the Belt Sea by DTU, Denmark, will provide information about migration speed, preferred migration routes and mortality of silver eels from German EMUs during their initial spawning migration in the Baltic Sea. Results of this study are expected in 2021.

Fully achieved regarding salmon data collection. Available data from German inland waters were collected and provided to end-user (ICES WGNAS).

Implications of COVID-19 pandemic restrictions
Laboratory operations and work in research projects were hampered or temporarily stopped in 2020 due to COVID-19 pandemic restrictions. This caused delays in sample processing and analysis (e.g. otolith age readings, morphometric measurements of samples from eel fisheries) and hampered the progress of spawner quality and environmental DNA analyses. Due to travel restrictions, sampling of commercial eel fisheries was temporarily not possible because work-related travel was restricted or prohibited.
The larval survey in the spawning area of the European eel (Sargasso Sea), planned for March/April 2020, was cancelled without replacement due to COVID-19 pandemic restrictions. The next survey is scheduled for 2023.

Text box 1F: Incidental by-catch of birds, mammals, reptiles and fish

General Comment: This box fulfils paragraph 3 point (a) of Chapter III of the multiannual Union programme and Article 2 of the Decision (EU) 2016/1701. This box is applicable to the Annual Report. This box is applicable only for those sections where Member States have reported that they have been carrying out regular sampling. Results and deviations for Pilot studies should be reported under Pilot Study 2.

1. Results

In certain German fisheries, the by-catch of single specimens of vulnerable species was observed very occasionally (see Table 1F). In 2020, no by-catch of mammals and birds was observed in the North Sea and North Atlantic area. Occurring by-catch of listed fish species (e.g. *Rajidae*) was notified. It was attempted to release the specimens alive when possible.

2. Deviations from Work Plan

No deviations. Our sampling covers all bird and marine mammal species (no reptiles occur in our fishing areas). If occurring species are identified to the lowest possible taxon (species level). Birds are usually dead and collected for sampling; the carcasses are provided to the Institute for Terrestrial and Aquatic Wildlife Research of the University of Veterinary Medicine Hannover (ITAW Büsum) in Germany. Cormorants are not collected.

3. Data quality

- Does the onboard observer protocol contain a check for rare specimens in the catch at opening of the codend? If YES is the observer instructed to indicate if the codend was NOT checked in a haul?

Yes for the North Sea and North Atlantic. The observer is advised to give an indication to which amount he/she was able to check the fishing activities for accidental by-catch.

Baltic Sea: No. Onboard vessels using passive gear, the entire catch is sampled (concurrent sampling) and all species in the catch are recorded. On vessels using active gear, the observer is usually on deck when the codend comes onboard and sampling is concurrent.

- In gill nets - and hook-and-line fisheries: does the onboard observer protocol instruct the observer to indicate how much of the hauling process has been observed for (large) incidental bycatches which never came on board (because they fall out of the net)? In large catches: does the protocol instruct to check for rare specimens during sorting of the catch (i.e. at conveyor belt)? Is the observer instructed to indicate what percentage of the sorting or hauling process has been checked at "haul level"?

North Sea and North Atlantic: Gill nets are only used by very few vessels in the North Sea and north-western waters. Due to the negligible effort, these vessels are not included in the observer program.

Baltic Sea: No, but usually the observer is on deck and observes the hauling process unless the observer is processing the sample. In large catches, subsamples are taken and all species in the subsample are identified to species level. Observers are instructed to indicate the percentage of the haul they have sampled.

- Does the onboard observer protocol instruct to report on the use of mitigation (i.e. Escape Devices or Acoustic Deterrent Devices)?

Yes, but only in use in the German Baltic Sea fisheries.

- Does the sampling design and protocol follow the recommendations from relevant expert groups? Provide appropriate references. If there are no relevant expert groups, the design and protocol have to be explained in the text.

The question is unclear. We follow the current sampling guidelines of the DCF/EU-MAP and try to include suggested improvements of relevant working groups (e.g. WGCATCH, WGBYC) whenever it is useful to our working routine. Our current sampling programme is not directed at sampling incidental bycatches or collecting additional data on sea birds or marine mammals (e.g. counting bird swarms or estimating the size of whale schools during the sampling).

- Are data quality issues taken into account?

The question is unclear. Sampling coverage follows the sampling obligations in accordance with the Commission Delegated Decision (EU) 2019/910. Observers are trained for species determinations.

- How are data (and samples) stored

The data are stored in a national database. Samples of incidental bycatch are only stored temporarily in a freezer and then provided to specialised research groups in Germany (e.g. ITAW Büsum).

SECTION 1: BIOLOGICAL DATA

Pilot Study 2: Level of fishing and impact of fisheries on biological resources and marine ecosystem

General comment: This Box fulfills paragraph 3 point (c) of Chapter III of the multiannual Union programme and Article 2 and Article 4 paragraph (3) point (b) of the Decision (EU) 2016/1701.
General comment: This box is applicable to the Annual Report. This box is intended to provide information on the results obtained from the implementation of the pilot study.
1. Aim of pilot study (Stomach sampling and analysis) Improve availability of data and tools for estimating the level of fishing and the impact of fishing activities on marine biological resources **2. Duration of pilot study** 24 months (1 Jan 2020 – 31 Dec 2021 - continuation) **3. Methodology and expected outcomes of pilot study** Fundamental changes in the importance of natural *vs.* fishing-induced mortality are observed while moving towards MSY management target. The comprehensive reduction of fishing mortality and successive recovery of fish stocks, especially of the larger predatory species, led to an increasing natural mortality as opposed to fishing mortality. Consequently, estimates of natural mortality become more important for stock assessments and forecasts. A DG MARE tender (Contract MARE/2012/02-SI2.632887) pilot study on stomach sampling in the North Sea and Baltic Sea was able to prove, in cooperation with the ICES Working Group on Multispecies Assessment Methods (WGSAM), that cost-effective sampling of stomachs is possible during existing surveys. It was possible to analyse stomachs in a cost-effective manner with the help of national labs and/or external contractors. Results of the fishPi project (MARE/2014/19) conclude that opportunistic stomach sampling on existing DCF surveys is a promising way forward. However, missing regional coordination was identified a major problem by the project. The lack of coordination leads to unbalanced sampling effort resulting in a lack of statistically sound sampling of all key species needed for food web characterisation and finally does not allow moving towards the Ecosystem Approach to Fisheries (EAF). Based on the lessons learned from the DG MARE pilot study and the fishPi project, Germany will in this pilot study establish a regular sampling scheme for stomachs on its vessels during international and national surveys in close cooperation with WGSAM, survey planning groups, regional coordination groups and international partner labs. The sampling will be carried out based on the guidelines from WGSAM to ensure that data can be used for multi-species modelling, assessments and advice. Currently, the Regional Coordination Group for the North Atlantic, North Sea & Eastern Arctic (RCG NANSEA 2019) is discussing ways to move forward to implementing a regional coordinated stomach sampling programme. For this purpose, an intersessional subgroup on stomach sampling has been established to work on this matter. The experience from the German stomach data sampling trial will be discussed further at the regional coordination meetings (RCGs), survey planning groups and WGSAM during 2019, 2020 and 2021. If other countries agree, the rolling scheme can be easily harmonized with other countries. The aim is to cover finally the whole North Sea. However, this depends on the willingness of other countries. In any case, Germany will deliver an overview on its sampling scheme, associated costs and uncertainties inherent in final data products. This will give guidance on which basis Germany will establish a regular sampling scheme.

For the Baltic Sea, stomach data of cod, flounder, plaice, dab and turbot, collected during 2017-2019 in the western Baltic, will be analysed in 2020 within the scope of BSc MSc and PhD theses.

References

RCG NANSEA 2019. Report of the Regional Coordination Group North Atlantic, North Sea & Eastern Artic. 3-6 June 2019, Ghent, Belgium, 114 pp.

Brief description of the results obtained (including deviations from planned and justifications as to why if this was not the case).

4. *Achievement of the original expected outcomes of pilot study and justification if this was not the case*

A German Bight stomach sampling programme was introduced in 2018 for the first time. The German Bight is the main sampling area for Germany. A rolling scheme has been established with the plan to sample each year one or two of the most important fish predators in the German Bight (whiting, cod, mackerel, turbot, grey gurnard). The rolling scheme started in 2018 with whiting (*Merlangius merlangus*) and was continued with cod (*Gadus morhua*) and turbot (*Scophthalmus maximus*) in 2019. Stomachs were sampled during various national and international surveys in the German Bight (IBTS, German Box survey (GSBTS), German EEZ survey (GAS EEZ), German young fish survey (DYFS) and a survey dedicated to sample brown shrimp and its predators four times a year). Because the surveys cover different spatial scales (e.g., Box survey as small-scale survey *vs*. IBTS as large-scale survey), the uncertainties in diet data and spatial autocorrelation can be analysed in a better and more detailed way than in any other sampling design based on only one survey. The surveys also cover near-shore and offshore areas to obtain a complete picture of feeding relationships in the German Bight. The sampling strategy is based on the guidelines from WGSAM (ICES 2010), i.e. the target is to sample three stomachs per 5 cm predator length class per station. As many stations as possible will be sampled. The analysis of the stomach contents follows the protocol from the last international stomach sampling study (MARE/2012/02-SI2.632887). In 2018, approximately 1600 whiting were sampled in the German Bight, while in 2019 approximately 150 turbot and cod stomachs were sampled. The frozen samples were processed at the Thünen Institute of Sea Fisheries in Bremerhaven, Germany. A total of 1 285 whiting and 63 turbot were weighed, length measured, sex distinguished and the stomach content mass was weighed and the contents stored in ethanol. The analysis of the whiting and turbot stomach contents has been completed. The analysis showed that juvenile whiting predominantly feed on crustaceans, while the proportion of fish in the stomachs increased with increasing total length of whiting. The most abundant fish families found in the stomachs were Clupeidae, Gadidae, Ammodytidae and Gobiidae with identified species herring *Clupea harengus*, sprat *Sprattus sprattus*, lesser sandeel *Ammodytes tobianus* and whiting *Merlangius merlangus*. Turbot was almost entirely piscivorous, feeding mainly on Clupeidae (e.g. *C. harengus*) and Gadidae (e.g. *M. merlangus*). The intensity of the feeding impact of whiting and turbot on juveniles of commercially important fish species and of whiting on brown shrimp (*Crangon crangon*) is currently being analysed. .

In the Baltic Sea, cod stomachs are sampled on a regular basis since 2015. In addition, the contemporary feeding ecology of cod from the Belt Sea (SD22) were published in Funk et al. 2020. Cod stomach content data from the Arkona Basin (SD24; sampling years 2017, 2018) and the Bornholm Basin (SD25; sampling years: 2018, 2019) are presently been prepared for publication. Moreover, stomach contents of the major flatfish species from the Bornholm Basin (i.e. flounder, plaice) were sampled (sampling years: 2018, 2019). In 2020, a stomach sampling of whiting in the western Baltic Sea was initiated in response to requirements indicated by WGSAM and the RCG ISSG stomach sampling.

5. *Incorporation of results from pilot study into regular sampling by the MS*

The experience from the German stomach data sampling trial have been and will be discussed at regional meetings (RCGs), survey planning groups (e.g. IBTSWG) and WGSAM. If other countries agree, the rolling scheme can be easily harmonized with other countries. However, this depends on the willingness of other countries. In any case, Germany has presented the experience with and the results of its sampling trial during the intersessional subgroup work of the RCG and the main lessons learned have been incorporated to the case study on a regionally coordinated stomach sampling program of the North Sea. The aim is to initiate a regionally coordinated stomach sampling program for the North Sea, in which the German sampling activities will be incorporated.

In the Baltic Sea, the sampling of cod stomachs has been implemented as part of the sampling routine since 2015. The implementation of a rolling scheme for the western Baltic Sea is in preparation, starting with whiting in 2020.

References

Funk S, Frelat R, Möllmann C, Temming A, Krumme U (2020) The forgotten feeding ground: patterns in seasonal and depth-specific food intake of adult cod *Gadus morhua* in the western Baltic Sea. J Fish Biol:in Press, DOI:10.1111/jfb.14615

General comment: This box is applicable to the Annual Report. This box is intended to provide information on the results obtained from the implementation of the pilot study

1. Aim of pilot study (Impact of fishing activities on marine biological resources)

Improve availability of data and tools for estimating the level of fishing and the impact of fishing activities on marine biological resources and on marine ecosystems

2. Duration of pilot study

24 months (1 Jan 2020 – 31 Dec 2021- continuation)

3. Methodology and expected outcomes of pilot study

When it comes to assessing the impact of fishing on marine ecosystems, two aspects have to be considered: i) Bottom-contacting fishing gears potentially impact habitat quality and thus suitability and carrying capacity of marine ecosystems and ii) non-target species including rare and sensitive species are by-caught in the fishery potentially affecting ecosystem composition and functionality. Data on by-catch of the latter species in the different fisheries are still scarce. Incidental by-catch of elasmobranchs and marine mammals can only be quantified with large uncertainties. Germany will train observers to better distinguish between different shark, ray and skate species and will ensure that by-catch of non-commercial and sensitive species will be recorded during observer trips. Habitat degradation by fisheries needs to be assessed differently. First of all, the level of fishing by metier needs to be determined at highest geographical resolution, to assess the overlap of fishing and habitat. Secondly, the impact of different gear types on the specific habitat type needs to be classified to assess the impact of fishing on habitat quality. In this pilot study, Germany will adapt existing methodology as applied by ICES WGSFD and OSPAR to establish a routine monitoring of fishing impacts on marine habitats. Combining indices of fishing impact on habitats with by-catch information on rare and sensitive species will allow addressing the impact of fishing on marine ecosystems.

The information on biological as well as technical interactions (including by-catch of non-commercial and sensitive species and habitat impact) in mixed fisheries needs to be combined in integrated modelling approaches. Under the new CFP, management strategies need to the established that ensure the ecological, social and economic sustainability of fisheries. Management plans need to take into account the knowledge on biological and technical interactions in mixed fisheries to reach this goal. Based on the traditional (including economics) and new information from the DCF pilot study, Germany will help to develop and parameterise management strategy evaluation tools that account for ecosystem considerations for the North Sea together with institutes from other MS. This will allow an integrated impact assessment of management strategies and ensures that all available DCF data are utilised to provide the best possible advice.

In the first phase of this pilot study, international fishing effort data were analysed in the German Bight in order to quantify fishing pressure on the seafloor. For this, we followed a similar indicator and assessment framework as described in ICES (2017) and used the swept area ratio (SAR) as proxy for seafloor abrasion. However, some adaptations were necessary in order to obtain estimates that are temporally and spatially more precise for the southern North Sea. For example, based on data from 2012-2016, on average 45% of the German offshore areas and 62% of the coastal areas were fished with bottom-contacting gears with relatively little interannual variation. The completed small-scale SAR estimates can now be related to by-catch information on rare and sensitive species, helping to assess ecosystem effects of fisheries.
In 2018, Germany significantly contributed to the ICES WGSFD and WGFBIT, the latter developing models to determine the impact/status of the seabed. These models form the basis for the future advice in relation to

fisheries impact on habitat quality, and the continuation of the Pilot Study helps to adapt them for a regional North Sea assessment and will ensure the incorporation of the results into a regular sampling by the MS.

References

ICES. 2017. Interim Report of the Working Group on Spatial Fisheries Data (WGSFD), 29 May – 2 June 2017, Hamburg, Germany. ICES CM 2017/SSGEPI: 16. 42 pp.

Brief description of the results obtained (including deviations from planned and justifications as to why if this was not the case).

4. *Achievement of the original expected outcomes of pilot study and justification if this was not the case*

In the first phase of this pilot study, international fishing effort data were analysed in the German Bight in order to quantify fishing pressure on the seafloor. For this, we followed a similar indicator and assessment framework as described in ICES (2017) and used the swept area ratio (SAR) as proxy for seafloor abrasion.

During the second phase, from Spring 2020 onwards, focus shifted towards the impact of fishing activities on marine biological resources and on marine benthic ecosystems. Firstly, we participate in a national research project "DAM Pilotmission: Ausschluss mobiler, grundberührender Fischerei in Schutzgebieten der Deutschen AWZ von Nordsee (MGF-Nordsee)". MGF-Nordsee focuses on the current impact of bottom-touching fisheries in Natura2000 areas, particularly those earmarked as Marine Protected Area (MPA). Our work specifically focusses on the Sylter Outer Reef and the Dogger Bank, where most fishing occurs. In addition to providing SAR information to the project, as established during the first phase of this pilot study (with high-resolution estimates for 2019 and 2020 planned for summer 2021 as pre-announced by ICES), we also employ species distribution models to be able to discern which benthic species respond similarly to bottom-touching fisheries while accounting for habitat characteristics. Ultimately this will give more insight in vulnerable or resilient benthic species, as well as the traits these species have. That then also enables us to study ecosystem functioning under various levels of fishing pressure. Finally, results will be used to inform management, as well as information used to develop monitoring subsequent fishing closures of these MPAs.

Another national project that started winter 2020-2021 is "Multiple Stressors on North Sea Life (MuSSel)", which geographically focusses on the southern North Sea. Here we use machine-learning approaches (Gradient Forest) to look for current and future breakpoints in species distributions under multiple stressors, allowing to identify hotspots of change. Again, species traits can consequently be used to determine which species' functions are most vulnerable or resilient to multiple stressors, such as fisheries or temperature changes, and where these occur spatially. Ultimately, this will result in an ability to prioritize recommendations for integrated management strategies to sustain or improve the current state of zoobenthos in the southern North Sea.

We also continue efforts assessing the overlap between Vessel Monitoring System (VMS) ship fishing positions and trawling tracks based on side-scan sonar, which will enable to study the longevity of trawling marks.

In 2020, Germany significantly contributed to ICES WGSFD (Working Group on Spatial Fisheries Data), and WGFBIT (Working Group on Fisheries Benthic Impact and Trade-offs), the latter developing models to determine the impact/status of the seabed. These models form the basis for the future advice in relation to fisheries impact on habitat quality.

In addition, VMS and logbook data are collected on a routine basis and are provided for scientific and management purposes usually four times a year. Workflows are now fully developed to provide annual fishing pressure assessments. For example, we provided input based on these data for various Natura2000 marine spatial planning initiatives from the UK, Belgium, the Netherlands and Denmark.

For mixed fisheries, the adoption of FLBEIA within the North Sea and other case studies involved in WGMIXFISH has resulted in a significant shift towards a more coordinated methodology in recent years. The FLBEIA model has now been proposed as the simulation model for future ICES mixed fishery advice in the North Sea and Celtic Sea case studies, and this transition is scheduled for a review in 2021. This shift will allow WGMIXFISH to more flexibly adapt yearly advice forecasts to changes model configuration (e.g. included stocks), while continuing to provide advice on the possible inconsistencies between the single-species quotas within a mixed fishery context.

The results of the scenarios focusing on by-catch indicate that the implementation of catch restriction for currently managed stocks is sufficient to protect the other stocks that do not receive quotas. Future work is still needed to incorporate the most vulnerable species, like rays and sharks, for which data has been too limited to provide even an initial biomass-based assessment and estimation of their stock dynamics. From the other scenarios concerning modifications to management measures, we observed that TAC grouping is not an effective management approach when one of the stocks is near full exploitation, as catch levels will be exceeded by the higher allowance of the underexploited stock. Gear modifications showed some improvements in terms of quota uptake, yet at the expense of fleet efficiency (i.e. in terms of catch-per-unit-effort, CPUE). Only minimal changes in stock status resulted despite the change in selectivity patterns. Metier effort optimization resulted in a shift in the distribution of catches among fleets, with larger fleets (i.e. in terms of vessel size and total effort) usually increasing their catches at the expense of smaller fleets and, again, only minimal changes in stock status. These results highlight that fact that the full implementation and enforcement of single stock quota limits was the principal factor in maintaining stocks in good status, while management measures are most likely to have impacts in terms of fleet efficiency and profitability.

The implementation of other model modifications provided new insights into the possible long-term stock and fleet dynamics. Specifically, the recruitment dynamics of several important gadoid stocks were found to be significantly influenced by historical environmental conditions at various life-history stages, which are likely to affect their dynamics in the future under scenarios of climate change. Using forecasted future environmental conditions (based on various climate change scenarios produced by global circulation models), the simulations provided new insights into the possible impacts to the stocks' equilibria under currently defined reference points (i.e. F_{MSY}, B_{lim}, $B_{trigger}$). The incorporation of natural mortality dynamics also had important effects to future stock biomass levels, and in some cases were predicted to produce top-down effects between predator and prey when combined with environmentally-mediated changes to recruitment.

Ongoing work is now focussed on the evaluation of how these future changes are likely to affect socio-economic outcomes and how best to mitigate negative effects. This builds on previous work which integrated economic data into the model. This work has been presented within the ICES WGECON working group, along with similar approaches for other case studies. One of the outcomes of the group was their suggestion to further develop FLBEIA as a common framework for comparison across case studies, and to continue to develop approaches to facilitate the linking of economic variables into the models.

5 Incorporation of results from pilot study into regular sampling by the MS

The sampling of sensitive bycatch is already incorporated in the regular sampling programme (*cf.* Table 1F and Text Box 1F).

For the other topics of this pilot study, see above.

References:

ICES. 2017. Interim Report of the Working Group on Spatial Fisheries Data (WGSFD), 29 May – 2 June 2017, Hamburg, Germany. ICES CM 2017/SSGEPI: 16. 42 pp.

Text Box 1G: List of research surveys at sea

General comment: This box fulfills Chapter IV of the multiannual Union programme and Article 2 and Article 7 paragraph (3) of the Decision (EU) 2016/1701. It is intended to specify which reseach surveys at sea set out in Table 10 of the multiannual Union programme will be carried out. Member States shall specify whether the research survey is included in Table 10 of the multiannual Union programme or whether it is an additional survey.

General comment: This box is applicable to the Annual Report. This box should provide complementary information on the performance of the surveys, the results and their main use.

Mandatory surveys:

Baltic International Trawl Survey (BITS)

1. Objectives of the survey

Target species are demersal fish species, mainly Baltic cod and flatfish species (flounder, plaice, dab, brill and turbot). The main aim is to determine the year-class strength of the target species. Target data are abundances, weight and length distributions of all fishes and length-weight-age-sex-maturity data of commercially important species as well as hydrographic data (temperature, salinity and oxygen). The collected data are stored in a national SQL database and submitted to the ICES DATRAS database. In addition, cod stomachs and marine litter are sampled.

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

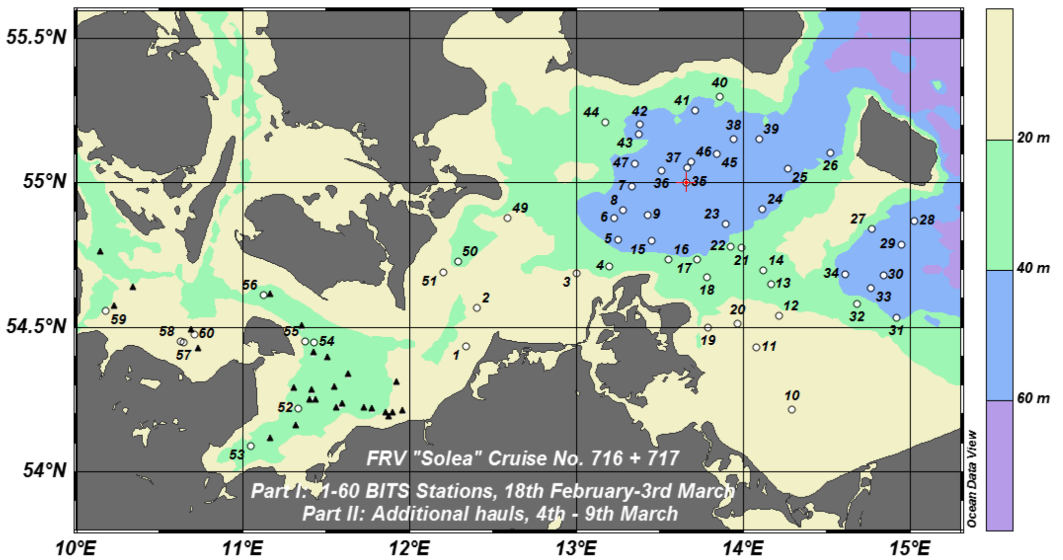
See survey manual: http://www.ices.dk/community/groups/Pages/WGBIFS.aspx

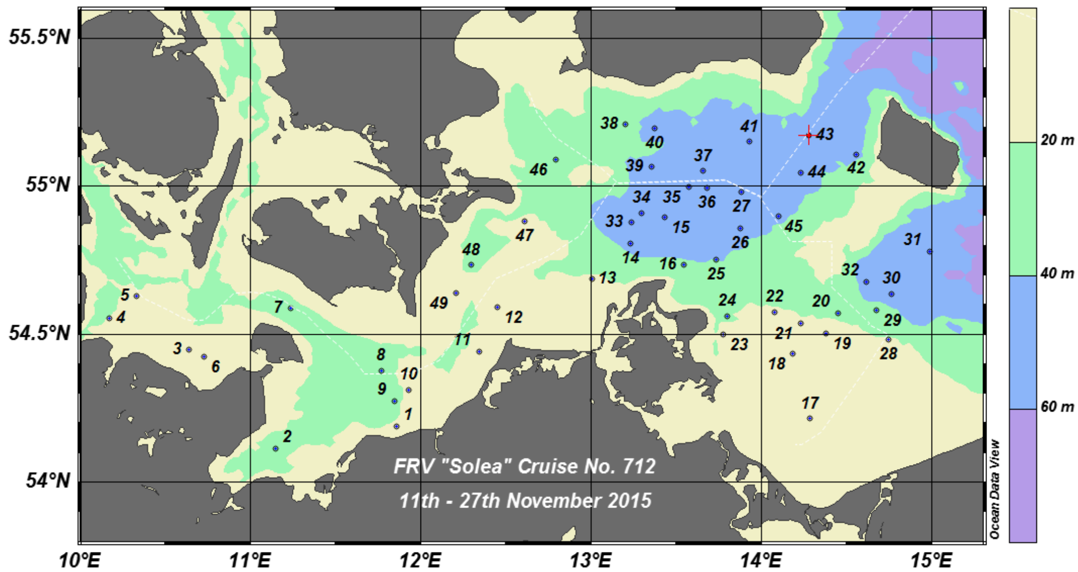
3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

Denmark (R/V DANA and R/V HAVFISKEN), Sweden (R/V SVEA), Germany (R/V SOLEA), Lithuania (F/V CLV*), Poland (R/V BALTICA), Latvia (R/V BALTICA) and Estonia (F/V CEV**) and Russia (R/V ATLANTIDA). ICES WGBIFS is coordinating the planning of this survey.
* BITS Code for: Commercial Lithuanian Vessel (Charter)
**BITS Code for: Commercial Estonian Vessel (Charter)

4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

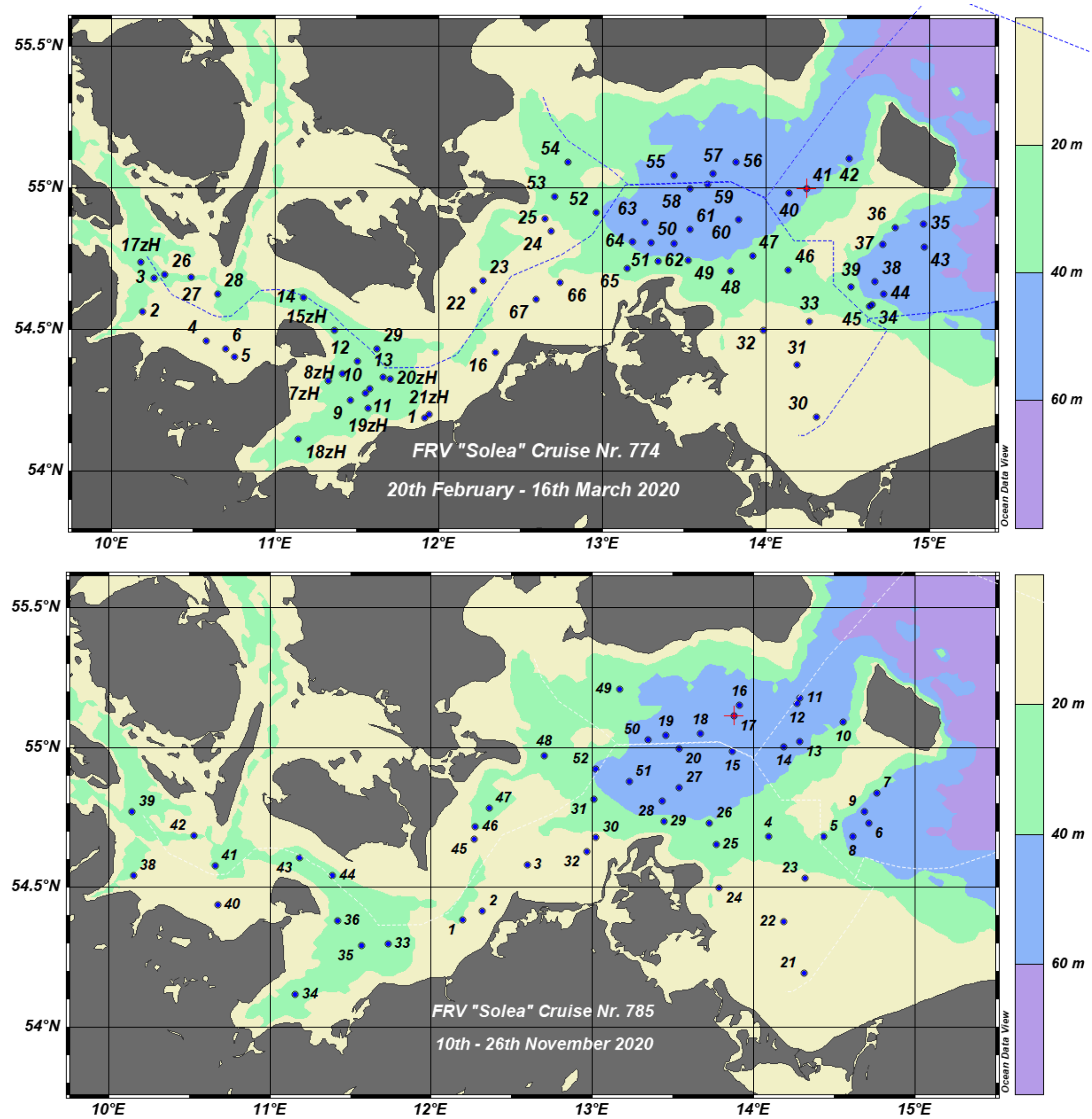
The ICES survey planning group (WGBIFS) assigns the tasks to the survey participants (e.g. coverage of certain areas in a certain time frame). Each participating country is responsible for the activities conducted on its national part of the international survey.





Map: Baltic International Trawl Survey (BITS): Example for trawling positions in the 1st quarter 2016 (upper panel) and in the 4th quarter 2015 (lower panel)

5. Graphical representation (map) showing the positions (locations) of the realized samples.



Map: Baltic International Trawl Survey (BITS): Distribution of the trawling positions in quarter 1 (upper panel) and 4 (lower panel) in 2020

6. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.
https://www.ices.dk/sites/pub/Publication%20Reports/Forms/DispForm.aspx?ID=37344

7. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

Target species are demersal fish species, mainly Baltic cod and flatfish species (mainly flounder, plaice, dab, turbot and brill). The main aim is to determine the year-class strength of the target species. Target data are abundances, weight and length distributions of all fishes and length-weight-age-sex-maturity-feeding data of commercially important species as well as hydrographic data (temperature, salinity and oxygen). The collected data are saved in a national SQL database and submitted to the ICES DATRAS database.

8. Extended comments (Tables 1G and 1H)

None

Baltic International Acoustic Survey (BIAS, Autumn)

1. Objectives of the survey

Target species are small pelagic fish species, mainly Baltic herring, sprat and additionally European anchovy and pilchard. The main aim is to provide information on stock parameters of small pelagics in the Baltic Sea. Target data are biomass, weight and length distributions and length-weight-age-sex-maturity of small pelagic target species in the Kattegat and western Baltic Sea including Belt Sea, Sound and Arkona Sea as well as hydrographic data (temperature, salinity and oxygen). The data are saved in a national SQL database and storage in the ICES Acoustic Trawl Database has been implemented.

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

see survey manual:

https://www.ices.dk/sites/pub/Publication Reports/ICES Survey Protocols (SISP)/2017/SISP 8 IBAS 2017.pdf

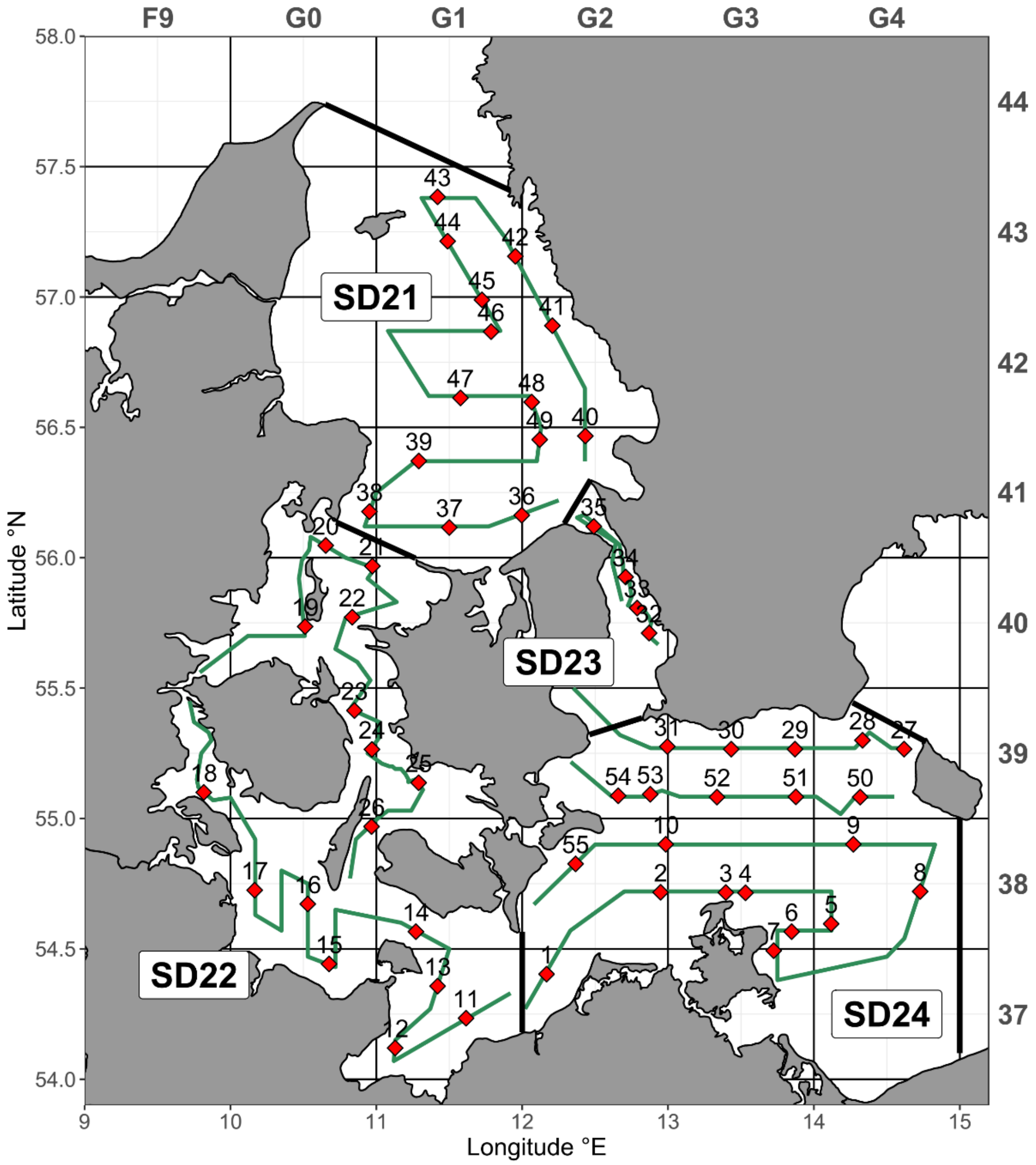
3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

Denmark (R/V DANA) and Sweden (R/V SVEA), Finnland (R/V ARANDA), Germany (R/V SOLEA), Lithuania (R/V DARIUS), Latvia (R/V BALTICA), Poland (R/V BALTICA), Estonia (R/V ULRIKA) and Russia (R/V ATLANTNIRO). ICES WGBIFS/WGIPS are coordinating the planning of this survey.

4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

The ICES survey planning group (WGBIFS) assigns the tasks to the survey participants (e.g. coverage of certain areas in a certain time frame). Each participating country is responsible for the activities conducted on its national part of the international survey. Cost sharing: There is no particular cost sharing agreement in place yet for this survey.

5. Graphical representation (map) showing the positions (locations) of the realized samples.



Map: Baltic International Acoustic Survey (BIAS), October 2020: Cruise track/hydroacoustic transects (green lines) and realized trawl hauls (red diamonds).

6. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.

http://www.ices.dk/community/groups/Pages/WGIPS.aspx

http://www.ices.dk/community/groups/Pages/WGBIFS.aspx

Latest report submitted and currently being prepared for publication.

7. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

Survey results are used for the assessment of WBSSH by the ICES Herring Assessment Working Group (HAWG) as fishery independent abundance indices.

8. Extended comments (Tables 1G and 1H)

none

Sprat Acoustic Survey (SPRAS)

1. Objectives of the survey

Target species is sprat. The main aim is to provide information on stock parameters of sprat in the Baltic Sea. Target data are biomass, weight and length distributions and length-weight-age-sex-maturity of sprat in the western Baltic Sea including Belt Sea, Sound, Arkona Sea and Bornholm Sea as well as hydrographic data (temperature, salinity and oxygen). The collected data are saved in an Access-database and the ICES international database.

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

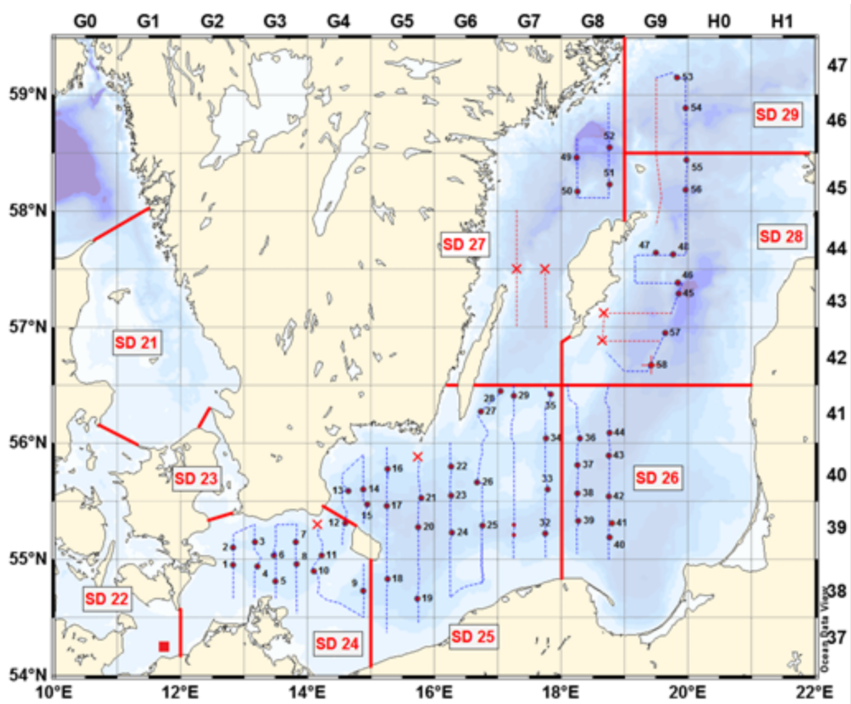
see survey manual: http://www.ices.dk/community/groups/Pages/WGBIFS.aspx

3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

Denmark (R/V DANA and R/V HAVFISKEN) and Sweden (R/V SVEA), Germany (R/V WALTER HERWIG), Lithuania (R/V DARIUS), Poland(R/V BALTICA), Latvia (R/V ULRICA), Estonia (R/V ULRICA) and Russia (R/V ATLANTNIRO). ICES WGBIFS is coordinating the planning of this survey.

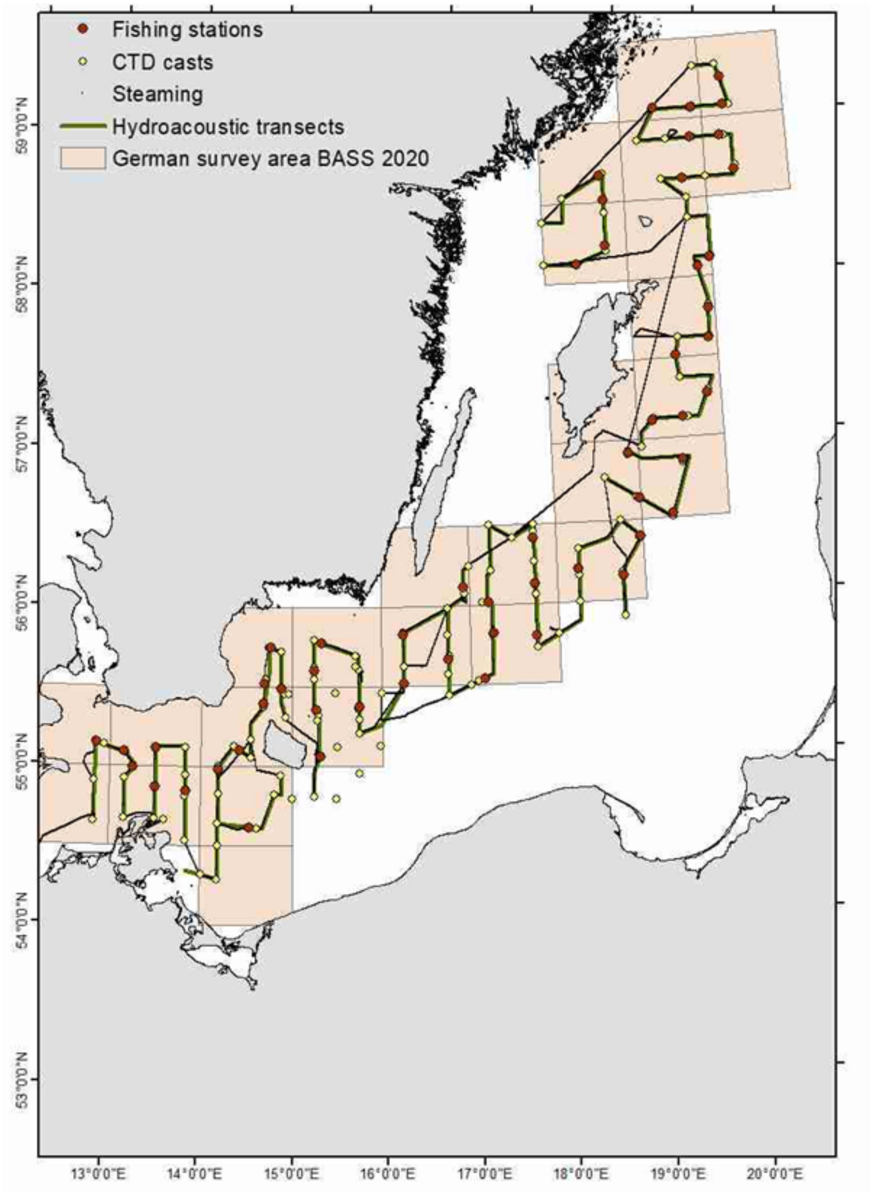
4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

The ICES survey planning group (WGBIFS) assigns the tasks to the survey participants (e.g. coverage of certain areas in a certain time frame). Each participating country is responsible for the activities conducted on its national part of the international survey. Cost sharing: There is no particular cost sharing agreement in place yet for this survey.



Map: Sprat Acoustic Survey (SPRAS), May 2015: Example of a cruise track

5. Graphical representation (map) showing the positions (locations) of the realized samples.



Map: Sprat Acoustic Survey (SPRAS), May 2020: Cruise track and activities

6. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.

http://www.ices.dk/community/groups/Pages/WGBIFS.aspx

7. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

The data are used as an index for the stock assessment of Baltic sprat.

8. Extended comments (Tables 1G and 1H)

Absence of licence delivery for all specific planned station within the Swedish EEZ due to military exercises forced significant track changes. This resulted in total hydroacoustic track lengths below 60 nautical miles in 24 of the 27 rectangles assigned as German investigation area.

Rügen Herring Larvae Survey (RHLS)

1. Objectives of the survey

Target species is the western Baltic spring-spawning herring. The main aim is to monitor the spawning activity of the spring-spawning herring of the Western Baltic Sea in its main spawning area, the Greifswald Bay. Target data are high-resolution spatial and temporal records of the larval abundance during the entire spawning period as well as hydrographic data (temperature, salinity and oxygen). The collected data are stored nationally and in the ICES Fish Eggs and Larvae dataset.

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

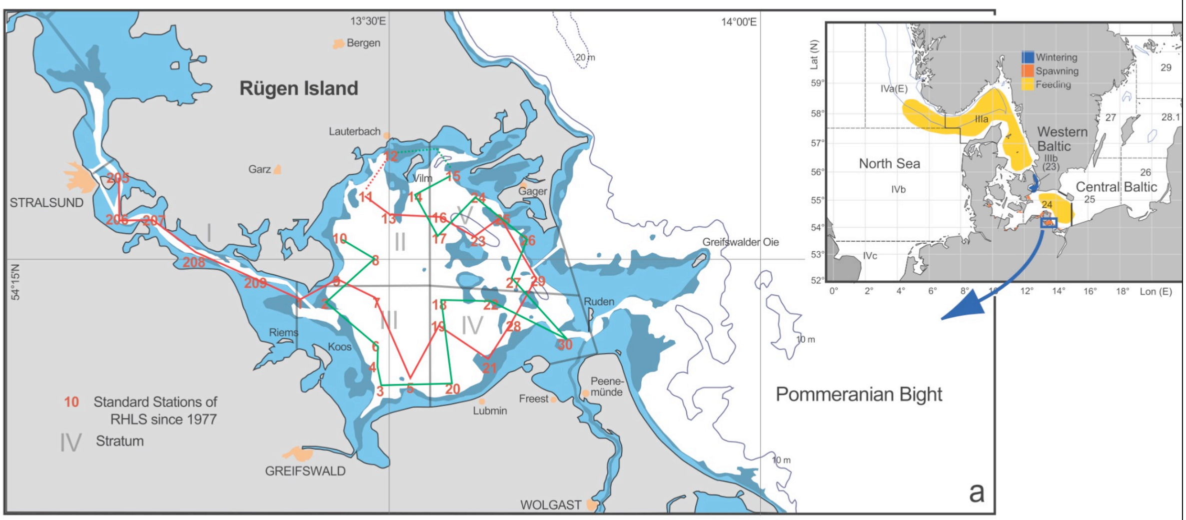
Manual is available on request.

3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

National survey only.

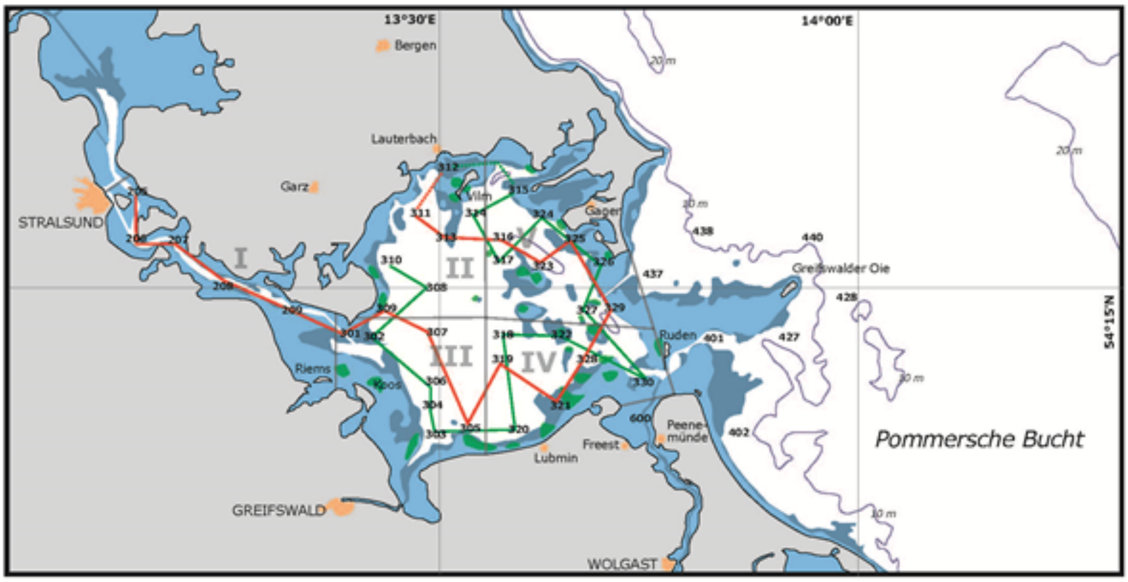
4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

National survey only.



Map: Rügen Herring Larvae Survey (RHLS), Cruise track and station plan

5. Graphical representation (map) showing the positions (locations) of the realized samples.



Map: Rügen Herring Larvae Survey (RHLS), February-June 2020: Cruise track and station plan

6. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.
   https://www.ices.dk/community/groups/Pages/WGSINS.aspx
7. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

Survey results (N20 index) are used for the assessment of Western Baltic Spring-Spawning Herring by the ICES Herring Assessment Working Group (HAWG) as fishery independent abundance indices.

8. Extended comments (Tables 1G and 1H)

none

International Bottom Trawl Survey, Quarter 1 (IBTS Q1)

1. Objectives of the survey
   - • To determine the distribution and relative abundance of pre-recruits of the main commercial species with a view of deriving recruitment indices;
   - To monitor changes in the stocks of commercial fish species independently of commercial fisheries data;
   - To monitor the distribution and relative abundance of all fish species and selected invertebrates;
   - To collect data for the determination of biological parameters for selected species;
   - To collect hydrographical and environmental information;
   - To determine the abundance and distribution of late herring larvae in order to provide the ICES Herring Assessment Working Group (HAWG) with a recruitment index for the North Sea herring stock.
   - To collect fish eggs in conjunction with the MIK sampling to determine principal spawning grounds of winter spawning fish in the North Sea

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

Bottom trawling with a standard GOV trawl; CTD casts; Plankton net haul with a MIK net and the attachment MIKeyM net;

Survey manuals
ICES 2015: Manual for the International Bottom Trawl Survey, Revision IX. SISP 10
http://www.ices.dk/sites/pub/Publication%20Reports/ICES%20Survey%20Protocols%20(SISP)/SISP%2010%20-%20Manual%20for%20the%20International%20Bottom%20Trawl%20Surveys%20-%20Revision%20IX.pdf
ICES 2017. Manual for the Midwater Ring Net sampling during IBTS Q1. Series of ICES Survey Protocols SISP 2. 25 pp. http://doi.org/10.17895/ices.pub.3434
ICES 2018. Manual for egg survey for winter spawning fish in the North Sea. Series of ICES Survey Protocols SISP 13. 19 pp. http://doi.org/10.17895/ices.pub.5225

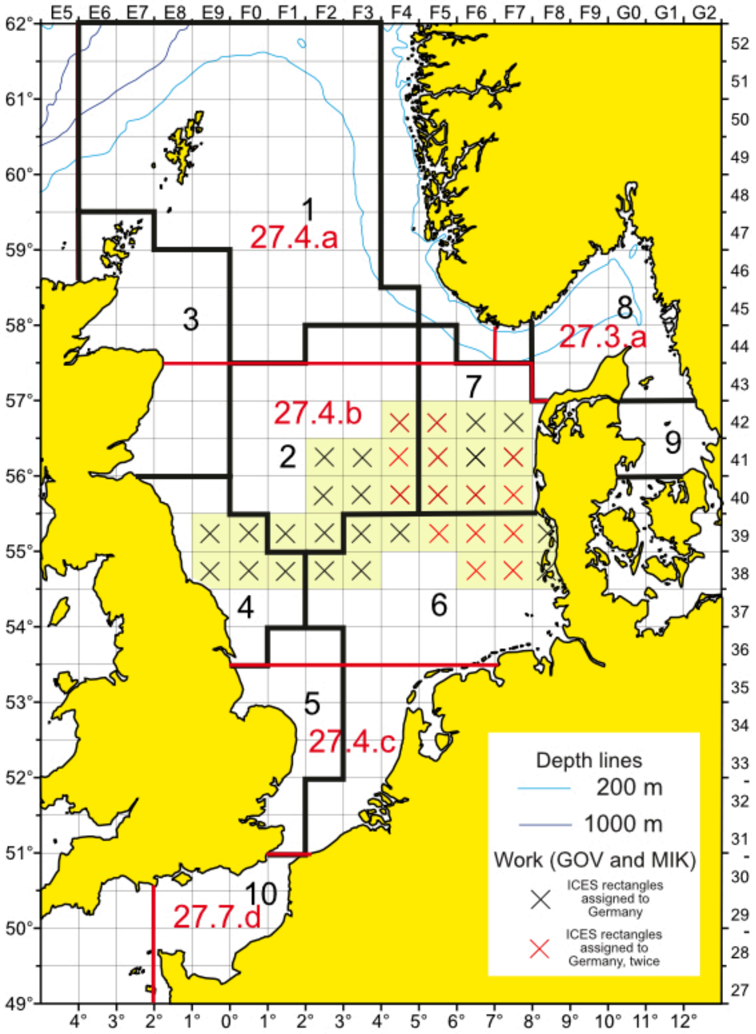
3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

France: RV Thalassa, The Netherlands: RV Tridens, Germany: RV Dana (charter in replacement of Walther Herwig III) , Denmark: RV Dana, Sweden: RV Svea, Norway: RV G.O. Sars, Scotland: RV Scotia

Coordinating body is the ICES International Bottom Trawl Survey Working Group (IBTSWG).

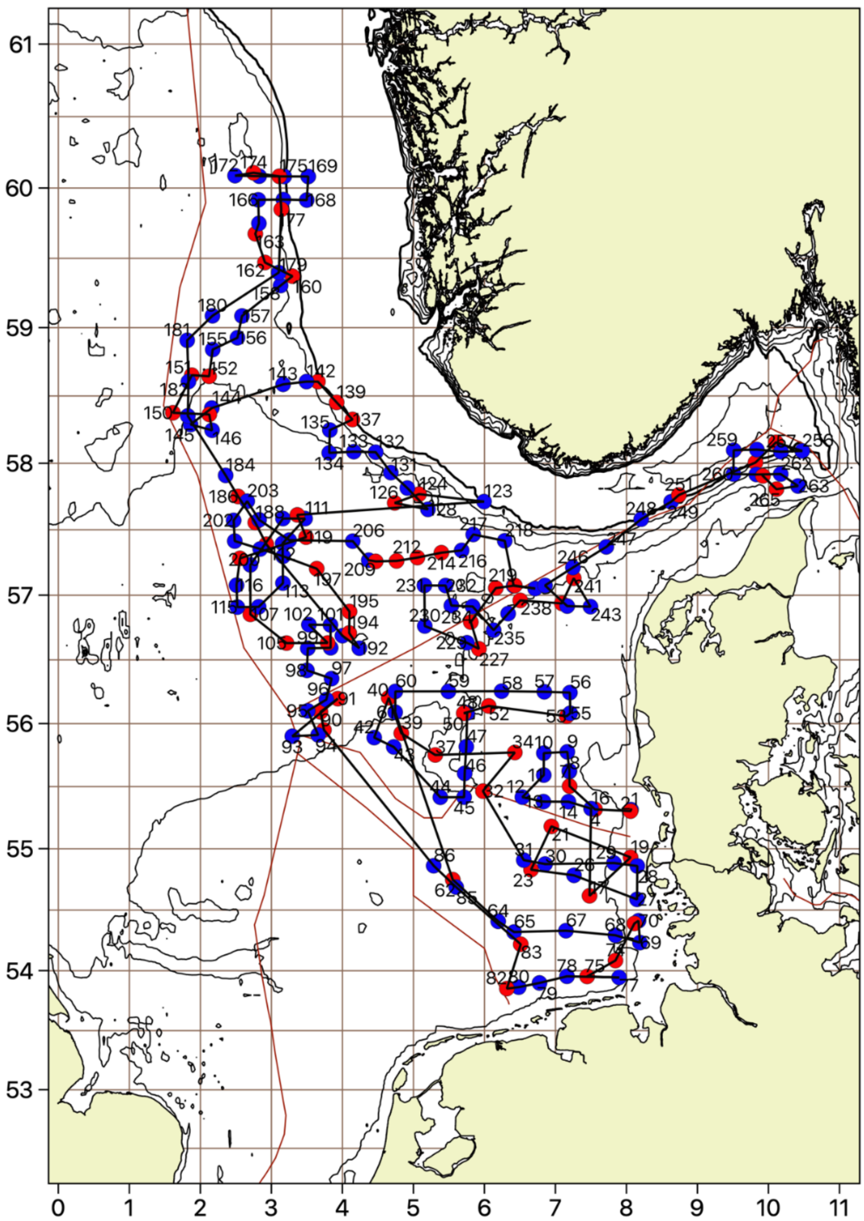
4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

Individual tasks to the survey participants (e.g. coverage of certain areas in a certain time frame) are allocated by the IBTSWG. Each participating country is responsible for the activities conducted on its national part of the international survey. Cost sharing: There is no particular cost sharing agreement in place yet for this survey.



Map: International Bottom Trawl Survey (IBTS) in the North Sea: Planning map for German Coverage in 2019 (Q1). Because of engine problems with the German FRV Walther Herwig III, which necessitated major repair works, the vessel had to be replaced by chartering the Danish RV Dana. The Danish vessel was only available for 20 days in January 2019 and the original survey plan had to be adapted by swapping major parts of the survey area with Denmark, reducing the amount of planned stations from 69 GOV/CTD and 142 MIK stations to 48 GOV/CTD and 96 MIK stations.

5. Graphical representation (map) showing the positions (locations) of the realized samples.



Map: GOV-hauls, CTD- and MIK-Stations of RV Dana cruise 01/2020 in 2020. Red dots: combined CTD and GOV-trawl stations, blue dots: MIK stations. The black line indicates the travelled routes between stations.

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6. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.
https://www.ices.dk/community/groups/Pages/IBTSWG.aspx
7. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

Survey indices for commercial fish species are used in the assessment by ICES WGNSSK, HAWG and WGWIDE.

8. Extended comments (Tables 1G and 1H)

none

International Bottom Trawl Survey, Quarter 3 (IBTS Q3)

1. Objectives of the survey

The main objective of the IBTS Q3 is to provide abundance indices of the target species haddock, cod, saithe, whiting, Norway pout, herring, sprat, mackerel and plaice in the North Sea and the Skagerrak. Germany participates as one of six nations in the internationally coordinated Q3 survey. Apart from abundance indices, information is collected on individual length, weight and age for the target species. Additional age data are obtained for selected fish species to be evaluated for future use in assessments. Furthermore, abundance, weight and length data are collected for all fish species caught. This serves the second objective to obtain information on changes in the abundance and distribution of fish species not commercially targeted, and in the composition of regional groundfish assemblages.

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

Types of data collected include biological data for the groundfish community, as well as additional data on the bycatch of benthic invertebrates. The German part of the survey includes a dedicated sampling programme of benthic epifauna and sediments. Further accompanying data recorded include information on stations and gear performance, hydrographic data, observations of weather and sea state. The data are stored locally in databases in the national institutes and submitted to public international databases at ICES. - A detailed description of the survey methods can be found in the corresponding survey manual: https://www.ices.dk/sites/pub/Publication%20Reports/ICES%20Survey%20Protocols%20(SISP)/SISP%2010%20%E2%80%93%20Revision%2011_Manual%20for%20the%20North%20Sea%20International%20Bottom%20Trawl%20Surveys.pdf

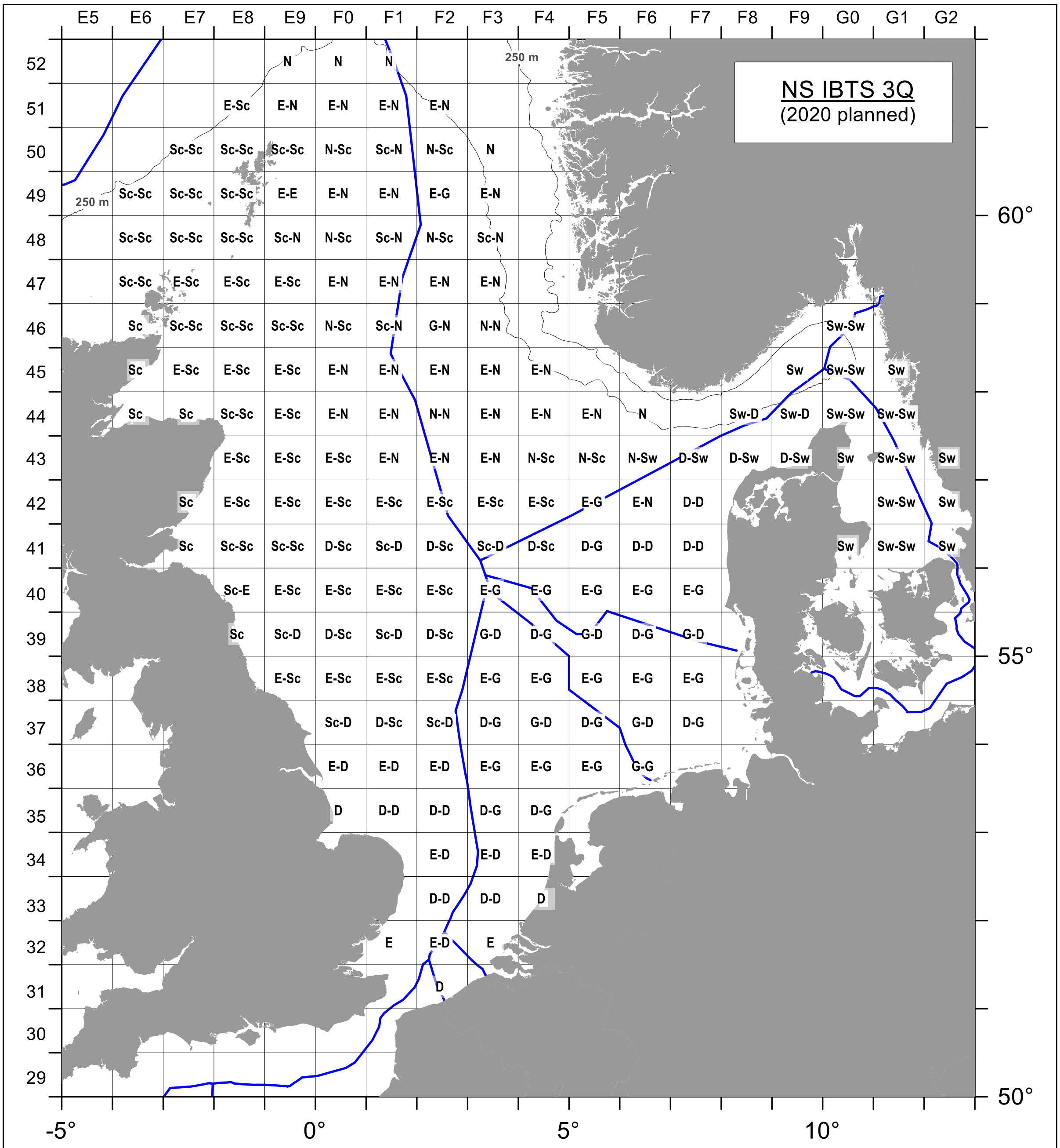
3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

UK England: RV Endeavour, Germany: FRV Walther Herwig III, Denmark: RV Dana, Sweden: RV Svea, Norway: RV Kristine Bonnevie, UK Scotland: RV Scotia

Coordinating body is the ICES IBTSWG.

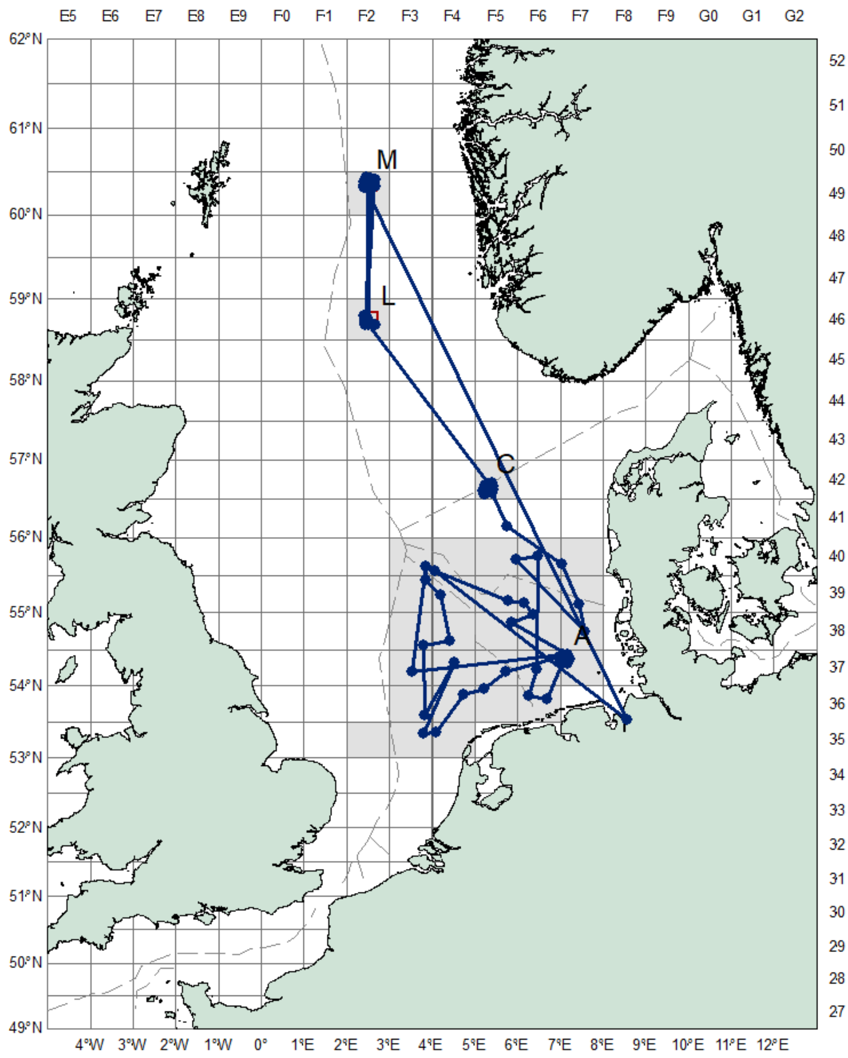
4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

Individual tasks to the survey participants (e.g. coverage of certain areas in a certain time frame) are allocated by the IBTSWG. Each participating country is responsible for the activities conducted on its national part of the international survey. Cost sharing: There is no particular cost sharing agreement in place yet for this survey.



Map: International Bottom Trawl Survey (IBTS) in the North Sea (Q3): Survey Grid

5. Graphical representation (map) showing the positions (locations) of the realized samples.



Map: International Bottom Trawl Survey (IBTS) in the North Sea (Q3); German contribution during cruise WH437: Position of the fishing stations in 2020 (note that in the research areas marked by "Box" and capital letters only one station each is dedicated to the IBTS, the other stations in the boxes belong to the GSBTS, see below.)

6. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.

IBTS: http://ices.dk/community/groups/Pages/IBTSWG.aspx

7. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

Survey indices for commercial fish species are used in the assessment by ICES WGNSSK, HAWG, WGSAM and WGWIDE. Abundance estimates for cephalopods are used by WGCEPH.

8. Extended comments (Tables 1G and 1H)

none

North Sea Beam Trawl Survey (BTS)

1. Objectives of the survey

Target species of this survey are mainly sole and plaice but also associated species. The survey provides densities (abundance and biomass) indices for the target species as well as hydrographic data.

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

All surveys coordinated by WGBEAM are carried out with a beam trawl. Depending on the local circumstances and the ship's capacity, the width and rigging of the beam trawls varies. Germany uses a light 7.2 m beam trawl.

Manual:
http://ices.dk/sites/pub/Publication%20Reports/ICES%20Survey%20Protocols%20(SISP)/SISP%2014%20-%20Manual%20for%20the%20Offshore%20Beam%20Trawl%20Surveys%20(WGBEAM).pdf

3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

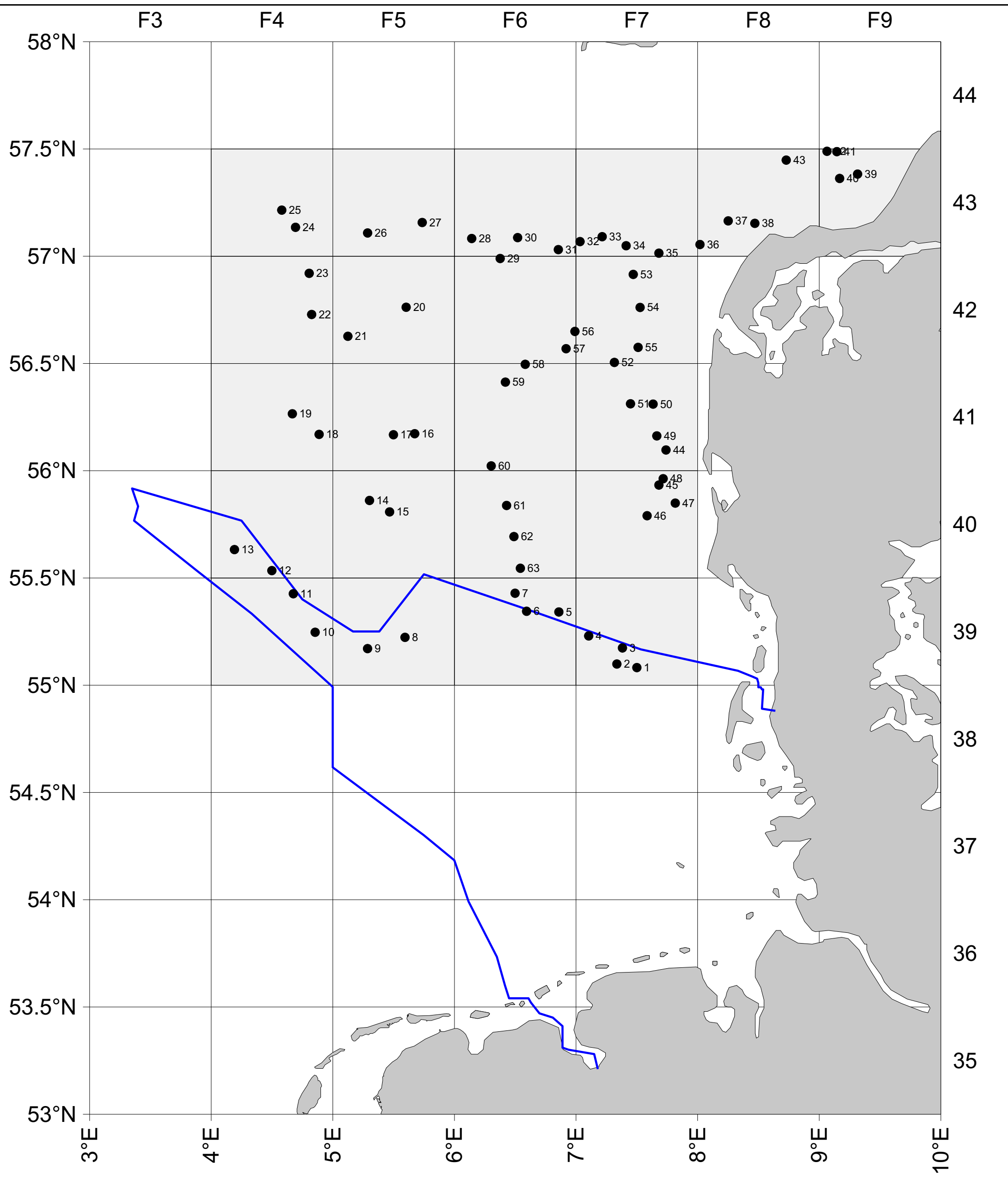
The Beam Trawl Survey in the North Sea and Eastern English Channel is carried out by Belgium, Germany, Netherlands and UK-Cefas.

The research vessels are BELGICA for Belgium, SOLEA for Germany, TRIDENS for The Netherlands and CEFAS ENDEAVOUR for the UK.

The survey planning group is the ICES WGBEAM.

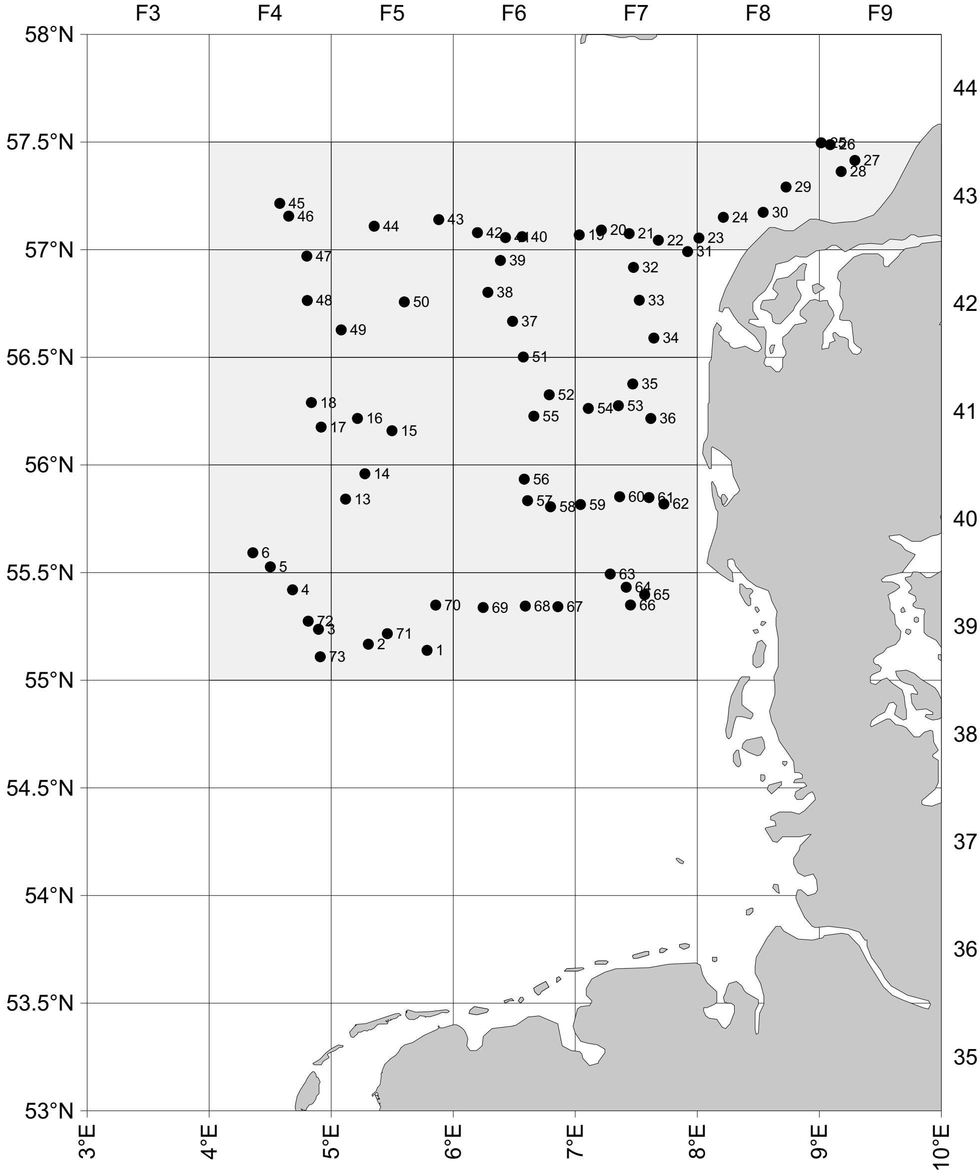
4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

Individual tasks to the survey participants (e.g. coverage of certain areas in a certain time frame) are allocated by the WGBEAM. Each participating country is responsible for the activities conducted on its national part of the international survey. Cost sharing: There is no particular cost sharing agreement in place yet for this survey.



Map: North Sea Beam Trawl Survey (BTS): Example for station plan

5. Graphical representation (map) showing the positions (locations) of the realized samples.



Map: North Sea Beam Trawl Survey (BTS): Realized fishing stations 2020

6. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.

http://ices.dk/community/groups/Pages/WGBEAM.aspx

7. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

ICES WGNSSK: *Limanda limanda, Pleuronectes platessa, Solea solea*; indices by age group, age 1-10+

ICES WGEF: elasmobranch species; CPUE per species per haul

Density plots per species: http://ecosystemdata.ices.dk/map/

8. Extended comments (Tables 1G and 1H)

none

Demersal Young Fish Survey (DYFS)

1. Objectives of the survey

The aim of the survey is to provide abundance indices of sole, plaice, whiting and cod as well as of other demersal young fish and brown shrimp. The indices are part of a time series which started in the early 1970's. The collected data are stored locally in a national data base and are submitted to the ICES DATRAS data base. Data are used by ICES WGNSSK, WGBEAM and WGCRAN and are relevant to the trilateral Wadden Sea Monitoring Programme (TMAP). Comparable investigations are conducted by NED and BEL. The German part of the survey consists of short trips on chartered commercial cutters and the RV Clupea yearly in September/October.

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

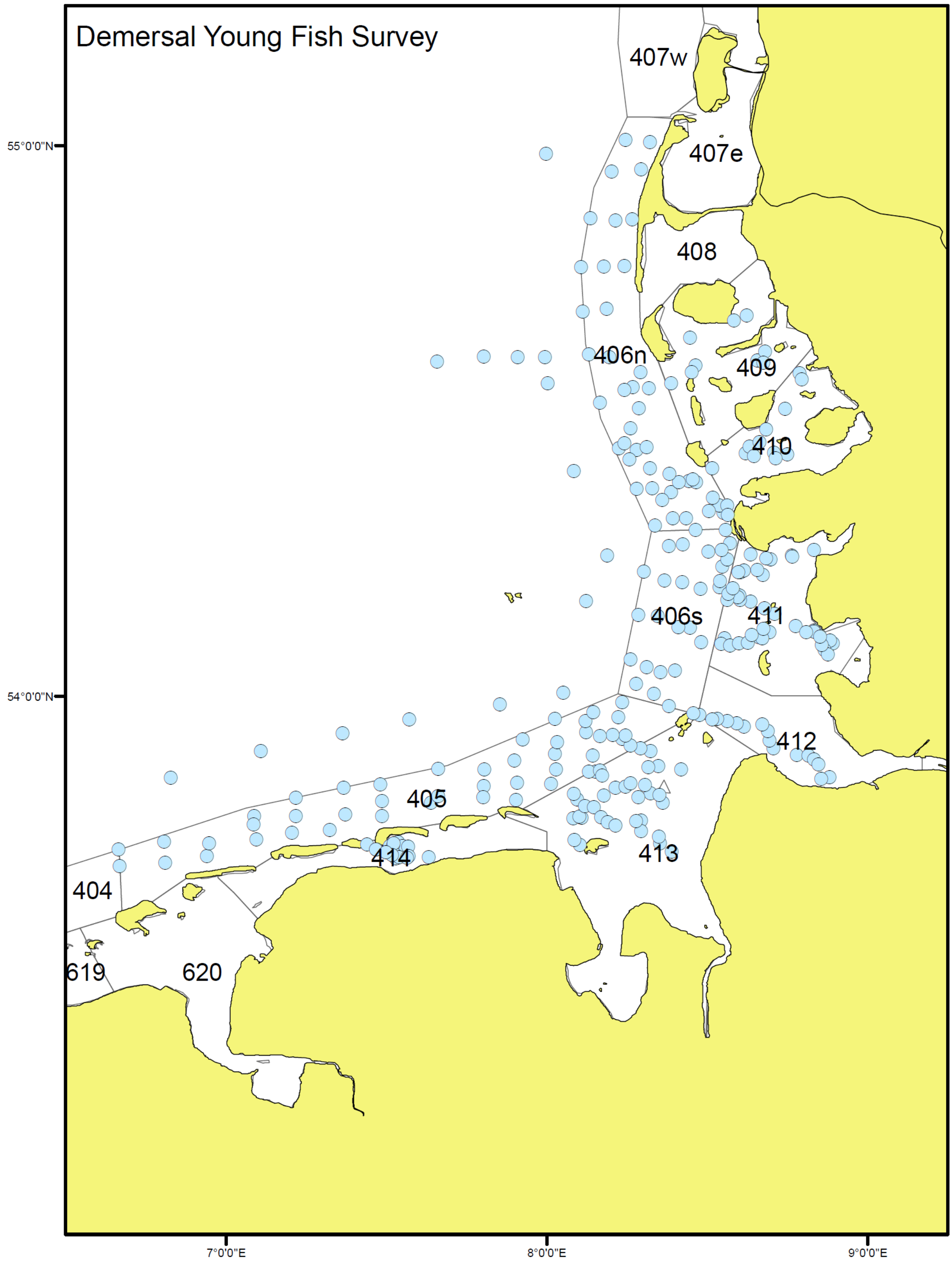
Steel 3m-shrimp-beam trawl without tickler chain, 20mm codend. An electronic sensor for time, temperature, salinity and pressure (turbidity optional) is attached. The whole catch is weighted and sorted, unless for the exceptional case of a very large catch, when only a sub-sample is processed. Length distributions are recorded for all finfish species caught, measured to the cm below. Herring and sprat are measured to the 0.5 cm. Survey manual:
http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/SSGIEOM/2015/01%20WGBEAM%20-%20Report%20of%20the%20Working%20Group%20on%20Beam%20Trawl%20Surveys%20%28WGBEAM%29.pdf

3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

This survey is coordinated by the ICES Working Group on Beam Trawl Surveys (WGBEAM). Participating countries are The Netherlands, Germany and Belgium. The Netherlands cover the area from the Dutch to the Danish coast with the RV Isis. In the Dutch Wadden Sea area, the RVs Stern and Waddenzee are used and the Scheldt Estuary is covered by the RV Schollevaar. Germany operates with chartered commercial shrimp cutters in the German Wadden Sea and operates along the German coast with the RV Clupea. Belgium operates along the Belgium coast with the RV Broodwinner. For further details, see the WGBEAM reports, e.g.:
http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/SSGIEOM/2015/01%20WGBEAM%20-%20Report%20of%20the%20Working%20Group%20on%20Beam%20Trawl%20Surveys%20%28WGBEAM%29.pdf).

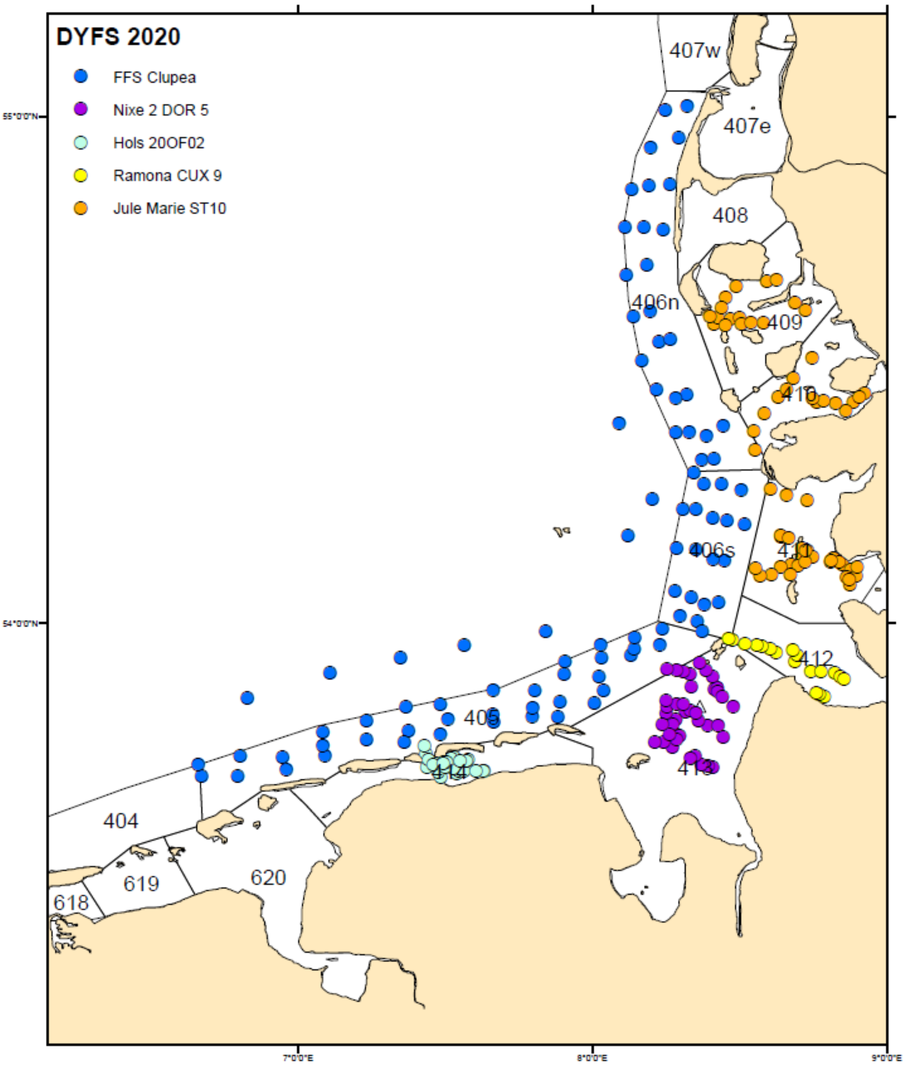
4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

Individual tasks to the survey participants (e.g. coverage of certain areas in a certain time frame) are allocated by WGBEAM. Each participating country is responsible for the activities conducted on its national part of the international survey. Cost sharing: There is no particular cost sharing agreement in place yet for this survey.



Map: Demersal Young Fish Survey (DYFS): Station grid

5. Graphical representation (map) showing the positions (locations) of the realized samples.



Map: Demersal Young Fish Survey (DYFS): Positions of fishing stations 2020

6. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.

   https://www.ices.dk/community/groups/Pages/WGBEAM.aspx

7. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

survey indices for plaice and sole, abundance estimates, biological data for brown shrimp and demersal fish in ICES sub-area IV, environmental status

8. Extended comments (Tables 1G and 1H)

none

International Herring Larvae Surveys (IHLS)

1. Objectives of the survey

The main objective of the survey is helping to assess the herring stocks in the North Sea. The results of the herring larvae surveys are used to calculate an overall biomass index of the SSB of North Sea autumn-spawning herring as well as the relative contribution of different stock components on the total herring reproduction. The surveys monitor the annual distribution and abundance of herring larvae at the main spawning locations, the length frequency of herring larvae, as well as ambient water temperature and salinity. All relevant herring larvae data are stored together with basic hydrographic information in the ICES eggs and larvae database. The surveys are conducted annually during autumn and winter.

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

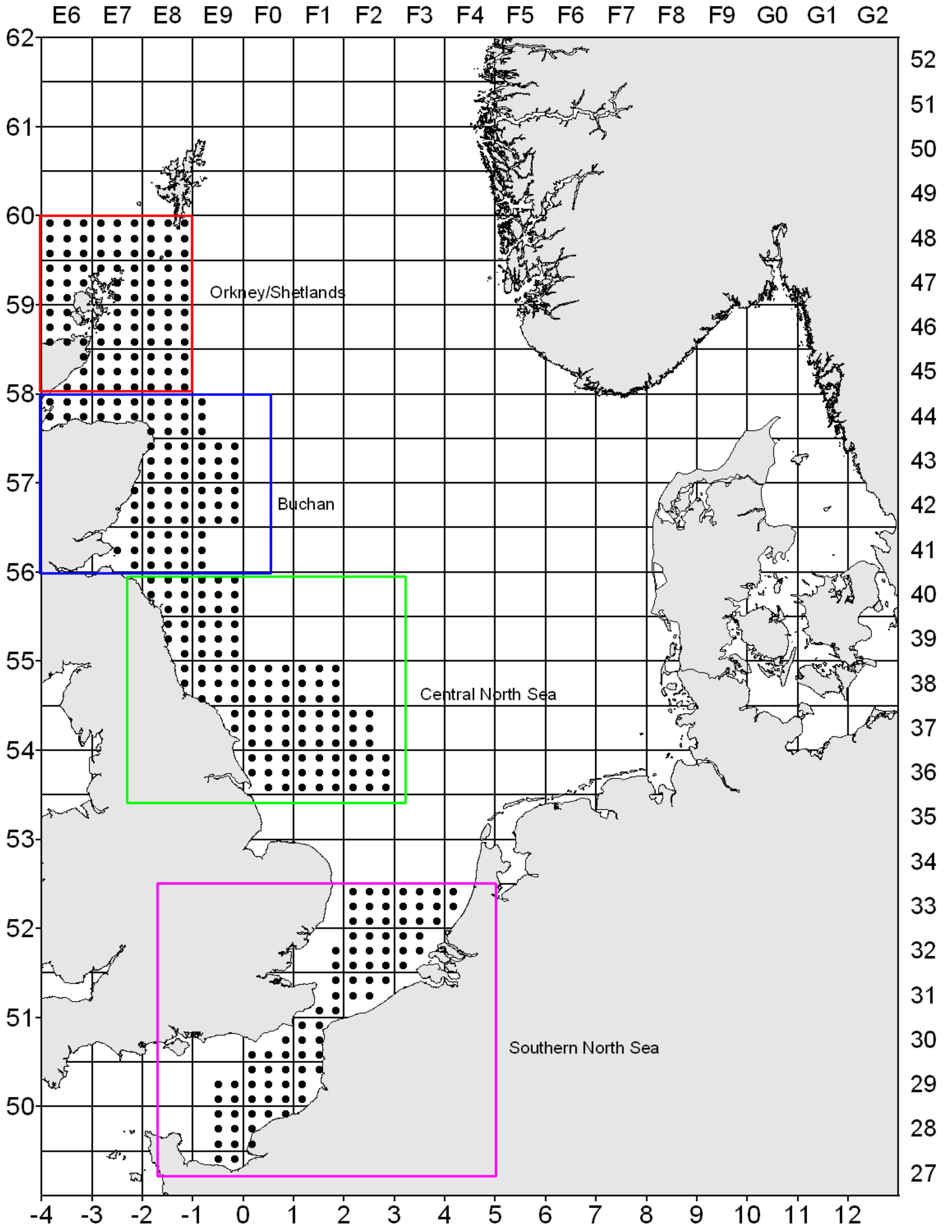
Herring larval abundance is surveyed at the major herring spawning grounds in the North Sea, e.g. in the Orkney/Shetland area, the Buchan region, the Central North Sea and the Southern North Sea. Standard gears are high-speed GULF samplers, deployed in a double oblique manner to near the sea bed and back to surface. Stations are located on a 10 by 10 nautical miles grid. This grid includes every square that is known to contain herring larvae less than 10 mm. Herring larvae are sorted from the samples and length-measured. The number of larvae per m^2 at each station is used to calculate mean numbers of larvae per m^2 for each ICES rectangle (consist of nine IHLS stations in total). These values are raised by the sea surface corresponding to the relevant rectangle and summed over the total area to obtain larvae abundance indices. The manual of the IHLS is available as Annex 7 to the ICES WGIPS Report 2010.

3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

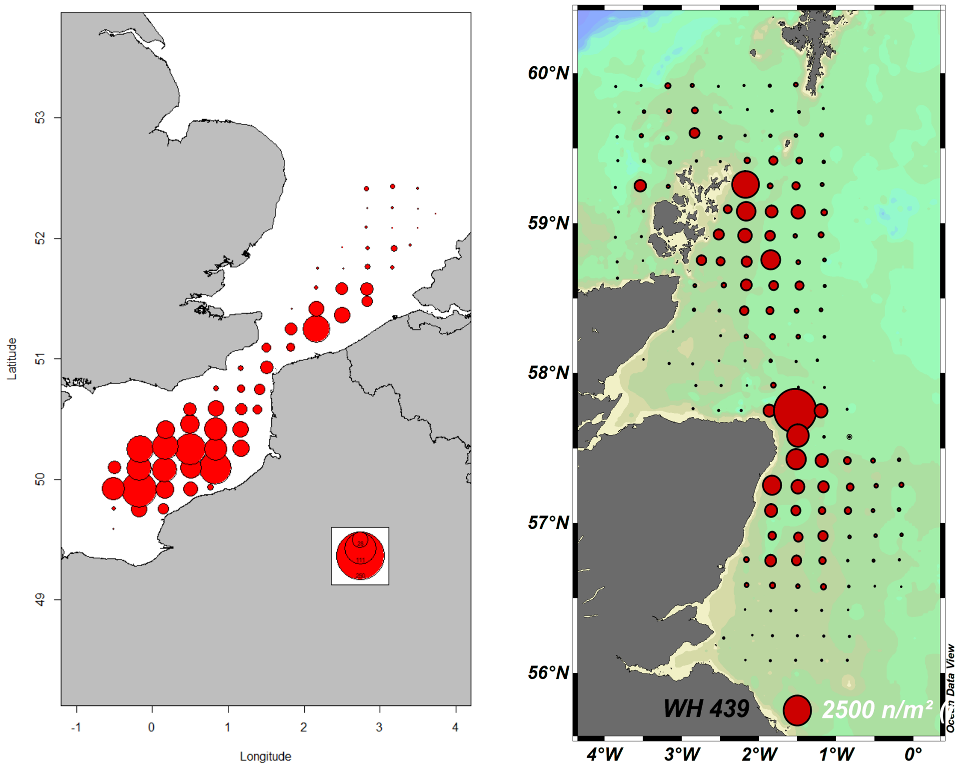
Germany and The Netherlands participate in the IHLS sampling. With regard to the prevailing weather conditions, they most frequently use larger research vessels, e.g. FRV "Walther Herwig III" and RV "Tridens". The parental committee for the IHLS is the ICES Working Group on Surveys on Ichthyoplankton in the North Sea (WGSINS).

4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

Individual tasks to the survey participants (e.g. coverage of certain areas in a certain time frame) are allocated by WGSINS. Each participating country is responsible for the activities conducted on its national part of the international survey. Cost sharing: There is no particular cost sharing agreement in place yet for this survey.



Map: Herring Larvae Survey (IHLS) in the North Sea: Station grid



Map: Herring Larvae Survey (IHLS) in the North Sea: Realized plankton stations in January 2020 (left panel) and September 2020 (right panel).

5. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.

The parental committee WGSINS has met in December 2020. The latest report is available here: ICES. 2021. ICES Working Group on Surveys on Ichthyoplankton in the North Sea and adjacent Seas (WGSINS; outputs from 2020 meeting). ICES Scientific Reports. 3:14. 31pp. https://doi.org/10.17895/ices.pub.7910

6. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

The survey provides SSB indices on herring spawning components and their dynamics in the North Sea. These data are used in the international ICES Herring Assessment Working Group. Information on fish eggs and larvae, e.g. taxa, abundance and distribution, is used on national basis.

7. Extended comments (Tables 1G and 1H)

none

North Sea Herring Acoustic Survey (NHAS)

1. Objectives of the survey

The survey aims to provide an annual estimate of the distribution, abundance and population structure to inform the assessment of the following herring and sprat stocks: Western Baltic spring-spawning herring (in ICES Divisions IV and IIIa), North Sea autumn-spawning herring (in IV, IIIa and VIId), West of Scotland herring (in VIaN), Malin Shelf herring (west of Scotland/Ireland in VIaN-S and VIIb,c), North Sea sprat (in IV) and sprat in IIIa (Skagerrak/Kattegat). The derived estimates and age structure of herring and sprat are used as tuning indices in the respective assessments and are submitted annually to the ICES Herring Assessment Working Group (HAWG).

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

Types of data collected include 1nm NASCs for clupeid fish (acoustic data), age and length distribution for all clupeids in the investigation area, maturity at age. Survey manual:

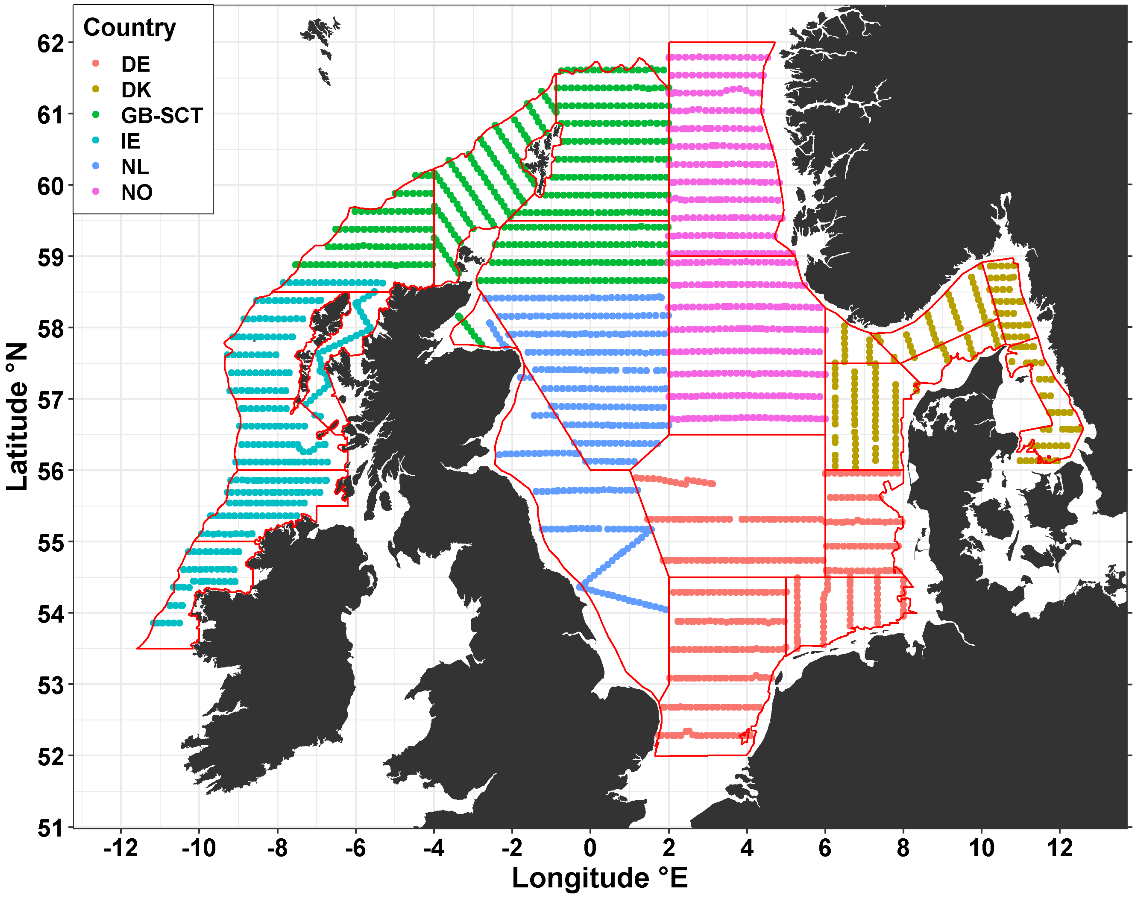
https://www.ices.dk/sites/pub/Publication Reports/ICES Survey Protocols (SISP)/SISP 9 Manual for International Pelagic Surveys (IPS).pdf

3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

Participants (countries/vessels) of this internationally coordinated survey include: IRL (RV "Celtic Explorer"), SCO (RV "Scotia"), NOR (RV "Johan Hjort"), DEN (RV "Dana"), NED (RV "Tridens"), GER (FRV "Solea"). The survey is planned, coordinated and evaluated by the ICES Working Group of International Pelagic Surveys (ICES WGIPS).

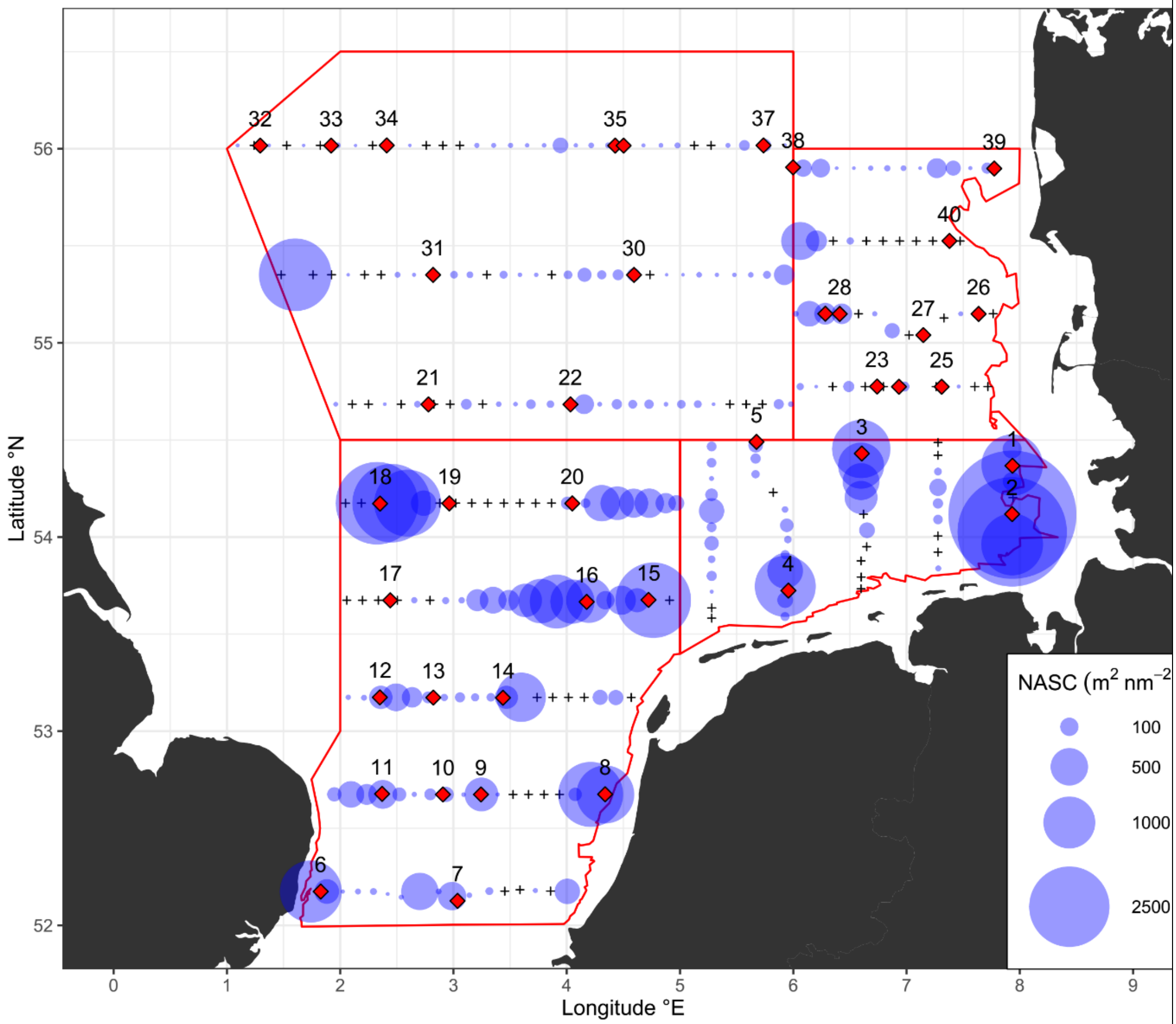
4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

Individual tasks to the survey participants (e.g. coverage of certain areas in a certain time frame) are allocated by WGIPS. Each participating country is responsible for the activities conducted on its national part of the international survey. Cost sharing: There is no particular cost sharing agreement in place yet for this survey.



Map: North Sea Herring Acoustic Survey (NHAS): Cruise tracks (total survey coverage, color coding according to strata allocated to participant. German (FRV "Solea") strata/cruise tracks in orange.

5. Graphical representation (map) showing the positions (locations) of the realized samples.



Map: North Sea Herring Acoustic Survey (NHAS): German strata covered with FRV "Solea" in 2020. Mean NASC values measured along the cruise track (5 nmi intervals) and allocated to clupeids are depicted as bubbles (empty intervals indicated as +). Red diamonds: Directed (pelagic) trawl hauls.

6. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.

7. http://ices.dk/sites/pub/PublicationReports/ExpertGroupReport/EOSG/2020/WGIPSreport2020.pdf

8. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

Survey results are used for the assessment of target species by the ICES Herring Assessment Working Group (HAWG) as fishery independent abundance indices.

9. Extended comments (Tables 1G and 1H)

none

International Deep Pelagic Ecosystem Survey (IDEEPS) – formerly called International Redfish Trawl and Acoustic Survey (REDTAS)

1. Objectives of the survey

This survey is part of a co-ordinated effort of ICES to undertake an International Deep Pelagic Ecosystem Survey in the Irminger Sea and adjacent waters in June/July, estimating the abundance and biomass of the pelagic beaked redfish (*Sebastes mentella*) stocks and conducting additional observations relevant to integrated ecosystem assessment in the area.

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

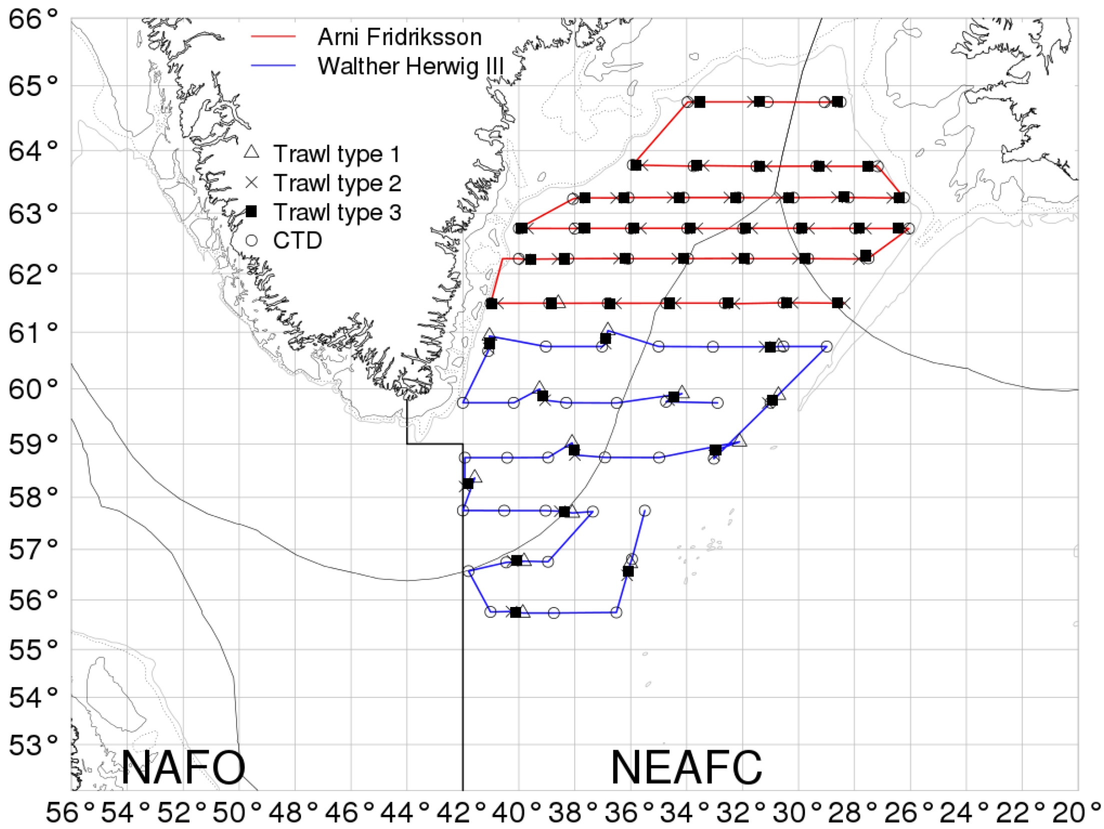
The international trawl/acoustic survey on pelagic redfish in the Irminger Sea and adjacent waters in June/July is generally carried out by three vessels from Germany, Iceland and Russia (currently only Russia and Germany participate in the survey). In the depth zone that can be surveyed by hydroacoustic measurements, i.e. shallower than the deep-scattering layer (DSL; down to about 350 m), hydroacoustic measurements and identification trawls are carried out. Within and below the DSL (down to about 950 m), redfish abundance is estimated by trawls. Biological are collected from the redfish caught in the pelagic trawls and hydrographical measurements are taken on regular stations on the survey tracks. For details, see: http://www.ices.dk/community/groups/Pages/WGIDEEPS.aspx

3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

The survey takes place every three years and is scheduled to be a joint survey by Germany with the FRV "Walther Herwig III" and by Russia (RV "Vilnyus") and usually Iceland. In November 2017, Iceland informed the responsible survey planning working group that they would not participate in the survey in 2018. No specific reason was given. The main objective of the survey and the international co-operation of the survey are planned by the "ICES Working Group on International Deep Pelagic Ecosystem Surveys (WGIDEEPS – former name: Working Group on Redfish Surveys)" which usually meets late January/early February of the survey year.

4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

Individual tasks to the survey participants (e.g. coverage of certain areas in a certain time frame) are allocated by WGIDEEPS. Each participating country is responsible for the activities conducted on its national part of the international survey. Cost sharing: There is no particular cost sharing agreement in place yet for this survey.



Map: International Deep Pelagic Ecosystem Survey (IDEEPS): Survey tracks and stations in 2015

5. Graphical representation (map) showing the positions (locations) of the realized samples.
   NA (next survey year: 2021)

6. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.
   https://www.ices.dk/publications/library/Pages/default.aspx?k=wgideeps

7. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

   - Provide survey biomass indices for the North Western Working Group (NWWG) to support advice on pelagic beaked redfish in the Irminger Sea and adjacent water;
   - Estimate the geographical and depth distribution and relative abundance of pelagic beaked redfish stocks;
   - Monitor changes in the stocks of pelagic beaked redfish independently of commercial fisheries data;
   - Collect data for the determination of biological parameters for beaked redfish stocks;
   - Collect hydrographical and environmental information;
   - Collect additional observations relevant to integrated ecosystem assessment in the area.

8. Extended comments (Tables 1G and 1H)

   NA (next survey year: 2021)

Greenland Groundfish Survey (GGS)

1. Objectives of the survey

The objective is to obtain data for the assessment of cod, demersal redfish and other demersal species in Greenland.

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

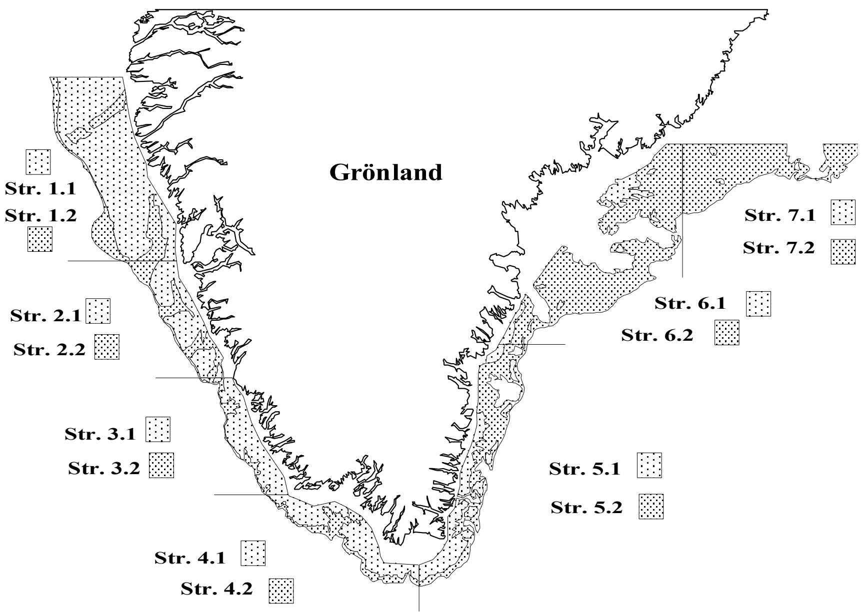
Demersal trawling, plankton sampling and CTD casts for physical oceanographic measurements along standard transects are carried out. Manual available at www.thuenen.de. The German groundfish survey started in 1982 and was primarily designed for the assessment of cod, but covers the entire groundfish fauna down to 400 m depth. It is carried out annually during the 4th quarter and provides the only fishery-independent information about the abundance & biomass of groundfish off Greenland (ICES Div. XIVb and NAFO Div. 1B-1F). Designed as a stratified random survey, the hauls are allocated to 14 strata (7 geographic areas * 2 depth strata, 0-200m, 201-400m) off West and East Greenland. The fishing gear used is a standardised 140-feet bottom trawl. Biological data from the catches (length distributions for all species, individual weights, gonad and liver weights as well as sex and maturity for the commercial species) are collected, population data raised to the total surveyed area and submitted to the ICES North-Western Working Group (NWWG) and NAFO Scientific Council and used in the respective stock assessments. In addition, hydrographic (CTD) and weather data are collected. The survey is carried out every October/November on FRV "Walther Herwig III".

3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

The survey is regularly evaluated through ICES NWWG. DEU is the only EU Member State to undertake this survey. The current vessel used for the survey is FRV Walther Herwig III.

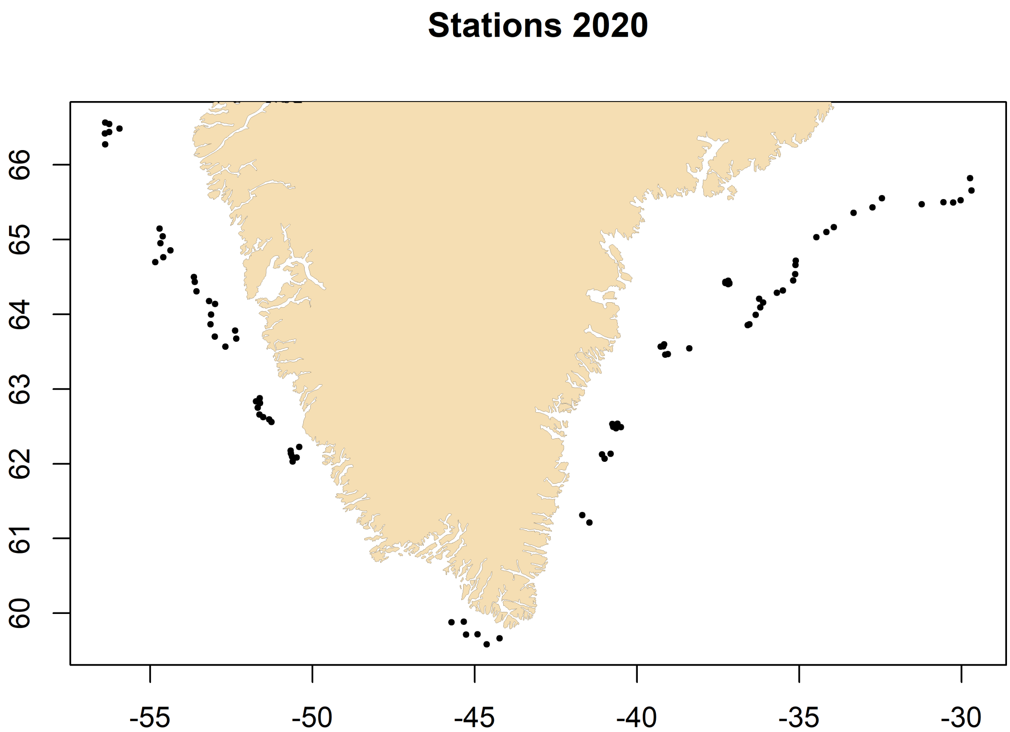
4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

No task sharing with other countries for the autumn survey. Greenland conducts a parallel spring survey with its own vessel. Data from the two seasons are combined in assessment.



Map: Greenland Groundfish Survey (GGS): Sampling strata

5. Graphical representation (map) showing the positions (locations) of the realized samples.



Map: Greenland Groundfish Survey (GGS). Fishing positions 2020

6. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.

https://www.ices.dk/community/groups/Pages/NWWG.aspx

7. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

Survey index for cod, survey index for redfish species for the assessment

8. Extended comments (Tables 1G and 1H)

none

International Mackerel and Horse Mackerel Egg Survey (MEGS)

1. Objectives of the survey

The main objective of this triennial survey is to produce both an index and a direct estimate of the biomass of the North East Atlantic mackerel stock and an egg production index of the southern and western horse mackerel stocks.

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

The general method is to quantify the freshly spawned eggs in the water column on the spawning grounds and to determine the fecundity of the females. This is done by sampling sufficient numbers of gonads before during and after the spawning. These are then histologically analysed. In combination, the realised fecundity (potential fecundity minus atresia) of the females and the actual number of freshly spawned eggs in the water render an estimate of the spawning stock biomass.

Survey Manual: ICES 2014. Manual for the mackerel and horse mackerel egg surveys (MEGS): sampling at sea. Series of ICES Survey Protocols. SISP 6 - MEGS V1.3. 62 pp.

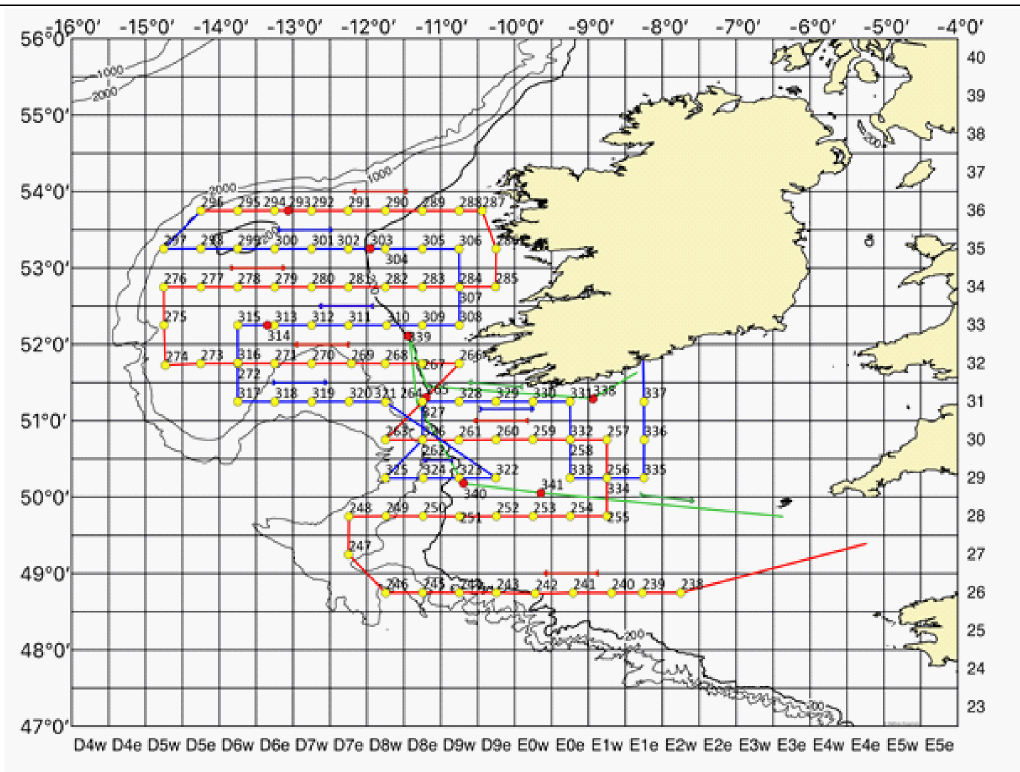
3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

Portugal: RV Noruega, Spain: RV Vizconde de Eza + RV Ramon Margalef, The Netherlands: RV Tridens, Germany: FRV Walther Herwig III (in 2019 Danish RV Dana was chartered), Ireland: RV Celtic Explorer + RV Corystes (2019), Faroe Islands: RV Magnus Hendersson, Iceland: RV Bjarni Saemundsson; UK Scotland: RV "Scotia" plus chartered vessels, Norway: chartered vessel Brennholm (2019)

Coordinating body is the ICES Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS).

4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

Individual tasks to the survey participants (e.g. coverage of certain areas in a certain time frame) are allocated by WGMEGS. Each participating country is responsible for the activities conducted on its national part of the international survey. Cost sharing: There is no particular cost sharing agreement in place yet for this survey.



Map: International Mackerel and Horse Mackerel Egg Survey (MEGS): German Coverage 2016 (yellow circles = positions of plankton hauls; red = positions of fishing hauls)

5. Graphical representation (map) showing the positions (locations) of the realized samples.

   No survey in 2020, next survey will be carried out in 2022.

6. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.
   https://www.ices.dk/community/groups/Pages/WGMEGS.aspx

7. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).
   An index and a direct estimate of the biomass of the North East Atlantic mackerel stock and an egg production index of the southern and western horse mackerel stocks used by ICES assessment group WGWIDE

8. Extended comments (Tables 1G and 1H)

   none

Non-mandatory surveys:

Fehmarn Juvenile Cod Survey (FEJUCS)

1. Objectives of the survey

Target species is the western Baltic cod. The main aim is to monitor the cohort strengths of age-0 and age-1 cod during autumn in the Western Baltic Sea. Target data are length-frequency distributions of undersized cod caught in commercial pound nets located near Fehmarn (the centre of the main spawning area of western Baltic cod). The collected data are stored and processed nationally.

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

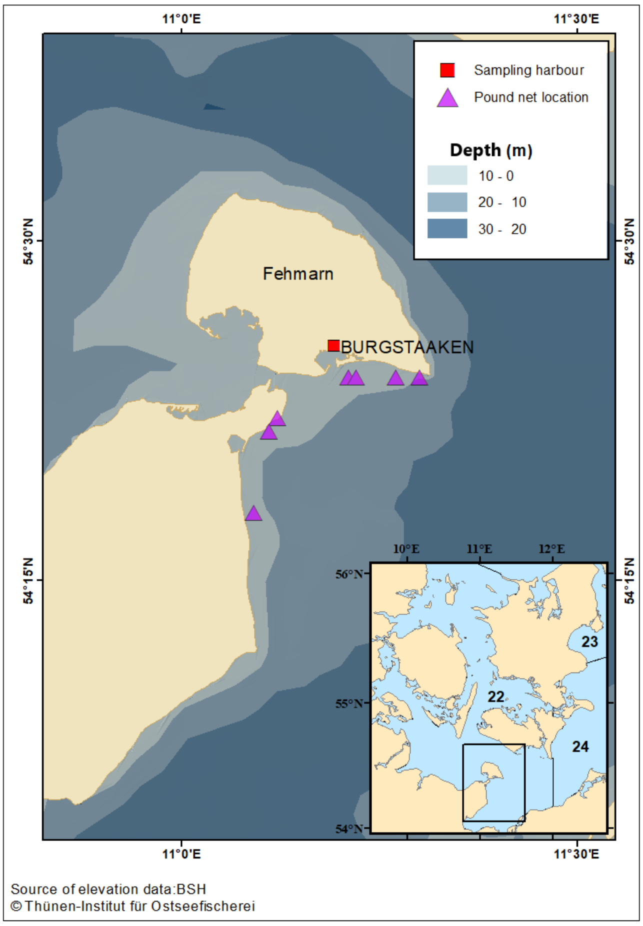
The method is described in the Working Document Number 18, p. 293-310 of ICES 2019, Benchmark Workshop on Baltic Cod Stocks (WKBALTCOD2). ICES Scientific Reports. 1:9. 310 pp. http://doi.org/10.17895/ices.pub.4984.

3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

National survey only.

4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

National survey only.



Map: Fehmarn Juvenile Cod Survey (FEJUCS). Location of pound nets off the coast of Fehmarn, from which samples are collected between September and December each year.

5. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.

National survey only.

6. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

The FEJUCS time series is used as a tuning fleet in the assessment of the Western Baltic cod stock by the ICES Baltic Fisheries Assessment Working Group (WGBFAS) as fishery independent abundance index. Water temperature (and oxygen content) is sampled using a data logger. Data are stored in a national data base.

7. Extended comments (Tables 1G and 1H)

None

Cod in the Baltic (CoBalt)

1. Objectives of the survey

Target species is Baltic cod. The main aim is to monitor the reproductive activities of eastern Baltic cod. Target data are abundances, weight and length distributions of all fishes and length-weight-age-sex-maturity data of cod as well as hydrographic data (temperature, salinity and oxygen). The collected data are saved in a national SQL database. In addition, cod and flatfish stomachs are sampled in June 2019.

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

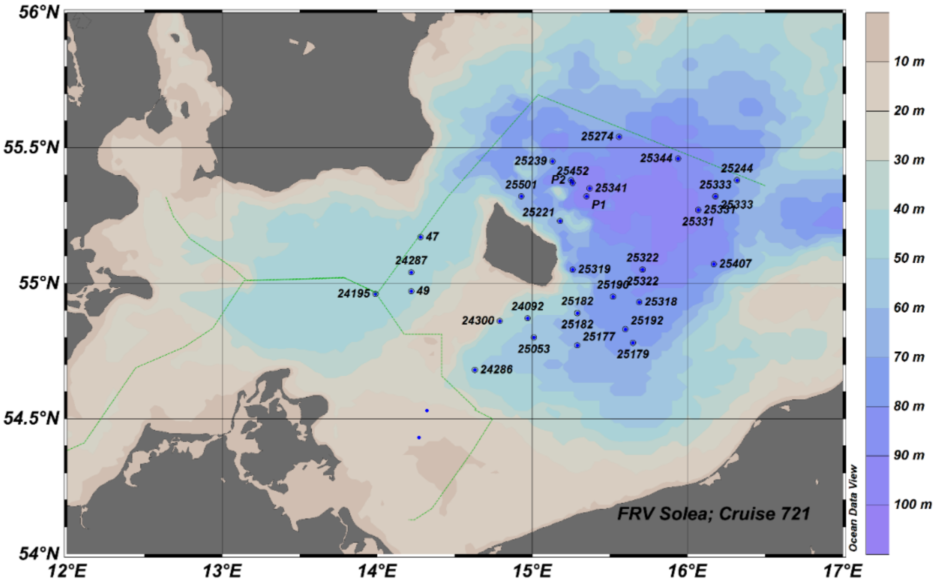
The used methods are standard BITS methods, which are described in the BITS survey manual: http://www.ices.dk/community/groups/Pages/WGBIFS.aspx

3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

National survey only.

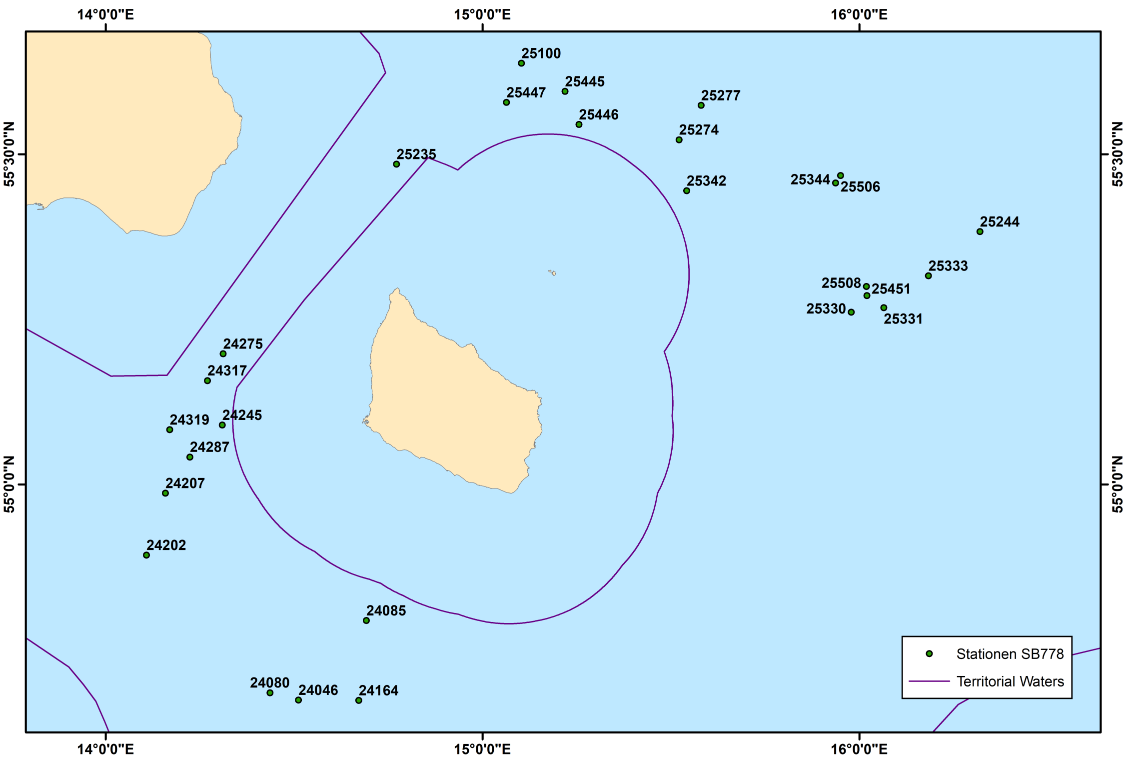
4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

National survey only.



Map: Cod in the Baltic Survey (CoBalt): Positions of fishing hauls

5. Graphical representation (map) showing the positions (locations) of the realized samples.



Map: Cod in the Baltic Survey (CoBalt): Positions of fishing hauls in 2020; survey Solea 778, 10-22 June 2020

6. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.

https://www.bsh.de/DE/DATEN/Ozeanographisches_Datenzentrum/Durchgefuehrte_Forschungsfahrten/_Anlagen/Jahre/2018_node.html

_nnex

7. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

Target species are demersal fish species in the Baltic Sea, mainly cod. The aim of the survey is the sampling of data to maturation, condition and spawning of cod in relation to hydrography (salinity, temperature, oxygen) in the Bornholm Basin and the Arkona Sea.

8. Extended comments (Tables 1G and 1H)

none

National Bottom Trawl Survey in the Baltic (BaltBox)

1. Objectives of the survey

The purpose of this survey is the qualitative and quantitative recording of changes in distribution and composition of the demersal fish fauna in the German EEZ of the Baltic Sea. The sampling areas are located in ecologically characteristic areas ranging from Kiel Bay and Fehmarn Belt in the west via the deep Arkona Basin through to Adlerground and Oderbank in the east. Since 2018 only the most characteristic areas concerning spatio-temporal distribution of fish species are investigated: “West”, “Deep” and “East”. Target data are abundances, weight and length distributions of all fishes and length-weight-age-sex-maturity data of Baltic cod, flounder, plaice, dab, turbot and brill as well as hydrographic data (temperature, salinity and oxygen). The data are stored in a national SQL database. In addition, cod stomachs were sampled.

1. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

The used methods are standard BITS methods, which are described in the BITS survey manual: http://www.ices.dk/community/groups/Pages/WGBIFS.aspx

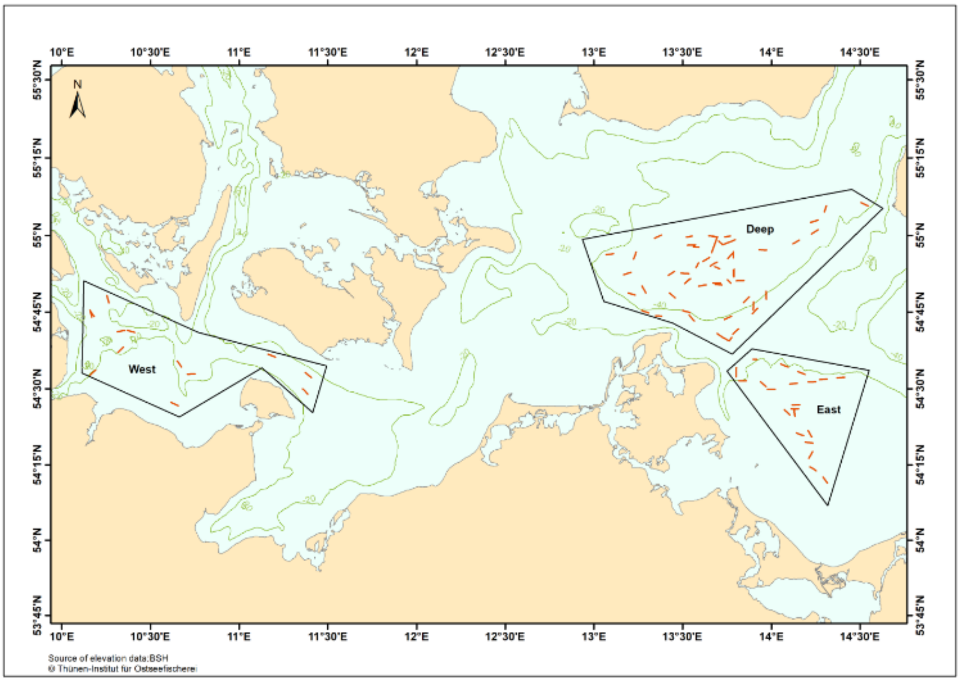
2. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

National survey only.

3. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

National survey only.

4. Graphical representation (map) showing the positions (locations) of the realized samples.



Map BaltBox survey. Location of fixed sampling areas for investigations of the demersal fish fauna in the German EEZ of the Baltic Sea.

5. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.

National survey only.

6. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

The main objective is to characterize the demersal fish fauna and their changes over time. Therefore, biodiversity indices, abundances and environmental parameters (e.g. salinity, temperature, oxygen saturation) were estimated, recorded and analysed.

7. Extended comments (Tables 1G and 1H)

The following publication resulted from the survey:

Rau A, Lewin W-C, Zettler ML, Gogina M, Dorrien C von (2019). Abiotic and biotic drivers of flatfish abundance within distinct demersal fish assemblages in a brackish ecosystem (western Baltic Sea). Estuar Coast Shelf Sci 220:38-47, DOI:10.1016/j.ecss.2019.02.035

German Autumn Survey in the Exclusive Economic Zone (GAS EEZ)

1. Objectives of the survey
    - To determine the distribution and relative abundance of demersal fish species;
    - To monitor changes in the stocks of commercial fish species independently of commercial fisheries data;
    - To monitor the distribution and relative abundance of all fish species and invertebrates
    - To collect hydrographical data (temperature, salinity and oxygen);
    - To collect data on marine litter.

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

The survey takes place every year alternately with beam trawl (7 meter) and otter bottom trawl (cod hopper). A fixed station pattern has been fished since 2004. Sorting of the catch follows the standard IBTS methods, which are described in the IBTS survey manual (ICES 2015: Manual for the International Bottom Trawl Survey, Revision IX. SISP 10).

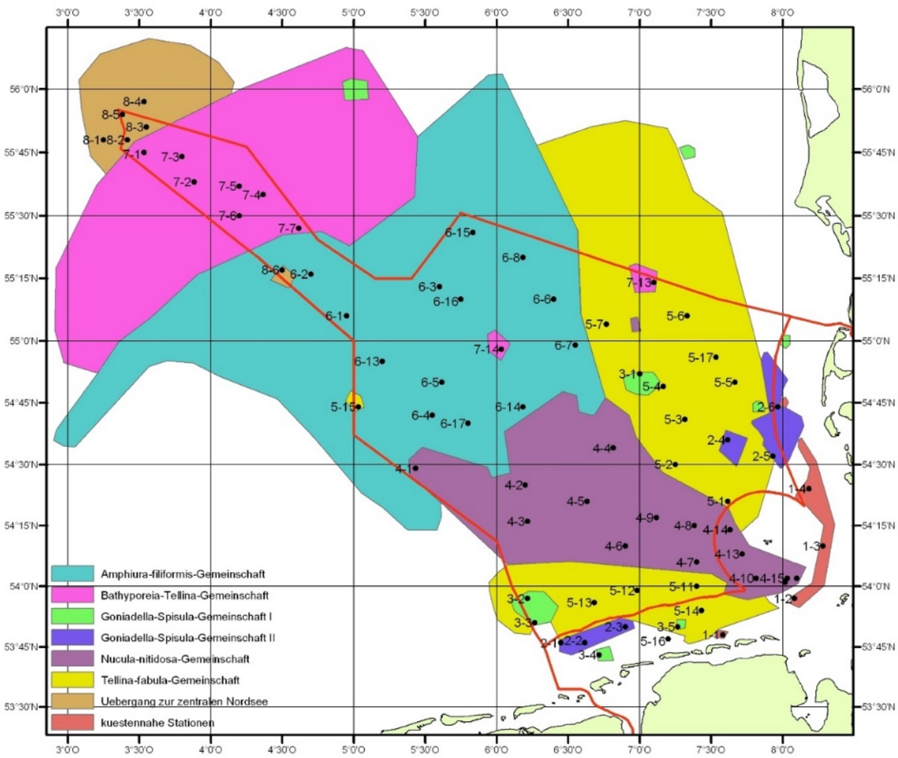
The data are so far stored locally in a national database.

3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

National survey only

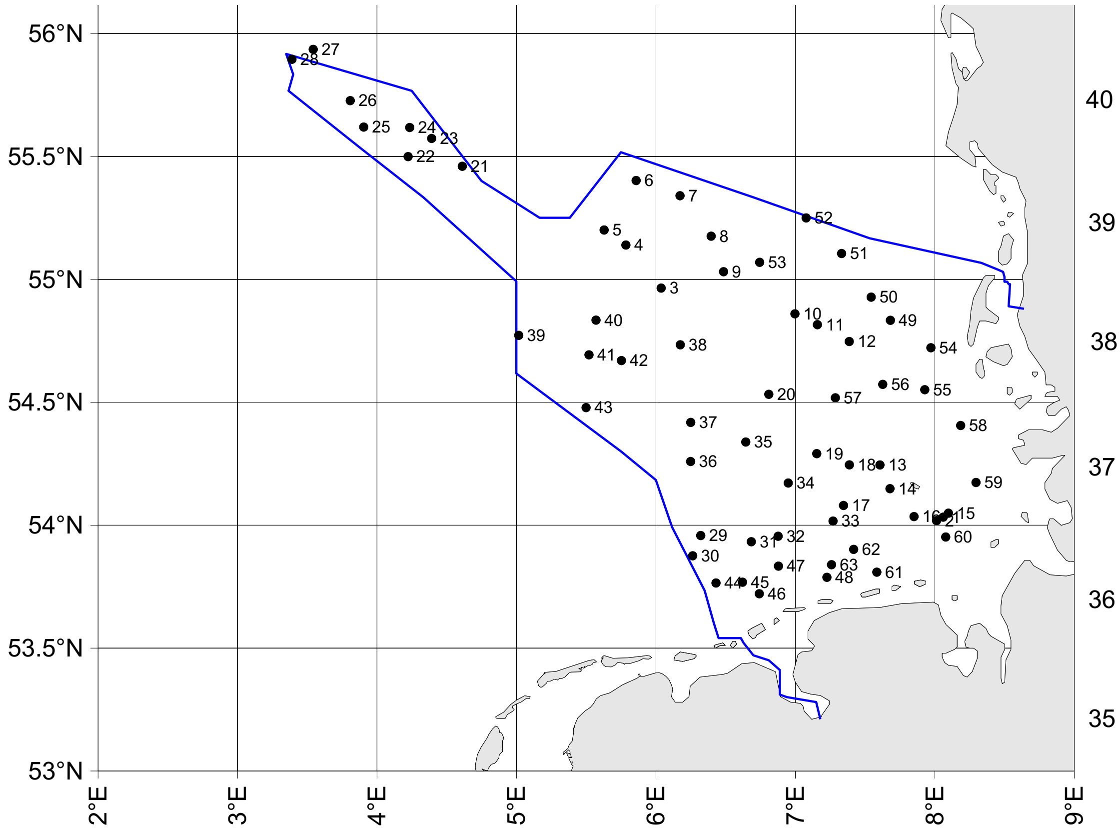
4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

National survey only



Map: German Autumn Trawl Survey (GAS EEZ) – Positions of hauls within different faunal zones

5. Graphical representation (map) showing the positions (locations) of the realized samples.



Map: German Autumn Trawl Survey (GAS EEZ) – Realized fishing hauls in 2020

6. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.

http://www.bsh.de/aktdat/dod/fahrtergebnis/2019/20190087.htm

see PDF annex

7. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

The survey provides information on the distribution and relative abundance of demersal fish species, monitors changes in the stocks of commercial fish species independently of commercial fisheries data and supplies information on the distribution and relative abundance of all fish species and invertebrates

8. Extended comments (Tables 1G and 1H)

none

Eel Larvae Survey

1. Objectives of the survey

A) Regular and standardized monitoring of larval eel (*Anguilla anguilla*) abundance in the Sargasso Sea as a basis for the establishment of a stock-recruitment relationship and stock assessment.

B) Larval abundance and distribution in the Sargasso Sea in relation to glass eel recruitment and hydrographic conditions in order to evaluate the effect of climate change on larval survival, retention and drift.

Data on larval abundance in the spawning area are poor and the existence of a stock-recruitment-relationship is unproven. Until today, European eel stock assessment is largely based on fluctuations in glass eel recruitment along European coasts. However, the age of arriving glass eels is scientifically disputed with estimations reaching between 1 and 3 years. In addition, oceanic factors influencing larval survival until metamorphosis into glass eel stages are still debated as potential drivers for the eel stock decline. The regular monitoring of larval abundance in the Sargasso Sea is aiming to provide information that is required to evaluate whether management measures (e.g. increase of spawner escapement) increase the reproduction success of *A. anguilla*. By comparing larval abundances with glass eel recruitment of the following years, the surveys also provide insights into the effect of oceanic factors on eel stock development. It is investigated how climatic changes affect the survival and distribution of eel larvae and to what extent the drift towards European waters might be impeded by hydrographic conditions.

2. Description of the methods used in the survey. For mandatory surveys, link to the manuals. Include a graphical representation (map)

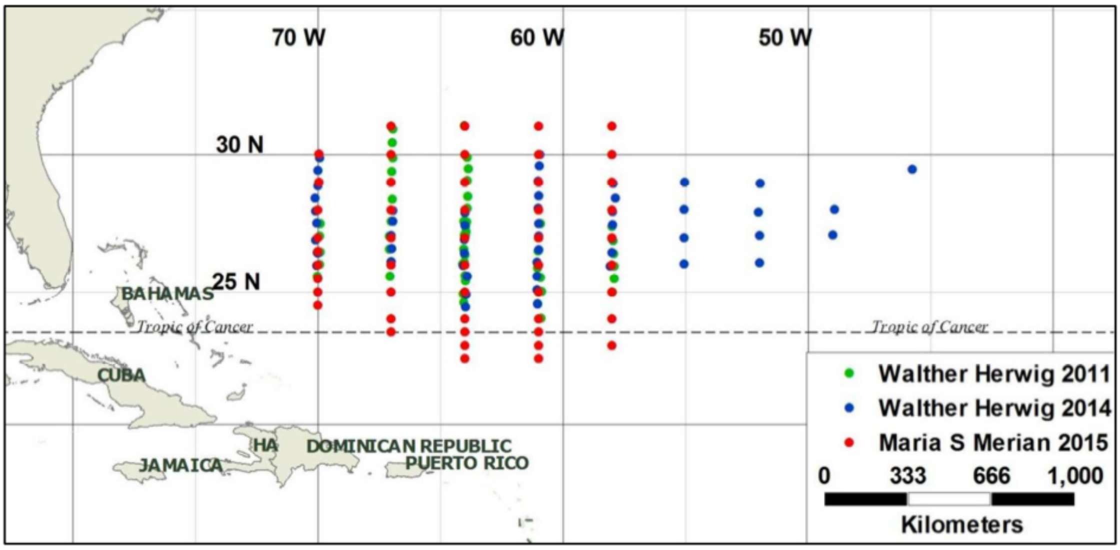
The study area ranges from 31° - 22°N and 70° - 50°W. Inside this area, a core sampling area is defined in accordance with larval distribution. Sampling takes place with an Isaac Kidd Midwater Trawl (net opening 6.3 m^2, mesh size 500 μm) at approximately 50 stations along north-south transects. Species identification and length measurements of all leptocephalus larvae are done on board. Hydrographic conditions are monitored by CTD throughout the sampling area.

3. For internationally coordinated surveys, describe the participating Member States/vessels and the relevant international group in charge of planning the survey

National survey only

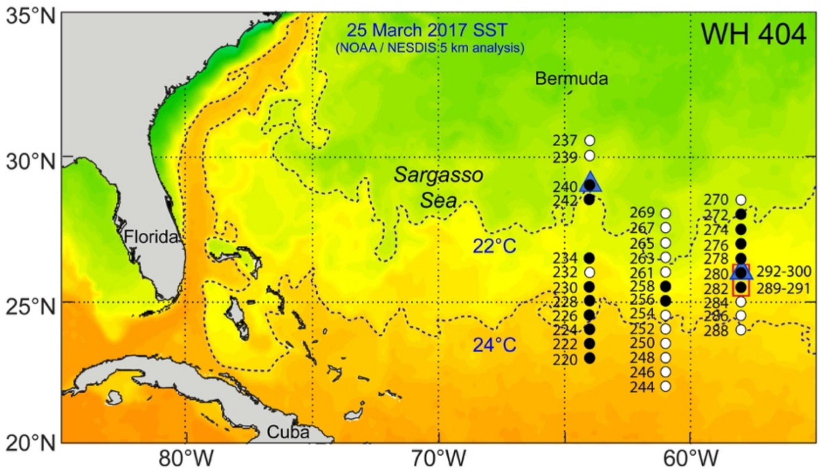
4. Where applicable, describe the international task sharing (physical and/or financial) and the cost sharing agreement used

National survey only



Map: Eel Larvae Survey, sampled transects in 2011, 2014 and 2015. In 2017 (FRV Walther Herwig III cruise WH404), the transects at 64°, 61° and 58°W were sampled (not shown).

5. Graphical representation (map) showing the positions (locations) of the realized samples.



Map: Eel Larvae Survey, sampled transects in 2017

6. For internationally coordinated surveys, provide a link to the latest meeting report of the coordination group.

http://www.bsh.de/aktdat/dod/fahrtergebnis/2017/20170155.htm,

Survey was completely cancelled in 2020 due to the Covid-19 pandemic. Next survey year is 2023

7. List the main use of the results of the survey (e.g. indices, abundance estimates, environmental indicators).

During the EELS-cruises, distribution and abundance of early life stages of eels (*Anguilla anguilla* and *A. rostrata*) are studied in the central Sargasso Sea. In the frame of a regular time series, the studies aim at enabling conclusions about the long-term effects of changing hydrographic conditions on distribution, abundance and survival of eel larvae in the Sargasso Sea. In the medium-term, the data shall offer relevant information for a successful and efficient management of this endangered fish species. Our catches of eel larvae, in combination with the oceanographic data obtained during the cruise, can also help to more precisely localize the spawning sites of European eel and to better understand the relevant abiotic factors in the spawning area.

In addition to the detailed work on eel larvae, we also investigate abundance and distribution of *leptocephalus*-larvae of other species, to detect potential changes in the *leptocephalus* community in the Sargasso Sea.

Beside the investigations of eel larvae, the behaviour of mature female eels in their presumed spawning area was investigated by using pop-up satellite tags in 2017. From this experiment, we expect data about the swimming behaviour of female eels short before spawning, including information about the spawning depth and hydrographic conditions at the spawning site.

The present research cruise is not understood as a stand-alone project. Instead, it represents a further step in our efforts to establish a continuous time-series of Sargasso Sea surveys, during which abundance and distribution of eel larvae as well as hydrographic conditions during the spawning period will be documented. By doing this, our studies provide a basis for a better understanding of the distribution of eel larvae and physical constraints for eels to spawn. By also conducting studies on related issues, e.g. trophic interactions, we further increase the knowledge about ecology of the youngest life stages of this fascinating, economically important but endangered species.

8. Extended comments (Tables 1G and 1H)

none

SECTION 2: FISHING ACTIVITY DATA

Text Box 2A: Fishing activity variables data collection strategy

General comment: This box fulfills paragraph 4 of Chapter III of the multiannual Union programme and Article 2, Article 4 paragraph (2) point (b) and Article 5 paragraph (2) of the Decision (EU) 2016/1701. It is intended to describe the method used to derive estimates on representative samples where data are not to be recorded under Regulation (EU) No 1224/2009 or where data collected under Regulation (EU) No 1224/2009 are not at the right aggregation level for the intended scientific use.
General comment: This box is applicable to the Annual Report. This box should provide information on the implementation of the data collection of fishing activity variables of Member States.

1. Description of methodologies used to cross-validate the different sources of data

Depending on the variable, the source is either the logbook (for effort) or the sales notes (for value of landings). The logbooks are also used to determine the metier. There is, however, no duplicate provision of data from separate sources which would require cross-validation.

2. Description of methodologies used to estimate the value of landings

The value of landings is taken directly from sales notes. In the case of missing entries for the value, it is being estimated using prices achieved at the same time in the same region with the same gear at the same place. In the case of missing hits, the criteria of similarity (e.g. “same place”) are reduced until a hit is achieved.

3. Description of methodologies used to estimate the average price (it is recommended to use weighted averages, trip by trip)

Prices are estimated using figures from the sales notes. In order to get the price per kg, the revenue is divided by the mass sold. In the case of missing entries for revenue, it is estimated as described before.

4. Description of methodologies used to plan collection of the complementary data (sample plan methodology, type of data collected, frequency of collection etc)

For vessels without logbooks, effort variables are estimated on the basis of a questionnaire which is sent together with the survey on fleet economic variables (stratified random sampling). Gear size and days at sea are requested. These data are compared with the sales notes which always refer to a certain time period. The sum of these periods is related to the survey result. The ratio of both figures is used estimate the fleet segment total by multiplying it with the total of the time periods derived from the sales notes.

All other fishing activity data are collected according to the standards as provided by the Control Regulation (1224/2009).

5. Deviations from Work Plan methodology used to cross-validate the different sources of data

No deviations.

Actions to avoid deviations.

NA

6. Deviations from Work Plan methodology used to estimate the value of landings.

No deviations.

7. Deviations from Work Plan methodology used to estimate the average price.

No deviations.

8. Deviations from Work Plan methodology used to plan collection of the complementary data

The 2020 NWP did not contain effort information by variable. For the 2020 AR, information is provided by variable. DEU performed an additional data collection on effort variables only for vessels without logbooks. According to COM Dec. 1251/2016 “number of fishing operations” is to be collected. However, this variable is only meaningful in context with purse seines (see COM Dec. 93/2010). This fishery is not performed by any German vessel, thus the variable is not relevant. Nonetheless, data can be estimated based on the survey (number of nets X fihsing days).

SECTION 3: ECONOMIC AND SOCIAL DATA

Text Box 3A: Population segments for collection of economic and social data for fisheries

General comment: This box fulfils paragraph 5 points (a) and (b) of Chapter III of the multiannual Union programme and Article 2, Article 4 paragraphs (1), (2) and (5) and Article 5 paragraph (2) of the Decision (EU) 2016/1701. It is intended to specify data to be collected under Tables 5(A) and 6 of the multiannual Union programme.

General comment: This box is applicable to the Annual Report. This box should provide information on the implementation of the fleet socio-economic data collection of Member States.

1. Description of methodologies used to choose the different sources of data

Data sources are chosen based upon availability and accessibility. Whenever data are available which are collected under a different legislation (transversal data), these are being used (fleet register, logbooks sales notes). Data which are not covered by the sources mentioned above, are collected through the following sources:

i. an accountancy network which consists of about 160 vessels providing a comprehensive set of economic data annually (covering beam trawlers 12-24 m, demersal trawlers 12-24 m, and fixed netters between 8 and 18 m)
ii. a questionnaire which is sent by mail to owners of small-scale fisheries vessels < 10m ("probability proportional to size" sampling), requesting "socio-economic" data on an enterprise level, and
iii. a questionnaire for the segments "Beam trawlers: 10-12 m*and 24-40 m*"; "Demersal trawlers 24-40 m and >40 m" and "Pelagic trawlers > 40 m*" referring to individual vessels.

All surveys are carried out on a voluntary basis. The selection under (ii) is related to the vessel owner. Most fishermen own only one vessel. In case that an owner is selected for sampling and owns more than one vessel, questionnaires will be sent for each individual vessel. However, fishermen owning more than one smaller vessel do not file expenses and employment data separated by vessel. Therefore, this group will be sampled on an enterprise basis, and only effort and physical value data will be surveyed on a vessel basis.

2. Description of methodologies used to choose the different types of data collection

Methodologies are chosen by means of segment size and importance. Segments with few vessels, but high importance for certain fisheries or in terms of total landings, are sampled exhaustively. This applies to most segments >24m. Other segments are sampled on the basis of "probability proportional to size" sampling ("size" refers to the value of landings). The bigger the segment (in terms of no. of vessels), the smaller the sample rate.

3. Description of methodologies used to choose sampling frame and allocation scheme

The sampling frame is the target population. The target population is the fleet on 31st December plus all vessels having reported any activity (landings declaration) during the year. Vessels are allocated to a segment gear by using logbook information or, for vessels without logbooks, main gear in the fleet register.

As approved for previous periods, vessels targeting mainly blue mussels are excluded from the fishing fleet, as their activity is defined as aquaculture (using seed mussels) and their figures are reported in the aquaculture section.

4. Description of methodologies used for estimation procedures

A correlation analysis is being performed between data which are available exhaustively (capacity, landings, and in most cases effort) and those data from the surveys. The Pearson correlation coefficient is used as a first indicator of which factor has the most influence on the variable which has to be estimated. As a result of this analysis, a scheme is being developed, which includes not only correlation aspects, but also considerations of meaningfulness. For instance, energy costs are likely to be dependent upon both the vessel size and some effort parameter, but not so much on value of landings – even if the correlation analysis might indicate something else.

	Basis for estimation				
Variable type to be estimated	GT	kW	fishing days	days at sea	value of landings
Direct subsidies		X			
Other income		X			
Wages and salaries of crew	X		X		X
Imputed value of unpaid labour	X		X		X
Energy costs	X		X		
Repair and maintenance costs	X				X
Variable costs	X		X		
Non-variable costs	X	X			
Investments in physical capital					X
Debt/asset ratio					X
Engaged crew				X	
FTE National				X	

Estimation for segments with sampling results

In a next step, the values are estimated for the segment for which sampled data are available. It has turned out that the fractions, which the sample represents within the considered segment, are in most cases quite similar, e.g. in TBB1218 the sample represents about 41% of the number of vessels, 41% of LoA, 44% of GT, 41% of kW, 52% of weight of landings, 49% of revenues and 45% of days at sea (example from 2008).

In other words, estimations are in most cases quite robust, no matter which factor is used for estimation. Nonetheless, the estimator is chosen with respect to the scheme above. In cases where more than one variable is indicated as basis for estimation, the average of the fraction will be applied.

Estimation for segments without sampling results

According to the experience in previous years, there is a chance that for a segment or a variable no responses are obtained. In this case, the basis for estimation will be a regression analysis of segments with the same fishing technique and an adjacent length class or with the same length class and a similar fishing technique, depending upon which version delivers the highest r^2. The final choice can be done only when the data are available.

5. Description of methodologies used on data quality

In accordance with the STECF report on quality aspects (SGECA 09-02), the coefficient of variation will be used as indicator of accuracy.

In addition, Germany is testing an alternative clustering approach to find a more suitable segmentation procedure, based on fishing pattern rather than on main gear class. The aim is to achieve segments with less variability.

6. Deviations from Work Plan methodology for selection of data source

No deviations. In addition to the sources mentioned, subsidies were comprehensively provided by the federal institutions resposible for approval and payment.

7. Deviations from Work Plan methodology to choose type of data collection

No deviations.

8. Deviations from Work Plan methodology regarding sampling frame and allocation scheme

No deviations.

9. Deviations from Work Plan methodology used for estimation procedures

No deviations.

10. Quality assurance

10.1 Sound methodology

The methodologies applied are in line with expert group recommendations (e.g. SGECA 09-02). Sampling schemes used are census and probability sampling. The methodologes applied are documented and being made publicly available in the National Work Plan, which is available e.g. under https://www.dcf-germany.de/documents.

Specific information on the FADN-based data can be found at https://www.bmel-statistik.de/landwirtschaft/testbetriebsnetz/testbetriebsnetz-fischerei-buchfuehrungsergebnisse/

10.2. Accuracy and reliability

Response rate and achieved sample rate are provided in Table 3A.

FADN-based data are additionally checked through an IT-based plausibility routine, comprising a comparison of numerous figures: https://www.bmel-statistik.de/landwirtschaft/testbetriebsnetz/testbetriebsnetz-landwirtschaft-buchfuehrungsergebnisse/plausibilitaetspruefung-landwirtschaft/

Figures from additional surveys comprise about 50 questionnaires. Those are assessed manually, following principles similar to the FADN plausibility routine, though being shorter (as the FADN contains many more variables than required for EU MAP). In principle, values are checked by the individual GVA – datasets are further scrutinised when the GVA is sensibly negative. In some cases, one-time expenses are an explanation (e.g. repair). If expenses substantially exceed a typical percentage of the value of landings, then the data will be cross-checked with the supplier, when regarded relevant.

10.3. Accessibility and Clarity

Are methodological documents publicly available? Yes

Are data stored in databases? Yes

Where can methodological and other documentation be found?

https://www.dcf-germany.de/documents

https://www.bmel-statistik.de/landwirtschaft/testbetriebsnetz/testbetriebsnetz-fischerei-buchfuehrungsergebnisse/

https://www.bmel-statistik.de/landwirtschaft/testbetriebsnetz/testbetriebsnetz-landwirtschaft-buchfuehrungsergebnisse/plausibilitaetspruefung-landwirtschaft/

Pilot Study 3: Data on employment by education level and nationality

General comment: This box fulfills paragraph 5 point (b) and paragraph 6 point (b) of Chapter III of the multiannual Union programme and Article 2 and Article 3 paragraph (3) point (c) of the Decision (EU) 2016/1701.It is intended to specify data to be collected under Table 6 of the multiannual Union programme.
General comment: This box is applicable to the Annual Report. This box is intended to provide information on the results obtained from the implementation of the pilot study (including deviations from planned and justifications as to why if this was not the case).
The pilot study was performed as planned by Germany within 2017-2019 and will be continued as regular data collection.
4. Achievement of the original expected outcomes of pilot study and justification if this was not the case. The pilot study was executed in 2018. . 5. Incorporation of results from pilot study into regular sampling by the Member State. The data collected through the pilot study and the data sources will be used for regular sampling in the future. Some adjustment to the number of engaged crew will be implemented for consistency reasons in the future.

Text Box 3B: Population segments for collection of economic and social data for aquaculture

General comment: This box fulfills paragraph 6 points (a) and (b) of Chapter III of the multiannual Union programme and Article 2, Article 4 paragraphs (1) and (5) and Article 5 paragraph (2) of the Decision (EU) 2016/1701.It is intended to specify data to be collected under Tables 6 and 7 of the multiannual Union programme.

General comment: This box is applicable to the Annual Report. This box should provide information on the implementation of the socio-economic data collection for aquaculture of Member States.

Background: 2,584 German aquaculture farms produced more than 31,800 tons of fish, crustaceans, molluscs and other aquatic organisms in 2018 (Destatis 2019). The main species are rainbow trout, common carp and blue mussels. According to the last tentative assumed Eurostat aquaculture production data, this represents a share of 2.2 % of the total EU-28 production (STECF-18-19). Taking into account the defined thresholds of the EU MAP (Implementing Decision 2016/1251, chapter V 6.), social and economic data on aquaculture will be collected, while environmental data on aquaculture will not be collected.

1. Description of methodologies used to choose the different sources of data

The Federal Statistical Office in Germany (Destatis) coordinates an annual aquaculture census on production data (volume, species, number of farms, used fish farming technique per federal state). These data do not provide further economic facts on aquaculture. Notwithstanding, it can be seen as a starting point for a planned evaluation on economic and social performance of the sector. In case of the German on-bottom blue mussel cultures, the Federal Office for Agriculture and Food (Bundesanstalt für Landwirtschaft und Ernährung, BLE) collects data on landings, crew and other logbook entries. Further, the German Federal Employment Agency (Bundesagentur für Arbeit, BA) collects monthly data on employment; but not on non-paid labour, which plays an important role in freshwater aquaculture in particular. The BA data covers information about number of permanent employees, casual contracts, apprentices, gender and nationalities. Regarding the data situation and the requirements of DCF, there are two different data resources to analyse the economic and social performance of the sector: assembly of already existing secondary data (data on employment and production/landings) from diverse sources and a collection of primary data done by the Thünen-Institute.

2. Description of methodologies used to choose the different types of data collection

A triangulation (mixed-method-approach) is applied. First, data on production and employment is collected by third party agencies via census (Destatis, BA, BLE) and collated by the Thünen-Institute according to DCF requirements. Second, data on economics and social variables are collected via survey (standardised questionnaire). Third, it is planned to build up a network of representative farms (according to the typical farm approach, cf. PGECON 2019). The typical farms will be used as supplementary data source for farm economics and labour characteristics (social variables) to balance shortcomings of the survey (e.g. insufficient response behaviour in case of some variables).

3. Description of methodologies used to choose sampling frame and allocation scheme

While Destatis coordinates the census of production data in Germany, the data itself is collected by the 16 state offices of statistics in Germany. Due to the strict interpretation and application of data protection law, the responsible state authorities rejected to give Thünen-Institute access to the diverse fish farmer address bases. As described in Germany's annual report for data collection in the fisheries and aquaculture sectors

2017-2019 from May, 2019 and approved through the letter of acceptance of annual report from EC MARE/C3 Joost Paardekooper from July 12th, 2018, the original planned two-stage sampling process including the planned threshold (cf. German Work Plan for data collection in the fisheries and aquaculture sectors 2017-2019) could not be applied, because the Thünen-Institute has no access to freshwater fish farmers' addresses combined with information about cultured species and volume. Alternatively, an own database has been built up. Here are freshwater aquaculture enterprises listed, which addresses is available via public sources. After the undertaken survey 2018, new information from respondees lead to cleanse the established address database. Several entries were deleted, because the addresses were invalid or interviewees had objections according to data protection regulation (EU) 2016/679 of the European Parliament and the Council. This cleansing process is ongoing and will exclude part-time and hobby farms in future. At the end, only professional operations will be considered as fish farms "whose primary activity is [are] defined according to the European classification of economic activities" (Decision 2016/1251, Chapter III 6.a). At the time of this report, the address database considers 766 addresses. In 2018, the Thünen-Institute received 146 responses for freshwater aquaculture enterprises in 2018, which represent around 20 percent of the total German fresh water aquaculture production.

Due to cleansing process the exact sample frame is still variable, but will oscillate between 200 and 400 companies. For the current workplan, the assumed number of 300 cases is applied, whereof the main species trout and carp farms have an almost equal share. For the marine sector, all approx. 10 companies holding licenses are surveyed by questionnaire.

In addition, a small network of representative farms will be build up, which is chosen by purpose sampling (PGECON 2019).

4. Description of methodologies used for estimation procedures

For production and for some social variables, there is no estimation necessary (cf. point 1.), as the data are based on a census from Destatis, BA or BLE. In case of economic data gained via sample or the network of representative farms, standard statistic parameters will be applied within the true population to a certain degree of confidence. Main reference for estimation will be the total production per species, production system and farm size.

5. Description of methodologies used on data quality

The quality of available production, landing, logbook and employment data can be regarded as high due to the fact that Destatis, BA and BLE data are conducted via census. Destatis sets thresholds, which exclude fish farms with a scale <0.3 ha or with a volume <200 m^3 (Destatis 2019). The same thresholds are applied for the address database used by Thünen-Institute. The planned sample for DCF economic data on freshwater aquaculture follows the common practices of statistics with linked sampling errors. The sampling errors will be expressed by standard error, coefficient of variation and confidence interval. Due to the experience of the Thünen-Institute regarding economic surveys for fisheries and (marine) aquaculture and an internal review process of the development of a well understandable questionnaire, measurement errors are not expected. Economic data collection is not mandatory for fish farmers in Germany and thus a low response rate is experienced. As a consequence, data collection activities include communication strategies (announcements in fish farmer magazines, personal introduction of the project to local research stations and fish farmer meetings) as well as mail reminders. Further, the planned network of representative farms will balance low response rates of the survey.

References

Bundesagentur für Arbeit (2018) Beschäftigte nach ausgewählten Wirtschaftsklassen nach Klassifizierung der Wirtschaftszweige (WZ 2008). German Federal Employment Agency, internal report, Nürnberg, July, 2016.

Destatis (2019) Land- und Forstwirtschaft, Fischerei. Erzeugung in Aquakulturbetrieben 2018. German Federal Statistical Office (Destatis), Fachserie 3 (4.6), Destatis, Wiesbaden.

Planning Group on Economic Issues (PGECON), PGECON 2019 Report, Slovenia, May 6th-10th, 2019, Online available: https://datacollection.jrc.ec.europa.eu/docs/pgecon

6. Deviations from Work Plan methodology for selection of data source

No deviations.

7. Deviations from Work Plan methodology to choose type of data collection

No deviations.

For the variable “unpaid labour”, information from the Federal Statistical Office (Destatis) census and as well as from the social survey data from 2017 (social variables collected for the first time) will be used for the projection in addition to the information deriving from the annual survey. The variable financial income was part of the annual survey in earlier years, however the feedback led to the conclusion that this economic variable is not relevant for the (rather low-capital) German sector. Therefore, this variable was not included in the 2020 survey.

8. Deviations from Work Plan methodology regarding sampling frame and allocation scheme

No deviations.

As described above, the frame population consists of the total of publicly available addresses of German freshwater aquaculture enterprises, continously cleansed and updated on the basis of responses/new farms to be added. The current frame population corresponds to 407 salmonid and 308 carp producing operations. Data from the 2017 survey including social variables (which are used for the projection of part of the variables for survey data up to the year 2019) correspond to an earlier version of the address data base including 440 salmonid and 344 carp producing operations (total of 666 as part of the farms produce both species). The total number of German aquaculture farms, collected within the census of the Federal Statistical Office (Destatis) corresponds to approx. 2500 (1694 salmonid and 1656 carp operations, partly producing both species) and their total production volume is the target size for extrapolation. The frame population for the variable “persons employed” was chosen according to the population frame of the National Labour Agency (BA) and corresponds to the number of registered employees (census). This decision was taken on the basis that the BA frame population does not neccessarily correspond to the frame population of aquaculture producing operations collected by Destatis.

9. Deviations from Work Plan methodology used for estimation procedures

No deviations.

10. Quality assurance

10.1 Sound methodology

The methodologies applied are in line with expert groups recommendations (e.g. SGECA 09-02). Sampling schemes used are census, probability sampling and indirect survey. The methodologes applied are documented and being made publicly available in the National Workplan, which is available e.g. under https://www.dcf-germany.de/index.php?id=187 .

Regarding data on aquaculture production volume per species, production techniques (segments), number of farms cf. Federal Statistical Agency (Destatis) “Qualitätsbericht. Erhebung über die Erzeugung in

Aquakulturbetrieben, 18. November 2020, Wiesbaden. (https://www.destatis.de/DE/Methoden/Qualitaet/Qualitaetsberichte/Land-Forstwirtschaft-Fischerei/aquakulturbetriebe.pdf?__blob=publicationFile (access on 14/05/2021; only available in German))

Regarding data on permament and casual employment, apprenticeships, gender and origins of employees cf. labour register of the National Employment Agency (Bundesagentur für Arbeit, November 2020).

https://statistik.arbeitsagentur.de/DE/Statischer-Content/Grundlagen/Methodik-Qualitaet/Qualitaetsberichte/Generische-Publikationen/Qualitaetsbericht-Statistik-Beschaeftigung.pdf?__blob=publicationFile&v=8 (access on 14/05/2021; only available in German)

10.2. Accuracy and reliability

For a continous synthesis of the freshwater aquaculture and marine aquaculture surveys, all questionnaires were sent at the beginning of November 2020 at once. Response rate and achieved sample rate per variable are provided in Table 3B.

10.3. Accessibility and Clarity

Are methodological documents publicly available? Yes

Are data stored in databases? Yes

Where can methodological and other documentation be found?

https://www.dcf-germany.de/index.php?id=187

(https://www.destatis.de/DE/Methoden/Qualitaet/Qualitaetsberichte/Land-Forstwirtschaft-Fischerei/einfuehrung.html (access on 05/05/2020; only available in German))

https://statistik.arbeitsagentur.de/cae/servlet/contentblob/4412/publicationFile/858/Qualitaetsbericht-Statistik-Beschaeftigung.pdf (access on 05/05/2020; only available in German)

Pilot Study 4: Environmental data on aquaculture

General comment: This box fulfills paragraph 6 point (c) of Chapter III of the multiannual Union programme and Article 2 and Article 4 paragraph (3) point (d) of the Decision (EU) 2016/1701. It is intended to specify data to be collected under Table 8 of the multiannual Union programme.
General comment: This box is applicable to the Annual Report. This box is intended to provide information on the results obtained from the implementation of the pilot study (including deviations from planned and justifications as to why if this was not the case).
1. *No data collection planned due to threshold (see background text at the beginning of Text Box 3B)*.
4. Achievement of the original expected outcomes of pilot study and justification if this was not the case. - 5. Incorporation of results from pilot study into regular sampling by the Member State. -

Text Box 3C: Population segments for collection of economic and social data for the processing industry

General comment: This box fulfils footnote 6 of paragraph 1.1(d) of Chapter III of the multiannual Union programme, Article 2, Article 4 paragraphs (1) and (5) and Article 5 paragraph (2) of Decision (EU) 2016/1701. It is intended to specify data to be collected under Table 11 of the multiannual Union programme.

General comment: This box is applicable to the Annual Report. This box should provide information on the implementation of the socio-economic data collection for aquaculture of Member States.

1. Description of methodologies used to choose the different sources of data

In Germany, the fish processing sector is part of the industry. Almost 80-90% of employment and turnover belong to companies with 20 and more employees. Therefore, already existing data collection schemes with the emphasis on these larger companies are used. Additional data in particular for the social variables are gathered by the Federal Employment Agency. These data are almost all based on census. In order to avoid doubling data collection, these primary data are used for the purpose of the data collection in the processing sector. For some variables, data are not available via other administrative bodies. In these cases, the Institute of Sea Fisheries conducts an additional survey and will make also use of published financial statements of the companies.

The Federal Statistical Office in Germany (Destatis) holds a database with data on turnover, number of enterprises and employees belonging to the social security scheme. Destatis further collects data on Investment and sales on a census basis with a threshold of companies with 20 employees and conducts a probability sample survey on several cost items and employment data.

The Federal Employment Agency registers all persons employed in Germany. Additional characteristics like gender, age etc. are collected as well. If data on employment figures are not sufficient or - as in the case of unpaid labour – maybe not fully covered by the Employment Agency, additional data collection on a triennial basis for social data and annually for economic data will be executed by the Institute of Sea Fisheries.

For the raw material input by species and origin, some experience in data collection exists at the institute from former years. In order to enhance quality, a pilot study will be conducted. The aim is to make use of data already stored for traceability purposes in the sector. It is intended to check the quality and availability of these data and eventually conduct an own survey to obtain reliable pictures of the raw material input by species and origin. Meetings with industry representatives will form the starting point.

2. Description of methodologies used to choose the different types of data collection

The already existing data collections by the Federal Statistical Office and the Federal Employment Agency are well established and provide reliable and validated time series. Respective quality reports are available on request or already on the respective websites. A report about the overall description of the organisation of the survey, the various segments, and the quality aspects of both data types - primary and secondary data - will be provided. Given the experience from former years, data on variables that are not covered by other administrative bodies are more or less well achievable by questionnaire and eventual telephone recall, so this methodology will be maintained.

For the volume of raw material by species and origin, no such regular collection scheme is established, so a pilot study will be conducted.

3. Description of methodologies used to choose sampling frame and allocation scheme

In many cases, where data are already covered by regular data collection, decision on sampling frame and allocation scheme have been made already years ago, e.g. on the European level for Structural Business

Statistics (SBS) data, or census is conducted.
For the data collection conducted by the Institute of Sea Fisheries, the principles are cost effectiveness and avoiding double data collection burden for the enterprises. On the other hand, the requirement is to obtain reliable data representing development and status quo of the sector. So a sampling frame concentrating on the large companies with 20 and more employees (representing 80-90% of the sectors turnover and employment) will be set up, and together with published financial statements, 20% sampling rate seems to be appropriate.

4. Description of methodologies used for estimation procedures

For some economic data and for some social variables, there is no estimation necessary because data are based on census and past experience shows no problems with non-response. In case of economic data gained via sample (cf. Table 3C), standard statistic parameters will be applied to calculate the range of values/volumes within the true population.
The pilot study conducted has shown a need for further collaboration with the industry and the industry organisation in order to provide a better basis to the use of the data and improve the procedure to gather them. Further contact is foreseen with firms that have shown interest, and subsequent approximations could be taken to others members of the industry. Therefore, to improve the success rate, non-probability sampling (purpose-sampling) could be employed in addition to probability sampling.

For the non-main activity sector, the population is unclear due to a lack a definition of the activity according to the EU-MAP in the official register of the ministry. The size of the population will be gradually estimated through the answers to the survey, which allows to distinguish among firms that have fish processing as their main activity, those who have it as a non-main activity and those who do not have it at all. Further efforts could be deployed to better define the population according to the EU-MAP, e.g. through exploring the possibility of using a different data source of administrative origin.

5. Description of methodologies used on data quality

The quality of available secondary data can be regarded as very high due to the fact that Destatis' data on fish processing industry are collected under European SBS standards and ARGE's data collection on employment is conducted via census. Destatis sets thresholds for specific cost data (20 and more employees, cf. Table 3C for details), but the stratified random sampling covering around 40% of the sectors larger companies allows high quality of the data. Due to the experience of the Thünen Institute regarding economic surveys for fisheries, (marine) aquaculture and fish processing, measurement errors are not expected. Some data are collected by the Institute of Sea Fisheries (cf. Table 3C), including the pilot study on raw material. As answering to this questionnaire is not mandatory for the companies, a low response rate is considered. As a consequence, a focus of data collection will include communication strategies in advance (announcements in fish sector magazines, personally introduction of the project to the association of fish processors) as well as mail reminder. Quality will be assessed by response rate and the sampling errors will be expressed by standard error and coefficient of variation.

References

ARGE (2018) Beschäftigte nach ausgewählten Wirtschaftsklassen der Wirtschaftszweige (WZ 2008). German Federal Employment Agency, internal report, Nuernberg, June, 2018.

Destatis (2017) Beschäftigte, Umsatz und Investitionen der Unternehmen und Betriebe des Verarbeitenden Gewerbes sowie des Bergbaus und der Gewinnung von Steinen und Erden, Fachserie 4 Reihe 4.2.1 - 2018 Destatis, Wiesbaden.

Destatis (2017) Kostenstruktur der Unternehmen des Verarbeitenden Gewerbes, Fachserie 4 Reihe 4.3 – 2019 Destatis, Wiesbaden.

6. Deviations from Work Plan methodology for selection of data source

After the first contacts in the pilot study, and given the low response rate, it was decided to focus on the data from the best available data source: a cooperating firm, leader of the industry and with a comprehensive, electronic data record. The low willingness to deliver data remains, nevertheless this stronger cooperation allows further improvements in the methodology.
In addition to this, the collection of data from national statistical sources was improved through cooperation with a national research project (see deviations from methodology below).

As there was no Data Call in 2020, no survey was conducted this year for the two variables "unpaid labour" and "weight of raw material per species and origin". The next survey will be conducted in 2021 and will collect economic data for 2018 and 2019 together with social data for 2020. It will also cover the variables employment by gender, age, education level and nationality and will include a request for information on the weight of raw material per species and origin. It was decided to conduct only one survey that covers all mentioned aspects to reduce the burden on the respondents.

7. Deviations from Work Plan methodology to choose type of data collection

No deviations.

8. Deviations from Work Plan methodology regarding sampling frame and allocation scheme

The pilot study had low response rate despite reminders, and it was further conducted using a case study with a cooperating industry leader presenting comprehensive data. This case study allowed the exploration of the "best case scenario".
The cooperation with a national research project also presented the opportunity to improve the methodology for the use of national statistical data on the origin of raw materials. The national project englobed not only the origin, but also the use of fish as raw material, which could contribute to advancing in possible uses of the data for traceability analyses.
Furthermore, possibilities and hindrances of the data collection of raw material were discussed during the last meeting of PGECON that took place virtually from 5th to 7th of October 2020. The documentation of the meeting can be found at:
https://datacollection.jrc.ec.europa.eu/docs/pgecon?p_p_id=110_INSTANCE_I4EJ6BVHCSBT&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&p_p_col_id=column-2&p_p_col_count=1&_110_INSTANCE_I4EJ6BVHCSBT_struts_action=%2Fdocument_library_display%2Fview_file_entry&_110_INSTANCE_I4EJ6BVHCSBT_redirect=https%3A%2F%2Fdatacollection.jrc.ec.europa.eu%2Fdocs%2Fpgecon%3Fp_p_id%3D110_INSTANCE_I4EJ6BVHCSBT%26p_p_lifecycle%3D0%26p_p_state%3Dnormal%26p_p_mode%3Dview%26p_p_col_id%3Dcolumn-2%26p_p_col_count%3D1&_110_INSTANCE_I4EJ6BVHCSBT_fileEntryId=1370340

9. Deviations from Work Plan methodology used for estimation procedures

No deviations

10. Quality assurance

10.1 Sound methodology
The methodologies applied are in line with expert group recommendations (e.g. SGECA 09-02). The quality of available secondary data can be regarded as very high due to the fact that Destatis' data on fish processing industry are collected under European SBS standards and the Federal Employment Agency´s (ARGE) data collection on employment is conducted via census. Sampling schemes used are census, probability and non-probability sampling. For the census and probability sampling to DESTATIS and ARGE the response rate is particularly good as delivery of data is compulsory for the firms.
The methodologies applied are documented and made publicly available in the National Work Plan, which is available e.g. under https://www.dcf-germany.de/index.php?id=187.

For the pilot study the methodology has been developed in cooperation with the SECFISH project. The documentation of the project can be accessed at: https://datacollection.jrc.ec.europa.eu/mare-2016-22-strengthening-regional-cooperation?p_p_id=110_INSTANCE_ye8qSc1W6ds3&p_p_lifecycle=0&p_p_state=normal&p_p_mode=v

iew&p_p_col_id=column-2&p_p_col_count=1&_110_INSTANCE_ye8qSc1W6ds3_struts_action=%2Fdocument_library_display%2Fview_file_entry&_110_INSTANCE_ye8qSc1W6ds3_redirect=https%3A%2F%2Fdatacollection.jrc.ec.europa.eu%2Fmare-2016-22-strengthening-regional-cooperation%3Fp_p_id%3D110_INSTANCE_ye8qSc1W6ds3%26p_p_lifecycle%3D0%26p_p_state%3Dnormal%26p_p_mode%3Dview%26p_p_col_id%3Dcolumn-2%26p_p_col_count%3D1&_110_INSTANCE_ye8qSc1W6ds3_fileEntryId=1293891

Further extensions to the methodology have been performed using a case study, among others to reduce the burden on respondents.

Specific information on the already existing data collections by the Federal Statistical Office and the Federal Employment Agency data can be found at:

ARGE (2018) Sozialversicherungspflichtig Beschäftigte nach ausgewählten Wirtschaftszweigen der WZ 2008. German Federal Employment Agency, internal report, Nürnberg, August 2018.

Destatis (2020) Beschäftigte, Umsatz und Investitionen der Unternehmen und Betriebe des Verarbeitenden Gewerbes sowie des Bergbaus und der Gewinnung von Steinen und Erden, Fachserie 4 Reihe 4.2.1 – 2020 Destatis, Wiesbaden.

Destatis (2019) Kostenstruktur der Unternehmen des Verarbeitenden Gewerbes, Fachserie 4 Reihe 4.3 – 2019 Destatis, Wiesbaden.

10.2. Accuracy and reliability

Response rate and achieved sample rate are provided in Table 3C.

Since enterprises with 20 and more employees are responsible for more than 90% of the sector's sales and employment, low response rates in the segments with fewer employees do not affect the results in terms of representation of the sector eminently. The data collected represent between 80% and 100% of the sector's total sales. The exceptions are data for debt and net value of assets. Here, the willingness to provide data voluntarily differs distinctly. As in all former years, data for debt are calculated from the interest payment of the enterprises, taking market interest rates for enterprises. Then it is compared to the data from those enterprises that have provided data, to check if the amount is in an appropriate range and otherwise adapted to the values from the sample, as in the years before. Different company sizes are taken into account by a weighting factor, based on the sales volume.

Data from the German Federal Statistical Office (Destatis) on cost are available through the annual "Report on the cost structure of Processing Trade" which is released each June (year n) and which refers to year (n-2). Thus in 2020, data on 2018 have been collected. This is in accordance with the STECF 14-24 report suggesting the rules for procedures under the EU MAP.

10.3. Accessibility and Clarity

Are methodological documents publicly available? Yes

Are data stored in databases? Yes

Where can methodological and other documentation be found?

https://www.dcf-germany.de/index.php?id=187

https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Industrie-Verarbeitendes-Gewerbe/Publikationen/Downloads-Struktur/beschaeftigte-umsatz-investitionen-2040421197004.html

https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Industrie-Verarbeitendes-Gewerbe/Publikationen/Downloads-Struktur/kostenstruktur-2040430177004.html

https://www.destatis.de/DE/Methoden/Qualitaet/Qualitaetsberichte/Industrie-Verarbeitendes-Gewerbe/kostenstruktur-verarbeitendes-gewerbe.html

https://www.unternehmensregister.de/ureg/result.html;jsessionid=026F2ADDE15882DF80064ECD45D055E1.web02-1

Text Box 4A: Sampling plan description for biological data

General comment: This box fulfills Article 3, Article 4 paragraph (4) and Article 8 of the Decision (EU) 2016/1701 and forms the basis for the fulfilment of paragraph 2 point (a)(i) of Chapter III of the multiannual Union programme. This Table refers to data to be collected under Tables 1(A), 1(B) and 1(C) of the multiannual Union programme.

General comment: This box is applicable to the Annual Report. This box should provide information on the deviations from the planned sampling of Member States.

1. General remark

Germany is conducting two approaches for the North Sea / North Atlantic (Institute of Sea Fisheries, Bremerhaven) and the Baltic Sea region (Institute for Baltic Sea Fisheries, Rostock) to account for the nature of the fisheries in the different regions.

a) North Sea / North Atlantic regions:

Table 4C lists all fleet segments operating in the North Sea and North Atlantic regions with average landings >100t per year. Overall, approx. 220 vessels are operating in these regions, the majority belonging to the brown shrimp fleet. All other segments operating in the North Sea and North Atlantic consist of only a few vessels (on average 2 to 5 vessels). The same vessels can be listed in more than one segment. For instance, the same pelagic trawlers are targeting North Sea herring or blue whiting in ICES Div. 6b depending on the season.

The sampling frames for biological data are described in Table 4B. Vessels to sample are selected from a telephone list. However, the approach is an opportunistic randomised PSU selection and not fully probability-based due to the low number of vessels within one segment. The primary sampling unit is the vessel x trip, the secondary sampling unit is the haul, the tertiary sampling unit is the fish in the haul.

The only fleet segment with a greater number of vessels is the brown shrimp fishery, yet the target species is not assessed by ICES and there is no TAC. Some segments in the high-seas fisheries might consist only of one trip of a three-month duration by a huge vessel and high catch leading to a nearly exhaustive sampling of the segment.

Overall, the sampling frame is designed to fulfil the sampling obligations according to Table 1A and to understand the catch compositions of the important fisheries in these regions qualitatively and quantitatively as well as to enable and secure the data delivery to the assessment groups. Adaptations to the selected fisheries will be carried out after regional work plans and/or agreements have been established.

For the North Sea and North Atlantic, sampling is undertaken by at-sea-sampling only. This is because in the harbours of the German North Sea coast, there are hardly any auctions and direct fish sales. Landings are directly transferred from the vessel to different processing plants in Germany, but also to processing plants in foreign countries. Overall, 68%, 64% and 70% of the German landings occurred in foreign countries in 2013, 2014 and 2015, respectively. Therefore, it is virtually impossible to sample at harbours.

Sampling strata by regions:

1) North Sea and Eastern Arctic

Fishing ground: Eastern Arctic (ICES Sub-areas I and II)

Arctic 1 – (Factory trawlers)
Target species: Saithe and cod. Peak season: 1st and 3rd quarter. Area: Northeast Arctic waters. Duration of trips: 4 weeks to 3 months.

Arctic 2 - (Pelagic freezer trawlers)
Target species: Atlanto-Scandian herring. Peak season: August to November. Area: Norwegian Sea. Duration of trips: 3 to 4 weeks.

<u>Fishing ground: North Sea and Skagerrak (ICES Sub-area IV and Divisions IIIa and VIId)</u>

North Sea 1 – (Small beam trawlers)
Target species: Brown shrimp. Peak season: March to October with peaks in the 2nd and 3rd quarter. Area: German North Sea coastal waters. Duration of trips: 1 to 3 days.

North Sea 2 – (Pelagic freezer trawlers)
Target species: Herring, mackerel. Peak season: Restricted fishing season for mackerel in the North Sea – January/February and 4th quarter; Herring – 3rd quarter/December. Area: North Sea and English Channel. Duration of trips: 3 to 4 weeks.

North Sea 3 – (Otter trawlers, pair trawlers and seine trawlers)
Target species: Saithe, cod, haddock. Peak season: All year round. Area: Northern North Sea and Skagerrak. Duration of trips: 1 to 2 weeks.

North Sea 4 – (Beam trawlers)
Target species: Sole and plaice. Peak season: All year round. Area: Southern North Sea. Duration of trips: 4 to 6 days.

North Sea 5 – (Otter trawlers)
Target species: Flatfish. Peak season: All year round. Area: Central and southern North Sea. Duration of trips: 5 to 8 days.

2) North Atlantic and NAFO

<u>Fishing ground: NAFO areas</u>

North Atlantic 1 (Factory trawlers)
Target species: Greenland halibut and cod. Peak season: 3rd/4th quarter. Area: West Greenland (NAFO Div. 1D). Duration of trips: 6 weeks to 3 months.

<u>Fishing grounds: Western waters (ICES Sub-areas VI-VIII, mainly West of Scotland and West of Ireland)</u>

North Atlantic 2 (Pelagic freezer trawlers)
Target species: Mackerel, horse mackerel, blue whiting, herring. Peak season: March to June/October/November. Area: West British waters and Bay of Biscay. Duration of trips: 3 to 4 weeks.

<u>Fishing ground: Iceland, Greenland and Irminger Sea (ICES Sub-areas XII and XIV and Division Va)</u>

North Atlantic 3 (Factory trawlers)
Target species: Greenland halibut and cod. Peak season: 2nd/3rd quarter. Area: East Greenland (ICES Div. XIVb). Duration of trips: 4 weeks to 3 months.

North Atlantic 4 (Factory trawlers)
Target species: Redfish. Peak season: 2nd/3rd quarter. Area: Irminger/Labrador Sea (ICES Sub-areas XII and XIV, NAFO Sub-areas 1-2). Duration of trips: 4 weeks to 3 months.

b) Baltic Sea:

The German fisheries in the Baltic Sea are separated into three fleet segments: 1) Demersal fish, 2) Sprat, 3) Herring.

The demersal fleet is further subdivided into 1a) passive SD2224, 1b) active SD2224, 1c) active SD2532. Each year, a list of vessels is produced using the landings data from the previous year (e.g. the lists for 2018 are compiled 2017 with data from 2016). The lists are sorted by total landings per vessel. The fleet segment lists of 1a, 1b and 1c include all vessels that contributed ~60%, ~90 and ~90% of the total landings, respectively. The list of vessels is then randomised by assigning a random number to each vessel on a list. The sequence of the random number determines the sequence of contacting the vessel. There is only one list for the entire year. If all vessels from a list have been contacted before the year ended, the same list is used again. Sampling is conducted all year-round and the effort is distributed according to fishing seasons. Each phone call with fishers is documented since 2010. This forms the basis for our recordings of success/non-response/rejection/refusal rates. In addition, we record if the sample is random or based on expert knowledge. Expert knowledge partly is used to ensure efficient sampling coverage of periods/strata with very low landings, e.g. demersal species in quarter 3. Flounder, plaice and other flatfishes and fish species are sampled as part of the demersal sampling programme mainly targeting cod. However, if a vessel is selected, any fishing trip is sampled, except for trips targeting freshwater species, herring or sprat (see below).

An at-sea observer catch sampling programme (including concurrent sampling of landings, discards and unwanted by-catches) is conducted for the demersal fleet segments. In addition, a self-sampling programme with fishers is used to collect biological and catch data; unsorted commercial catch samples of usually 200-300 kg from the last or last but one haul are purchased. Diagnostics show that sampled trips are representative of the overall national population of vessels and their spatio-temporal dynamics. In addition, opportunistic sampling of landed discards (BMS cod under the landing obligation) may take place.

The primary sampling unit is the vessel x trip, the secondary sampling unit is the haul, the tertiary sampling unit is the fish in the haul.

The sprat catches mainly originate from two pelagic trawlers. Since 2013, we have a self-sampling programme where each vessel provides one frozen catch sample (5 kg) from each trip. This covers the ICES subdivisions 25-29. In addition, the minor sprat catches in SD22 and SD24 are sampled opportunistically upon expert knowledge and notification from the few fishers that are temporarily targeting sprat.

The fleet targeting herring is subdivided into 3a) passive SD2224, 3b) active SD24. For 3a, five major ports around the Greifswald Bay - the major fishing ground - are sampled using 50 kg unsorted catch samples from a vessel per port. Samples from the ports are taken from a known group of fishers, which are considered representative for the respective fleet given that similar mesh sizes are used. For 3b, a 50 kg unsorted catch sample is taken from an arbitrary (pair) trawler landing in the only German herring processing plant in Neu-Mukran, Rügen island. During the herring season (Nov-Apr), each week either 3a or 3b is sampled. The day of the week is selected according to wind and logistic considerations. In addition, to estimate the by-catches of cod (and other species) of the herring trawlers, the by-catch of 3b landed in Neu-Mukran is sampled once bi-weekly since 2014.

The assessment input data for small pelagics are prepared by quarter, gear (for herring: gillnet, trapnet, pelagic trawl; for sprat: pelagic trawl) and ICES Subdivision (for herring: 22 and 24; for sprat: 22, 24, 25-29). The landings are raised by the corresponding total length/age-length distributions of the commercial samples.

Deviation from the sampling plan according to Article 5 paragraph (3) of the Decision (EU) 2016/1701:

2. Deviations from the Work Plan

Baltic Sea:

The planned number of 30 PSU for “Baltic herring active 2224” given in the previous Work Plan was corrected to a realistic number of 10 PSU. A PSU of 30 must have been a wrong entry. A PSU of 30 is completely unrealistic because our national sampling scheme of the landings in the herring processing plant in Neu-Mukran usually does not exceed 14 samples in a year. The sampling scheme closely follows the fishery, which usually takes place between November and April. Given a bi-weekly sampling with 1 sample in a given week, we can expect 10-12 samples a year. Therefore, we changed the planned number of PSU to 10.

On July 22, 2019, the European Commission issued an immediate measure to protect the cod stock of the eastern Baltic Sea (EU 2019/1248). In 2020, Eastern Baltic cod could only be fished under a bycatch quota. This resulted in a massive decrease in fishing trips of German trawlers on Eastern Baltic cod in SD25.

In 2020, the strongly reduced quota for Western Baltic cod and the COVID-19 restrictions also affected the commercial fishery and the sampling effort. Fewer samples could be obtained in the active gear segments in all areas. This is mainly due to a reduced fishing effort, as trawlers require larger catch volumes to be profitable; this was impeded by small fishing opportunities and COVID-19-related marketing problems. In addition, many fishers referred to COVID-19 restrictions and rejected observers.

The reduced number of samples in the active fisheries was compensated by an increase of self-samples from the passive gear segment. The passive gear segment was less affected by the COVID-19 restrictions, as these vessels are profitable at lower catch volumes and can more easily adjust to smaller catch volumes, and are usually operated by one or two person. Though, observer trips were also very limited in this segment.

Regarding other deviations from the Work Plan, please refer to Text Box 1C.

North Sea and Eastern Arctic:

Arctic 1 – (Factory trawlers)
Target species: Saithe and cod. Peak season: 1st and 3rd quarter. Area: Northeast Arctic waters. Duration of trips: 4 weeks to 3 months. Sampling effort: 2 observer trips were planned but only 1 trip was carried out. In 2020, it was not possible to place an observer onboard a fishing trip within the 3rd quarter due to restrictions caused by the COVID-19 pandemic.

North Sea 1 – (Small beam trawlers)
Target species: Brown shrimp. Peak season: March to October with peaks in the 2nd and 3rd quarter. Area: German North Sea coastal waters. Duration of trips: 1 to 3 days. Sampling effort: 8 observer trips were planned but only 6 trips were carried out. Due to the COVID-19 pandemic, the placement of observers in the 3rd and 4ht quarter was restricted and not all trips could be carried out. However, self-sampling within the EMFF pilot project “Estimating the catch composition in the brown shrimp fisheries as required for the exemption from the landing obligation” (see Annex 2) supplied additional 81 samples from fishing trips.

North Sea 2 – (Pelagic freezer trawlers)
Target species: Herring, mackerel. Peak season: Restricted fishing season for mackerel in the North Sea – January/February and 4th quarter; Herring – 3rd quarter/December. Area: North Sea and English Channel. Duration of trips: 3 to 4 weeks. Sampling effort: 2 observer trips were planned and 2 trips were carried out. In addition, 1 trip was self-sampled.

North Sea 3 – (Otter trawlers, pair trawlers and seine trawlers)
Target species: Gadoids, mainly saithe, in ICES areas 4 and 3a. Peak season: All year around. Area: Northern North Sea. Duration of trips: 7 to 10 days. Sampling effort: 6 observer trips were planned, only 5 trips could be carried out. In the 4th quarter it was not possible to place an observer on a vessel due to restrictions caused by the COVID-19 pandemic. However, for this quarter saithe samples were purchased from the fishery to obtain samples for length and age measurements.

North Sea 4 – (Beam trawlers)
TBB Target species: Flatfish. Peak season: All year round. Area: Central and southern North Sea. Duration of trips: 5 to 8 days. Sampling effort: 4 observer trips were planned, only 3 trips could be carried out. The missing trip occurred due to difficulties placing observers on vessels caused by the COVID-19 pandemic.

North Sea 5 – (Otter trawlers)
OTB Target species: Flatfish. Peak season: All year round. Area: Central and southern North Sea. Duration of trips: 5 to 8 days. Sampling effort: 2 observer trips were planned, only 1 trip could be carried out. The missing trip occurred due to difficulties placing observers on vessels caused by the COVID-19 pandemic.

North Atlantic and NAFO areas

North Atlantic 1 (Factory trawlers)
Target species: Greenland halibut and cod. Peak season: 3rd/4th quarter. Area: West Greenland (NAFO Div. 1D). Duration of trips: 6 weeks to 3 months. 1 trip planned - 1 trip sampled.

North Atlantic 2 (Pelagic freezer trawlers)
Target species: Mackerel, horse mackerel, blue whiting, herring. Peak season: March to June/October/November. Area: West British waters and Bay of Biscay. Duration of trips: 3 to 4 weeks. 3 trips planned - only 2 trips sampled by self-sampling due to COVID-19 pandemic restrictions.

North Atlantic 3 (Factory trawlers)
Target species: Greenland halibut and cod. Peak season: 2nd/3rd quarter. Area: East Greenland (ICES Div. XIVb). Duration of trips: 4 weeks to 3 months. 2 trips planned - 1 trip sampled; The sampled trip in the 4th quarter took place exclusively in NAFO Division 1D. Sampling in ICES Division XIVb during the same trip was not possible. It was not possible to sample another trip due to the restrictions of the COVID-19 pandemic.

North Atlantic 4 (Factory trawlers)
Target species: Redfish. Peak season: 2nd/3rd quarter. Area: Irminger/Labrador Sea (ICES Sub-areas XII and XIV, NAFO Sub-areas 1-2). Duration of trips: 4 weeks to 3 months. 1 trip planned - 1 trip sampled.

3. Action to avoid deviations

In 2020 most of the deviations were caused by restrictions for placing observers onboard of fishing vessels due to the COVID-19 pandemic.
However, in general based on the list of fishing vessels supplied by the Federal Agency for Agriculture and Food (BLE), Germany is always aiming at reaching a wide participation of vessels in the observer programme and including vessels which have not been sampled by observers before. Although this is partially successful, there are always vessel owners, of smaller vessels in particular, who are not willing to allow observers onboard. In the high-seas fisheries, there are only a few vessels and the fishing trips have a duration of up to 3 months. Here, it is often logistically difficult to place an observer out of the available pool on board, simply because of holidays, sickness etc. Based on the present situation, random sampling of the fleet is not fully implemented. This leads somewhat to an opportunistic sampling strategy, taking sampling opportunities when they occur, irrespective if they are planned or not. Other deviations occurred because of short-notice changes in the fishing behaviour. When more or other than the planned trips were carried out, opportunities for samplings were taken which arose due to contacts with the fishing industry.

Although article 12(2) of Reg. 2017/1004 stipulates that *"the masters of Union vessels shall accept on board scientific observers and cooperate with them"* and the Federal fisheries research institutes hold a co-operation agreement with the German Fisheries Association, this situation remains to be difficult for some metiers.

Germany, however, was participating in the MARE/2014/19 project "Strengthening regional cooperation in the area of fisheries data collection" (FishPi), where regional statistically sound sampling schemes were tested. We were also involved in the FishPi2 project, which develops practical recommendations for regional sampling plans.

In 2019, the German catch sampling schemes were evaluated externally. The results suggest that the current sampling efforts, given the constraints already explained above, cannot be improved to a large extent. One of the recommendations is to focus on regional coordination and adaptation towards sampling the main fisheries more intensely and release sampling effort by task-sharing with other countries.

Regarding other deviations from the Work Plan, please refer to Text Box 1C.

Text Box 5A: Quality assurance framework for biological data

General comment: This box is applicable to the Annual Report. This box fulfills Article 5 paragraph (2) point (a) of the Decision (EU) 2016/1701. This box is intended to specify data to be collected under Tables 1(A), 1(B) and 1(C) of the multiannual Union programme. Use this box to provide additional information on Table 5A.
1. Evidence of data quality assurance NA 2. Sampling design NA 3. Sampling implementation NA 4. Data capture NA 5. Data Storage NA 6. Data processing Presently, we do not evaluate bias and precision of our data, since we are not aware of routine tools available for such estimates on a national level. However, data accuracy evaluation processes (bias and precision) are currently undergoing internal reviews, as the database holding the commercial sampling data is being updated and processes and routines are improved. Documentation will be given together with the new version of the database.

Text Box 5B: Quality assurance framework for socioeconomic data

General comment: This box fulfills Article 5 paragraph (2) point (b) of the Decision (EU) 2016/1701. This box is intended to specify data to be collected under Tables 5(A), 6 and 7 of the multiannual Union programme. Use this box to provide additional information on Table 5B.

Within this section MS shall provide information on the methodology used to assure the quality of the data collected, highlighting those aspects where changes have been made during the sampling year. Information shall be provided by each sector (Fishing fleet, Aquaculture, Fish processing) for which data was collected and by each data collection scheme. In the case where the same quality assurance framework is applied to all sectors or/and all data collection schemes, information can be provided at general level with the indication "all sectors" or "all data collection schemes".

In those sections of Table 5B where "N" is indicated, Member States shall explain the main constrains and/ or the steps taken to fulfil this obligation. In the cases where a reference documents is requested, Member States shall provide a web link.

In cases where documents are not publicly available, due to institutions internal policy, confidentiality or other reasons, this shall be indicated by the Member State.

1. Evidence of data quality assurance

NA

2. Section P3 Impartiality and objectiveness

Explain main constraints and/ or steps taken, if 'N' (no) was indicated in Table 5B

NA

3. Section P4 Confidentiality

Explain main constraints and/ or steps taken, if 'N' (no) was indicated in Table 5B

In case of data collection through questionnaires no other DCF partner is involved, i.e. the issue is not applicable. The same applies to external users. There are no constraints as consequence.

4. Section P5 Sound methodology

Explain main constraints and/ or steps taken, if 'N' (no) was indicated in Table 5B

Information on this principle should be briefly explained in Text boxes 3A, 3B and 3C. Description of methodologies used on data quality.

Sound methodology is now documented for the pilot study, in cooperation with the project SECFISH, and will be available with the project documentation.

5. Section P6 Appropriate statistical procedures

Explain main constraints and/ or steps taken, if 'N' (no) was indicated in Table 5B. Please provide a link if the documented revisions are available and not confidential.

NA

6. Section P7 Non-excessive burden on respondents

Explain main constraints and/ or steps taken, if 'N' (no) was indicated in Table 5B

NA

7. Section P8 Cost effectiveness

Explain main constraints and/ or steps taken, if ‘N’ (no) was indicated in Table 5B

NA

8. Section P9 Relevance

Explain main constraints and/ or steps taken, if ‘N’ (no) was indicated in Table 5B

The survey by questionnaire is aimed to fulfil EU MAP requirements in combination with the other “data collection schemes”. There are no specific end users of the survey by questionnaire other than the end users of EU MAP data. Therefore there are no constraints as consequence.

9. Section P10 Accuracy and reliability

Explain main constraints and/ or steps taken, if ‘N’ (no) was indicated in Table 5B. Information on this principle should be briefly explained in Text boxes 3A, 3B and 3C. Description of methodologies used on data quality.

NA

10. Section P11 Timeliness and punctuality

Explain main constraints and/ or steps taken, if ‘N’ (no) was indicated in Table 5B

For the pilot study information on timeliness and punctuality will be available as the pilot study is completed and the subsequent survey put in place

11. Section P12 coherence and comparability

Explain main constraints and/ or steps taken, if ‘N’ (no) was indicated in Table 5B

The internal coherence and time comparability of information on the origin of raw material have been further developed through a national project on the origin and dependence on biological raw materials.

12. Section P13 Accessibility and Clarity

Explain main constraints and/ or steps taken, if ‘N’ (no) was indicated in Table 5B. Information and links to documentation on this principle should be briefly explained in Text boxes 3A, 3B and 3C. Description of methodologies used on data quality.

NA

Annexes

- separate documents -

(Annex 1 - cruise reports of non-mandatory surveys)

(Annex 2 - Summaries of EMFF pilot studies)

Annex 1 to the German Annual Report for data collection in the fisheries and aquaculture sectors 2020:

Cruise reports of non-mandatory surveys

BaltBox

CoBalt

GSBTS

GAS EEZ

Institute of Baltic Sea Fisheries (TI-OF)

Alter Hafen Süd 2, 18069 Rostock Fon +49 381 66099-124 Fax +49 381 66099-199 Date 14.12.2020 E-Mail: daniel.oesterwind@thuenen.de

Cruise Report
FRV „Solea" Cruise 777
22.05. - 04.06.2020

Study on changes in benthic and demersal fish communities after exclusion of mobile bottom-contacting fishing gear in marine protected areas of the German Baltic Sea
&
Long-term survey on demersal fish communities in the German Baltic Sea

Cruise leader: Dr. Daniel Oesterwind & Michael Kriegl (Thünen-OF)

1. Background

a) The pilot mission "Protected Areas Baltic Sea: Effects of the exclusion of mobile bottom contacting fisheries in marine protected areas" funded by the German Marine Research Alliance (DAM) aims to assess changes in the benthic and demersal fish fauna in two contrasting Natura 2000 sites after the exclusion of mobile bottom-contacting fishing gear. This cruise served the purpose of assessing the current status (i.e. before the planned exclusion is implemented) of local fish communities in the marine protected areas Fehmarnbelt and Odra Bank.

Objectives:

- Assessing the fish fauna in the two study sites Fehmarnbelt and Odra Bank using beam trawls
- Collecting specimens for further analysis in the laboratory
- Conducting oceanographic measurements at the study sites (temperature, salinity and oxygen) to interlink fish occurrence with abiotic conditions
- Collecting video material of benthic habitats

b) Since 2003, the Thünen Institute of Baltic Sea Fisheries (OF) has been conducting surveys to assess long-term changes in the distribution and composition of the demersal fish fauna in fixed ecologically characteristic reference areas of the German Baltic Sea EEZ. These surveys are vitally important for e.g. marine spatial planning, the implementation of nature conservation measures and the sustainable management of fish stocks in this area. This cruise aimed at continuing these long-term investigations.

Distribution list:

Ship management FFS „SOLEA"
BA für Landwirtschaft und Ernährung (BLE) Fischereiforschung
BM für Ernährung und Landwirtschaft (BMEL), Ref. 614
BA für Seeschifffahrt und Hydrographie (BSH), Hamburg
Deutscher Angelfischerverband e.V.
Deutsche Fischfang-Union, Cuxhaven
Deutscher Fischereiverband Hamburg
Doggerbank Seefischerei GmbH, Bremerhaven
Erzeugergemeinschaft der Deutschen Krabbenfischer GmbH
Euro-Baltic Mukran
GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel
Kutter- und Küstenfisch Sassnitz
LA für Landwirtschaft, Lebensmittels. und Fischerei (LALLF)
LFA für Landwirtschaft und Fischerei MV (LFA)
Landesverband der Kutter- u. Küstenfischer MV e.V.
Leibniz-Institut für Ostseeforschung Warnemünde
Thünen-Institute - Institute of Fisheries Ecology
Thünen-Institute - Institute of Sea Fisheries
Thünen-Institute – Institute of Baltic Sea Fisheries
Thünen-Institute – Press office, Dr. Welling
Thünen-Institute – Presidential office
Thünen-Institute – Scheduling research vessels, Dr. Rohlf
Participants

Objectives:

- Assessing the demersal fish fauna in the ecologically distinct regions Kiel Bight, Odra Bank and Arkona Basin using bottom trawls
- Conducting oceanographic measurements (temperature, salinity and oxygen) to interlink fish occurrence with abiotic conditions

2. Cruise track

The cruise started on Friday, May 22nd 2020 in Rostock Marienehe and was separated into two legs:

During the first leg, fishing was conducted in Kiel Bight: From May 23rd until May 27th, a total of 10 hauls using the TV3-520 bottom trawl were performed throughout the bight (cf. Fig. 1), with each haul being preceded by a CTD cast. Furthermore, 4 hauls using the 2m beam trawl and 4 hauls using the 3m beam trawl were performed on May 23rd, within the marine protected area Fehmarnbelt (Natura 2000 site), in an area that is planned to be closed for mobile bottom-contacting fishing ("exclusion site") in the future. On May 26th, 4 hauls using the 3m beam trawl as well as 2 hauls using the 2m beam trawl were performed within a corresponding reference site outside the Natura 2000 site (Fig. 1D). Due to a net rupture, two further hauls using the 2m beam trawl within the reference site could not be realized. Within each site, 4 CTD casts were performed on the day of sampling (cf. Table 1).

While steaming towards Warnemünde on May 27th, another haul using the 3m beam trawl, preceded by a CTD cast, was performed on request of researchers from the University of Rostock in order to retrieve live *Arctica islandica* samples. After the successful completion of the first leg, cruise leader Dr. Daniel Oesterwind stepped off in Warnemünde and Michael Kriegl took over as the cruise leader for the second leg.

During the second leg, fishing was conducted in two areas to the east of the island Rügen, namely Arkona Basin as well as Odra Bank: On May 28th, 6 hauls using the 3m beam trawl and 7 hauls using the 2m beam trawl were performed within the planned future exclusion site at Odra Bank (cf. Table 1). On May 29th, 6 hauls using the 3m beam trawl and 6 hauls using the 2m beam trawl were conducted in the corresponding reference site (Fig. 1E). At each site, 4 CTD casts were performed. Additionally, 10 hauls using the 2m beam trawl and 3 hauls with the 3m beam trawl were performed within the wider area of the Odra Bank.

On May 30th, June 2nd and June 3rd, a total of 9 TV3-520 bottom trawls were conducted within the Odra Bank region, each preceded by a CTD cast. From May 31st to June 1st, FRV Solea operated within the Arkona Basin, where a total of 8 hauls using the TV3-520 bottom trawls were performed (cf. Fig. 1), each preceded by a CTD cast.

At specific locations within the Fehmarnbelt as well as the Odra Bank region, water samples were collected and prepared for subsequent isotope analysis in the laboratory. In addition, Van Veen grabs were used within the Odra Bank and Fehmarn region in order to retrieve characteristic samples of benthic organisms for isotope analysis. In order to collect visual material of the studied benthic habitats, a camera sledge equipped with a GoPro and lighting system was towed at Fehmarnbelt and Odra Bank, both within the future exclusion sites as well as the adjacent reference sites, for a cumulative duration of at least 30 minutes at each site.

In total, 27 hauls using the TV3-520 bottom trawl, 29 hauls using the 2m-beam trawl and 24 hauls using the 3m-beam trawl were performed as well as 50 CTD profiles recorded (cf. Tab. 4 for exact locations, date and time of gear deployment). Weather conditions were good throughout the whole cruise, which allowed fishing and related activities to be performed as planned.

The fish caught with the TV3-520 bottom trawl were identified to species level, weighed and processed according to BITS standard. The fish caught with the beam trawl were identified to the lowest possible taxonomic level, counted, weighed (in bulk for each species) and frozen for subsequent analysis in the laboratory.

The cruise ended on Thursday, June 4th in Rostock Marienehe.

Table 1 Overview of the number of realized beam trawl hauls and CTD casts within the Natura 2000 sites Fehmarnbelt and Odra Bank, separated for management regimes (“Exclusion” = study site planned to be closed for mobile bottom-contacting fishing gear, “Reference” = nearby reference area of the same habitat type).

Gear	Fehmarnbelt		Odra Bank	
	Exclusion	**Reference**	**Exclusion**	**Reference**
3m beam trawl	4	4	6	6
2m beam trawl	4	2	7	6
CTD casts	4	4	4	4

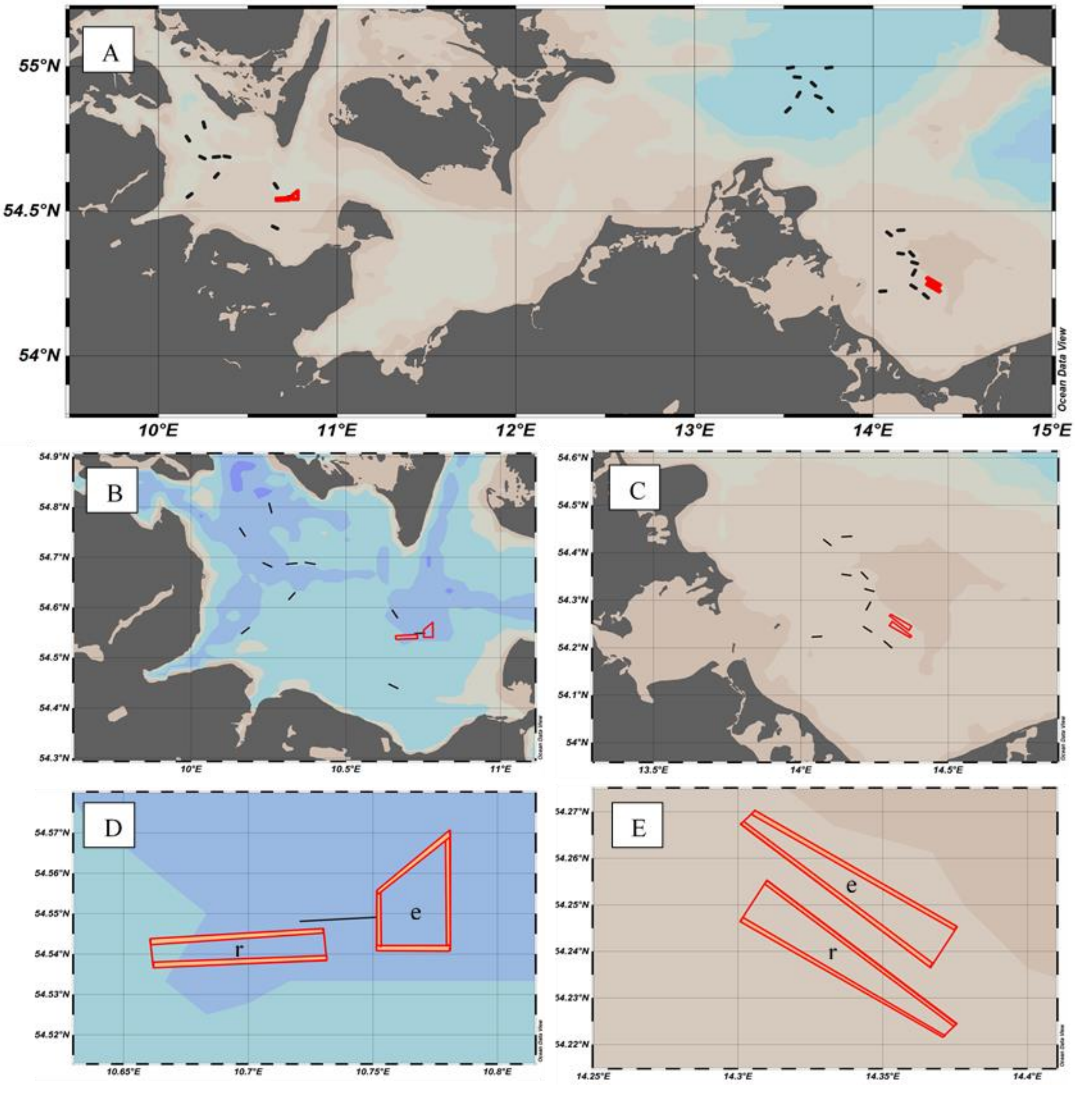


Figure 1 Maps illustrating the fishing stations realized during cruise SB777. An overview map of the German Baltic Sea (A) as well as a close-up of Kiel bight (B) and Odra Bank (C) are shown, with realized TV3-520 bottom trawl hauls indicated by black lines. Studied exclusion sites (“e”) and corresponding reference sites (“r”) are indicated by red polygons. Close-up views on these sites in the areas Fehmarnbelt (D) and Odra Bank (E) show areas sampled with the beam trawls highlighted in orange.

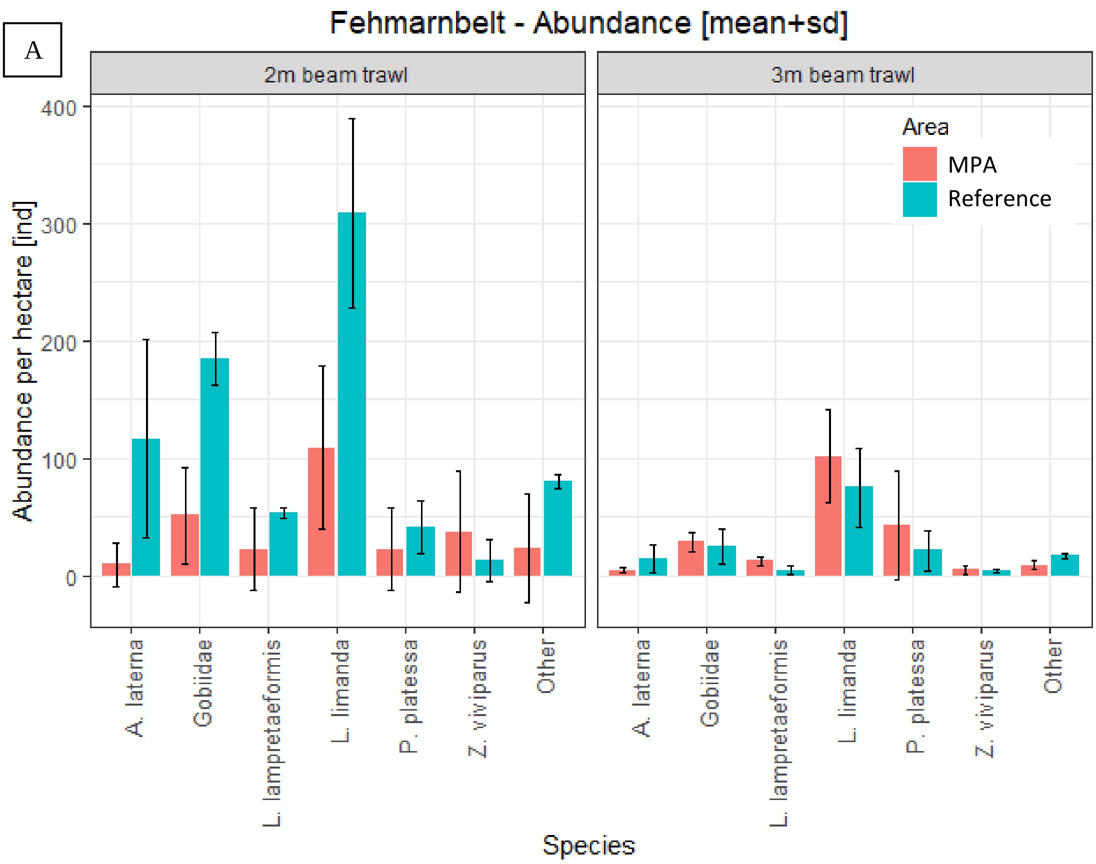
3. Preliminary results

a) Study on changes in benthic and demersal fish communities after exclusion of mobile bottom-contacting fishing gear in marine protected areas of the Baltic Sea

During the study on benthic and demersal fish communities occurring within the marine protected areas of the German Baltic Sea, a total of 1604 individuals, belonging to 19 species and weighing a total of 42.1 kg were caught with the two different beam trawls.

The fish composition in Fehmarnbelt consisted mainly of dab (*Limanda limanda),* plaice *(Pleuronectes platessa),* and Gobiidae, while the fish composition of Odra Bank was mainly made up of Gobiidae, flounder (*Platichthys flesus)* and plaice *(Pleuronectes platessa).* For the dominant fish species of the two areas, the mean and standard deviation of A) fish abundances per hectare and B) biomass (in kg) per hectare are presented in Figure 2 for Fehmarnbelt and Figure 3 for Odra Bank. For each area, the absolute abundances and biomass per species per management are presented in Table 2.

With a total of 17 species, the Fehmarnbelt region exhibits a higher species richness compared to the Odra Bank region, where only 5 species were found.



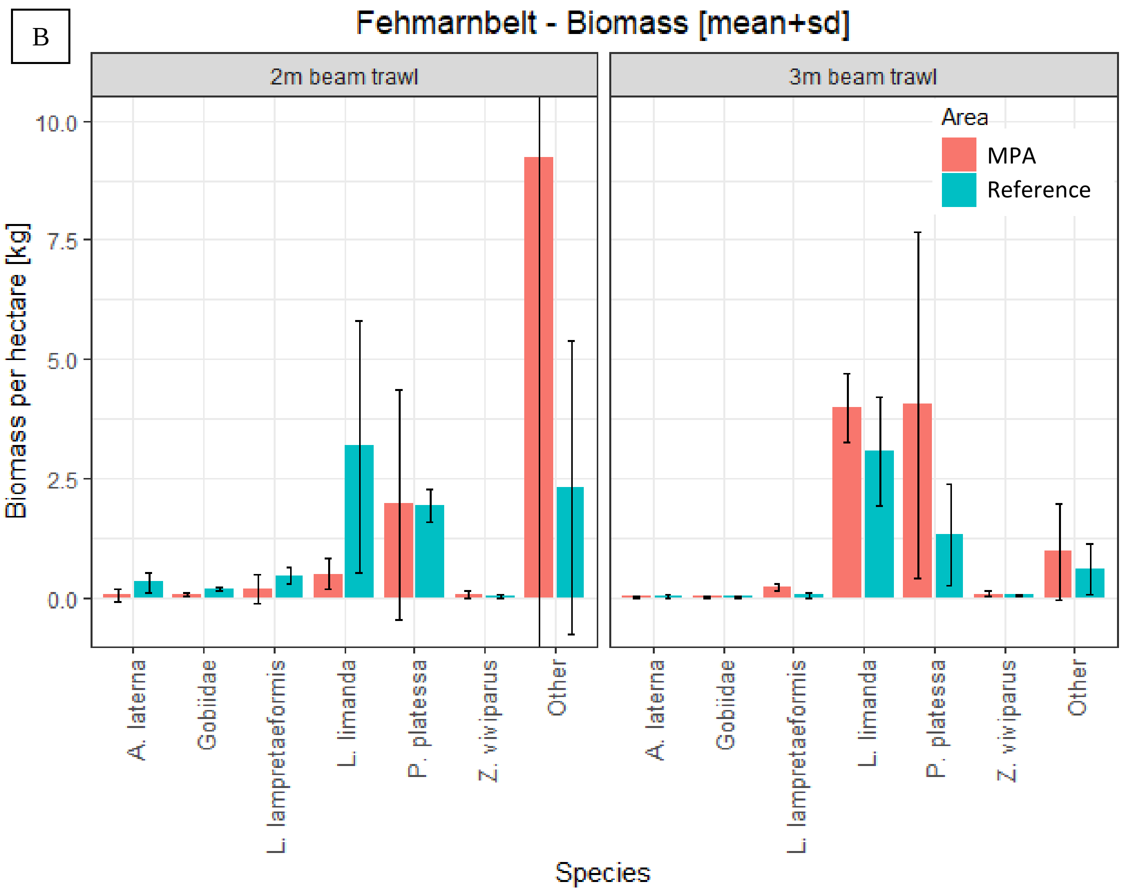


Figure 2 Mean and standard deviation of fish abundances per hectare (A) and biomass per hectare (B) for the dominant fish species of the area Fehmarnbelt, separated for employed fishing gear and management regime (MPA (red) = future exclusion site, Reference (blue) = corresponding reference site)

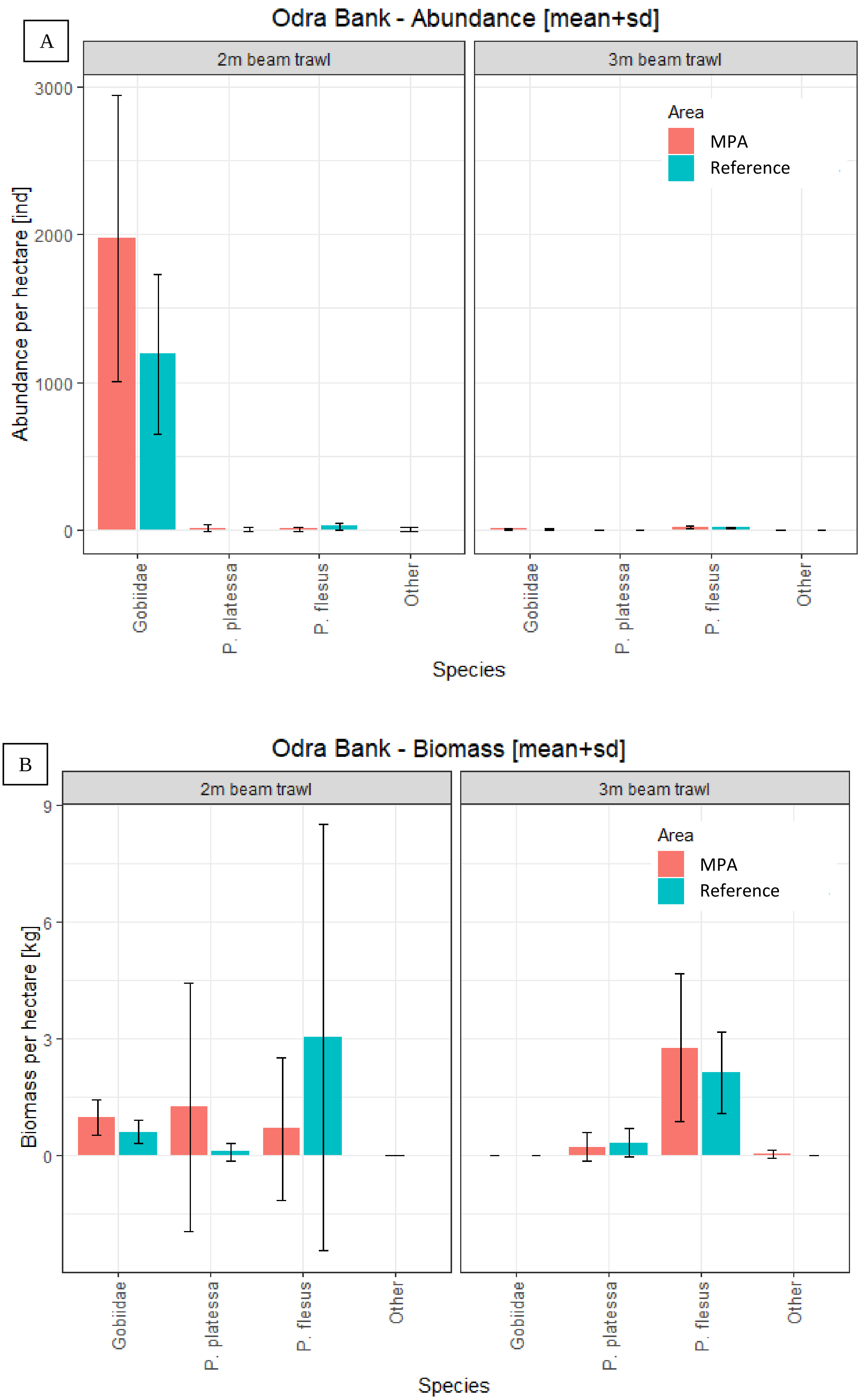


Figure 3 Mean and standard deviation of fish abundances per hectare (A) and biomass per hectare (B) for the dominant fish species of the area Odra Bank, separated for employed fishing gear and management regime (MPA (red) = future exclusion site, Reference (blue) = corresponding reference site)

Table 2 Fish species caught during the cruise SB777 in the areas Fehmarnbelt and Odra Bank using 2m and 3m beam trawls. Absolute abundances (total number of individuals caught) and absolute biomass (total weight of individuals caught) are indicated per fish species, separated for management regime (Exclusion = study site planned to be closed for mobile bottom-contacting fishing gear, Reference = nearby reference area of the same habitat type).

	Fehmarnbelt				**Odra Bank**				**Sum**	
Species	**Exclusion**		**Reference**		**Exclusion**		**Reference**			
	Abundance [ind]	**Biomass [g]**	**Abundance [ind]**	**Biomass [g]**	**Abundance [ind]**	**Biomass [g]**	**Abundance [ind]**	**Biomass [g]**	**Abundance [ind]**	**Biomass [g]**
Zoarces viviparus	12	155	7	98	0	0	0	0	19	253
Pholis gunnellus	0	0	2	9	0	0	0	0	2	9
Gadus morhua	0	0	13	17	0	0	0	0	13	17
Platichthys flesus	2	822	0	0	45	7423	50	6065	97	14310
Gobiidae undet.	53	61	55	58	547	272	251	129	906	520
Limanda limanda	182	6753	149	5406	0	0	0	0	331	12159
Ctenolabrus rupestris	2	8	4	25	0	0	0	0	6	33
Arnoglossus laterna	8	51	33	91	0	0	0	0	41	142
Pleuronectes platessa	74	7093	39	2398	6	872	6	879	125	11242
Taurulus bubalis	1	96	0	0	0	0	0	0	1	96
Syngnathidae undet.	0	0	0	0	0	0	1	1	1	1
Myoxocephalus scorpius	0	0	0	0	1	109	0	0	1	109
Solea solea	2	1204	6	772	0	0	0	0	8	1976
Lumpenus lampretaeformis	23	401	11	130	0	0	0	0	34	531
Sprattus sprattus	0	0	1	13	0	0	0	0	1	13
Agonus cataphractus	1	18	3	27	0	0	0	0	4	45
Enchelyopus cimbrius	1	8	1	2	0	0	0	0	2	10
Merlangius merlangus	7	300	4	349	0	0	0	0	11	649
Trisopterus minutus	1	10	0	0	0	0	0	0	1	10
Sum	**369**	**16980**	**328**	**9393**	**599**	**8676**	**308**	**7074**	**1604**	**42123**

Long-term survey on demersal fish communities in the German Baltic Sea

During this year's survey on demersal fish communities in the German Baltic Sea, 53 586 individuals belonging to 27 species and weighing a total of 4 140.5 kg (~4.1 tons) were caught with the TV3-520 bottom trawl. The fish composition consisted mainly of the flatfishes*: L. limanda, P. flesus and P. platessa*, the Gadoids: *G. morhua and M. merlangus*, and the clupeids: *S. sprattus and C. harengus*. Overall, dab (*L. limanda*) was the most abundant demersal species in the catch (Tab. 3). For the following assessment of the demersal fish fauna, the pelagic species herring and sprat were not considered.

Largest biomasses in the catch, relative to towed distance, occurred in the Arkona Basin (114.1 kg/nm), followed by the Kiel bight (109.8 kg/nm) and Odra Bank (41.6 kg/nm). The weight and number per towed distance of the main fish species caught are presented in table 3.

In 2020, cod biomass in the Arkona Basin amounted to 72.75 kg/nm. Compared to previous years, this value falls within the lower range of assessed cod biomass in this area (2018: 64.36 kg/nm; 2016: 225.9 kg/nm; 2015: 154.6 kg/nm; 2014: 127.9 kg/nm; 2013: 101.5 kg/nm; 2012: 76 kg/nm). Cod constituted 63.7% of catches in the Arkona Basin.

During this year's survey, 97.8% of the cod catches (according to biomass) occurred in SD24 (Arkona Basin and Odra Bank).

Preliminary results show highest fish abundances in the Kiel Bight (1137 individuals/nm), followed by Arkona Basin (503 individuals/nm) and Odra Bank (235 individuals/nm). The high fish abundances in Kiel bight are mainly driven by large quantities of dab (897individuals/nm) and - to a lesser extent - plaice (130 ind/nm) in the catch. The catch in Arkona bay is dominated by cod (240 ind/nm), followed by whiting (90 ind/nm) and flounder (86 ind/nm), while flounder (176 ind/nm) is dominating the catch in Odra bank.

Overall, dab constituted the largest biomass of demersal fish species (35.1%), followed by cod (26.9%), flounder (19.1%) and plaice (13.1%), while whiting contributed 4.8% of the total biomass. The residual 20 species accounted for the remaining 1% of the total biomass. The highest number of species was found at Kiel Bight (22 fish species), followed by Odra Bank (11 fish species) and Arkona Basin (8 species).

For the purpose of age determination, a total of 300 otoliths in SD 22 and 570 otoliths in SD 24 were sampled from cod (*Gadus morhua*), dab (*Limanda limanda*), flounder (*Platichthys flesus*), plaice (*Pleuronectes platessa*), turbot (*Scophthalmus maximus*) and brill (*Scophthalmus rhombus*).

Table 3 Main fish species caught during the long-term survey on demersal fish communities in the German Baltic Sea during this year's cruise SB777 in the areas Kiel Bight, Arkona Basin and Odra Bank using a TV3-520 bottom trawl.

	Kiel Bight				**Arkona Basin**				**Odra Bank**				**Sum**	
	10 hauls | towed distance: 15.45 nm				**8 hauls | towed distance: 12.75 nm**				**8 hauls | towed distance: 12.70 nm**					
Species	**Biomass**		**Abundance**		**Biomass**		**Abundance**		**Biomass**		**Abundance**		**Biomass**	**Abundance**
	kg	**kg/nm**	**n**	**n/nm**	**kg**	**kg/nm**	**n**	**n/nm**	**kg**	**kg/nm**	**n**	**n/nm**	**kg**	**n**
Gadus morhua	20,8	1,3	165	10,7	927,5	72,7	3056	239,7	39,4	3,1	64	5,0	987,8	3285
Merlangius merlangus	28,9	1,9	706	45,7	148,5	11,6	1153	90,4	0,1	0,0	1	0,1	177,5	1860
Limanda limanda	1265,4	81,9	13864	897,3	26,1	2,1	211	16,5	0,3	0,0	15	1,2	1291,8	14090
Platichthys flesus	114,4	7,4	342	22,1	204,4	16,0	1100	86,3	384,6	30,3	2230	175,6	703,4	3672
Pleuronectes platessa	239,9	15,5	2012	130,2	148,4	11,6	885	69,4	92,2	7,3	540	42,5	480,5	3437
Sprattus sprattus	368,7	23,9	22471	1454,4	2,5	0,2	200	15,7	40,5	3,2	2605	205,1	411,8	25276
Clupea harengus	44,0	2,9	1219	78,9	2,5	0,2	64	5,0	3,3	0,3	68	5,4	49,9	1351
Others	26,3	1,7	477	30,9	0,2	<0,1	3	0,2	11,2	0,9	135	10,6	37,8	615
Sum	**2108,6**		**41256**		**1460,2**		**6672**		**571,7**		**5658**		**4140,5**	**53586**
Sum (excl. clupeids)	**1695,8**		**17566**		**1455,2**		**6408**		**527,8**		**2985**		**3678,8**	**26959**

Oceanographic Data

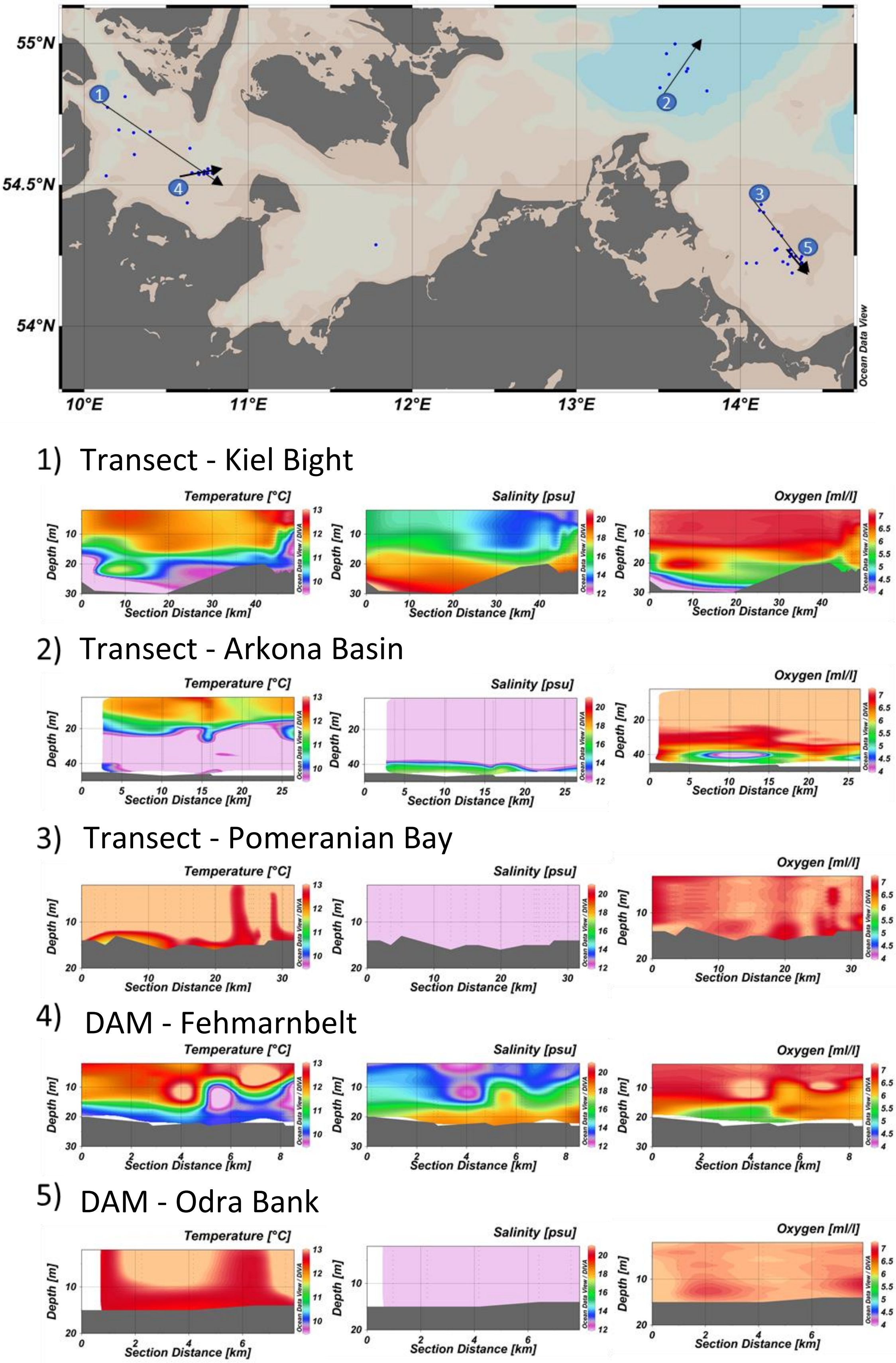


Figure 4 Overview of performed CTD casts during SB777 with gridded temperature, salinity and oxygen profiles for the different study areas.

Kiel Bight: CTD data illustrates an expected oceanographic situation, with salinity (13 -20 psu) increasing with depth, and temperature (10 – 13°C) as well as oxygen content decreasing with depth.

Arkona Basin: A well-mixed water layer with temperatures around 12°C [± 1°] was found in surface waters reaching up to the thermocline in 20m water depth. Water temperatures below the thermocline ranged between 9-10°C. The halocline was found to be in a depth of 40m.

Pomeranian Bay: The water column at Odra Bank was, in general, well-mixed with temperatures ranging around 12°C and salinity values of ~13 psu. However, comparatively higher temperatures observed along the Odra Bank indicated a warm water current flowing along this morphological structure.

4. Cruise participants

Dr. Daniel Oesterwind	scientist	Thünen-OF
Michael Kriegl	scientist	Thünen-OF
Thomas Hogh	technician	Thünen-OF
Tom Jankiewicz	technician	Thünen-OF
Dr. Martin Paar	scientist	University of Rostock

Dr. Daniel Oesterwind (TI-OF)
(Scientist in charge, 1st leg)

Michael Kriegl, M.Sc. (TI-OF)
(Scientist in charge, 2nd leg)

Station list

Table 4 Overview of the performed activities during FRV Solea cruise 777, including station number, date and time (UTC) of deployment, area of deployment, device identifier (OTB = otter bottom trawl, TBB = beam trawl, CTD = oceanographic probe) as well as latitude and longitude at the time of first bottom contact for beam trawls, otter bottom trawls, video sledge and Van Veen grabs as well as at the start of gear deployment for CTD casts.

Station	Date & Time (UTC)	Area	Device Code	Latitude	Longitude
SOL777_1-1	23.05.2020 05:40	Kiel Bight	CTD SBE19+	54° 32.914' N	010° 43.940' E
SOL777_1-2	23.05.2020 05:56	Kiel Bight	OTB TV3-520	54° 32.848' N	010° 44.112' E
SOL777_2-1	23.05.2020 07:30	Fehmarnbelt	CTD SBE19+	54° 33.398' N	010° 45.210' E
SOL777_2-2	23.05.2020 07:50	Fehmarnbelt	TBB 3m	54° 33.531' N	010° 45.476' E
SOL777_3-1	23.05.2020 09:00	Fehmarnbelt	CTD SBE19+	54° 32.849' N	010° 46.852' E
SOL777_3-2	23.05.2020 09:12	Fehmarnbelt	TBB 3m	54° 33.062' N	010° 46.809' E
SOL777_4-1	23.05.2020 10:14	Fehmarnbelt	CTD SBE19+	54° 32.446' N	010° 46.866' E
SOL777_4-2	23.05.2020 10:28	Fehmarnbelt	TBB 3m	54° 32.458' N	010° 46.719' E
SOL777_5-1	23.05.2020 11:27	Fehmarnbelt	CTD SBE19+	54° 32.446' N	010° 45.043' E
SOL777_5-2	23.05.2020 11:36	Fehmarnbelt	TBB 3m	54° 32.579' N	010° 45.074' E
SOL777_6-1	23.05.2020 12:50	Fehmarnbelt	TBB 2m	54° 33.464' N	010° 45.384' E
SOL777_7-1	23.05.2020 14:02	Fehmarnbelt	TBB 2m	54° 33.484' N	010° 46.815' E
SOL777_8-1	23.05.2020 14:33	Fehmarnbelt	TBB 2m	54° 32.478' N	010° 46.536' E
SOL777_9-1	23.05.2020 15:00	Fehmarnbelt	CTD SBE19+	54° 32.435' N	010° 45.159' E
SOL777_9-2	23.05.2020 15:13	Fehmarnbelt	TBB 2m	54° 32.648' N	010° 45.115' E
SOL777_10-1	24.05.2020 05:29	Kiel Bight	CTD SBE19+	54° 48.724' N	010° 14.975' E
SOL777_10-2	24.05.2020 05:44	Kiel Bight	OTB TV3-520	54° 48.334' N	010° 15.185' E
SOL777_11-1	24.05.2020 07:42	Kiel Bight	CTD SBE19+	54° 46.424' N	010° 08.563' E
SOL777_11-2	24.05.2020 07:55	Kiel Bight	OTB TV3-520	54° 45.979' N	010° 08.972' E
SOL777_12-1	24.05.2020 09:56	Kiel Bight	CTD SBE19+	54° 41.671' N	010° 12.709' E
SOL777_12-2	24.05.2020 10:12	Kiel Bight	OTB TV3-520	54° 41.479' N	010° 13.207' E
SOL777_13-1	24.05.2020 12:25	Kiel Bight	CTD SBE19+	54° 41.086' N	010° 18.065' E
SOL777_13-2	24.05.2020 12:40	Kiel Bight	OTB TV3-520	54° 41.183' N	010° 18.827' E
SOL777_14-1	25.05.2020 05:27	Kiel Bight	CTD SBE19+	54° 31.923' N	010° 08.025' E
SOL777_14-2	25.05.2020 05:42	Kiel Bight	OTB TV3-520	54° 32.120' N	010° 08.461' E
SOL777_15-1	25.05.2020 07:24	Kiel Bight	CTD SBE19+	54° 36.416' N	010° 18.356' E
SOL777_15-2	25.05.2020 07:37	Kiel Bight	OTB TV3-520	54° 36.708' N	010° 18.579' E
SOL777_16-1	25.05.2020 09:58	Kiel Bight	CTD SBE19+	54° 41.267' N	010° 24.134' E
SOL777_16-2	25.05.2020 10:11	Kiel Bight	OTB TV3-520	54° 41.262' N	010° 23.244' E
SOL777_17-1	25.05.2020 12:45	Kiel Bight	CTD SBE19+	54° 37.759' N	010° 38.691' E
SOL777_17-2	25.05.2020 13:02	Kiel Bight	OTB TV3-520	54° 37.327' N	010° 38.943' E
SOL777_18-1	25.05.2020 14:13	Fehmarnbelt	Video sledge	54° 32.834' N	010° 42.951' E
SOL777_18-2	25.05.2020 14:36	Fehmarnbelt	Video sledge	54° 32.858' N	010° 42.742' E
SOL777_18-3	25.05.2020 15:09	Fehmarnbelt	Video sledge	54° 32.485' N	010° 45.618' E
SOL777_19-1	26.05.2020 05:28	Fehmarnbelt	CTD SBE19+	54° 32.274' N	010° 43.746' E
SOL777_19-2	26.05.2020 05:41	Fehmarnbelt	TBB 3m	54° 32.320' N	010° 43.783' E
SOL777_20-1	26.05.2020 06:22	Fehmarnbelt	CTD SBE19+	54° 32.203' N	010° 41.988' E
SOL777_20-2	26.05.2020 06:37	Fehmarnbelt	TBB 3m	54° 32.260' N	010° 41.769' E
SOL777_21-1	26.05.2020 07:15	Fehmarnbelt	CTD SBE19+	54° 32.558' N	010° 39.453' E
SOL777_21-2	26.05.2020 07:28	Fehmarnbelt	TBB 3m	54° 32.623' N	010° 39.899' E
SOL777_22-1	26.05.2020 08:27	Fehmarnbelt	CTD SBE19+	54° 32.606' N	010° 41.737' E
SOL777_22-2	26.05.2020 08:38	Fehmarnbelt	TBB 3m	54° 32.704' N	010° 41.847' E
SOL777_23-1	26.05.2020 09:12	Fehmarnbelt	TBB 2m	54° 32.762' N	010° 43.510' E
SOL777_24-1	26.05.2020 10:11	Fehmarnbelt	TBB 2m	54° 32.756' N	010° 43.438' E
SOL777_26-1	26.05.2020 10:52	Fehmarnbelt	Video sledge	54° 32.771' N	010° 43.627' E
SOL777_27-1	26.05.2020 11:37	Fehmarnbelt	Video sledge	54° 33.061' N	010° 45.031' E
SOL777_28-1	26.05.2020 11:54	Fehmarnbelt	Video sledge	54° 33.002' N	010° 45.244' E
SOL777_29-1	26.05.2020 13:06	Fehmarnbelt	Video sledge	54° 33.932' N	010° 46.240' E

SOL777_31-1	26.05.2020 15:24	Fehmarnbelt	Video sledge	54° 32.516' N	010° 42.177' E
SOL777_32-1	27.05.2020 04:54	Kiel Bight	OTB TV3-520	54° 26.392' N	010° 40.584' E
SOL777_32-2	27.05.2020 05:35	Kiel Bight	CTD SBE19+	54° 26.984' N	010° 37.723' E
SOL777_33-1	27.05.2020 10:24	Nienhagen	CTD SBE19+	54° 17.276' N	011° 46.700' E
SOL777_33-2	27.05.2020 10:39	Nienhagen	TBB 3m	54° 17.145' N	011° 47.142' E
SOL777_34-1	28.05.2020 05:35	Odra Bank	CTD SBE19+	54° 16.066' N	014° 18.006' E
SOL777_34-2	28.05.2020 05:47	Odra Bank	TBB 3m	54° 15.944' N	014° 18.330' E
SOL777_35-1	28.05.2020 06:21	Odra Bank	CTD SBE19+	54° 14.254' N	014° 21.956' E
SOL777_35-2	28.05.2020 06:31	Odra Bank	TBB 3m	54° 14.328' N	014° 21.740' E
SOL777_36-1	28.05.2020 06:57	Odra Bank	TBB 3m	54° 14.947' N	014° 20.474' E
SOL777_37-1	28.05.2020 07:33	Odra Bank	CTD SBE19+	54° 14.749' N	014° 22.427' E
SOL777_37-2	28.05.2020 07:44	Odra Bank	TBB 3m	54° 14.738' N	014° 22.394' E
SOL777_38-1	28.05.2020 08:08	Odra Bank	TBB 3m	54° 15.206' N	014° 21.098' E
SOL777_39-1	28.05.2020 08:38	Odra Bank	CTD SBE19+	54° 16.201' N	014° 18.271' E
SOL777_39-2	28.05.2020 08:50	Odra Bank	TBB 3m	54° 16.162' N	014° 18.463' E
SOL777_40-1	28.05.2020 10:03	Odra Bank	TBB 2m	54° 15.995' N	014° 18.192' E
SOL777_41-1	28.05.2020 10:14	Odra Bank	TBB 2m	54° 15.771' N	014° 18.667' E
SOL777_42-1	28.05.2020 11:24	Odra Bank	TBB 2m	54° 15.296' N	014° 19.853' E
SOL777_43-1	28.05.2020 11:40	Odra Bank	TBB 2m	54° 14.450' N	014° 21.476' E
SOL777_44-1	28.05.2020 12:20	Odra Bank	TBB 2m	54° 14.766' N	014° 22.291' E
SOL777_45-1	28.05.2020 12:36	Odra Bank	TBB 2m	54° 15.541' N	014° 20.214' E
SOL777_46-1	28.05.2020 12:53	Odra Bank	TBB 2m	54° 16.073' N	014° 18.681' E
SOL777_47-1	28.05.2020 13:23	Odra Bank	CTD SBE19+	54° 14.838' N	014° 20.199' E
SOL777_48-1	28.05.2020 13:45	Odra Bank	Video sledge	54° 15.835' N	014° 19.796' E
SOL777_48-2	28.05.2020 14:40	Odra Bank	Video sledge	54° 15.155' N	014° 18.932' E
SOL777_49-1	29.05.2020 05:28	Odra Bank	CTD SBE19+	54° 13.322' N	014° 22.197' E
SOL777_49-2	29.05.2020 05:42	Odra Bank	TBB 3m	54° 13.410' N	014° 22.025' E
SOL777_50-1	29.05.2020 06:10	Odra Bank	TBB 3m	54° 13.988' N	014° 20.364' E
SOL777_51-1	29.05.2020 06:39	Odra Bank	CTD SBE19+	54° 14.767' N	014° 18.055' E
SOL777_51-2	29.05.2020 06:49	Odra Bank	TBB 3m	54° 14.718' N	014° 18.344' E
SOL777_52-1	29.05.2020 07:21	Odra Bank	CTD SBE19+	54° 15.300' N	014° 18.581' E
SOL777_52-2	29.05.2020 07:32	Odra Bank	TBB 3m	54° 15.223' N	014° 18.780' E
SOL777_53-1	29.05.2020 07:56	Odra Bank	TBB 3m	54° 14.552' N	014° 20.133' E
SOL777_54-1	29.05.2020 08:25	Odra Bank	CTD SBE19+	54° 13.453' N	014° 22.491' E
SOL777_54-2	29.05.2020 08:35	Odra Bank	TBB 3m	54° 13.515' N	014° 22.404' E
SOL777_55-1	29.05.2020 09:10	Odra Bank	TBB 2m	54° 13.330' N	014° 22.188' E
SOL777_56-1	29.05.2020 10:04	Odra Bank	TBB 2m	54° 14.096' N	014° 20.043' E
SOL777_57-1	29.05.2020 10:24	Odra Bank	TBB 2m	54° 14.771' N	014° 18.162' E
SOL777_58-1	29.05.2020 10:43	Odra Bank	TBB 2m	54° 15.278' N	014° 18.680' E
SOL777_59-1	29.05.2020 11:22	Odra Bank	TBB 2m	54° 14.390' N	014° 20.542' E
SOL777_60-1	29.05.2020 11:42	Odra Bank	TBB 2m	54° 13.533' N	014° 22.360' E
SOL777_61-1	29.05.2020 12:10	Odra Bank	Van Veen Grab	54° 15.370' N	014° 19.959' E
SOL777_65-1	29.05.2020 13:44	Odra Bank	TBB 2m	54° 17.841' N	014° 21.244' E
SOL777_66-1	29.05.2020 14:17	Odra Bank	Video sledge	54° 17.903' N	014° 21.654' E
SOL777_67-1	30.05.2020 05:27	Odra Bank	CTD SBE19+	54° 11.315' N	014° 18.954' E
SOL777_67-2	30.05.2020 05:41	Odra Bank	OTB TV3-520	54° 11.546' N	014° 18.544' E
SOL777_68-1	30.05.2020 06:41	Odra Bank	CTD SBE19+	54° 13.669' N	014° 15.551' E
SOL777_68-2	30.05.2020 06:56	Odra Bank	OTB TV3-520	54° 13.940' N	014° 14.753' E
SOL777_69-1	30.05.2020 07:59	Odra Bank	CTD SBE19+	54° 16.147' N	014° 12.661' E
SOL777_69-2	30.05.2020 08:12	Odra Bank	OTB TV3-520	54° 16.442' N	014° 12.876' E
SOL777_70-1	30.05.2020 09:59	Odra Bank	CTD SBE19+	54° 19.172' N	014° 15.044' E
SOL777_70-2	30.05.2020 10:12	Odra Bank	OTB TV3-520	54° 19.222' N	014° 14.201' E
SOL777_71-1	30.05.2020 11:30	Odra Bank	CTD SBE19+	54° 20.012' N	014° 13.876' E
SOL777_71-2	30.05.2020 11:45	Odra Bank	OTB TV3-520	54° 20.300' N	014° 13.781' E

SOL777_72-1	30.05.2020 12:34	Odra Bank	CTD SBE19+	54° 20.636' N	014° 11.925' E
SOL777_72-2	30.05.2020 12:51	Odra Bank	OTB TV3-520	54° 20.690' N	014° 11.110' E
SOL777_73-1	30.05.2020 14:00	Odra Bank	CTD SBE19+	54° 24.527' N	014° 06.945' E
SOL777_73-2	30.05.2020 14:13	Odra Bank	OTB TV3-520	54° 24.783' N	014° 06.301' E
SOL777_74-1	31.05.2020 05:30	Arkona Basin	CTD SBE19+	54° 50.591' N	013° 30.563' E
SOL777_74-2	31.05.2020 05:51	Arkona Basin	OTB TV3-520	54° 50.458' N	013° 30.311' E
SOL777_75-1	31.05.2020 07:19	Arkona Basin	CTD SBE19+	54° 53.436' N	013° 33.827' E
SOL777_75-2	31.05.2020 07:38	Arkona Basin	OTB TV3-520	54° 53.884' N	013° 34.313' E
SOL777_76-1	31.05.2020 09:56	Arkona Basin	CTD SBE19+	54° 54.661' N	013° 40.738' E
SOL777_76-2	31.05.2020 10:22	Arkona Basin	OTB TV3-520	54° 55.125' N	013° 40.775' E
SOL777_77-1	31.05.2020 11:59	Arkona Basin	CTD SBE19+	54° 59.512' N	013° 43.070' E
SOL777_77-2	31.05.2020 12:19	Arkona Basin	OTB TV3-520	54° 59.639' N	013° 43.767' E
SOL777_78-1	01.06.2020 05:29	Arkona Basin	CTD SBE19+	54° 49.930' N	013° 47.748' E
SOL777_78-2	01.06.2020 05:53	Arkona Basin	OTB TV3-520	54° 49.998' N	013° 47.393' E
SOL777_79-1	01.06.2020 07:37	Arkona Basin	CTD SBE19+	54° 59.908' N	013° 36.086' E
SOL777_79-2	01.06.2020 07:56	Arkona Basin	OTB TV3-520	54° 59.852' N	013° 34.772' E
SOL777_80-1	01.06.2020 09:55	Arkona Basin	CTD SBE19+	54° 57.849' N	013° 32.938' E
SOL777_80-2	01.06.2020 10:15	Arkona Basin	OTB TV3-520	54° 57.835' N	013° 33.597' E
SOL777_81-1	01.06.2020 11:59	Arkona Basin	CTD SBE19+	54° 54.077' N	013° 40.266' E
SOL777_81-2	01.06.2020 12:18	Arkona Basin	OTB TV3-520	54° 53.933' N	013° 41.040' E
SOL777_83-1	02.06.2020 05:24	Odra Bank	CTD SBE19+	54° 24.138' N	014° 08.501' E
SOL777_84-1	02.06.2020 06:23	Odra Bank	CTD SBE19+	54° 25.820' N	014° 07.558' E
SOL777_84-2	02.06.2020 06:35	Odra Bank	OTB TV3-520	54° 25.994' N	014° 08.172' E
SOL777_86-1	02.06.2020 10:04	Odra Bank	CTD SBE19+	54° 13.172' N	014° 17.288' E
SOL777_86-2	02.06.2020 10:18	Odra Bank	TBB 2m	54° 13.136' N	014° 17.381' E
SOL777_87-1	02.06.2020 10:33	Odra Bank	TBB 2m	54° 13.077' N	014° 17.534' E
SOL777_88-1	02.06.2020 11:32	Odra Bank	TBB 2m	54° 13.044' N	014° 17.369' E
SOL777_92-1	02.06.2020 13:01	Odra Bank	CTD SBE19+	54° 13.392' N	014° 05.842' E
SOL777_93-1	02.06.2020 13:10	Odra Bank	Van Veen Grab	54° 13.301' N	014° 05.768' E
SOL777_94-1	02.06.2020 13:21	Odra Bank	Van Veen Grab	54° 13.321' N	014° 06.175' E
SOL777_95-1	02.06.2020 13:31	Odra Bank	Van Veen Grab	54° 13.522' N	014° 06.012' E
SOL777_96-1	02.06.2020 13:43	Odra Bank	TBB 2m	54° 13.417' N	014° 05.829' E
SOL777_97-1	02.06.2020 13:55	Odra Bank	TBB 2m	54° 13.314' N	014° 05.811' E
SOL777_98-1	02.06.2020 14:08	Odra Bank	TBB 2m	54° 13.289' N	014° 06.227' E
SOL777_99-1	02.06.2020 14:23	Odra Bank	TBB 3m	54° 13.343' N	014° 05.648' E
SOL777_100-1	02.06.2020 14:43	Odra Bank	TBB 3m	54° 14.136' N	014° 06.068' E
SOL777_101-1	03.06.2020 05:31	Odra Bank	TBB 3m	54° 13.317' N	014° 07.008' E
SOL777_102-1	03.06.2020 06:04	Odra Bank	CTD SBE19+	54° 13.374' N	014° 02.161' E
SOL777_102-2	03.06.2020 06:17	Odra Bank	OTB TV3-520	54° 13.581' N	014° 02.643' E
SOL777_103-1	03.06.2020 07:36	Odra Bank	CTD SBE19+	54° 16.409' N	014° 13.336' E
SOL777_103-2	03.06.2020 07:54	Odra Bank	TBB 2m	54° 16.351' N	014° 13.219' E
SOL777_104-1	03.06.2020 08:27	Odra Bank	TBB 2m	54° 16.233' N	014° 13.253' E
SOL777_105-1	03.06.2020 08:39	Odra Bank	TBB 2m	54° 16.259' N	014° 13.403' E
SOL777_106-1	03.06.2020 08:52	Odra Bank	Van Veen Grab	54° 16.196' N	014° 13.130' E
SOL777_107-1	03.06.2020 09:02	Odra Bank	Van Veen Grab	54° 16.224' N	014° 13.508' E
SOL777_108-1	03.06.2020 09:13	Odra Bank	Van Veen Grab	54° 16.365' N	014° 13.169' E

Institut für Ostseefischerei

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Bericht

über die 778. Reise des FFS Solea
vom 10.06. bis 22.06.2020

Untersuchungen zur Laicherbestandsstruktur, zum Anteil aktiver Laicher, zu Kondition und Laichaktivitäten und zur Reifeentwicklung von Dorschen in Beziehung zur hydrographischen Situation in der Bornholmsee und Arkonasee (COBALT)

Fahrtleitung: M. Bleil

Das Wichtigste in Kürze

Der Fokus der Untersuchungen lag in der Abschätzung der aktuellen reproduktiven Aktivitäten von Dorschen in der Bornholmsee und der Arkonasee in Beziehung zur hydrographischen Situation.

In der Bornholmsee ist aktuell ab einer Wassertiefe von ca. 68 m die erfolgreiche Reproduktion von Dorschen nicht mehr möglich, unterhalb dieser Wassertiefe sind unterkritische Sauerstoffwerte (< 2 ml/l) beobachtet worden. Aufgrund dieser Situation war am Boden des Bornholmbeckens kein Fisch, jedoch bei Wassertiefen von 60 - 68 m konnten schwache pelagische Anzeigen von Dorschen beobachtet und befischt werden.

Die erzielten Einheitsfänge von Dorsch waren in der Bornholmsee deutlich geringer als im Vorjahr. Tiere mit Längen von > 43 cm wurden lediglich in Einzelexemplaren gefangen.

Die Auswertungen zur Laicherbestandsstruktur und zur Reifegradverteilung in der Bornholmsee zeigen eine dramatische Situation. Die Laichaktivitäten werden von Erstlaichern dominiert. Eine normale Laicherbestandsstruktur ist nicht mehr vorhanden. Das Laichgeschehen war überraschend weit vorangeschritten, es laichten bereits 90 % der Tiere. Der kleinste laichende Dorsch hatte eine Länge von 19 cm. Es dominierten die Längengruppen 25 – 29 cm. Auch in der Arkonasee, in Tiefen ab 40 m, wurden laichende Dorsche beobachtet. Die hydrographischen Bedingungen für eine erfolgreiche Reproduktion waren hier gut. Im Tiefenhorizont von 20-38 m sind, wie auch bereits im Vorjahr, Konzentrationen von Dorschen beobachtet worden, die aufgrund ihrer Längen- und Reifeverteilung, aus der Beltsee stammen und auf Nahrungssuche waren.

Verteiler:

Schiffsführung FFS „Solea“
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Thünen-Institut - Präsidialbüro
Thünen-Institut - Reiseplanung Forschungsschiffe, Dr. Rohlf
Fahrtteilnehmer*innen

2 AUFGABEN DER FAHRT

Im Verlauf der Reise war laut Fahrtprogramm vorgesehen Untersuchungen zu Laichaktivitäten, zur Struktur der Laicherbestände, zur Reifeentwicklung und Kondition von Dorschen im Seegebiet der Bornholmsee und der Arkonasee durchzuführen. Gezielt sollten in der Arkonasee die Laichaktivitäten in Beziehung zur Wassertiefe untersucht werden.
Routinemäßig waren alle in den Fängen vorkommenden Fischarten zu erfassen. Seltene Arten waren bei vorhandenem Überlebenspotenzial wieder in die See zurück zu setzen. Das Fahrtprogramm sah vor, auf jeder Fischereistation fischereibiologisch relevante, hydrographische Parameter zu messen. Für das LALLF/MV sind, den Vorgaben entsprechend, verschiedene Fischarten und Organproben für Schadstoffuntersuchungen konserviert worden.

3 FAHRTVERLAUF UND DURCHGEFÜHRTE ARBEITEN

FFS "Solea" wurde am 09.06.2020 in Rostock aufgerüstet und lief am 10.6.2020 aus. Die fischereilichen Arbeiten begannen noch am 10.6. in der südlichen Mecklenburger Bucht. Nach dem hier 3 Hols in unterschiedlichen Tiefenhorizonten befischt worden sind, verholte Solea in die Arkonasee/Borholmsgatt. Hier waren auf 48 m Wassertiefe sehr gute Dorschfänge möglich. Bis zum 13.6. ist hier gefischt worden. Durch das Aufziehen eines Sturmtiefs mussten die Arbeiten unterbrochen werden. Es wurde der Hafen Sassnitz angelaufen. Am 14.6. stieg Herr R. Stechert auf die Solea auf, um das wissenschaftliche Team zu verstärken. Ab 15.6. konnte dann mit 4 Wissenschaftlern statt wie zuvor nur mit 3 Mitarbeitern gearbeitet werden. Nach zwei erfolglosen Grundschleppnetzhols und den ersten hydrographischen Messungen wurde vom TV3/520 auf das pelagischen Netz PSN 388 umgeschlagen und alle Stationen mit Wassertiefen von > 70 m pelagisch befischt. Ab dem 17.6. wurde das Netz erneut gewechselt. Am 18.6. waren sämtliche in der Bornholmsee beantragte und genehmigte Stationen befischt worden.
Nach Beendigung der Fischerei in der Bornholmsee verholte FFS „Solea“ bis zum 20.6. in die Arkonasee um noch weitere Stationen zu bearbeiten. Insbesondere die gezielte Fischerei in verschiedenen Tiefenhorizonten um Laichareale abzugrenzen war hier Ziel der Untersuchungen. Am 21.6. fand noch ein Hol in der südlichen Mecklenburger Bucht statt. Die fischereilichen Arbeiten wurden am 21.6. gegen 10.00 Uhr erfolgreich beendet.
FFS „Solea“ lief am 21.6. 2020 gegen 11.00 Uhr den Hafen von Rostock-Marienehe an. Nach dem Reinigen der Labore und Kammern und dem Packen des Expeditionsgepäcks verließ das wissenschaftliche Team um 14.00 Uhr das Schiff. Abgerüstet wurde am 22.6.2020, gegen 10.00 Uhr war die Reise planmäßig beendet.

4 ERSTE ERGEBNISSE

4.1 Fischerei

Während der Reise wurde sowohl das internationale Standard - Grundschleppnetze TV 3/520 sowie, in Abhängigkeit von der hydrographischen Situation am Boden des Bornholmbeckens, das pelagische Netz PSN 388 eingesetzt. Die Holdauer lag bei 0,25 – 0,5 h. Die Aufarbeitung der Fänge erfolgte nach BITS Standard.

Die Sammlung der Daten/Proben fand in der Bornholmsee, in der Arkonasee und in der südlichen Mecklenburger Bucht statt. Im Verlauf der Reise sind insgesamt 40 Hols realisiert worden.

Während der fischereilichen Analysen wurden 98 521 Fische gefangen und 17 261gemessen. Es sind 3120 kg (10 095 Stk) Dorsch gefangen und davon 6580 Tiere gemessen worden. Es waren die Längengruppen 4 – 77 cm in den Fängen vertreten.
In der Bornholmsee dominierten die Längengruppen 25 – 29 cm und in der Arkonasee 22 – 34 cm (Abb. 1). Dorsche mit einer Länge von >43 cm wurden in der Bornholmse nur noch in Einzelexemplaren beobachtet. Ledigliche 2,4 % der Tiere waren hier größer als 40 cm.
Es wurden 4 zusätzliche Hols in der südlichen Mecklenburger Bucht durchgeführt, die überraschende Ergebnisse erbrachten. Der Jahreszeit entsprechend war zu erwarten, dass sich im befischten Gebiet lediglich vereinzelt Dorsche aufhalten. Die Fänge zeigten jedoch, dass im Tiefenhorizont von 14 - 17 m am Anfang der Reise noch eine große Anzahl an Dorschen vorhanden war. Darüber hinaus wurden auch juvenile Dorsche (4 - 9 cm) gefangen. Diese juvenilen Tiere wurden auch, jedoch in geringerer Anzahl, in der Arkonasee und in der Bornholmsee beobachtet.
Die erzielten Einheitsfänge von Dorsch (kg/h; *Stück/h*) waren in der Bornholmsee dramatisch niedrig:

2020	-	81	kg/ *383 Stk*
2019	-	183	kg/ *830 Stk*
2018	-	155	kg/ *519 Stk*
2017	-	286	kg/ *944 Stk*
2016	-	292	kg/ *757 Stk*
2015	-	886	kg/ *2535 Stk*

Es wurden hier bei Wassertiefen von 60 - 73 m schwache, aber anhaltende pelagische Anzeigen von Dorschen beobachtet, die mit dem PSN 388 befischt wurden.

Die Einheitsfänge in der Arkonasee lagen mit 252 kg/1h (*767 Stk/1h*) auf einem durchschnittlichen Niveau. Auffällig war hier, die Vermischung von kleinen laichenden Dorschen des östlichen Bestandes mit großen, abgelaichten Tieren des Westbestandes.
Neben Dorsch waren zahlenmäßig in den Fängen Scholle, gefolgt von Hering und Sprotte regelmäßig vorhanden. Flunder sowie Wittling kamen ebenfalls häufig in den Fängen vor. Insgesamt sind 21 verschiedene Fischarten gefangen worden.

Darüber hinaus ist, entsprechend Anforderung, Probenmaterial für das LALLF MV gesammelt und eingefroren worden.

4.2 Biologische Untersuchungen

Für die biologischen Untersuchungen sind 1481 Dorsche für die Untersuchungen zur Reifeentwicklung und zur Laichaktivität in Beziehung zur Kondition analysiert worden.

Die vorläufigen Auswertungen der Reifegradverteilung von Dorschen zeigen, dass in der Bornholmsee 94 % der potentiellen männlichen Laicher und ebenfalls 94 % der potentiellen weiblichen Laicher am diesjährigen Laichen teilnehmen werden, wobei 92 % der Männchen und 83 % der Weibchen sich bereits im aktiven Laichprozess befanden. Das ist jahreszeitlich ein sehr frühes Laichen. Der Laicherbestand besteht weiterhin überwiegend aus Erstlaichern, das kleinste laichende Tier hatte eine Länge von 19 cm.

Das Durchschnittsgewichtes der gefangenen Dorsche war mit 318 g etwas höher als in den Vorjahren (220 g – 2019; 299 g – 2018; 303 g - 2017).

Die Auswertungen zur Kondition der Dorsche in Beziehung zu ihrer Länge zeigen für den gesamten Längenbereich keine markanten Veränderungen zum Vorjahr (Abb.2).

Auch in der Arkonasee wurden Laichaktivitäten beobachtet. Es laichten 30 % der Dorsche. Lediglich 6 % befanden sich in Vorlaichkondition, was die Beobachtungen zum jahreszeitlich sehr frühen Laichen aus der Bornholmsee bestätigt. Aufgrund der beobachteten Längen- und Reifeverteilung liegt die Hypothese nahe, dass sich im Seegebiet, zum Reisezeitraum, ein hoher Anteil von Dorschen aus der Beltsee zur Nahrungssuche aufhielt. Das unterstreicht die Bedeutung dieses Gebietes als Mischgebiet beider Bestände.

Wie auch bereits während der Laichzeit der „Frühjahrslaicher" im März in der Beltsee wurde in der Arkonasee gezielt untersucht ob es auch für die „Sommerlaicher" eine Abhängigkeit der Laichaktivitäten von der Wassertiefe gibt. Die Analysen zur Tiefenstratifizierung bestätigen die Ergebnisse aus den Vorjahren. Die Laichaktivitäten (Reife 5-7) in der Arkonasee konzentrieren sich auf den Bereich mit Wassertiefen von mehr als 40 m (Tab. 2).

In der Mecklenburger Bucht war, der Jahreszeit entsprechend, das Laichen beendet 98 % der Dorsche befanden sich im Ruhestadium.

4.3 Hydrographie

Für die hydrographischen Messungen kam die Seabird Sonde SBE19V- 6434 im online-Betrieb zum Einsatz.
Es sind 41 hydrographische Tiefenprofil-Messungen durchgeführt und 39 Wasserproben gewonnen worden. In Tabelle 3 ist ein Überblick zu den maximalen und minimalen Messwerten im Tiefenhorizont kurz über Grund und an der Wasseroberfläche angegeben. Die homogene, schwach saline Deckschicht in der Bornholmsee lag zwischen 45 bis 55 m. Auf der Station mit der höchsten Wassertiefe (88 m) betrug die Wassertemperatur 2,5 m über dem Boden 8,3 °C, bei einem Salzgehalt von 16,5 ppt und einem Sauerstoffgehalt von 0,5 ml/l (Tab. 2). Ab einer Wassertiefe von ca. 64 - 74 m (im Durchschnitt 68,5 m) war die erfolgreiche Reproduktion von Dorschen nicht mehr möglich. Es wurden unterhalb dieser Wassertiefe unterkritischer Sauerstoffwerte (<2 ml/l) beobachtet. Die potentiell reproduktive Schicht für Dorsch lag bei durchschnittlich 11,9 m (minimal 9 m bis maximal 19 m). In der Arkonasee waren die Bedingungen für erfolgreiches Laichen ab einer Wassertiefe von ca. 40 m gut.
Am 20.6. konnte auf den Stationen mit Wassertiefen von > 43 m ein kleiner Salzwassereinstrom beobachtet werden.

5 FAHRTTEILNEHMER:

• Martina Bleil	Fahrtleitung
• Titus Rohde	TA
• Tobias Reßing	stud. Hilfskraft
• Rainer Stechert	TA (14.6. – 21.6.)

6 DANKSAGUNG

Hiermit bedanke ich mich ausdrücklich bei den zwei, ab Reisemitte drei, weiteren Mitgliedern der wissenschaftlichen Arbeitsgruppe für ihr überdurchschnittliches Engagement bei der bedingungslosen Erfüllung der Arbeitsaufgaben. Ebenso danke ich dem wissenschaftlichen Team, wie auch der gesamten Schiffsbesatzung, für ihre Bereitschaft, trotz Corona Pandemie, die Reise durchzuführen.

gez. M. Bleil
(Fahrtleitung)

ANHANG

Tab.1: Reifeverteilung (%) nach Geschlecht [Aktive = Reife 3-8; Ruhe = Reife 1-2]

Gebiet	**25**		**24**	
Sex	Aktive	Ruhe	Aktive	Ruhe
1	93,9	4,5	34,7	60,1
2	82,8	5,7	25,5	60,7

Tab. 2: Laichaktivitäten von Dorschen (%) in der Arkonasee in Beziehung zur Wassertiefe

Wassertiefe	**23 - 26 m**	**36 - 38 m**	**44 - 47 m**
	N = 138	N = 129	N = 201
Reife			
Ruhe (1-2)	98,6	95,3	70,6
Vorlaichreif (3-4)	0	3,1	4,5
Laichend (5-7)	0,7	0	21,9
Abgelaicht (8)	0,7	1,6	1,0

Tab. 3: Hydrographische Messungen an der Oberfläche und in der Fischereitiefe in der Bornholmsee und Arkonasee

	SD 25		**SD 24**	
	Oberfläche	**Bodennähe**	**Oberfläche**	**Bodennähe**
Temperatur (°C)	12,7 – 15,0	5,8 – 11,8	12,7 – 17,3	8,8 – 14,8
Salinität (ppt)	7,7 – 8,0	13,3 – 16,6	7,9 - 8,2	8,7 – 16,2
Sauerstoffgehalt (ml/l)	7,1 – 7,7	3,8 - 0,3	6,7 – 7,5	3,4 – 6,6

Abb. 1: Totallängenhäufigkeitsverteilung Dorsch (Anzahl in Stk.) nach ICES Gebieten, im Juni 2020

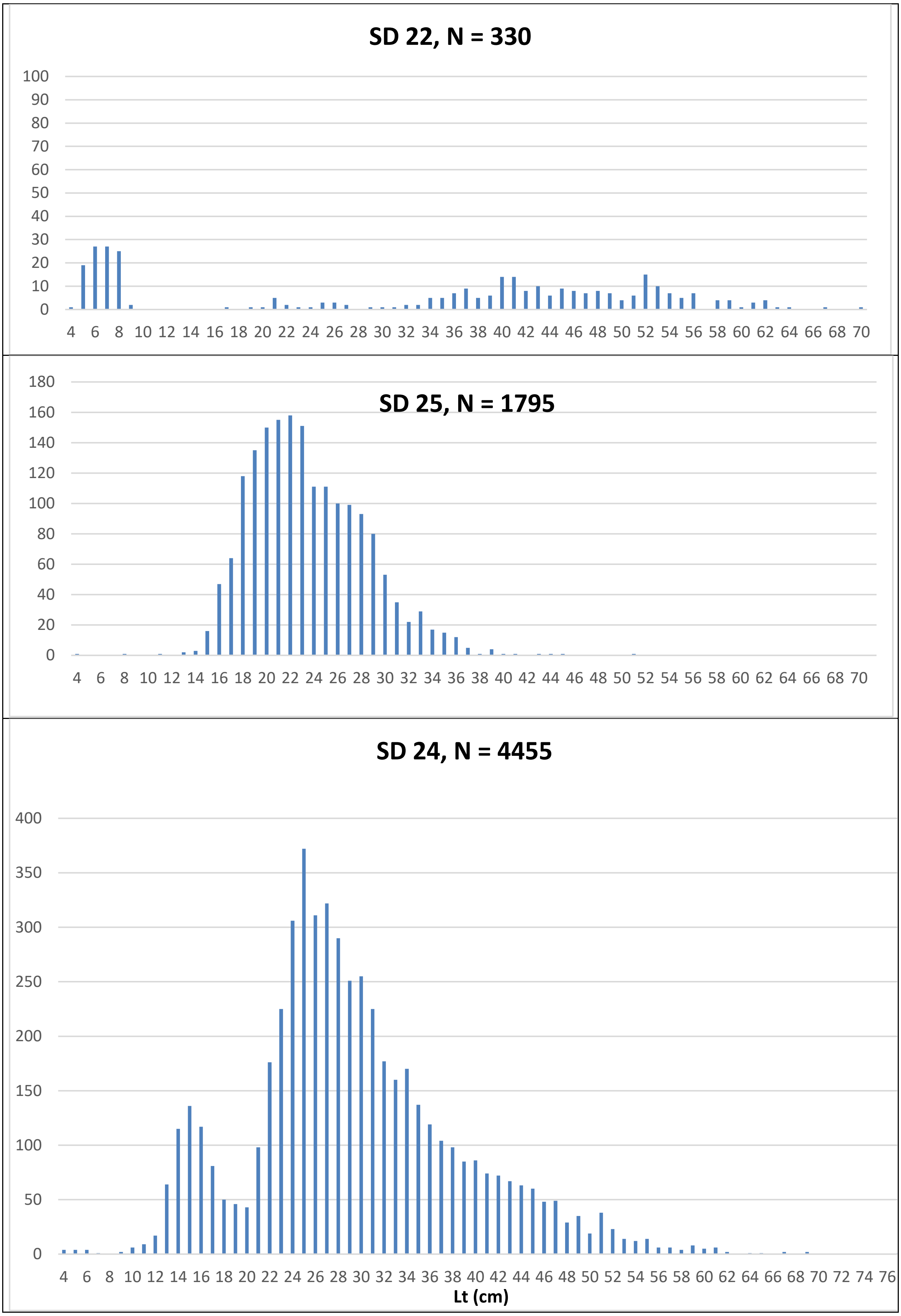
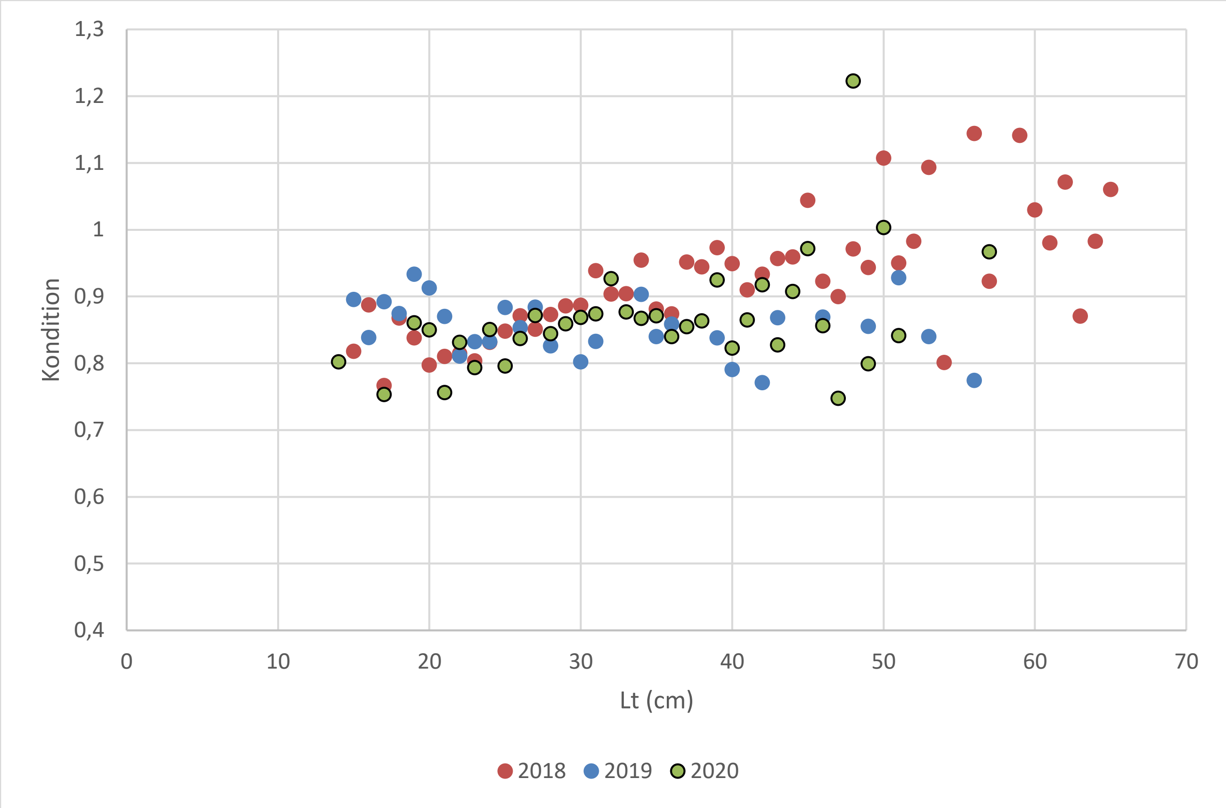


Abb.2: Vergleich der Kondition von Dorschen in der Bornholmsee, im Juni der Jahre 2018, 2019 und 2020



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Report
Cruise SO 765 of FRV „SOLEA“
22.07. –11.08.2020

Chief scientists: Dr. Wolfgang Nikolaus Probst & Dr. Vanessa Stelzenmüller

Objectives

1. Participation in the German Small-Scale Bottom Trawl Survey (GSBTS) to monitor the fish fauna in 5 out of 12 small areas (boxes),

2. Investigation of the hydrographical conditions within the boxes (vertical distribution of temperature, salinity and turbidity).

3. Experimental fisheries in the vicinity of two offshore windparks located in the German EEZ

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DFFU

1. Narrative

FRV "Solea" left Cuxhaven on the 22nd of July 2020 and started its scientific program the following day in Box P (see Figure 1). In general, the scientific program consisted of three days with 7 hauls per day within each box. Each day at least two CTD casts were deployed. The scheduled personnel exchange was carried out around noon of the 1st of August in Cuxhaven. The scientific program continued from the 2nd until the 11th of August. The vessel returned to Cuxhaven on the 11th of August 2020.

During this year's survey a total of 91 hauls with the cod hopper trawl net and an additional 26 accompanying CTD casts were conducted in five boxes of the GSBTS assigned to FRV "Solea". In addition, an experimental box W and the vicinity of an offshore windfarm close to the island of Helgoland was sampled.

Like in previous years the actual sequence of sampling in the boxes was adapted to the prevailing weather conditions (Box H (British EEZ; 3 days), Box E (German EEZ; 4 days), Box N (German EEZ; 2 days), Box K (Danish EEZ; 2 days), and Box P (German EEZ; 1 day)(Figure 1). Box F was omitted from this year's survey due the experimental fishing around two offshore windfarms. A summary of the activities during SB780 within each box is given in Table 1 and a summary of the total sampling effort within the GSBTS survey program by box and year for the cod hopper is presented in Table 2.

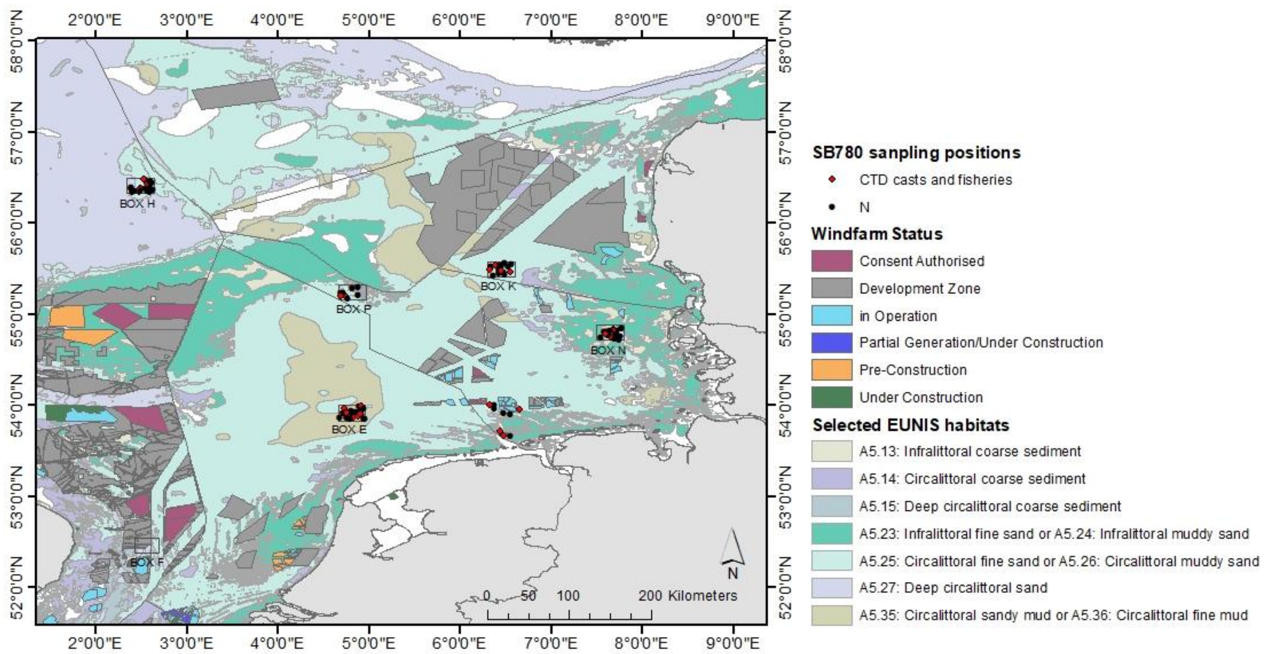


Figure 1: Positions of German small scale bottom trawl survey "boxes" (10 x 10 nm) monitored by the research vessel „Solea" during cruise no. 780 and sampling stations as mid positions indicating fishing activity (black dot) or fishing in combination with a CTD cast (red dot) per GSBTS box with intersecting EUNIS habitats categories and offshore windfarm locations.

Table 1. Total number of valid cod hopper (KJN) hauls and CTD casts during SO 780. OWP indicates sampling stations allocated in the vicinity of the offshore windfarms Borkum Riffgrund and Riffgat.

Box	KJH hauls	CTDs
BOX E	20	6
BOX F	-	-
BOX H	21	6
BOX K	16	4
BOX N	17	4
BOX P	8	2
OWF	9	4
Total	91	26

Table 2. Total sampling effort (cod hopper hauls) in the standard GSBTS boxes per survey year.

Year	BOX E	BOX F	BOX H	BOX K	BOX N	BOX P	Total
1990	8	28	-	-	-	-	36
1991	28	28	27	24	-	-	107
1992	28	21	23	19	-	-	91
1993	27	23	25	27	-	-	102
1994	19	25	27	26	-	-	97
1995	21	25	26	24	-	-	96
1996	28	26	17	28	-	-	99
1997	6	18	25	26	-	-	75
1998	17	20	25	23	-	-	85
1999	10	27	17	30	-	-	84
2000	-	-	-	-	8	-	8
2001	18	24	27	22	17	-	108
2002	15	17	17	9	-	-	58
2003	15	24	23	24	-	24	110
2004	19	17	23	17	15	16	107
2005	14	16	20	14	20	14	98
2006	-	-	16	24	19	-	59
2007	23	22	24	12	21	16	118
2008	21	22	21	18	21	18	121
2009	24	22	21	15	22	16	120
2010	21	21	21	16	21	14	114
2011	10	-	21	7	21	21	80
2012	21	-	21	7	21	18	88
2013	21	21	21	21	23	18	125
2014	21	21	23	18	17	24	124
2015	22	23	21	21	17	18	122
2016	12	12	21	14	16	18	93
2017	15	14	15	17	16	18	95
2018	21	-	14	21	21	15	92
2019	-	-	16	21	20	16	73
2020	20	-	21	16	17	8	82
Total	**525**	**517**	**619**	**561**	**353**	**292**	**2863**

2. Results

2.1. Long-term trends in catch compositions

Trawl durations were constantly close to 30 min and the trawl speed ranged around 3.6 kn across all valid hols (Table 3). Mean depth in sampled boxes varies between 20 and 70 m.

Table 3. Summary of mean catch depth (m), mean vertical net opening (m), mean trawl duration (min), mean trawl speed (kn), mean length of trawl warp (m) and mean distance between trawl doors (m), and of all valid hols per box.

Box	mean depth (m)	mean vertical net opening (m)	mean trawl duration (min)	mean trawling speed (kn)	mean length trawl warp (m)	mean distance trawl doors (m)
BOX E	39.2	3.23	30	3.70	241	51.60
BOX H	70.2	3.50	30	3.63	400	61.21
BOX K	40.2	3.28	30	3.69	250	55.92
BOX N	20.4	2.84	30	3.70	150	50.19
BOX P	34.0	3.54	30	3.66	186	55.88

In Figures 2 to 6 for each GSBTS box the annual catches (kg 30min^{-1}) of the species contributing at least 0.5% to the cumulative total catch across all sampling years as well as long-term trends in mean cpue per haul (kg 30 min-1) are displayed. Between a number of ten and thirteen species contributed the most to the overall biomass caught in the respective GSBTS boxes.

- In Box P cpue values (Fig. 2 top and bottom) were highest for dab (*Limanda limanda*) and European sprat (*Sprattus sprattus*). In 2020, only a total number of 8 hauls have been sampled in Box P, which have caused the lowest total cpue since 2003. For the majority of the selected species mean cpue's were well below the median of the previous years. An exception are catches of plaice (*Pleuronectes platessa*), which continued to decrease over the last five years.
- In Box H (Fig. 3 top and bottom) highest cupe values were detected for dab, haddock (*Melanogrammus aeglefinus*) and whiting (*Merlangus merlangus*). Catches of haddock were clearly increased compared to previous years. Only one individual for each species was caught for European hake (*Merluccius merluccius*), turbot (*Psetta maxima*) and poor cod (*Trisopterus minutus*).
- In Box N (Fig.4 top and bottom) cpue values were highest for dab and Atlantic mackerel (*Scomber scombrus*). The downward trend of catches continued in 2018 for dab, plaice and grey gurnard (*Eutrigla gurnadus*). Catch es of Atlantic horse mackerel (*Trachurus trachurus*) remained at levels well below the all-time median. Only o ne individual was caught for instance for turbot or brill (*Scophthalmus rhombus*).
- In Box K (Fig. 5 top and bottom) the catches of dab and plaice were highest in weight and where well above th e median value of the respective time series. Since 2015 the catches of herring (*Clupea harengus*) remained at very low compared to previous years. In contrast, catches of plaice were well above the median value. Compa red to all previous years European hake and American plaice (*Hippoglossoides platessoides*) were not caught.
- In Box E (Fig. 6 top and bottom) catches were highest in numbers and weight for dab, whiting and European sprat. One individual of the deep sea species blackbelly rosefish (*Helicolenus dactylopterus*) was caught like in boxes H and K in the previous year.

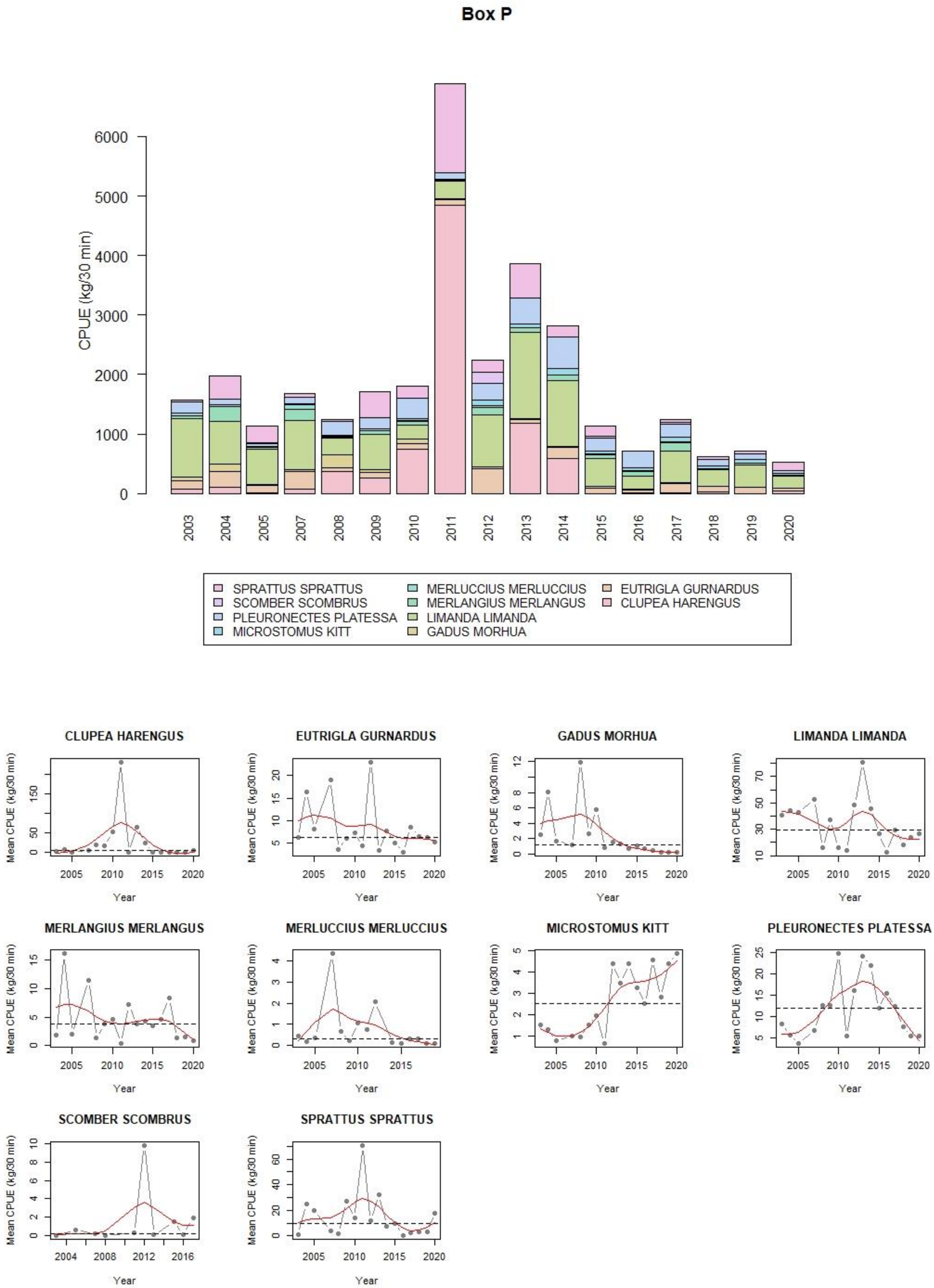


Figure 2: Summed CPUE (kg 30 min^{-1}) of the species contributing to least 99.5% to the cumulative biomass in Box P. Bottom: Long-term trends in mean CPUE per haul (kg 30 min^{-1}) of the selected species in Box P, with indicated median CPUE per haul value over all sampling years (dashed line).

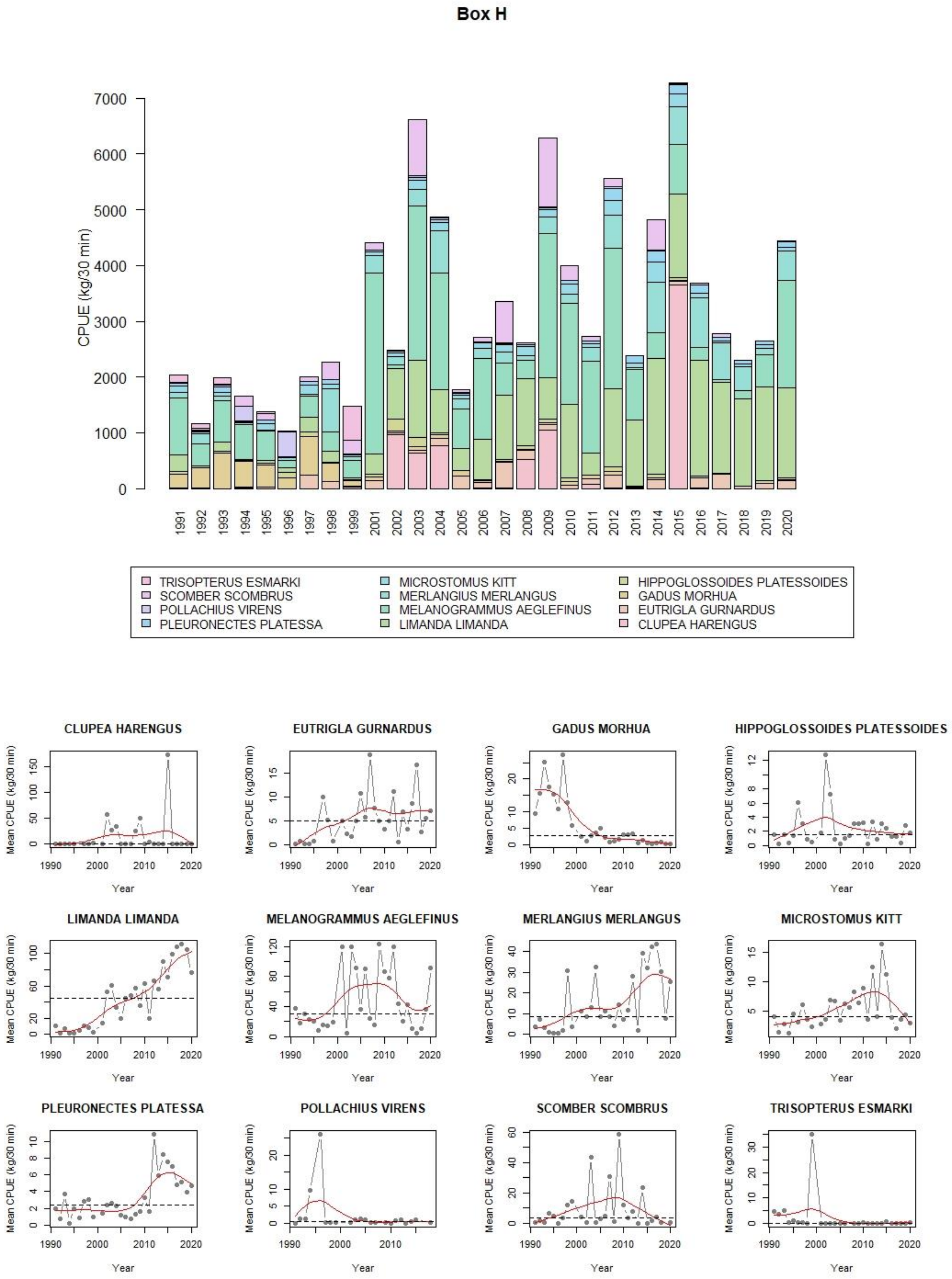


Figure 3: Top: Summed CPUE (kg 30 min^{-1}) of the species contributing to least 99.5% to the cumulative biomass in Box H. Bottom: Long-term trends in mean CPUE per haul (kg 30 min^{-1}) of the selected species in Box H, with indicated median CPUE per haul value over all sampling years (dashed line).

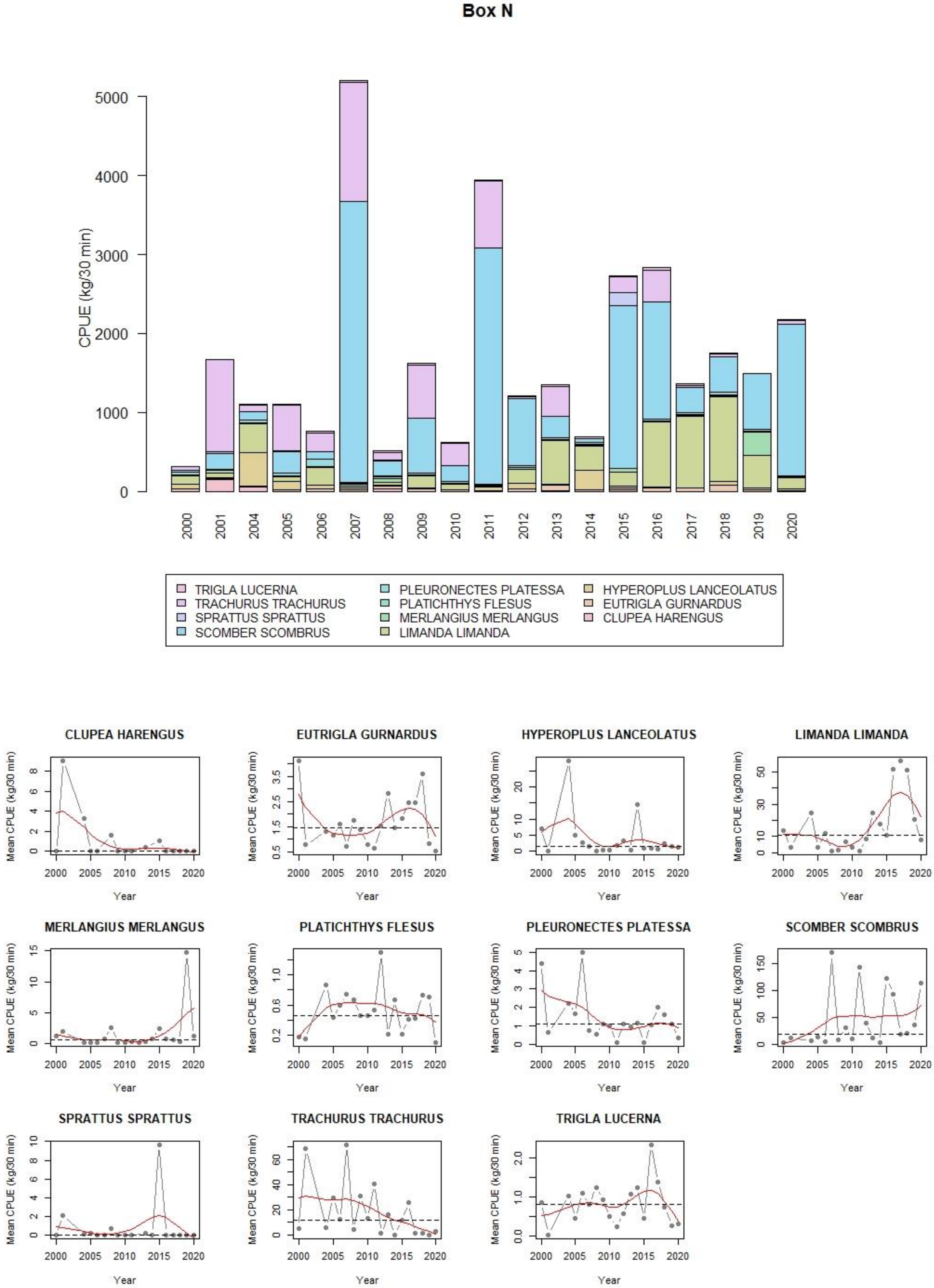


Figure 4: Top: Summed CPUE (kg 30 min^{-1}) of the species contributing to least 99.5% to the cumulative biomass in Box N. Bottom: Long-term trends in mean CPUE per haul (kg 30 min^{-1}) of the selected species in Box N, with indicated median CPUE per haul value over all sampling years (dashed line).

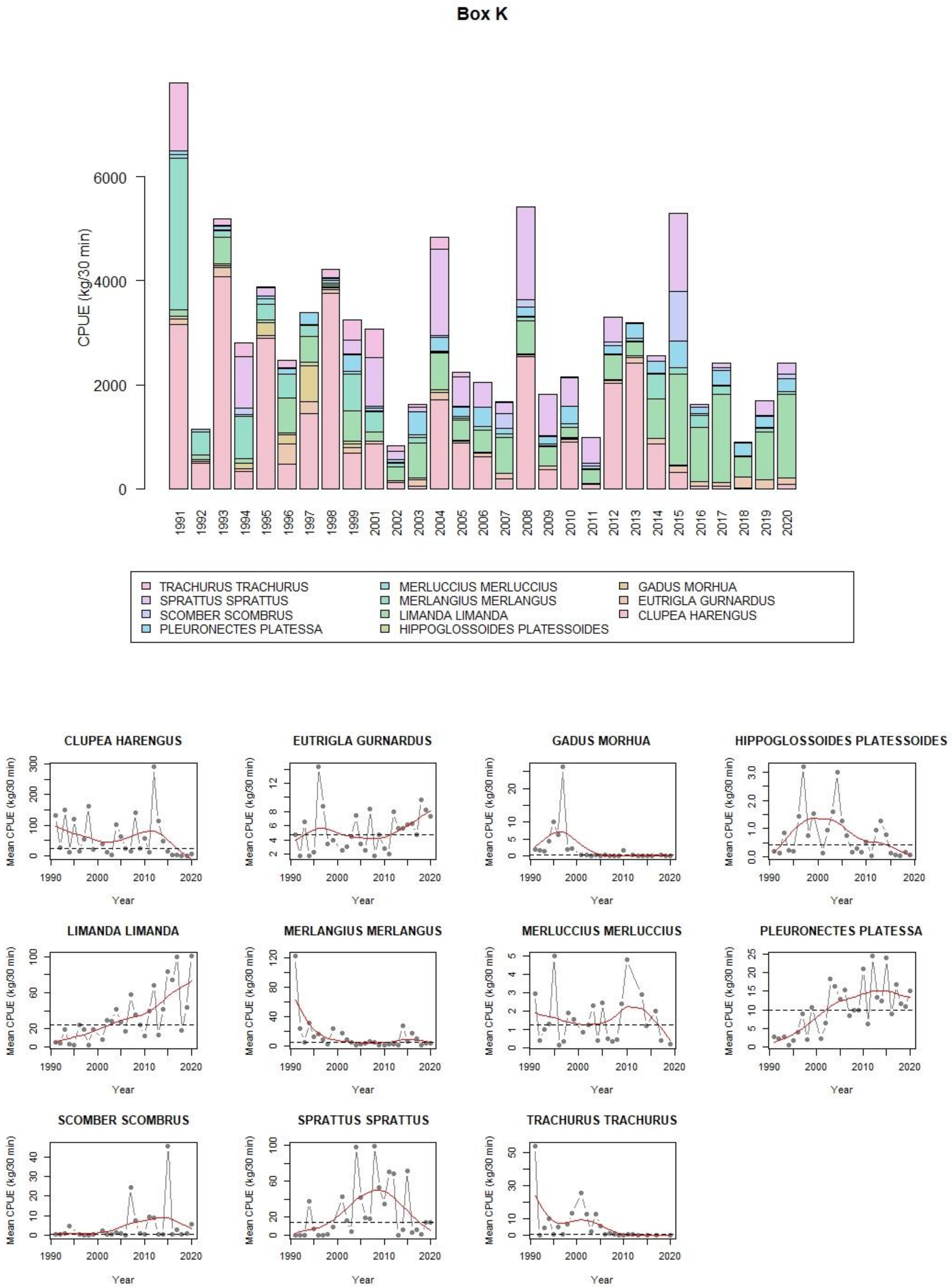
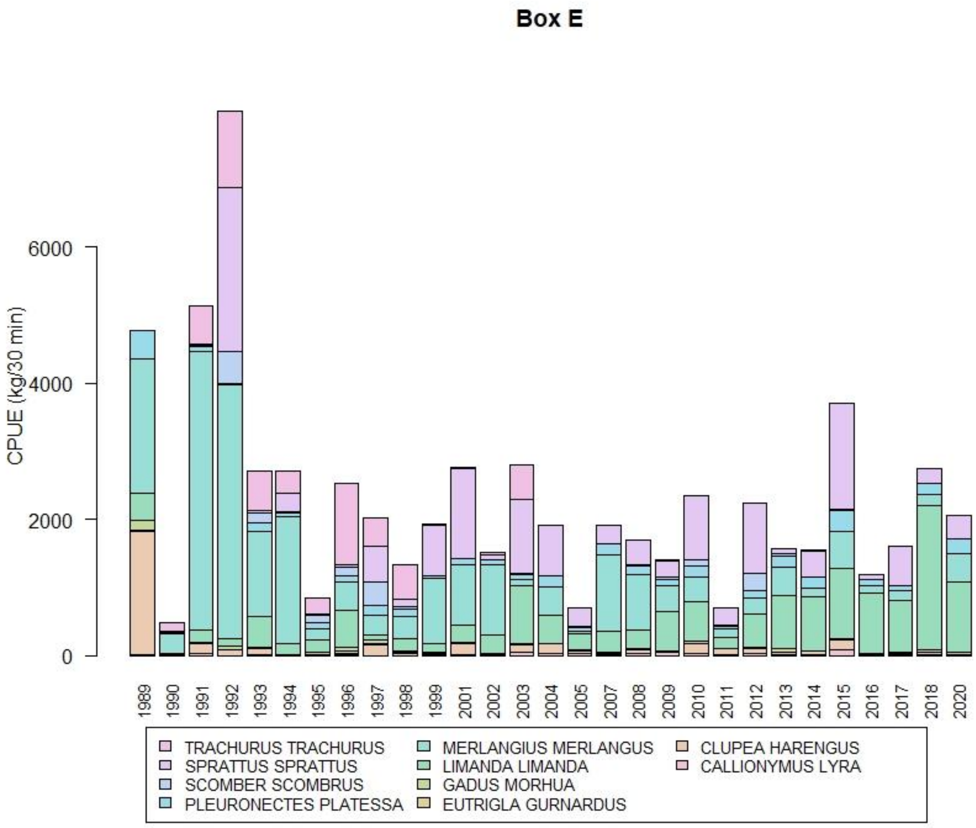


Figure 5: Top: Summed CPUE (kg 30 min^{-1}) of the species contributing to least 99.5% to the cumulative biomass in Box K. Bottom: Long-term trends in mean CPUE per haul (kg 30 min^{-1}) of the selected species in Box K, with indicated median CPUE per haul value over all sampling years (dashed line).



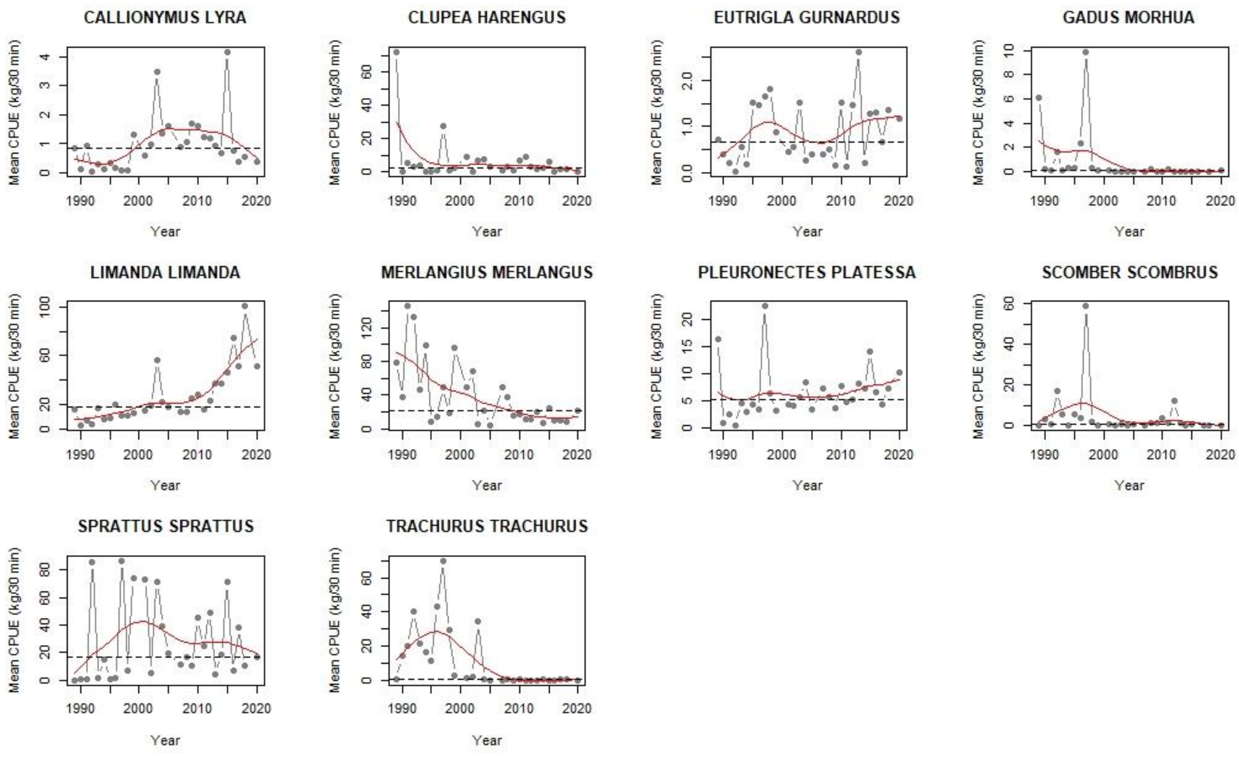


Figure 6: Top: Summed CPUE (kg 30 min^{-1}) of the species contributing to least 99.5% to the cumulative biomass in Box K. Bottom: Long-term trends in mean CPUE per haul (kg 30 min^{-1}) of the selected species in Box K, with indicated median CPUE per haul value over all sampling years (dashed line).

2.2. Long-term trends in elasmobranch catches

An overview of the total elasmobranch catches in 2020 as kg per 30 min and numbers per 30 min for each box are given in Table 4. Overall, most elasmobranches were caught in box E. In Figure 6 the decreasing trend of catches of thorny skate is shown for box H while in boxes K and E the catches of lesser spotted dogfish (*Scyliorhinus canicula*) seem to slightly increase over the last decade.

Table 4. Overview of elasmobranch catches in the 2020 GSBTS.

Box	Species	Total catch (kg)	Total catch (n)
BOX E	MUSTELUS ASTERIAS	0.21	2
BOX E	RAJA CLAVATA	0.53	6
BOX E	RAJA MONTAGUI	0.04	1
BOX E	SCYLIORHINUS CANICULA	0.22	8
BOX K	RAJA MONTAGUI	0.22	1
BOX K	SCYLIORHINUS CANICULA	0.22	4
BOX H	RAJA RADIATA	0.07	3
BOX P	SCYLIORHINUS CANICULA	0.103	1

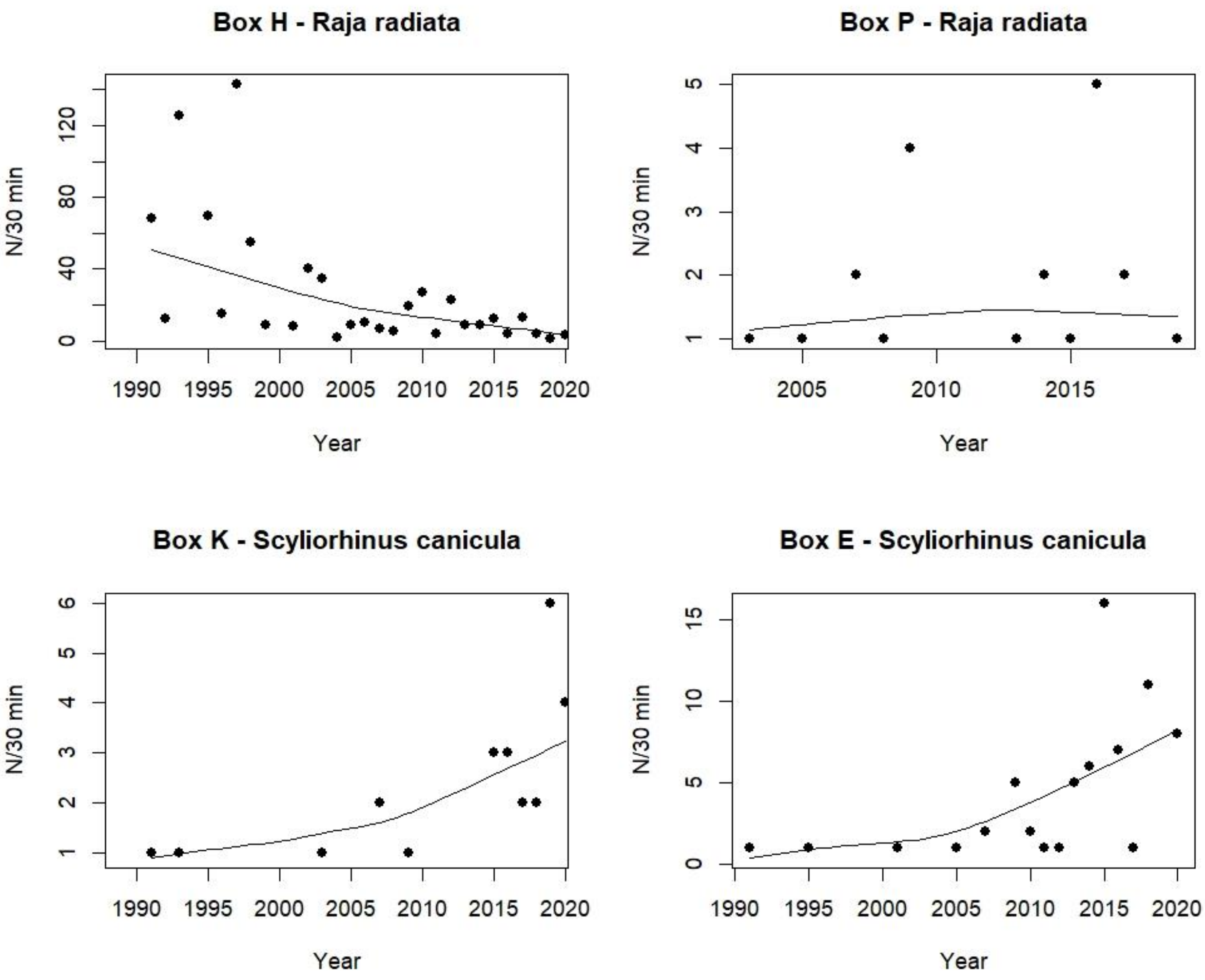


Figure 7: Long-term trends of the two more frequently caught elasmobranchs thorny skate (*Raja radiata*) and lesser spotted dogfish (*Scyliorhinus canicula*) as total numbers 30 min^{-1}.

2.3. Experimental fisheries in the vicinity of two offshore windparks

A total of 9 stations have been sampled with the standard GSBTS cod hopper and a trawl duration of 30 min around the offshore windparks (OWPs) Borkum Riffgrund (6) and Riffgat (3) on fine and muddy sand (Figure 8). Riffgat is located within coastal waters and close proximity to shore. The catch composition as mean kg per 30 min is shown in Table 5 and a relative comparison of mean cpues per species is shown in Figure 9. The main aim of the experimental trawls was to assess the proportion of brown crab (*Cancer pagurus*) catches since this species is expected to benefit from the artificial hard substrate within in OWPs. We only sampled brown crab around Borkum Riffgrund. Although the two OWPs are only located 30 km apart we found clear differences in catch composition between those two areas. For instance, lesser weever (*Echiichthys vipera*) a species associated to sandy bottoms were only caught in relatively high numbers (36) around Borkum Riffgrund. Only for a few species such as small sandeel (*Ammodytes tobianus*), dragonet (*Callinoymus lyra*) or European flounder (*Platichthys flesus*) mean catches were comparable.

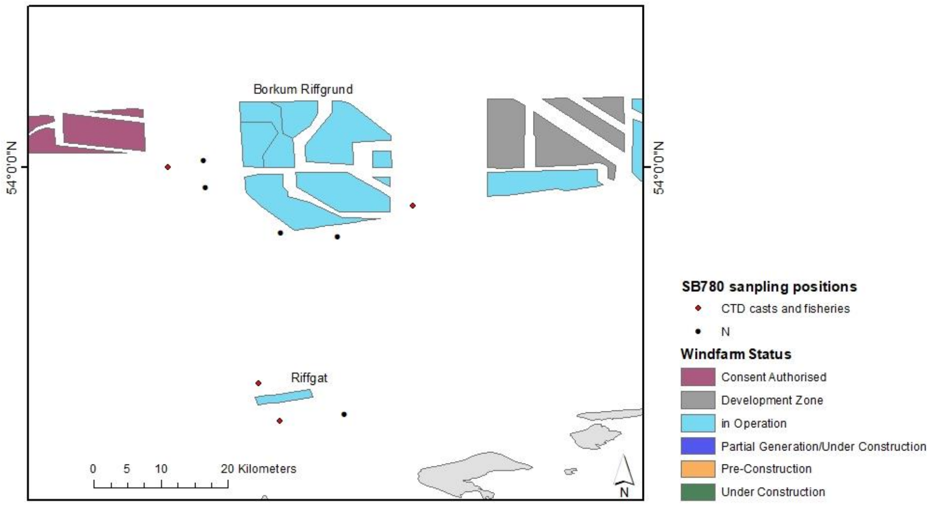


Figure 8: Mid trawl positions of the experimental fisheries in the close proximity of two offshore windparks.

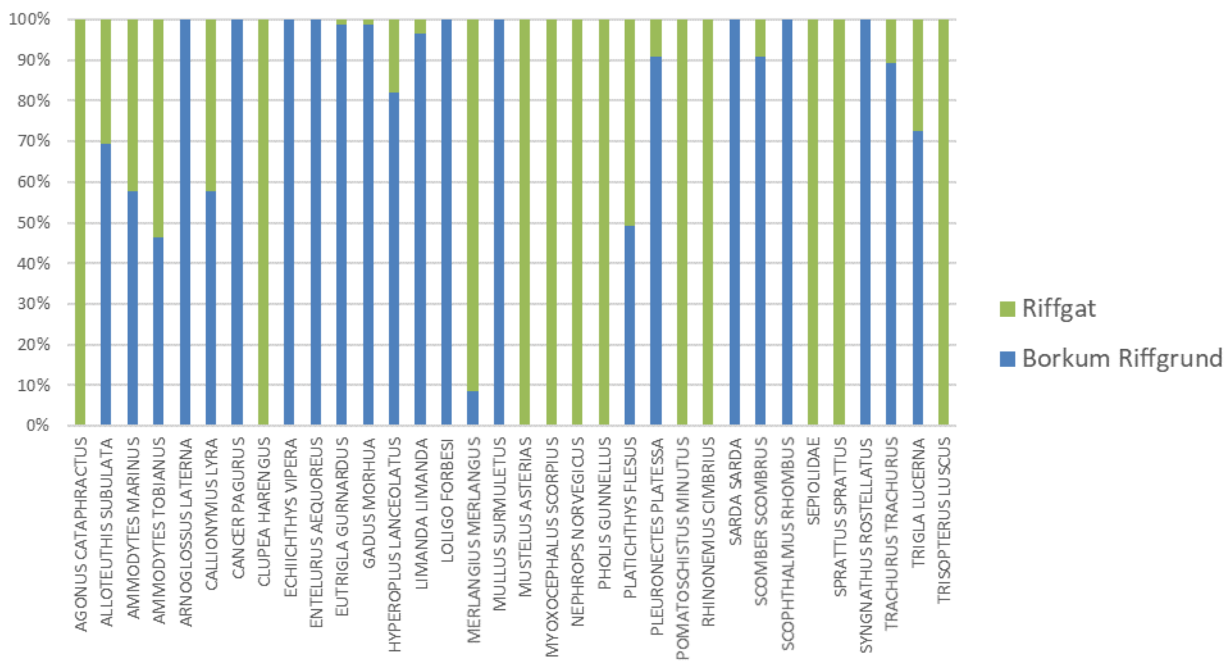


Figure 9: Relative comparison of the catches (mean kg per 30 min) per species. Note that the number of stations varied for the two distinct OWPs

Table 5. Catch composition (kg per 30 min averaged by OWP) of the nine stations sampled around the two OWPs Borkum Riffgrund (6 stations) and Riffgat (3 stations) during the course of SB780.

Species	Borkum Riffgrund	Riffgat
AGONUS CATAPHRACTUS	0.00	0.34
ALLOTEUTHIS SUBULATA	1.64	0.73
AMMODYTES MARINUS	0.65	0.47
AMMODYTES TOBIANUS	0.60	0.70
ARNOGLOSSUS LATERNA	0.03	0.00
CALLIONYMUS LYRA	0.08	0.06
CANCER PAGURUS	0.07	0.00
CLUPEA HARENGUS	0.00	9.31
ECHIICHTHYS VIPERA	1.12	0.00
ENTELURUS AEQUOREUS	0.02	0.00
EUTRIGLA GURNARDUS	0.15	0.00
GADUS MORHUA	0.69	0.01
HYPEROPLUS LANCEOLATUS	3.56	0.78
LIMANDA LIMANDA	3.83	0.14
LOLIGO FORBESI	1.13	0.00
MERLANGIUS MERLANGUS	0.94	9.99
MULLUS SURMULETUS	0.13	0.00
MUSTELUS ASTERIAS	0.00	3.38
MYOXOCEPHALUS SCORPIUS	0.00	0.06
NEPHROPS NORVEGICUS	0.00	0.03
PHOLIS GUNNELLUS	0.00	0.01
PLATICHTHYS FLESUS	0.25	0.26
PLEURONECTES PLATESSA	0.77	0.08
POMATOSCHISTUS MINUTUS	0.00	0.02
RHINONEMUS CIMBRIUS	0.00	0.00
SARDA SARDA	3.38	0.00
SCOMBER SCOMBRUS	6.27	0.63
SCOPHTHALMUS RHOMBUS	0.27	0.00
SEPIOLIDAE	0.00	0.00
SPRATTUS SPRATTUS	0.00	70.66
SYNGNATHUS ROSTELLATUS	0.00	0.00
TRACHURUS TRACHURUS	8.20	0.99
TRIGLA LUCERNA	0.45	0.17
TRISOPTERUS LUSCUS	0.00	0.04

We further deployed at 20 stations around the two OWPs a string of five baited pots with a total soaking time of 24 h (Figure 10). The total catches as number of female (N_F) and male (N_M) brown crab per station are also shown in Figure 10. Catches were standardised to a soaking time of 24 and were highest at the western boarder of Borkum Riffgrund (Figure 11). Overall more male brown crabs were sampled than female (Figure 12). The mean carapace width varied between females and males (F:142 mm; M:130 mm).

The observed differences in catches around Borkum Riffgrund could either indicate some degree of spatial preferences of brown crab or the effect of local depletion due to pot fishery that might have occurred around the days of sampling. We have observed UK pots being deployed at the western boarder at the dates of our experimental pot fisheries.

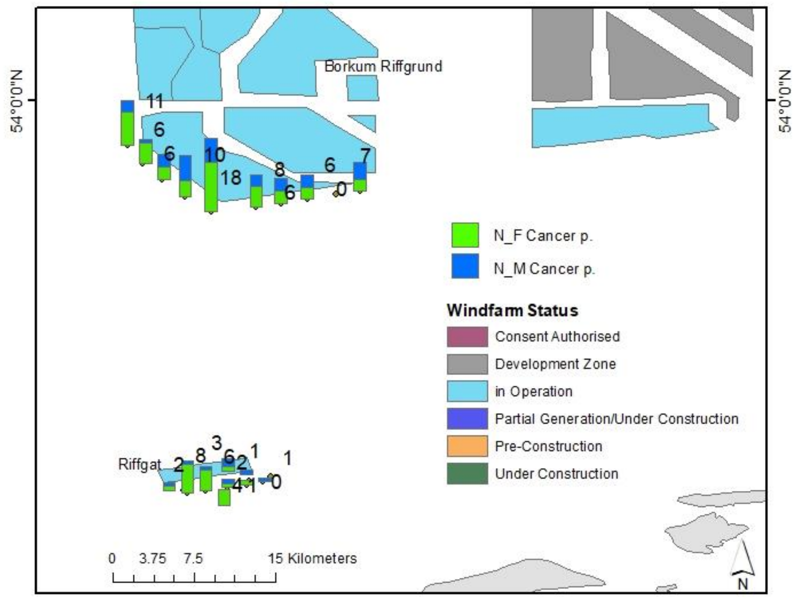


Figure 10: Relative position of pot strings with total number of female and male brown crab catches.

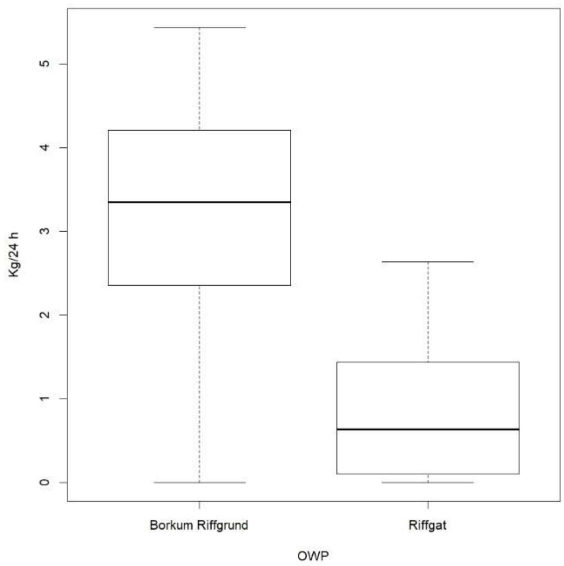


Figure 11: Standardised brown crab catches around the two OWPs Borkum Riffgrund and Riffgat.

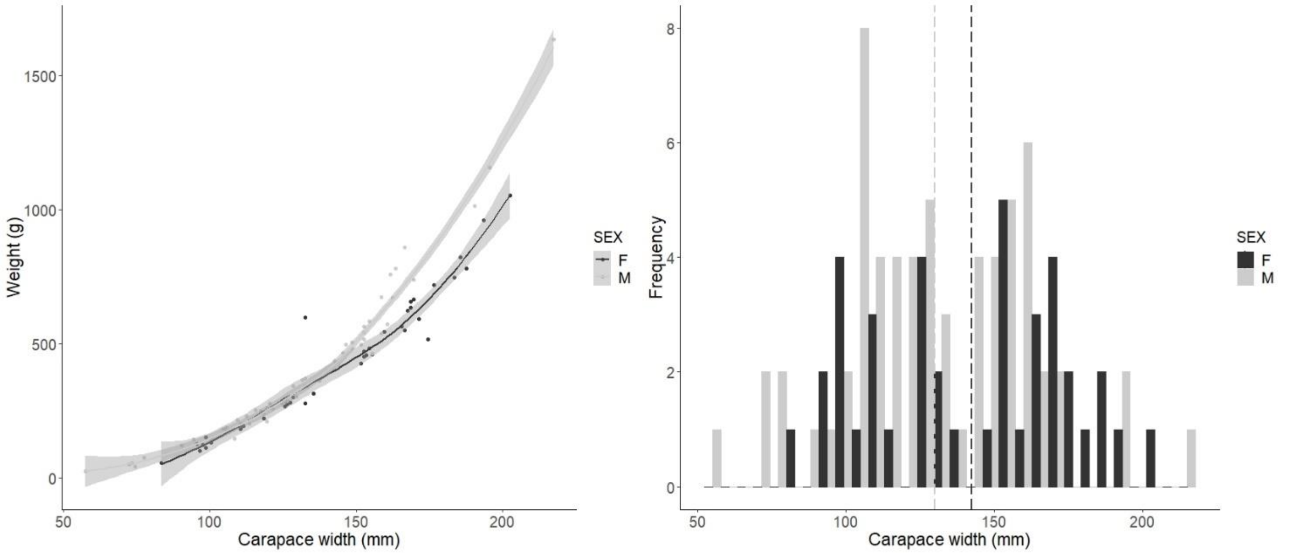


Figure 12: Carapace width – weight relationships of brown crab sampled by the experimental pot fishery (left); frequency distribution of carapace width for female and male brown crab with the mean width (F:142 mm; M:130 mm) (right).

Personnel

Name	Role	Affiliation
Dr. Nikolaus Probst	Scientist in charge/CTD (First part)	TI - SF
Dr. Vanessa Stelzenmüller	Scientist in charge/CTD (Second part)	TI - SF
Jana Bäger	Fisheries biology	TI - SF
Annika Elsheimer	Fisheries biology/database	TI - SF
Nicole Stollberg	Fisheries biology	TI_SF
Simon Wieser	Fisheries biology	TI - SF

Acknowledgements

We thank Captain Stefan Meier as well as the crew of FRV "Solea" and all members of the scientific team for their cooperation and outstanding commitment that allowed the successful accomplishment of the survey.

Dr. Wolfgang Nikolaus Probst Dr. Vanessa Stelzenmüller

Federal Research Institute for Rural Areas, Forestry and Fisherie

Thünen-Institute of Sea Fisheries

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Cruise Report
FRV Solea 786
02.12. – 20.12.2020

Cruise Leader: Kay Panten

Summary

The purpose of this trip was again the qualitative and quantitative recording of the demersal fish fauna in the German Exclusive Economic Zone (EEZ) of the North Sea. In conjunction with the results of investigations of the benthic invertebrate fauna of other research institutes possible changes due to increasing industrialization (wind farms, sand and gravel extraction) are to be detected. The entire EEZ was divided into different ecological zones and covered with a fixed station network. Since the investigation began in 2004, an annual exchange between the beam trawl and bottom trawl maintained. This year the investigations were therefore carried out again with the bottom trawl.
A total of 49 fish species and 43 invertebrate species were detected in the 63 carried out hauls with the bottom trawl. The fish were dominated by species dab, sprat, grey gurnad, plaice, herring and whiting. The catch of invertebrates consisted mainly of starfish, swimming crabs and whelks.

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TI - Ostseefischerei Rostock
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MRI - BFEL HH, FB Fischqualität

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Fahrtteilnehmer
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Doggerbank Seefischerei GmbH, Bremerhaven
Deutscher Fischerei - Verband e. V., Hamburg
Leibniz-Institut für Meereswissenschaften IFM-GEOMAR
H. Cammann-Oehne, BSH

Objectives

1. Monitoring of the demersal fish fauna in the German EEZ
2. Distribution of temperature and salinity in the area of investigation

Narrative (Fig. 1)

Due to the crew's test on COVID-19 on the day of departure and the waiting time for the results, the scientific crew did not board the ship until the late afternoon of 3^{rd} December. FMS Solea left Cuxhaven on 4^{th} December at around 12:00 p.m. The research work began on the same day southeast of Helgoland. During the following three days, the stations west and north of Helgoland could be fished before Helgoland was used as a safe harbour for one night before a storm. In the early morning of 8^{th} December the harbour was left again and the research work continued in a north-westerly direction. In the morning of 10^{th} December the wind freshened up so much that the research had to be stopped after two hauls in the far north-west of the German EEZ. In the last week of the survey it was possible to work on another 35 stations with changing winds. On the morning of 18^{th} December, the last haul of the voyage was finished. The survey was completed in the early afternoon of 19^{th} December at the Fassmer shipyard in Berne. The return journey to Bremerhaven took place the next day.

Results (Fig. 2 – 10)

A total of 63 half an hour and valid hauls were made using the “cod hopper” demersal trawl. At all 63 stations salinity and temperature were measured.
The species composition distribution showed the usual geographic pattern with Whiting, dab and haddock as the most frequent fish, followed by sprat, grey gurnad, herring and plaice. Cod was present only in small amounts and quantities. More southern species such as anchovy were sporadically represented. The catch of invertebrates consisted mainly of starfish, swimming crabs and whelks.

Participants:

Name	**Institution**
Kay Panten	TI-SF
Jana Bäger	TI-SF
Karin Krüger	TI-SF
Sandra Krüger	TI-SF
Sophie Lanners	TI-SF

K. Panten

Dipl.-Biol. K. Panten

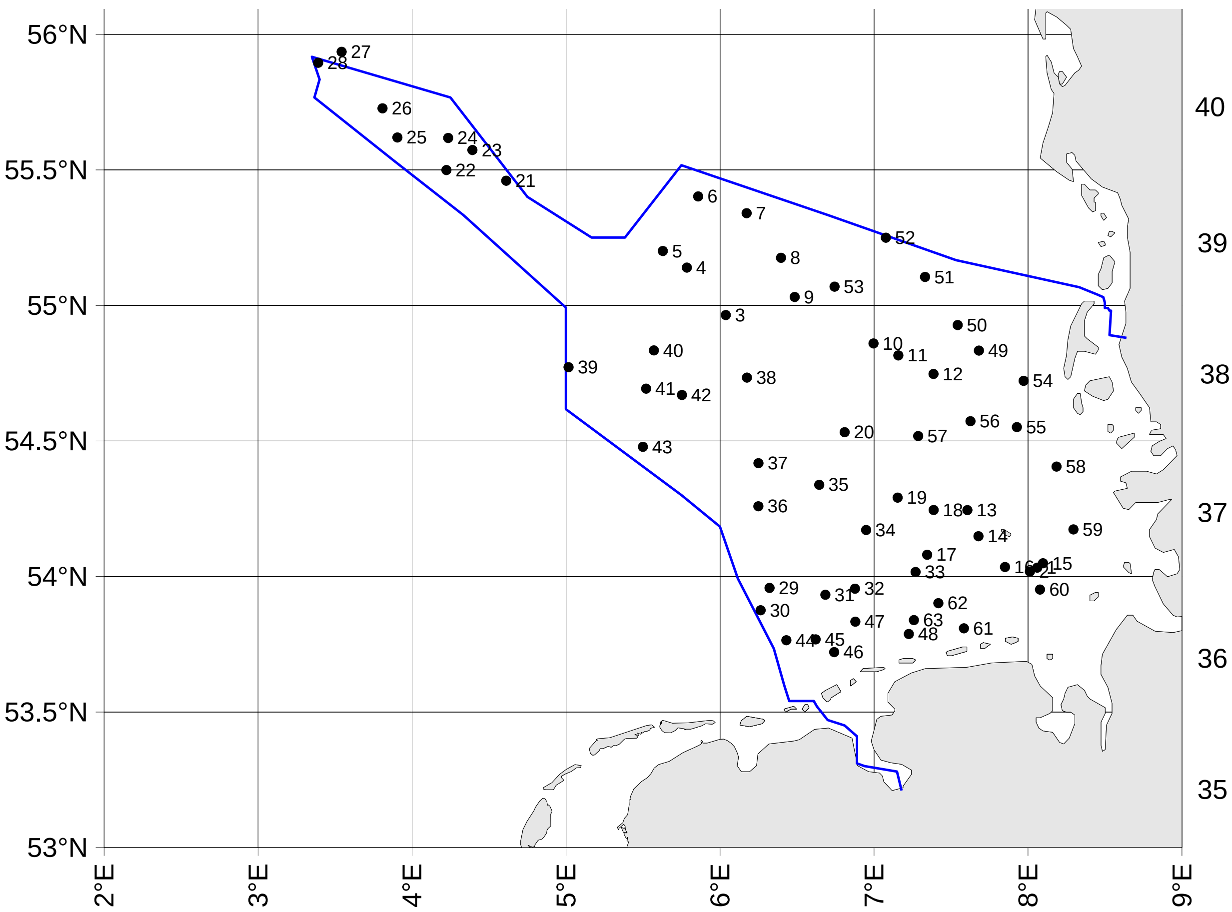


Fig. 1: "Solea", Cruise no. 786 , Haul positions and area of investigation

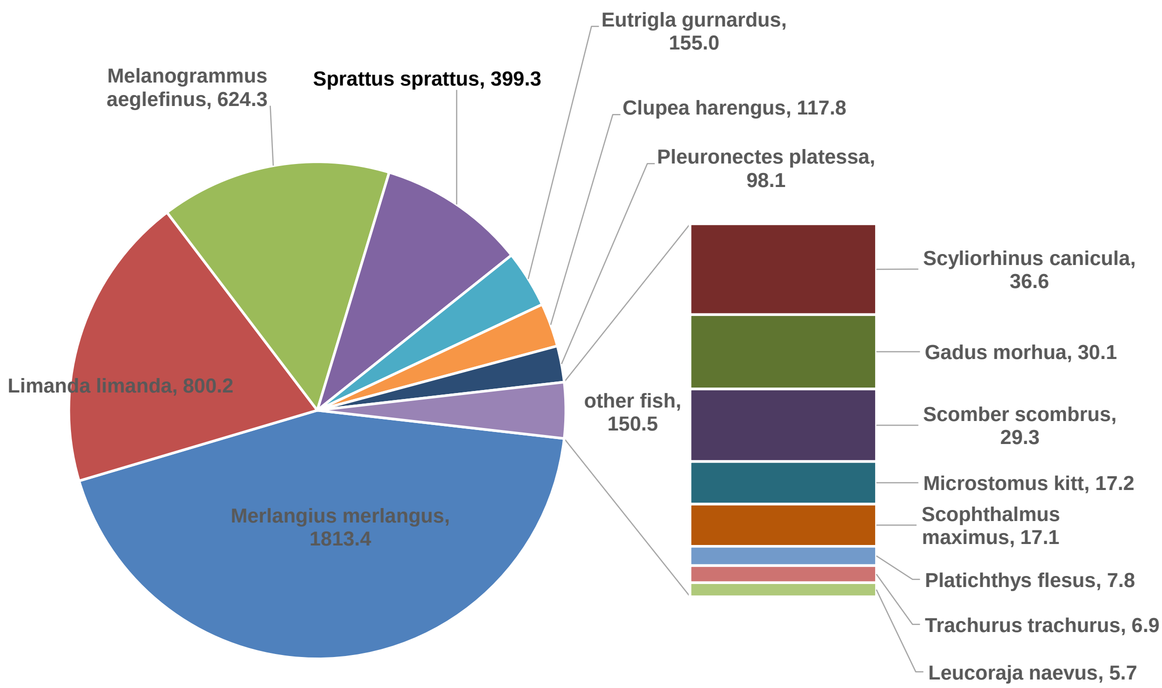


Fig. 2: Catch composition with the 15 most fish species caught in kg

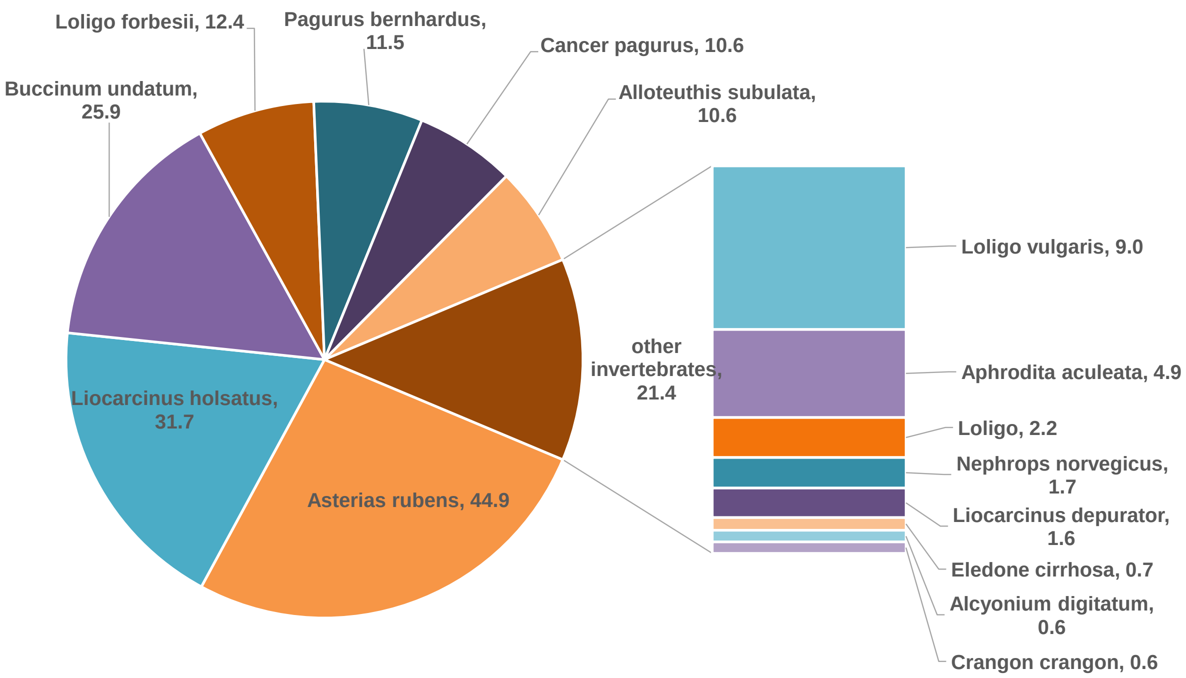


Fig. 3: Catch composition with the 15 most invertebrates caught in kg

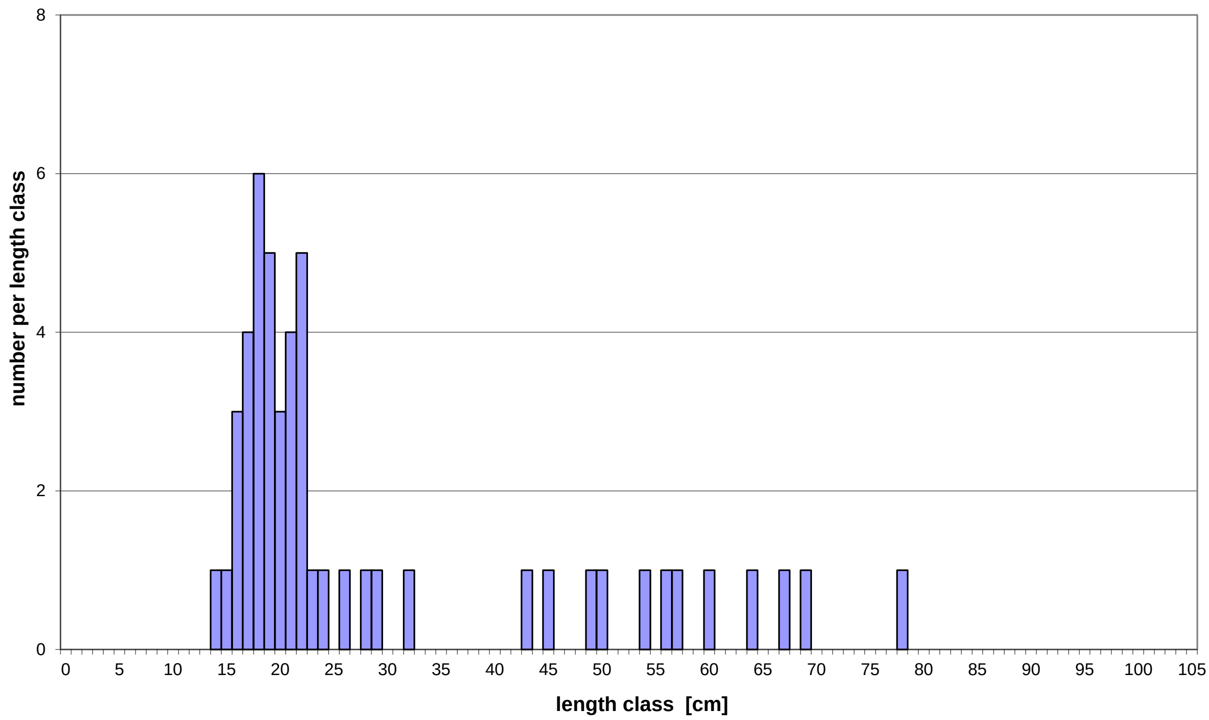


Fig. 4: Length distribution of cod (*Gadus morhua*)

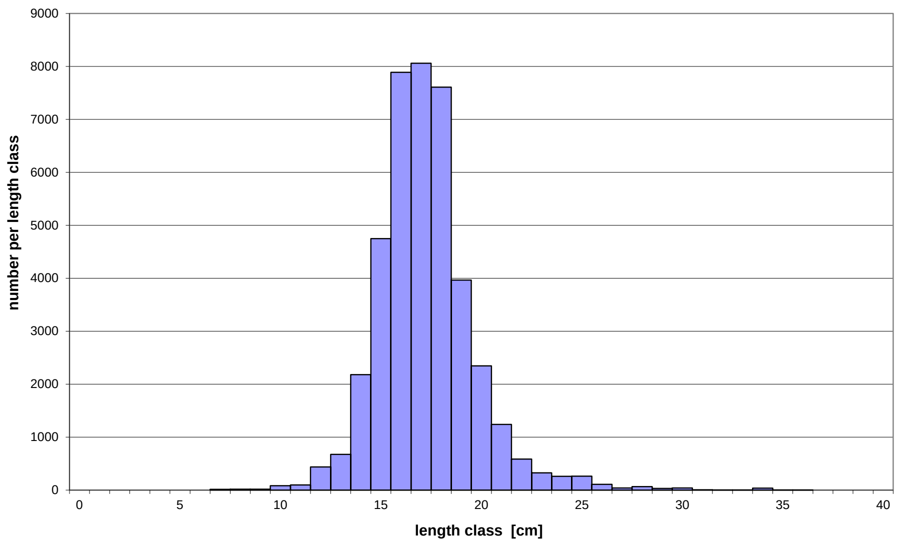


Fig. 5: Length distribution of whiting (*Merlangius merlangus*)

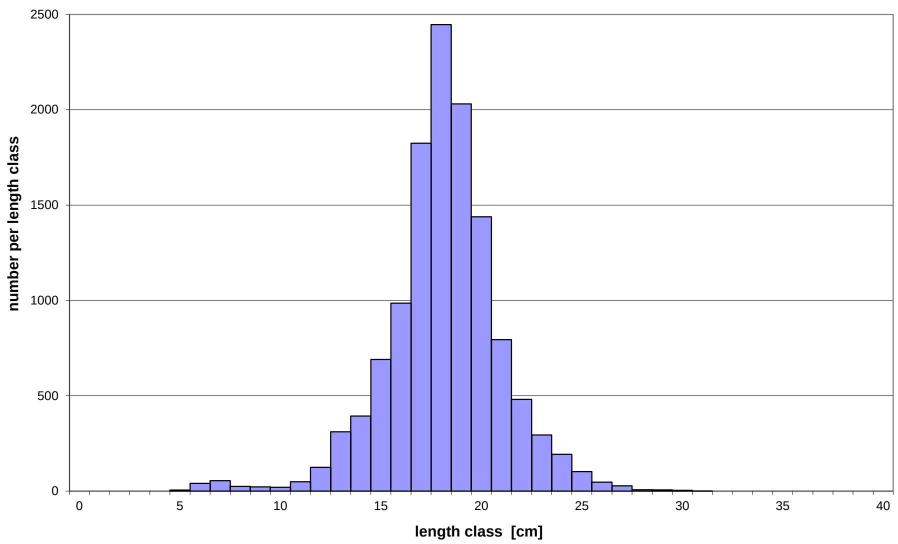


Fig. 6: Length distribution of dab (*Limanda limanda*)

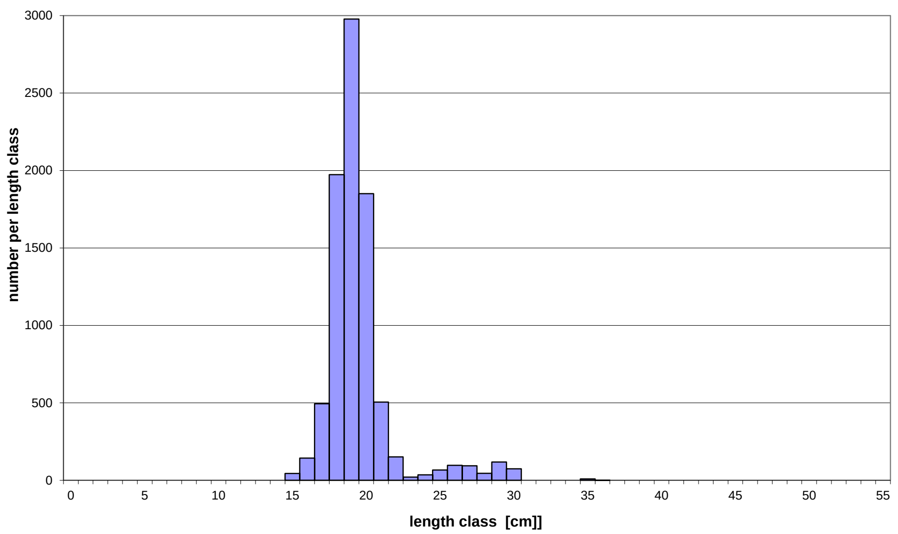


Fig. 7: Length distribution of haddock (*Melanogrammus aeglefinus*)

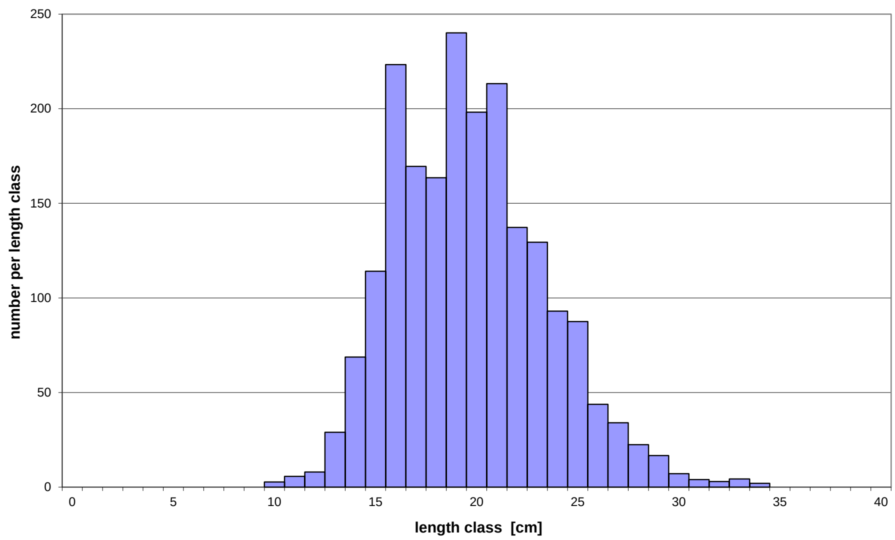


Fig. 8: Length distribution of grey gurnad (*Eutrigla gurnadus*)

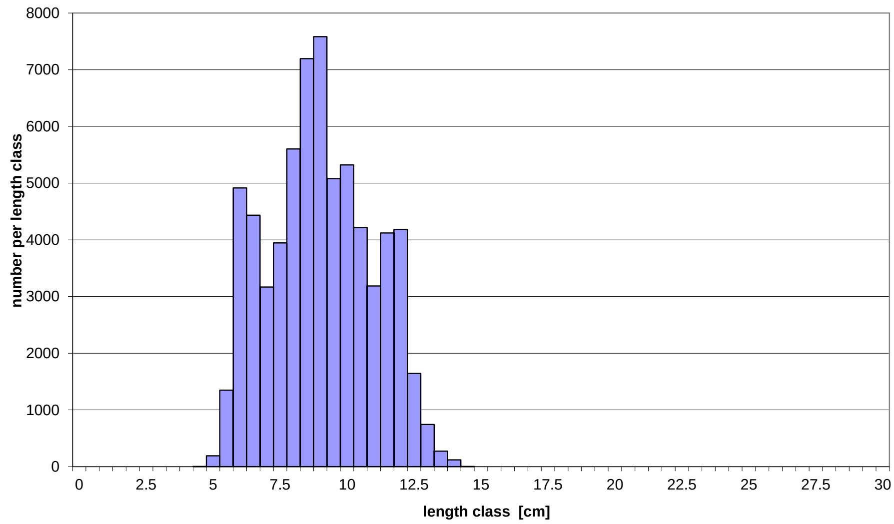


Fig. 9: Length distribution of sprat (*Sprattus sprattus*)

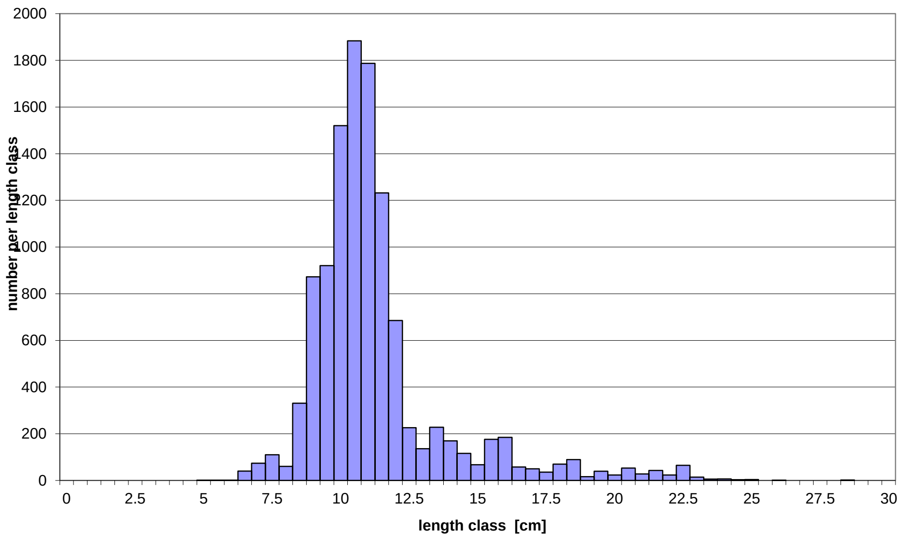


Fig. 10: Length distribution of herring (*Clupea harengus*)

Annex 2 to the German Annual Report for data collection in the fisheries and aquaculture sectors 2020:

Summaries of EMFF pilot studies

Evaluation of the German commercial catch sampling schemes in the Baltic Sea

Introduction

The Thünen Institute of Baltic Sea Fisheries (TI-OF) in Rostock, Germany, is responsible for implementing catch sampling of several German fisheries in the Baltic Sea, as listed in the infobox below. Currently sampling for biological parameters of important commercial species (e.g. herring, cod, plaice) in the Baltic Sea is conducted using a combination of approaches: at-sea, self-sampling and harbour sampling. The sampling design is similar for all three approaches; all are based on a multi-stage cluster design where the primary sampling unit (PSU) is vessel x trip for the at-sea and self-sampling methods and port x week for the harbour sampling (e.g. processing plant in Neu-Mukran). It is the PSU that is probabilistically sampled where practicable. The lower order sampling units, e.g. hauls in a trip or vessels landing at a location on that day, are generally selected opportunistically/randomly. The combination of sampling schemes is required since the fleets targeting different species differ in fishing methods, length of trips and species composition.

The present catch sampling programme is a mixture of long-standing routines and improvements implemented since 2012 based on suggestions from several ICES catch sampling working groups [1,2]. Since the sampling and raising procedures had never been formally evaluated, an external expert in catch sampling was contracted to assess the catch sampling programme for the following stocks: Western Baltic Spring Spawning Herring (WBSSH), Western Baltic cod (WBC), and Baltic plaice (BP).

Commercial sampling strata: Baltic Sea, Germany

Stratum ID	Description	Target Species, Assemblages
Baltic active 2224	Trawlers in SD22-24	Mixed demersal
Baltic passive 2224	Gillnetters and Longliners in SD22-24	Mixed demersal
Baltic active 2532	Trawlers in SD25-32	Mixed demersal
Baltic herring passive 2224	Gillnetters and Pound nets in SD22&24	Herring
Baltic herring active 2224	Trawlers in SD22&24	Herring
Baltic sprat	Trawlers in SD22&24-32	Sprat

Material and methods

Some of the following issues that were addressed: efficiency improvements from a statistical point of view; optimizing use of the available resources, e.g. observers and self-samples; number of otoliths aged; number of lengths measured; appropriateness and correctness of the raising schemes and random vessel selections; identifying and reducing bias in the information and data provided to stock assessors; and, optimization of sampling approaches and analyses where feasible.

The current approaches that are used e.g. to distribute annual sampling effort, data collection and management, data summarization and raising were reviewed in detail, and shortcomings and advantages of those approaches were discussed the with the scientists charged with implementation of the sampling programme. TI-OF provided data and simulations were conducted to identify the main sources of variability in the sampling effort. If the conclusion was that the current approaches are not

[1] ICES 2012. Report of the second Workshop on Practical Implementation of Statistical Sound Catch Sampling Programmes (WKPICS2). 6-9 November 2012, ICES Copenhagen. ICES CM 2012/ACOM:54, 71 pp.

[2] ICES 2013. Report of the third Workshop on Practical Implementation of Statistical Sound Catch Sampling Programmes (WKPICS3), 19-22 November 2013, ICES Copenhagen, ICES CM 2013/ACOM:54, 109 pp.

optimal, simulation studies of the effect of modifications to the current schemes or implementation of new alternative designs were considered.

Results

A review of the 2017 and 2018 sampling of the herring in SD22&24 and demersal fisheries in SD 22&24 indicated reasonably good coverage spatially, either in a geographic region or métier, and temporally (all relevant quarters). Specific suggestions for improvements are given for the three stocks evaluated:

*Herring SD22&24/*WBSSH: The evaluation showed that the current catch sampling already provides good estimates. However, simulation results revealed that a significant reduction in variability can be achieved by reducing the number of fishes aged per sample and by increasing the number of samples while the size of a sample can be reduced from presently ~50 kg to ~30 kg. This could be done using proportional allocation of trips to be sampled among strata. This suggestion would lead to an increase of the number of samples per year, an approximate doubling of the current number of samples. This would further limit the number of fishes measured for length to approximately 100 per sample, which would significantly decrease the number of fishes to be aged per year. Moreover, if possible, additional samples could also attempt to increase the temporal coverage (start and end of seasonal herring occurrence) and the spatial coverage (widen the number of ports sampled) to improve the quality for scientific analyses.

Cod SD22-24/WBC: Simulation results revealed that a significant improvement can be achieved when both the number of onboard observer trips and the number of trips with self-samples for aging could be doubled. To maintain the overall work load in the laboratory, a doubling of the number of self-samples would require a reduction in the size of the self-samples. Both of these together would reduce the variance of the two sets of frequency distributions that are provided to stock assessors.

Plaice SD22-32/BP: Since demersal fishes are sampled together, simulation results for plaice also revealed that a significant improvement can be achieved by increasing the number of onboard observer trips and doubling the number of trips with self-samples for aging, however with fewer fish per trip aged. However, specific for plaice, the best gain in precision is in the passive gear strata and so if resources are limited, the first strata that should be considered for a change in sample sizes are those strata.

Discussion and conclusions

The recommendations were discussed with the catch sampling experts and internally. As of January 2021, the TI-OF attempts to implement the expert suggestions, i.e. to increase the number of (self-)samples and observer trips while reducing the size of the self-samples.

An evaluation of national catch sampling schemes by an independent external expert is highly recommended. The evaluation can highlight improvements and, once a “certified” statistically sound sampling schemes is in place, it is beneficial is numerous ways (e.g. trust by the staff involved in catch sampling and the end users of the data). Finally, the EU Commission and the stakeholders can be sure that the catch sampling schemes can deliver the data quality requested.

Quantitative contribution of inner coastal waters to the population dynamics of Atlantic herring (*Clupea harengus*) in the Western Baltic Sea

Introduction

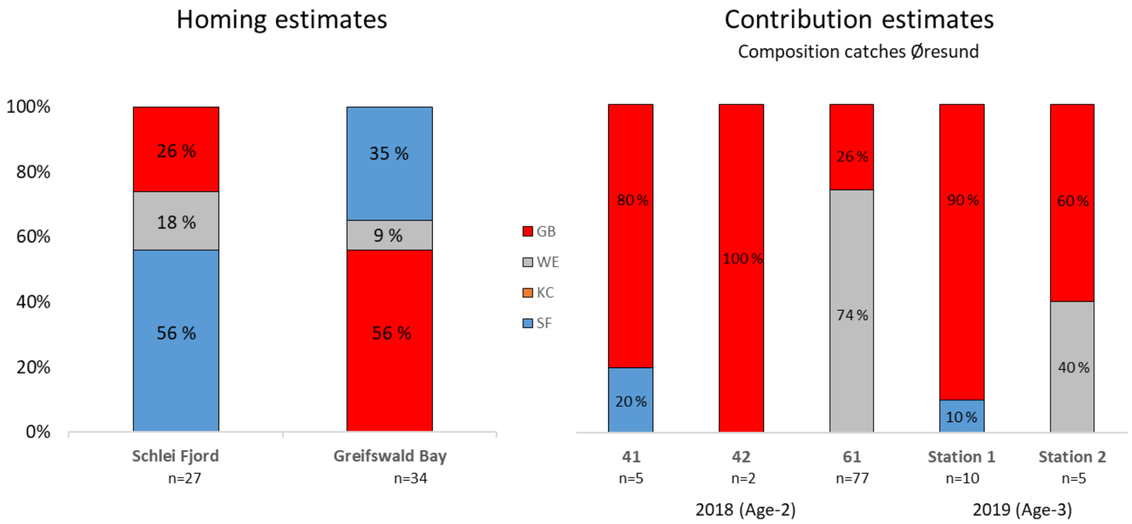
Herring recruitment in the Western Baltic Sea decreased dramatically within the last 17 years, being on a reduced level since the mid-2000 with the lowest values of the more than 30 years-time series determined in 2016 and 2017. The reasons for this continuous decline is still unknown, assuming that on-going climate change, eutrophication processes in the past and related cascade effects have a cumulative impact on the local scale of important spawning grounds, being vital for Western Baltic herring reproduction. Moreover, Western Baltic herring is considered to annually return to the same bays and estuaries for spawning. This so-called homing behavior potentially renders the population rather vulnerable against environmental changes in those coastal inshore areas. Hence, knowing the quantitative contribution of single spawning areas to the overall population and the degree of herring habitat dependency throughout the life cycle is essential to understand recruitment variability. Within this EMFF pilot project, Western Baltic herring habitat connectivity was investigated with the method of elemental fingerprinting to provide empiric data for the first time.

Material and methods

The general approach is to use otoliths from young-of-the-year (YOY) herring, caught in four historically known spawning areas along the Western Baltic coastline in 2016 (see map: (1) Schlei Fjord, (2) Kiel Canal, (3) Warnow Estuary, (4) Greifswald Bay) as chemical baseline signals for each habitat (natal fingerprints). In a second step, adult herring in spawning mode (age-3) were sampled during the spawning season in two distinct spawning areas in 2019 (Schlei Fjord (1) and Greifswald Bay (4)) to investigate the precision of homing. Additionally, adult herring in post-spawning condition were caught in the Øresund (5) in 2018 (age-2) and 2019 (age-3), known to be the main overwintering area for Western Baltic herring, thus warranting a representative sample of the entire population. All adult individuals originated from the same hatching season (2016) as the YOY herring to avoid temporal variability effects. Elemental concentrations in the otolith cores from YOY and adult herring were analysed with a Laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) in cooperation with the Max-Planck-Institute for Chemistry in Mainz (Germany). A combination of 13 elements (Li, B, Na, Mg, Si, Mn, Fe, Cu, Rb, Sr, Sn, Ba, Tl) was used to assess the natal origin of adult herring, according to the elemental fingerprints in YOY herring. The classification method of random forest was used to classify the adult individuals to a certain spawning area with a model accuracy of 96 %.Due to the corona pandemic, there was a four-month delay in otolith chemical analysis and subsequent data analysis

Results

Regarding herring habitat dependency (homing estimates: left bar chart), classification data showed a precise homing behavior of the Western Baltic herring population. In both sampling area Schlei Fjord and Greifswald Bay, the majority (56%) of adult herring returned to their natal spawning areas for reproduction, showing natal homing. Regardless of catch area, 44% of adult individuals were identified as straying individuals. Those straying fish originated from Greifswald Bay, Warnow Estuary and Schlei Fjord. No single fish was assigned to Kiel Canal.



Regarding contribution estimates (right bar chart), the fish from the Øresund overwintering area consisted mainly of herring originated from Greifswald Bay and Warnow area with a further small amount from Schlei Fjord. However, results have to be considered in relation to sample sizes. Contributions vary along haul/station. For the stations 41, 42, Station 1 and Station 2, only few individuals were caught within the area. These fish originated mainly from Greifswald Bay, whereas Warnow Estuary contributed the majority within the catch at station 61, with a sample size of 77 individuals. Overall, spawning areas located in the eastern German coastline contributed the majority to the herring year-class of 2016.

Discussion and conclusions

Natal homing and related straying behavior are well-documented traits for diadromous fish species and marine fish, such as Atlantic tuna. The understanding of the driving guidance mechanisms are still lacking, however, larval imprinting and magnetic field orientation are widely discussed for diadromous fish. In terms of coastal spawning areas being intensively stressed by climate change and habitat degradation, the high habitat dependency of herring to specific reproduction areas poses the risk to affect the overall population level, emphasizing the need for directed coastal zone management strategies. One aspect that needs to be considered for interpretation of contribution results is the general low catches of herring in the Øresund area (see sample sizes per haul). We can only speculate on the reasons, either there is no fish due to decline in population size or there might be a change to other/new overwintering areas. Nevertheless, results revealed that composition is driven by catching schooling herring (with potential strayers). This is an important result, which should be considered in future fishery science sampling strategies.

Acoustic telemetry in the western Baltic Sea

Introduction

Cod (*Gadus morhua*) is a commercially and ecologically important fish species in the western Baltic Sea. There are several indications that the western Baltic cod (WBC) stock is currently not in a good state. Although little is known about the individual movements and behaviors of WBC, recent research has revealed seasonal patterns in habitat use of this stock[1]. Slopes with “stony fields” apparently play a key role for cod as a transition area, or as day-time resting sites, between the shallow water night-time feeding grounds and the deeper areas that are used in spring for spawning[1].

Acoustic telemetry is a method with the potential to provide the required information on movement and behaviour of individual fish within a certain area. This method is based on the deployment of receivers at an area of interest, which “listen” for acoustic signals transmitted by electronic tags attached to individuals of the study species, which were tagged within or near the telemetry array.

The aim of this study is to use acoustic telemetry to explore how cod in the western Baltic Sea use a sloped area with stony habitats. This study required the establishment of an array of acoustic telemetry receivers within an area of the western Baltic Sea that is known to be inhabited by cod, with receivers covering different depths and substrate types. This document briefly summarizes the first three years of work concerning the establishment of such an array in the German coastal waters of the western Baltic Sea.

Material and methods

The establishment of an array of acoustic telemetry receivers requires a number of tasks that have to be handled both sequentially and in parallel. The tasks involved: identification of an appropriate area, array design, permission to deploy receivers, assemble equipment, animal experiment application, training and networking, range testing, deployment and monitoring.

Photographs showing the equipment on-board a research vessel, prior to a range test deployment.
From left to right: acoustic transmitter (at the tip of the blue wire); acoustic receiver with two yellow flotation collars to keep it upright in the water column; ropes and buoys for a range test.

Results

The **identification of an appropriate area** yielded an area called "Walkyriengrund" (western Mecklenburg Bay). In 2018, a permission was, however, not issued because we had applied for a closed area which, for sea safety reasons, would have required a buffer zone so large that it had impeded the marine traffic. A re-evaluation together with fishers and anglers identified an area in the southern Lübeck Bay. The **array design** was adapted and a **permission to deploy receivers** was finally issued in autumn 2020. This, however, only came with the obligation of the Waterways and Shipping Office to indicate the positions of the 30 small acoustic receivers (see middle photo in Text Box) with a total of 24 large and anchored surface buoys – and permissions from several other authorities. Hence, buoys, chains, weights and accessories had to be purchased, requiring a national tendering and awarding procedure which took half a year. **Assembling other equipment** like release canisters was necessary.

In 2020, the array region was explored several times using underwater camera, taking measurements of water parameters and performing **range tests** under different environmental conditions. The range tests indicated that a spacing of 500 m between receivers should allow for high detection probability during good conditions. An **animal experiment application** was submitted and a permission issued in 2020. In terms of **networking,** in 2019 staff members participated in **training courses** and conferences.

Since the 24 buoys with chains and weights are too large and heavy to be deployed by any of the vessels available to the Thünen Institute, a specialized vessel had to be chartered - which again required a national tendering and awarding procedure. This procedure was only finalized in March 2021. Ultimately, the **deployment** of the telemetry array will happen in July 2021. In the fourth quarter of 2021, with decreasing water temperatures, cod will be caught, marked and released in the array so that the **monitoring** of cod movements and behavior can start.

Discussion and conclusions

The establishment of an array of acoustic telemetry receivers in German coastal waters is a time-consuming, expensive and complex endeavor. In total it will have taken 3 years before a first tagged cod will transfer data to one of the receivers. A chronicle was started to document the tasks, challenges and lessons learned from this ongoing project.

In the meantime, scientists of the Leibniz Institute of Baltic Sea Research in Warnemünde, Germany, were invited to cooperate in the project. They will mainly contribute with detailed oceanographic measurements and side-scan sonar images but other research groups may join; and Deutsches Meeresmuseum in Stralsund, Germany, plans to provide detection devices to assess the presence of Cetaceans in and near the telemetry array.

Development and testing of an open source software framework for optical data acquisition and image recognition for use in fisheries biological research and fisheries

Introduction

This project aimed to improve the biological sampling and data collection on research vessels and commercial ships in terms of efficiency and data quality through better spatial and temporal resolution

In order to be able to carry out biological sampling and data collection on research vessels and commercial vessels more efficiently and at the same time improve data quality through better spatial and temporal resolution, an open-source software framework is to be established that enables optical data collection to be carried out and evaluated automatically. Therefore, it was aimed to research over exiting open-source software frameworks and test best candidates. The software framework should be able to handle multitude of different applications (zooplankton/fish; in-situ/ex-situ). The best suited open source framework was implemented for one use case.

Material and methods

At the beginning of the project, existing open source software frameworks for image recognition and classification (using convolutional neural networks - CNN) were evaluated. Based on this research, a suitable framework was chosen and implemented. This framework uses OpenCV, TensorFlow with the Keras API and YOLOV3 for video annotation and the feature extractor VGG16 with different classifier methods. Two different scenarios were used for optical data acquisition (the hardware/camera system) and adapted for the classification in fishery-biological sampling:

- in-situ (e. g. with camera systems in the net)
- ex-situ (in the lab at fishing vessels)

In addition to the choice of software framework(s), classified trained data are essential for a successful implementation. The research study showed that there is no suitable public available database with classified training data available for the aimed species at the Baltic Sea. Therefore, it was necessary to create and own training data set and to find solutions that are able to work also on smaller datasets, which limits the exemplary implementation planned in this project. Consequently, it was necessary to invest more time and effort as intended in creating a suitable dataset from Thuenen own video data collections.

Results and discussion

After setting up the open source software framework for species classification with convolutional neural network, a use case for fish classification in the lab was implemented and published [1]. It is based on a hierarchical classification. While conventional CNN (convolutional neural networks)achieve remarkable performance on visual recognition, they do not recognize the object on the natural paradigm of hierarchy as humans as desired. Therefore, a framework was developed that allows the classification of fish species in the semantic hierarchy. Inspired by the stacking model approach proposed by Wolpert [9] and combined with semantic hierarchical label classification, we implemented a framework to

a. detect
b. classify fish in a two-level semantic hierarchy
c. count the number and measure the length of fish

Deeper CNN's with a large number of model parameters and also trained on a huge number of examples drastically improves the classification accuracy [2]. Simonyan et al. [3] proposed a network called VGG16 in ILSVRC 2014, trained on ImageNet [4] dataset, which achieves 92.7% test accuracy applied to the testing data. ImageNet is a dataset of nearly 15 million common object images with around 22,000 categories. ILSVRC14 uses a subset of the ImageNet dataset with 1000 images per class (1000 categories). While there are so many fish species in the world, only a few small open source fish datasets [5] [6] are available. Therefore, at this moment it is not possible to develop a generalized fish detection model using currently available datasets. To increase classification accuracy using a small dataset, Siddiqui et al. [7] used a cross-layer pooling algorithm with the CNN as feature extractor and support vector machine as a classifier to classify fish species such as P. porosus, P. emeryii etc. In general, a single deep learning model (feature extractor and a classifier) trained on small datasets can bias to the dataset used for the training and not performing well on unseen data (overfitting). Wolpert [9] proposed a method called stacked generalization, which uses a number of base models and a single meta model to minimize the generalization error.

This use case specific implementation on our small dataset has shown that the classification accuracy, precision and the recall of the fish species can be increased using a stacked generalization. The disadvantage of this approach is a computationally expensive training of the model and tuning of the hyper- parameter. The predicted length measurement values have relatively high root mean square error (RMSE). Therefore, the applied, quite simple method of length estimation might not be suitable for most biological applications. Hence, for further improvement, we have to add more data in the training set for better accuracy of object localization or could implement a machine vision approach such as a stereo vision for length measurement.

Conclusion and outlook

In this project, an open source software framework has been established that is applicable on several use cases as desired. The weakness of this framework is the high computational power that results in the limitation that a method has to be choosen that can run on small databases. Therefore, the upcoming task is to setup cooperations to work together on the generation of a qualified training database for the desired species, e.g. in the Baltic Sea. The next step will be to extend the existing framework on faster methods for bigger training datasets and the extension on other desired use cases.

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Development of an agent-based simulation model to estimate angler behaviour on management decisions and stock development of western Baltic cod

Introduction

Marine recreational fishing (MRF) is a popular activity, which generates significant economic and social values (Cisneros-Montemayor and Sumaila, 2010; Hyder et al., 2018). Marine recreational fishers (anglers) catch substantial quantities of fish (Coleman, 2004; Cooke and Cowx, 2004; Hyder et al., 2018), and recreational catches exceed commercial catches for certain fish stocks (Lloret et al., 2008; Herfaut et al., 2013). In mixed recreational-commercial fisheries targeting overexploited fish stocks, the burden of stock rebuilding has to be shared between commercial and recreational fisheries, especially when the recreational fisheries have a high share of the total fish removals (Eero et al., 2015). For this reason and the poor stock situation of western Baltic cod, the Council of Ministers introduced a daily bag limit for the western Baltic recreational cod fishery in 2017 (EU, 2016) to share the burden of rebuilding with the western Baltic commercial cod fishery. The introduced bag limit is believed to have significantly changed angling behaviour. Although simple simulations on the impact of different management measures (closed season, minimum size increase, daily catch limit) on the total removal of cod have been carried out in advance (Strehlow and Zimmermann, 2016), these simulations could neither take into account the changes in angler behaviour nor the interactions between angler behaviour and stock development. However, changes in angler behaviour, for example in terms of fishing effort, catches or target fish species, can be decisive for the success of a management measure (Hunt et al., 2013). So far, it has not been possible to predict these behavioural changes in advance of the management decision, as the reactions of anglers to management measures are subject to complex and individual behavioural patterns that are not reflected in models developed so far. This makes reliable predictions of the effects of certain management measures impossible.

Material, methods and implementation

The aim of the project is to develop an agent-based simulation model (ABM) that is able to heterogeneously represent the behaviour of anglers in response to management measures in the Baltic Sea system on the basis of available data on angling and fish stocks. Therefore, the project uses recreational data, collected within the framework of the German marine recreational fisheries data collection program. During a multiannual on-site access-point-intercept survey catch per unit effort data for different fishing methods are obtained together with further information about anglers (e.g. place of origin). The data from the on-site survey will be mainly used to parametrize the ABM in regard to catch, harvest and release rates at different fishing locations and it´s seasonal variations. In addition, information of the angler origin will be used to model realistic spatial distribution patterns of anglers. Also, data from an ongoing nationwide random digit dialling telephone survey will be used. Firstly, to build a realistic angling community with its heterogeneity in socio-demographics, skills, centrality to lives, catch-orientations and motivations. Secondly, to model realistic angling behaviour (e.g. effort or reactions to new regulations). The project will thus create a simulation tool that will enable scientists to study the effects of different management measures on both angler behaviour and the development of the cod stock. The results of these simulations can then in turn serve as a basis for knowledge-based decision making of fisheries management and policy. In the longer term, the model will be coupled with existing macro models on the cod population (Haase, 2018) and micro models of cod physiology and behaviour (Pierce et al., 2017). The knowledge gained in the project as well as the models developed should be also applicable not only to the specific case of Western cod, but beyond that to other fish species and fisheries. The project is carried out in close cooperation with the Institute of computer science at the University of Rostock (Prof. Dr. A. Uhrmacher - Chair of Modelling and Simulation) and builds on an already existing cooperation. The actual project work is carried out by a jointly supervised doctoral student.

Current status of the project

The familiarisation with recreational fishing literature and available empirical data resulted in a paper draft which will be submitted shortly. The paper presents the effects on the removals, angler community and fish stocks of four recreational fisheries management measures, namely bag limits, minimum landing sizes, slot limits and seasonal closures using German recreational time series data (Haase et al., in prep).

For the development of the ABM, the modelling language ML3 has been learned, which allows in contrast to most other methods the use of continues time. On this basis an ABM has been developed, which included numerous components of the German western Baltic recreational cod fishery, for example, the model has been able to represent a realistic angler community in regard to origin, fishing effort and catch rates. Also, the angler agents have been able to communicate in social networks and over a broadcast function, which could be used to simulate information transfer over social media. In the current state two main mechanisms of angler behaviour have been examined. Firstly, information of current catches is transferred between the angler agents and leads to increased or decreased fishing effort. With this mechanism, we might be able to explain some of the effort fluctuation before the bag limit has been introduced. The second mechanism is limiting the hope for a very good fishing day with a high number of caught cod and thus is reflecting a bag limit that is usually not reached but nevertheless may constitute a psychological constraint to angler catch expectation. Anglers react differently to catch restrictions (Hunt et al., 2013) due to their individual set of attributes, e.g. a less catch-oriented angler keeps going fishing, whereas a catch-oriented angler leaves the fishery. Thus, the model will enable to determine optimal management measures that achieve compliance and maximize fishing quality for the participants to sustain the recreational fisheries sector and ensure economic benefit to coastal regions.

These two mechanisms will be validated with available effort dynamics. In a next step, the data from an ongoing national telephone survey targeted at recreational fishers and contacting 150,000 German households will be used to integrate several angler subdimensions, such as skill, centrality and catch orientation into the model and to further parameterize simulation runs, which will then in turn be calibrated and validated against the recreational charter boat fishery around Fehmarn. Next to the ongoing model development, model documentation with an ODD+D protocol and data provenance are under construction to ensure the trustworthiness and replicability of the model. Additionally, sociological theories explaining individual decision processes have been examined and a review paper about the use of this decision theories in fisheries models will be written and presented at an international conference in Spring 2021. The evaluation framework for the review process has been developed and submitted to the proceedings of the 2021 Winter Simulation Conference (Haase et al., submitted). In the long-term, the ABM will be coupled with the existing population and physiology-behaviour models of cod and the gained knowledge made available through scientific publications.

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Food availability for herring

Introduction

Current literature demonstrates strong effects of climate change on plankton communities that can result in a decline of energy availability for higher trophic levels, like herring, as warming conditions lead zooplankton communities to shift towards lower densities, small sized zooplankton species, and individuals decrease in body size. In addition to these changes in zooplankton density and biomass, energy availability for herring can be altered by spatial and temporal mismatch. For the past two decades, poor recruitment has been observed in the Western Baltic spring spawning herring stock as shown by monitoring programs. Insufficient food has the most potential for adverse effects on herring survival and development during the early larval stages. Therefore, we investigated zooplankton prey field for herring larvae in the Greifswald Bay where a major component of Western Baltic spring spawning herring performs annual spawning migrations.

Material and methods

Since 2008 zooplankton has been sampled weekly in several monitoring stations throughout the Greifswald Bay from February/March till the end of June. Each sample was taken by a vertical Apstein net (55 µm) tow from the bottom to the surface and preserved in 4% formaldehyde solution. Subsequently samples from four monitoring stations representing different parts of the bay were analysed in a laboratory to determine zooplankton species composition and abundance. In addition, copepods were sorted in developmental stages (nauplii, copepodites 1-3, copepodites 4-5, males, females). Lastly, a 13-year data series (2008-2020) were analysed for trends.

Results

Our data show that mean zooplankton abundance has decreased about 10 times since 2013 compared to 2008-2012 (Fig. 1). The change seems to be mostly driven by decrease in Copepoda nauplii, particularly *Acartia spp*. nauplii, the dominant copepod species in the bay (Fig. 2), as well as Rotifera and meroplankton organisms Bivalvia larvae (Fig. 3).

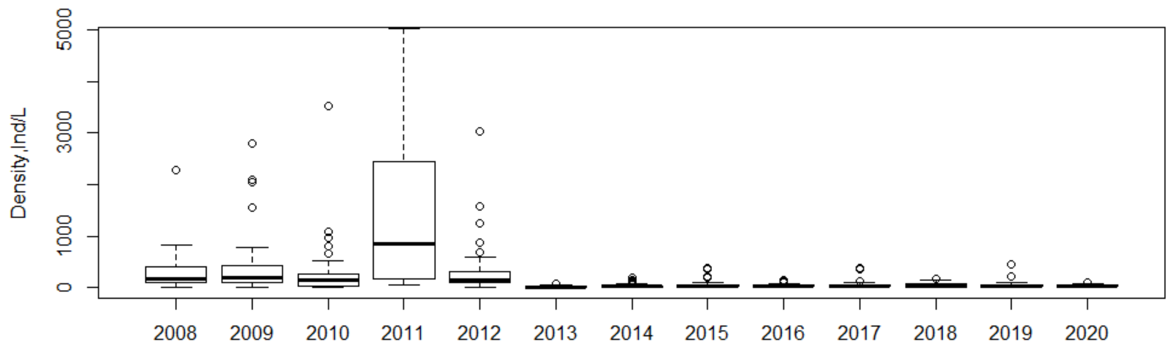


Figure 1. Annual mean zooplankton density in 2008-2020. The boxplot: Quartiles (25, 50, 75 percentiles), 50% is the median, the upper whisker is the maximum value of the data that is within 1.5 times the interquartile range over the 75th percentile, the lower whisker is the minimum value of the data that is within 1.5 times the interquartile range under the 25th percentile. Outlier values any values over 1.5 times the interquartile range.

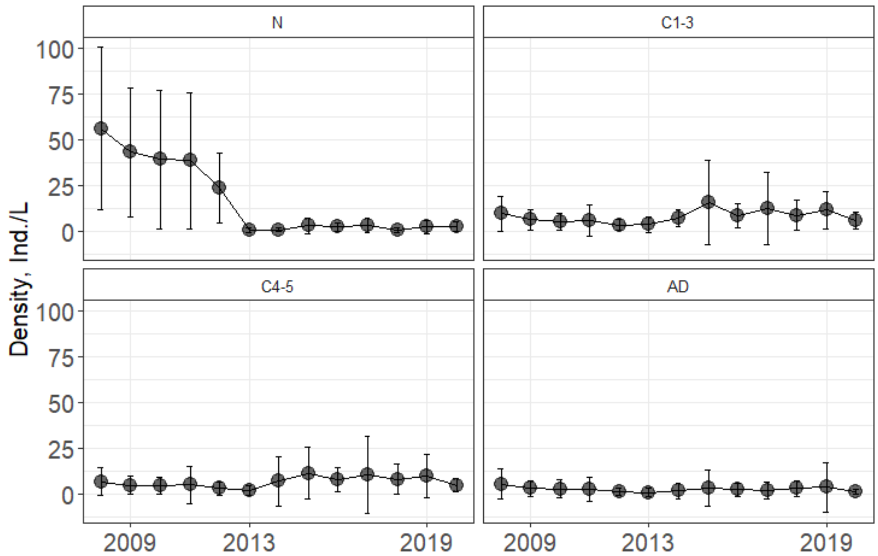


Figure 2. Annual mean ± S.D. density of *Acartia spp*. Nauplii (N), copepodites (C1-3 and C4-5) and adults (AD) in 2008-2020.

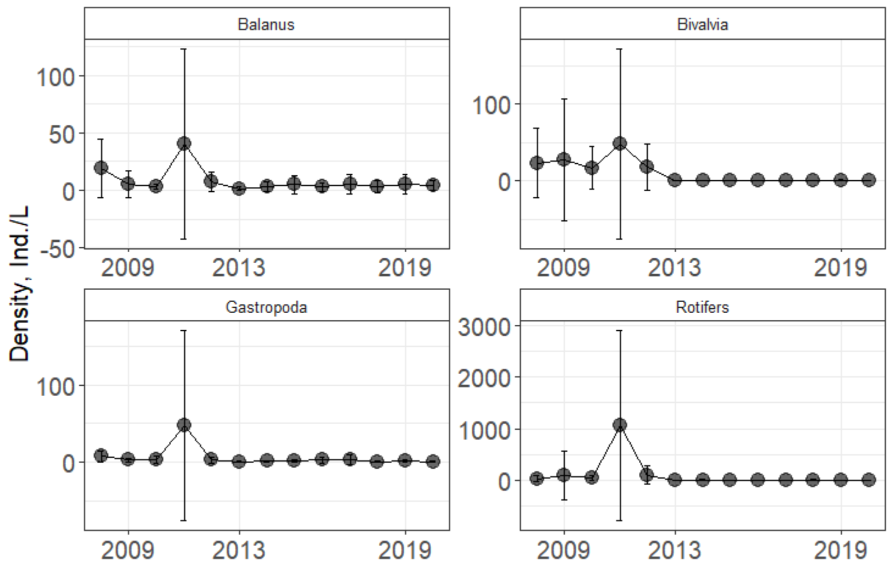


Figure 3. Annual mean ± S.D. density of dominant meroplankton taxa (Balanus, Bivalvia, Gastropoda) and Rotifers in 2008-2020.

Discussion and conclusions

The decrease in zooplankton density might partly explain the decrease in number of herring larvae that recruit to the adult Western Baltic spring-spawning herring stock. The available prey spectrum of herring larvae is additionally narrowed down by the limiting size of their mouth opening. Therefore, the decrease in nauplii, Rotifera and Balanus larvae that constitute suitable prey size class raises additional concern. If prey density is too low (somewhere below 30 individuals per litre), it can delay or halt exogenous feeding of herring larvae. The proportion of weeks with insufficient prey densities has been very high and only a few weeks show adequate prey densities for larval herring after 2013 during the first feeding period.

Evaluation of Western Baltic Spring Spawning herring landings data from the Euro-Baltic fish factory in Neu-Mukran between 2003 and 2019

Introduction

Scientific analyses suggest that the stock of the Western Baltic Spring Spawning Herring (WBSSH), a major resource of the German fishery in the Western Baltic Sea, is in a very poor state. In contrast, the German fishing industry claims that the stock is in a much better shape than conveyed by fisheries scientists.

To contribute to a better understanding of WBSSH ecology and stock dynamics and assess differences in the perceptions of the scientific community and the fishing industry, Euro-Baltic Verarbeitungs GmbH (EB) (see infobox) made available sampling data collected from Western Baltic commercial herring landings in Neu-Mukran from 2003-2019 for analysis by the Thünen Institute of Baltic Sea Fisheries.

Material and methods

In a first step the time series between 2003 and 2019 was electronically compiled into a database and quality-controlled. The database contained more than 60.000 entries of individually weighed herring from more than 4.500 landing events, as well as more than 3.000 fat content measurements. The analysis only used data from landings of pelagic trawlers because these vessels are fishing in pre-spawning aggregations off the coast of the island of Rügen where changes in population structure are more likely to be detected. Gillnetters mainly target herring in the spawning grounds, i.e. mostly homogenous selection of ripe and running fish inside the coastal lagoons.

The analysis covered the examination of landing weight distributions, length-weight-age relationships and their changes over time. It also included the comparison of landings which were sampled both by EB and the Thünen Institute.

EURO-Baltic fish factory

The Euro-Baltic factory in Neu-Mukran, Mecklenburg Pomerania, Germany, is one of the largest (production area: 14.000 m^2) fish processing factories in the European fish industry. It was inaugurated in 2003. Herring is directly landed at the pier. The factory is part of Parlevliet & Van der Plas.

Photo: PP group

Results

EB data only allow analysis of weight distributions because for the commercial purpose of EB only weights are recorded and length measurements are not taken. In (fisheries) science, however, changes in population structure are preferably assessed in reference to changes in length because length data have a distribution closer to a gaussian (or normal) distribution than weight data, and for statistical reasons, the mean from a normal distribution is more reliable than the mean from a skewed (weight) distribution. Nevertheless, EB weight data were not transferred into length data and all analyses of temporal changes were based on herring weights to avoid adding uncertainty.

Comparisons of more than 80 landing events sampled both by EB and the Thünen Institute of Baltic Sea Fisheries (TI-OF) showed that the weight distributions of >90% of the landing events were similar despite differences in sampling design; the non-overlap in ~10% of the landing events can likely be attributed to mismatches in vessel assignments. This suggests that the sampling designs produce comparable and, hence, reliable weight distributions from the landings usable for further analyses of the EB data.

Analyses of the weight distribution of different trawlers for the same landing day showed that the distributions were relatively homogenous. Despite the homogeneity, three vessel groups were identifiable. However, there were some notable exceptions when the weight distribution of one fishing vessel differed from the others. Such deviations occurred in about 20% of the landing dates with more than 6 landings for a day, but only in 4% of all dates with at least two landing events. This suggests that on a short-term herring catches are usually taken from the same source, irrespective of the vessel, but sometimes there are effects of specific fishing areas, or herring shoals targeted by the different vessels.

Given the similarity and dominance in overall landings, the major groups of vessels were pooled and monthly and yearly weight distribution variability was assessed. There were no clear long-term trends from 2003 to 2019 but a seasonal shift was detectable from larger/heavier herring at the beginning of the fishing season to smaller/lighter herring at the end. The variability in weight distributions among months was more important in the past than in the recent years. Since approximately 2015/16, the weight distributions in landings from December to March were relatively uniform. Since 2015/16, a small shift towards heavier herring was evident but the trend was not consistent. In general, no cohort effect was visible in any of the weight distributions across the years. The fat content consistently decreased through the fishing season from autumn to spring, with some inter-year differences.

Discussion and conclusions

First feedback from the industry showed that the commercial trawlers do not follow a stable, systematic sampling approach to exploit the herring aggregations off Rügen so that the influence of several possible factors which could contribute to changes in the weight distributions, cannot be controlled. Possible factors involve a behaviour effect of the captains in response to changes in commercial incentives, changes in the overall effort, weather effects, unknown herring population effects, or other possible factors. Therefore, it is not possible to unambiguously conclude on the ecological causalities behind the changes observed in the weight distribution sampled by EB. However, the close agreement between data collected by both EB and TI-OF is promising and opens interesting perspectives for the future analyses; i.e. in the same way as TI-OF data are used in the stock assessment process, EB data, after further analysis, may become useable in the future in the same way.

Due to time constraints of this pilot study, the full potential of the EB time series could not be fully explored and several important analyses are still pending. These involve: (i) attempts to transform the EB weight data into weight-age-structured data, (ii) attempts to transform the individual EB weight data into individual length data, (iii) linking the decrease in fat content values to the spawning cycle of herring, (iv) using VMS and/or AIS data to assess spatial changes in effort and link spatial fishing patterns to changes in the weight distributions of the landings, (v) using fishers´ ecological knowledge and conducting interviews to better understand and document changes in fishers´ behaviour and fish behaviour. This study will be published as a report of the Thünen Institute in 2021.

Western Baltic herring genetics

Collaborative case study on Herring Genetics (Thünen-OF/ DTU Aqua Denmark)

Spawning time plasticity in WBSS herring-or: are shifts of spawn timing potential strategies to cope for unfavorable spring conditions?

Dr. Patrick Polte, Thuenen-Institute of Baltic Sea Fisheries, Rostock, Germany

Before spring spawning herring became the ultimate fishery target in the Western Baltic Sea there used to be a major fishery on autumn spawning fish which almost entirely vanished in the 1970's. In other areas, i.e. the Gulf of Riga this shift is attributed to a collapse of the distinct autumn-spawning population as a consequence of overfishing. However, what caused a similar shift in the Western Baltic Sea is not empirically studied. Historical documentation implies that Autumn spawning herring frequented different spawning grounds than spring spawners. Based on distribution of yolk-sac stages it is assumed that gravel beds along the eastern Fehmarn coast to be a major spawning area. Based on recent observations of autumn yolk-sac larvae, the Bornholm coast might presently harbor spawning grounds for this population. Additionally, post-flexion larvae regularly occur during late winter in a major spawning area of the Rügen-spring spawners, Greifswald Bay. Preliminary findings determine the temporal origin of those larvae to mid-November of the previous year. During scientific gill net sampling in that system, minor but regular spawning activity (based on ripe and running fish) can be found in November.

In the context of degrading habitat conditions for larval herring during spring it is essential to understand the potential of spring spawners to adapt accordingly. Although numerically of minor relevance today, the mere existence of fish corresponding to the spring-spawning population by their genotype but reproducing in autumn could prove the adaptive capacity of the population to the changing environment.

On the other hand, the numerical contribution of autumn spawners to what is considered the WBSS spawning stock is not well understood. However, two annual peaks of 1-year juveniles of similar body length found regularly in the German Hydroacoustic Survey might imply some recruitment by autumn spawners. If those fish are genetically „true" or „false" autumn spawners is yet unclear.

Hypotheses to be addressed in the case study include:

H1: There are „true" (genetically distinct) autumn spawners and „false" (spring spawners spawning in autumn) herring in the Western Baltic Sea

H2: Late winter post-flexion larvae in Greifswald Bay i) origin from autumn spawners and are ii) genetically similar to „true" autumn spawners

H3: Bornholm spawned (September) and GWB foraging (February-March) larvae i) origin from the same autumn spawning period and ii) belong to the same population.

Project status: Ongoing. As a result of the COVID-19 Pandemic, the Biochemistry Lab of DTU was locked down during much of 2020. Additionally, the final contract between Thünen and DTU signed 26. February 2021. Results are expected at the end of 2021.

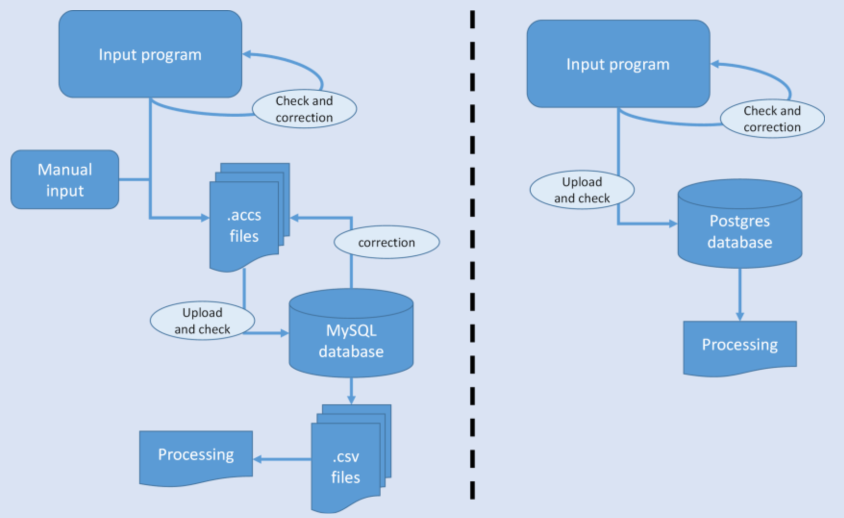
Development of an input program for observer data from the commercial fisheries sampling programme

Introduction

The Thünen Institute of Baltic Sea Fisheries is collecting data from the commercial fishing fleets in the context of the „Data Collection Framework" (DCF) such as catch composition, fishing effort and gears. These data are not only used for assessing the stock status and give catch advice, but also are the basis for official statements issued by federal offices, give background information for management decisions and to answer questions from governmental bodies, economy and society. Furthermore, theses data are used for scientific purposes and studies, ranging from PhD theses to foundational research.

The transfer of the data is done manually by the observer or the technicians who recorded them either on board of a vessel or in the laboratory of the institute, e.g. after finalizing the age reading or taking biological parameters. The used program however is not feasible for this task anymore, since it was developed for the requirements of the first sampling program "DCR" (2008-2011). Since this period, not only the amount of samples increased, but also the quality and complexity of the collected data. The current sampling program includes for example passive fishing gears such a gill nets, traps and long lines, which are not part in the old sampling program and hence in the old input system. The old input system does not allow changes or updates, e.g. updating vessel names, harbor codes or fish species. This has to be done manually by the technician or data base staff afterwards, making it time-consuming and might lead to mistakes. Also the correction of erroneous inputs is only possible to a limited amount which results in manual correction done in the output files, which is another source of mistakes. The input system generates a Windows Access file which has to be manually loaded into the database by another program and is once again open to mistakes (see Infobox).

Info Box. Data input process old (left) and new (right) process



Therefore, a new flexible input program is needed that can easily accommodate various data formats, allows the acquisition of complex data structures and can easily be updated and adjusted to changing data needs. The task of this pilot study is the improvement of the existing system and the development of modern solution to enhance the data collection and data processing in the context of the EMFF regulation (EU 508/2014), Art. 77.2.f.

Material and methods

It was possible to employ an additional programmer for this pilot study, starting in September 2020. With the additional support, the database team started to develop an input program by reviewing all parameter and data that are acquired in the context of the DCF program. The program would have to be flexible to account for complex sampling situation or multiple additional parameters and needs to be easy to update (e.g. adding additional input fields for parameter or adding new codes and tables.) and will be directly connected to the database to avoid intermediate working steps (e.g. using Access files like the current program does). Depending on the sample, input fields should be available or deactivated (e.g. gear specifications or biological parameter) to make it easier to navigate and transfer the protocols. The direct connection to the database will also allow for automatic updates in codes and vessel information. Also the structure of the database was changed accordingly to make it more flexible, reduce redundancies and enable the direct communication between the input program, the database and RStudio (for later downloading and data work). In parallel, while working on the input program itself, error search routine were developed to give real-time feedback on erroneous entries.

All work was stored on a Thünen github to allow for version control and allow for more transparency in the development.

Results

Within the seven months the pilot study was running, it was possible to develop a prototype for a new input-program for the data collected from commercial fisheries in the context of the DCF. The developed input program is an object-orientated Python 3.9 desktop client, using a psycopg2 data server connection to link the new postgres-database of the Thünen-OF. The user interface is using PySide2 and Wt5 as a basis and features event-triggered input masks and different model-views. Before the end of the pilot study, it was also possible to incorporate the error search routines for the non-biological tables (e.g. station data or gear specifications). The biological data tables (e.g. the length measurements or age data) however are still lacking those error routines and will be added in the near future. After fixing some interaction problems with two of the biological data input tables, the program can be tested by the institute technicians and their feedback on the input fields, order of masks and the naming of the fields will be implemented.

Discussion and conclusions

Due to a lack of applicants when the pilot study was originally supposed to launch (in March 2020, providing funding for two E13 programmers), both the work force and the time was reduced compared to the original pilot study structure. The pilot started in September 2020 with only one additional programmer. However, while not fully functional, the development went much faster than anticipated. A first version of a new input program is ready to go into testing, while some features, minor bugs and issues will be solved in parallel. The new input program allows us to reduce errors and work.

The new program enables us to accommodate for the increased complexity of collected data while reducing the work load and error sources.

Changes in condition factor and other biological parameters of Western Baltic cod since 1977

Introduction

The Western Baltic cod is an ecologically and economically important demersal fish. Cod from this stock are a major resource of the commercial and recreational fisheries of Denmark, Germany, Sweden and Poland. Since 2015, recruitment has been poor and since 2018 the stock is dominated by the only strong recent year class from 2016.

The ultimate interplay of possible causes for the poor stock status is unclear but overfishing (F >> FMSY since 2009) and negative effects of regional warming on the offspring production are strongly correlated with changes in the stock[1,2]. In addition, hotter summers are suggested adversely affect the metabolic stage of cod in the Western Baltic [3,4]. Prolonged summer periods may shorten the gonadal development phase of adults in autumn and winter and thus result in spawners in a gradually deteriorating condition taking part in spawning. It is also conceivable that this could increase the proportion of skip spawners. Moreover, preliminary analyses had suggested that the condition factor (see infobox) of Western Baltic cod has been gradually decreasing since the 1990s

In the present study, we used the longest and most comprehensive data sets available of biological parameters to assess the well-being of cod in the Western Baltic Sea. We analysed the temporal changes of the condition factor and other biological parameters across 44 years of data; and we investigated the potential roles of external drivers of these changes, namely changes in cod diet, feeding level and influence of three environmental parameters: oxygen content, water temperature and salinity.

Condition factor: the body-mass index of fishes

In humans, we use the body-mass index as a rule of thumb to broadly categorize a person as underweight, normal weight, overweight, or obese based on tissue mass (muscle, fat, and bone) and height.

In fish, the so-called Fulton index K_F is calculated based on: $K_F = W * 100 / L^3$ with W the full weight (g) and L the length (cm) of each individual. A condition factor of 1 indicates a “normal” fish in OK condition. A really fat fish will be higher, like 1.2 or even higher, while a skinny fish will be below 1, like 0.8 or less for a post spawning fish or a really skinny fish. The recent mean condition factor of Western Baltic cod is below 0.9, with some specimens close to 0.8.

Material and methods

Time series of several biological parameters were compiled and quality-controlled. Statistical analyses involving linear regressions and Spearman correlation were used to assess the temporal changes of the biological parameters. Classification and regression trees were built to group condition factor values into homogeneous subgroups to evaluate the influence of external drivers.

Results

The condition factor gradually decreased since the 1990s, with a major drop in the last three years. From the 1990s to 2020s the mean decrease in condition factor was about 10%. Likewise, the

hepatosomatic index (indicating the size of the liver to the rest of the fish body) decreased, also with a drop in recent years. There were also changes in maturity detected.
An increase in bottom water temperature was correlated with the decreasing condition factor. Oxygen content, measured as water age, and stomach fullness had a secondary influence on changes in condition factor. In contrast, salinity had no effect on the detected changes. Moreover, there was evidence for a change in cod diet with reduced proportions of herring in the recent period.

Discussion and conclusions

The decrease in condition factor and liver proportion suggest that the Western Baltic cod stock is in distress. Changes are ongoing in the Western Baltic cod stock that negatively influence the physiological status and the metabolic state of individual fish and of the stock. Particularly, the decrease in liver size is of concern. Similar to humans, the liver in fish is a central organ; it is responsible for nutrient assimilation, bile production, protein synthesis and maintenance of metabolic homeostasis, it serves as an energy reserve and breeding capital for cod. A decrease in liver size indicates that the fish has less energy reserves; and if most fish of a population have less energy reserves, the productivity of the stock decreases, and so do the fishing opportunities. It should be noted that these changes are unrelated to liver parasites because infestation of Western Baltic cod livers is very low, unlike in Eastern Baltic cod[5].

The stock is subject to overfishing since years but this study and other studies[1,2] strongly suggest that environmental changes are also playing a role. Eutrophication, e.g. from agriculture and other sources, has increased the size and duration of temporary hypoxic and anoxic areas in the deeper areas of the Western Baltic Sea during summer and early autumn. During summer Western Baltic cod avoid the warmer surface waters (>15°C) and over-summer on the edges of the basins. When extreme hot summers force cod to go even deeper, the hypoxic areas in the basins determine the downhill end of distribution. Thus, cod end up in a sandwich position with shallow-waters too hot and deeper waters too hypoxic. And the record-warm summers in recent years likely aggravate this phenomenon. During these periods, cod likely pay a metabolic price which is reflected in the decrease of the liver size and of the condition factor. This may result in poorer quality of spawners and reduced recruitment.

These changes are gradual and therefore difficult to detect. However, in recent years the negative trend accelerated, likely driven by the dominance of a single cohort which is strongly affected by intra-specific competition (the strongest form of competition between animals) and the Rosa-Lee phenomenon (the recent population is skewed by more slower growing cod, as the faster growing cod of the 2016 cohort died at a younger age so that mostly under-performing cod are left).

Apparently, the Western Baltic cod stock is in the dire straits, similar to Eastern Baltic cod, but with a different set of interacting factors. A scientific publication is in preparation.

Evaluation and Optimization of the National German Catch Sampling Programme for North Sea and North Atlantic Fisheries

Introduction

The Thünen Institute of Sea Fisheries is responsible for implementing catch sampling of several German fisheries in the North Sea and North Atlantic. Currently, sampling by the Institute for biological parameters of important commercial species in the areas is conducted using a single approach, at-sea sampling using observers. The sampling design is labelled as "opportunistic randomized" in the DCF Annual Reports. The primary sampling unit (PSU) is a vessel × trip; secondary units are the hauls on selected trips and tertiary units are individual fish sampled from hauls for biological parameters. The number of individual PSUs that are selected is relatively low due to: the low numbers of vessels in most of the fisheries; low numbers of trips/vessel; long trips; fish being commonly processed at sea; and the occasional need for observers as additional help on research vessel trips. The Institute aims for 30-35 trips/year with observers over all fisheries. For example, in 2018, 30 trips (17 vessels) were sampled; in 2017, 33 trips (17 vessels); in 2016, 33 trips (19 vessels) and in 2015, 35 trips (20 vessels). These are manned using 7 observers. For 2019, approximately 36 vessel-trips were planned to be sampled. The number of PSUs available for selection vary widely by fishery. But, although there are some fisheries with large numbers of PSUs, there is also a reluctance in several fisheries to take observers. Another issue that is likely to have a negative impact on availability of vessels able to take observers is the full implementation of the landing obligation in 2019 since it requires more work from the crew and could cause reluctance on the part of the captain to allow additional individuals on board. There are fifteen species for which the Institute in Bremerhaven is responsible for providing one or more biological parameters.

Material and methods

The basic approach within each fishery is quasi-random sampling of vessel-trips with some stratification into quarters where possible. The fisheries are as indicated in Table 1, and all vessel-trips (PSUs) can be classified into a fishery *a priori* given their characteristics, e.g. size, gear, etc.

At the beginning of each year, the Institute receives a list of all trips by all vessels from the previous year from the official fisheries statistics (Federal Office for Agriculture and Food, BLE). This active vessel list is used as the start of the sampling frame for each fishery for the current year with some caveats.

Table 1. Commercial fisheries sampling schemes in the North Sea & Eastern Arctic and North Atlantic regions.

ID	Description/Targets/Fishing Ground
Arctic 1	Trawlers targeting cod, saithe in I, II; seasonal fishery where the geographic region and species targeted vary but vessels are the same
Arctic 2	Trawlers targeting herring in II (ASH)
North Sea 1	Beam trawl targeting brown shrimp in the German coastal area
North Sea 2	Trawlers targeting mackerel, herring in IV, VIId; seasonal fishery where the geographic area and species targeted are different but the vessels are the same
North Sea 3	Trawlers targeting gadoids in IV, IIIa
North Sea 4	Beam trawl targeting flatfish in IV
North Sea 5	OTB targeting plaice in IV
North Atlantic 1	OTB targeting Greenland halibut In NAFO SA1-2; one season
North Atlantic 2	OTM targeting small pelagic species in VI, VIIbcjk, VIIe, VIIfgh, VIII, V-XIV, (IVa); the fisheries differ geographically according to season and fish species but vessels are the same
North Atlantic 3	OTB targeting Greenland halibut in XII, XIV, Va; one season
North Atlantic 4	OTM targeting redfish in XII, XIV, Va; one season

Most vessels in the sampling frame use the same gear throughout the year but will target different species at different times. In some cases, different gears are used. Hence, vessels could appear on more than one of the sampling frames for the 11 fisheries listed in Table 1 at different times of the year. In addition, the sampling frames for each fishery are modified since some vessels refuse to take observers.

Results

The Institute in Bremerhaven provided data from the Intercatch submissions for the period of 2014 to 2018, inclusive, for six species: COD, SOL, POK, POL, MAC, and HER. These data were used in several ways. In addition to comparing the distribution of landings to the distribution of samples of those landings, plots of the estimated numbers at age and mean lengths and weights by combinations of métier, quarter, and fishing area were also reviewed. The plots were used to determine whether the summary information was consistent over time and space; such a review is informative of whether the observer coverage is sufficient when compared to the distribution of sampling of the trips. Any conclusions though assume that the consistency (or lack of) shown in the sampled trips is similar for the unsampled combinations of seasons/métiers/fishing areas. For example, if there appears to be spatial variability in the estimated frequency distributions of the numbers at age for a species, then it is likely that the unsampled fishing areas are also diverse in their frequency distributions. Any conclusion that sampling should be done in these unsampled areas must be tempered by the determination of whether a significant fraction of the stock is being sampled or not.

The actual assignment of observers to trips is opportunistic and appears to be a combination of observer availability, need for sampling in different quarters, consideration for a fair distribution of assignment of short and long trips as well as different métiers to be sampled per observer, and prompt notification of upcoming trips within each fishery. An effort is made at the beginning of the year to arrange observer assignments based on last year's fishing activities and anticipated activities for the current year. It is not possible to have a truly random assignment of observers to PSUs due to the changing sampling frame that happens in real time over the year and the need to ensure adequate sampling across fisheries in the appropriate seasons.

Given the requirements for coverage of the different stocks, the large number of species for which the Institute is currently responsible, and the possibility that additional species will be added in future for monitoring, it is unlikely that the current allotment of observers is sufficient. The number of observers is low but their placement on vessel-trips appears to be as efficient as is possible given the variety of stocks and the large spatio-temporal coverage required to meet ICES stock assessments data calls.

Discussion and conclusions

As so much of the catch is landed in other countries, the need for observers on these trips is increased since port sampling within Germany would access too little of the overall catch by German flagged vessels. To do port sampling in these other countries would require an inter-country agreement to allow foreign observers at these ports.

Because of the low observer coverage rates, spatial coverage of the fisheries is somewhat incomplete, at least for some of the species reviewed. It is likely true for other species not reviewed as well. This could be due in part to the temporal emphasis on ensuring that each quarter or month in which a fleet is active is covered and the lack of available observers during those quarters.

Based on the distribution of sampled trips it appears that all demersal species in the review datasets, even those not targeted, were sampled for aging when the species appeared in the trip hauls. – this is actually a good thing and should be encouraged.

Observers should be placed on vessels fishing in quarters/fleets or ICES areas that are not currently being sampled and for which large landings are reported. A regional plan should be considered for sharing the required data collection via catch sampling of the various managed species in order to more fully cover the spatio-temporal ranges of those species and minimize duplicate data collection efforts. This could take the form of different countries being responsible for data collection of different species or métiers, that are of particular importance to each country, for example. Such an approach would require negotiation and cooperation for resource allocation and data sharing that may partially already exist for some of the geographic regions. Building on current cooperative agreements is encouraged. Any such agreement would also have to ensure that any information important to an individual country for internal use is available, either though collection by that country or data sharing arrangements that cover each country’s requirements.

Expanding the current program of self-sampling that is currently being done in the herring fishery to other species should be considered. Although a full implementation of self-sampling may not be possible, a small-scale implementation of self-sampling in other fisheries could be possible if the vessels are amenable to providing a self-sample in a port that is easily accessible by Institute staff and are given sufficient time to prepare. The advantage is that an observer would not be required to accompany the trip; the disadvantage is that this may be difficult to implement if the majority of the landings are in ports outside of Germany. There would need to be a mechanism for transferring the self-sample to Bremerhaven in order to collect data on the biological parameters. The alternative would be to develop a regional approach where laboratories in the country in which the catch was landed performed the measurements and uploaded them to what will soon be the regional database (RDB-ES). The latter would require additional discussion on regional cooperation.

Improvement of fleet segmentation

Introduction

Under the Data Collection Framework (DCF), fleet economic data have to be provided by fleet segment. This segmentation is based on technical data of the vessels. This segmentation method is well defined and easily applicable, but it does not adequately represent target fisheries. Vessels with similar technical parameters are often active in different fisheries that differ in terms of catch composition, fishing activity, and cost structure. Therefore, to improve reporting with respect to individual target fisheries, a transferable, systematic approach based on multivariate statistics methods was developed in the pilot project 'Fleet Segmentation' and tested in cooperation with multiple partners within the STECF. In addition to developing the fishery-based approach to the segmentation of fishing fleets, we organized a stakeholder workshop to create a model fishing vessel dataset containing all necessary micro-and macroeconomic variables (see infobox).

Material and methods

The newly developed fleet segmentation approach is based on the catch composition of the considered fishing vessels within one reference year. We chose data of the German fishing fleet from the reporting year 2018 as the basis of our analysis, as this year's data was the most comprehensive, particularly in terms of cost data. Catches were aggregated not only on the species but even on the stock level. In accordance with ICES stock descriptions, catches were assigned to stocks based on species and fishing areas. Stock-based catch weights of each vessel were expressed as a proportion of the total catch, scaled to values between 0 and 1, and then transformed into a Euclidean distance matrix. We computed a separate matrix for each fishing gear class. A vessels' main fishing gear was identified following the DCF-procedure, i.e., a gear being used for more than 50% of a vessel's fishing time was treated as the vessels' main gear. The matrices provided the basis of a 'hierarchical agglomerative clustering (HAC) procedure, for which the UPGMA fusion algorithm was used. An array of specific indices, tests, and visual validation methods was applied to determine the optimal number of clusters. The procedure was finalized by a post-hoc validation of the clustering result to identify the actual fleet segments. The analysis was concluded by comparing the cost structure and the spatial distribution of vessels under the old and the new segmentation scheme in specific case studies of the Brown shrimp fishery and coastal mixed demersal fisheries.

DEU-CSH-34 - The typical German brown shrimp beam trawler

It is difficult to understand the economic characteristics and dynamics in capture fisheries on the vessel level if only survey data is available. Statistical averages and projections do not necessarily resemble a valid representative business and often contain substantial uncertainties. In order to fill this gap we followed the typical farm approach of the *agri benchmark* network and created the typical German brown shrimp beam trawler DEU-CSH-34. This typical fishing vessel is a disaggregated and comprehensive full-cost account dataset that was created in cooperation with vessel captains and state advisors. If you want to learn more about the typical brown shrimp vessel our the *agri benchmark network*, please visit the *agri benchmark* website[1] and the news & results-section[2].

Results

Seventeen fleet segments were created from the underlying data, representing 1005 vessels of 5 different gear classes. The vessels ranged between 4m and a 140m length and operated in various management areas, from Baltic inshore fisheries to distant overseas territories. We detected Mixed fisheries, especially on diverse demersal fish assemblages, as well as target fisheries on demersal and pelagic fish, crustacean, and bivalve species. The detected fleet segments were in accordance with expert predictions on the German fishing fleet structure, which were made prior to the analysis. In a selected case study, cost structure indicators such as fuel efficiency, economic productivity, and effort-specific costs were compared for the German brown shrimp fishery. This fishery comprises vessels of 6 different fleet segments in the old fleet segmentation. Yet, all these vessels were identified as a single fleet segment by the new approach. We showed that the two old fleet segments accounting for more than 90% of the shrimp fishery had minimal differences in their cost structure and therefore could be legitimately considered one single fleet segment. The spatial separation of the fleet segments was analyzed by the example of coastal mixed demersal fisheries. While the fleet segments created with the old segmentation scheme showed only little spatial patterns and were extensively overlapping, fleet segments created with the new fleet segmentation approach showed distinct spatial patterns. However, they still overlapped at key fishing grounds.

Discussion and conclusions

The newly developed fishery-based approach for the segmentation of fishing fleets has proven its functionality and usefulness. The overall number of fleet segments was reduced (from 24 in the old to 17 in the new fleet segmentation). The case studies of the resulting fleet segments revealed improvements in the cost structure and the spatial separation of fleet segments. Furthermore, fishery-based fleet segments are much more suitable for impact assessment and statistical modeling, as they are defined by their catch composition, including a reference to stocks. If fleet segments are based on technical parameters only, vessels can be aggregated in a fleet segment even though they might be operating in different fisheries and therefore are unequally affected by management measures or stock fluctuations. Our newly developed approach is capable of specifying such fisheries due to its mechanistic yet flexible nature. Our partners not only gave us positive and encouraging feedback, but they also pointed out the potential for further development. The statistical procedure contains certain junctions at which the user has to make decisions, supported by diagnostic features. These decision points introduce a component of subjectivity and require some practice. Even though the project has officially ended, we are working on further improvement of the procedure. On the one hand, we aim to remove the aspects of subjectivity by applying state-of-the-art machine learning methods, and on the other hand, we are preparing a workshop on the subject. In this workshop, we aim to collect the STECF member states' experience and formulate their requirements for a fleet segmentation procedure to finalize the fishery-based approach for the fleet segmentation and anchor it as a standard procedure in the DCF context.

Impact of changing spatial management on fish communities and resource use in the German EEZ of the North Sea

Introduction

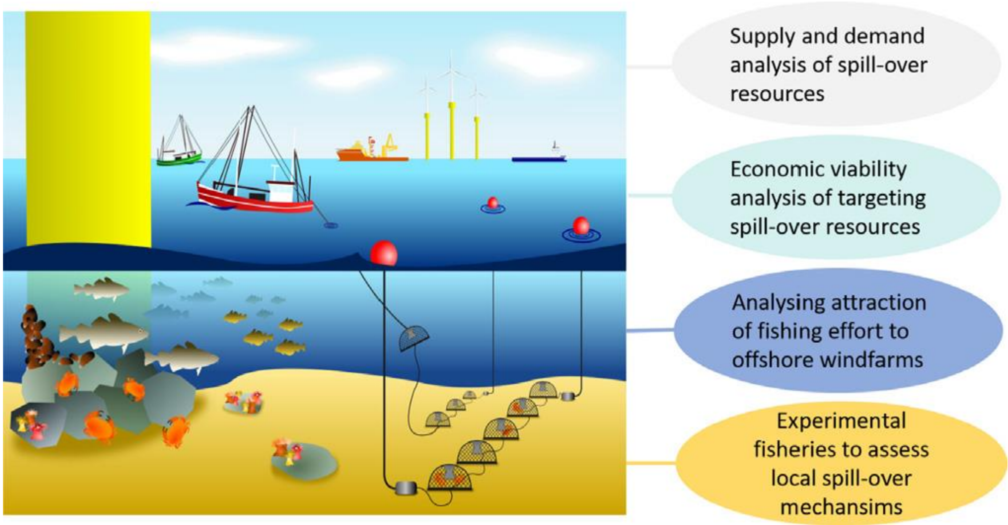
The designation of protected areas and priority areas for wind energy and the associated exclusion of fisheries is already leading to a shortage of space and an increasing potential for conflict. Little is known about the ecological impact of the rapid sprawl of Offshore Wind Farms (OWF) on demersal fish and benthos organisms. The aim of this project was to fill knowledge gaps regarding the effects of changing environmental conditions in OWF in the German Exclusive Economic Zone (EEZ) on brown crab (*Cancer pagurus*) and cod (*Gadus morhua*). So far, wind farm operators have carried out small-scale campaigns during construction and operation phases to investigate the fish and benthic communities in corresponding OWF clusters and reference areas. An integrated and holistic analysis of the effects on fishery resources has not been carried out yet. The project allowed an integrated view of spatial and temporal developments of the benthos and fish community with regard to spillover effects for of brown crab and the aggregation and spawning behavior of cod in OWF. The resulting improved data provide a basis for recommendations in the field of spatial management approaches in the German North Sea EEZ in order to reduce long-term conflicts of use and promote sustainable resource use.

Material and methods

Our case study area comprised the OWF Meerwind Süd/Ost located 25 km north-west of the Island of Helgoland at a bottom depth of 22 - 26 m. The OWF is in operation since autumn 2014, covers an area of approximately 8 x 4 km and comprises 80 monopiles with scour protection. In compliance with safety conditions in the OWF, we investigated during summer and Winter 2019 and 2020 different life stages of cod. Close to the monopiles we sampled adult individuals by fishing with hand rods and tracked drift patterns of cod eggs with a hydrodynamic 2D-drift model. We further conducted a novel socio-ecological assessment of fisheries benefits, which combines exploring potential spillover from an OWF with an experimental brown crab pot fishery and an economic viability analysis of such a fishery. To conclude on cumulative spillover potentials from all OWF in the German EEZ and drivers of passive gear fisheries we analysed Vessel Monitoring System (VMS)-data and computed random forest regressions.

Results

Our results revealed an attraction effect of adult cod to OWF monopiles. The increased body condition and trophic position even suggests an effect of site fidelity, triggered by a more diverse prey spectrum. The maturity stage of most of the individuals found inside the OWF during winter, the male-skewed sex ratio found inside the OWF during winter and the computed drift patterns of cod eggs further indicate spawning activity within the OWF. Local spillover mechanisms from brown crab occurred up to distances of 300 to 500 m to the nearest turbines and revealed an increasing attraction of pot fishing activities to particular OWF. This corresponds to the observation of constantly increasing fishing effort targeting brown crab likely due to both a growing international demand and stable resource populations at suitable habitats, including OWF. Our break-even scenarios showed that beam trawlers have the capacities to conduct during summer an opportunistic but economically viable pot fishery.



Experimental design that allowed an integrated view of spatial and temporal developments of spillover effects for of brown crab in offshore wind farms (taken from Stelzenmüller et al. 2021; https://doi.org/10.1016/j.scitotenv.2021.145918). Moreover, the aggregation and spawning behavior of cod in offshore wind farms was analysed.

Discussion and conclusions

We conclude that OWF could have a local positive effect on cod recruitment reproduction and could strengthen the resilience of the cod stock against pressures such as fisheries and climate change. The fact that local cod individuals accept OWF even as spawning ground gives reason to believe that OWF have the potential to partially offset decreasing habitat suitability and improve recruitment success. Even a limited, passive (static) fishery inside the wind farm might have pronounced detrimental effects on the viability of this spawning component of the North Sea cod population and its genetic pool. On the other hand, we observed local spillover mechanisms of brown crab from an OWF in the southern North Sea and demonstrated a patchy, but increasing attraction of pot fishing activities to OWF. At the same time, we showed that the international fishing effort targeting brown crab enlarged gradually over the past years due to an increasing demand and stable resource populations at suitable habitats, including OWF. Hence, we illustrated that under these conditions brown crab fisheries benefit from the rapid expansion of OWF.

The improved data situation forms the basis for an assessment of the impact of the change in land use on fish communities and resource use in the German EEZ of the North Sea. We argue that particularly in the North Sea, where space becomes limited, integrated assessments of the wider environmental and socio-economic effects of planning are crucial for a sustainable co-location of OWF and fisheries. Previous cooperation with authorities (esp. BSH, BfN etc.) and requests for political advice have confirmed the relevance of the topic, especially for the future. This pilot study refers to Article 77.2.f of Regulation (EU) No 508/2014 of the European Parliament and of the Council on the European Maritime and Fisheries Fund (EMFF).

Estimating the catch composition in the brown shrimp fisheries as required for the exemption from the landing obligation

Introduction

In the context of the landing obligation (Art. 15 Regulation (EU) 1380/2013), the Delegated Regulation (EU) 2018/2035* Article 9(i) granted a *de minimis* exemption for by-catches in beam trawl fisheries on brown shrimp (*Crangon crangon*) until the end of 2021. The exemption implies that the discard quantity of TAC-regulated species shall not exceed 7% (in the years 2019 and 2020) and 6% (in 2021) of the total annual catch of all species subject to catch limits made in those fisheries.

The landing certificates of the brown shrimp fishery only record the quantity of marketable brown shrimp. Details on the total catch composition are not registered due to disproportional effort and limited time during on-board sorting required for the fast processing (immediate boiling) of the target species. Nevertheless, in order to prove the required low catch percentages of TAC-regulated species, the brown shrimp fishery and the producer organisation committed to implement a sampling program. The program envisaged a pilot study on self-sampling by the fishery with sample processing and data analyses being performed at the Thünen-Institute of Sea Fisheries.

Material and methods

The details on the sampling program were defined by representatives of the fishery, science and policy in February 2019. The commercial vessels participating to the sampling were recruited by the producer organisation. The selection included small local fisheries as well as larger shrimp vessels. Another selection criterion was the home port to obtain best spatial coverage of the whole German fishing area. The sampling was scheduled all over the year and ran from July 2019 to December 2020.

Self-sampling

The sampling was performed by the crews of different shrimp vessels. The producer organisation provided all necessary equipment. The sample was randomly taken from the unsorted catch by using a 10-l-bucket. Each sample was labelled with detailed catch information. After landing, the sample was frozen and stored at the sieving stations for later transport to the Thünen-Institute.

Data collection

At the Thünen-Institute, samples were thawed and all components sorted, counted and weighed. Length was additionally recorded for all fish species. A sub-sample of brown shrimp was separated into ‘consumption shrimp’ (total length ≥50mm) and ‘undersized shrimp’ (total length <50mm) and measured for length distribution. The generated data were combined with relevant logbook information and stored in Microsoft Access Database.

Scientifically assisted self-sampling supporting the exemption from the landing obligation

The European Commission granted a *de minimis* exemption from the landing obligation for brown shrimp fisheries. Discards of TAC-regulated species shall not exceed 7 % (in 2019/2020) and 6 % (in 2021) of the total annual catches of all species subject to catch limits made in those fisheries.

Details on the total catch composition are not registered by the fishermen due to disproportional effort and limited time during on-board sorting required for the fast processing (immediate boiling) of the target species *Crangon crangon*. In order to determine the weight percent of TAC-regulated fish species discarded by the shrimp fishery, additional sampling is

Data Analyses

For general analyses, i.e. a compositional overview of the sample delivered, sample components were classified in nine main groups: consumption shrimp, undersized brown shrimp, TAC-regulated species, other fish, decapods, bivalves, cephalopods, other invertebrates and other objects. The discard quantities of TAC-regulated species were further estimated by projecting the different species' mass portions to the mass of landed commercial brown shrimp as reported from the logbook of respective vessel's fishing trip.

Results, discussion and conclusions

The collected data allow to estimate and monitor the total catch composition of the brown shrimp fishery as well as the quantity of TAC-regulated fish species discarded by the fishery. Until the end of December 2020, a total of 117 samples were delivered by 16 shrimpers participating. The samples originated from seven ICES rectangles distributed along the German coast (35F6, 36F6, 36F7, 36F8, 37F8, 38F8, 39F8).

In the first sampling year, a total of 36 samples were delivered. Due to minor handling problems, missing sample sheets and mismatch to logbook information, seven samples had to be excluded from analyses. 21 out of the 29 samples evaluated originated from the 3rd quarter of the year, eight samples from the 4th quarter. In 2019, a total of 44 different species were found (including the target species). Seven species were identified as TAC-regulated species. Amongst these, highest mass were found for whiting *Merlangius merlangus*, plaice *Pleuronectes platessa* and herring *Clupea harengus* (listed in decreasing order).

In 2020, despite continuous fishing halts entailed by the COVID-19 pandemic, a total of 81 samples were delivered. All samples could be evaluated. 19 samples originated from the 1st quarter of the year, 27 samples from the 2nd quarter, 22 from the 3rd quarter and 13 samples from the 4th quarter. In 2020, a total of 62 different species (including the target species) were found. Nine species were identified as TAC-regulated species. As in 2019, highest mass were found for whiting, plaice and herring. Whiting and plaice were most present in the 2nd quarter of the year whereas herring had its peak presence in the 4th quarter.

Detailed evaluations and statistical analyses are expected within 2021. In particular, the interpretation of the results with regard to the consolidation of the *de minim*is exemption from the landing obligation for brown shrimp fisheries will be incumbent upon European policy makers. For the period 2021-2023, specifying details of implementation of the landing obligation were updated in August 2020 by the Delegated Regulation (EU) 2020/2014. Article 11(7) grants a further *de miminis* exemption for brown shrimp fisheries as long as the discard quantity of TAC-regulated species "[...] will not exceed 6 % in 2021 and 2022, and 5 % in 2023 of the total annual catches of all species subject to catch limits made in those fisheries [...]".

The project`s general sampling procedure (i.e. self-sampling by the fishery) allowed a broad coverage of data collection. In comparison to the routine DCF data collection, the sampling involved a larger proportion of commercial vessels, and hence, greater spatial as well as temporal coverage with relatively low additional effort. Accordingly, self-sampling programmes appear as prospective optional tools for the future which could additionally support the routine observer based data collection.

If further implemented, the data quality is expected to increase in the future due to anticipated increased fishery attendance and reliability due to improved collection and handling of the samples. This was also experienced in the dynamic process of the pilot study by continuous feedback to the fishery.

Molecular-biological validation of fish egg identification

Introduction

Several ichthyoplankton surveys, specifically targeting freshly spawned eggs, are carried under the Data Collection Framework, in order to provide data on daily or annual egg production as well as time and distribution of spawning. These data provide invaluable sources to aid management of exploited fish populations, either for stock assessment purposes or to define time and area for closure and protection of principle spawning habitats. Fish eggs, however, are notoriously difficult to identify, particularly when they are in an early developmental stage. These early stages lack conspicuous morphological characteristics other than size, which is why in many species genetic methods have to be used. These genetic methods are applied either to directly identify those species that cannot be separated based on their size alone, or for quality assurance purposes where size is the major discrimination factor between species. DNA sequencing, however, is extremely expensive and also requires tedious processing of the egg samples. Protein mass spectrometry (proteomics), which is widely used in clinical diagnostics for e.g. separation of bacterial species, has only been recently applied to also discriminate between metazoan taxa/species and should here, for the first time, used to identify fish eggs. The here utilized method, Matrix-Assisted Laser Desorption/Ionization Time-of-Flight Mass Spectrometry (MALDI-TOF MS), is much cheaper than DNA barcoding and also able to deliver results quicker than the latter. The method relies on a so-called proteome fingerprint (proteomics) to distinguish between species. Application of this method is new in fish egg identification. Therefore, a database of characteristic mass spectrograms had to be constructed based on the results of both, DNA barcoding and MALDI-TOF MS proteomics. The proteomics database could then be used for using MALDI-TOF MS alone for future fish egg identification and quality assurance in egg production estimation.

Material and methods

Fish eggs were collected during several cruises of the Mackerel and Horse Mackerel Egg Survey (MEGS) in 2019, and during a survey in January 2020 for a project, which aimed at investigating potential effects of offshore windfarms on cod reproduction. Plankton samples were taken at pre-defined stations and fish eggs sorted from those samples, identified if possible, staged and preserved singly in Eppendorf tubes in undenatured 96% ethanol. Sorting eggs from the planktons samples, staging, identifying and preserving had to be done as fast as possible and possibly under controlled temperature conditions in order to avoid quick deterioration of the eggs after catch. A maximum handling time of 10 – 15 minutes was allowed for the entire process. Sorting had to be done in a tray placed on a bed of crushed ice. If possible, pictures were taken of each egg for later inspection of the molecular ID results. Egg samples were then stored at cold temperatures, preferably in a freezer at -18°C.

Eggs from the mackerel egg survey participants outside Germany – The Faroe Islands, Scotland, and Portugal – were sent by ordinary mail to the Thünen Institute of Sea Fisheries (TISF). At the TISF, all eggs were transferred singly to 96-pipette-well-plates, position of each egg in the wells noted, and sent to BiomeID lab for analysis. Molecular analysis of the eggs was then carried out in two steps. The homogenate of each egg was first analyzed using PCR barcoding (genetics) using species specific primers and in a second step using MALDI-TOF MS.

Results

Altogether, 459 fish eggs were analyzed utilizing both, barcoding or MALDITOF-MS. From the mackerel and horse mackerel egg survey 269 eggs were analyzed, of which 157 were provided by Germany, 58 by the Faroe Island, 30 by Portugal and 24 by Scotland. The windfarm study provided 190 eggs. In 74 of all cases (16.1 %), neither DNA barcoding nor MALDITOF-MS delivered a result. All those cases occurred in samples from the MEGS (27.6 %). By country, the amount of non-identifiable eggs varied between 5.1 and 96.7 % (Table 1).

Table 1: The number of fish eggs provided for molecular identification by survey and country, the number of eggs that could successfully assigned to a species, either by DNA barcoding, MALDI-TOF or both (irrespective of correct or incorrect ID), and numbers and percentages of eggs that couldn't be assigned.

Survey	Country	N eggs	successful	failure	fail (%)
MEGS	Germany	157	121	36	22.9
MEGS	Faroese	58	55	3	5.1
MEGS	Scotland	23	17	6	26.1
MEGS	Portugal	30	1	29	96.7
Windfarm	Germany	191	191	0	0.0

In total, the eggs of 15 different species were identified. In the MEGS samples, the eggs were assigned to 13 different species, in the Windpark samples, 5 different species occurred. Inspection of the successful results utilizing the pictures taken of each egg showed that 30 of the assignments to species (7.8 %) were doubtful and didn't match the characteristics of the eggs shown in the pictures. All these cases occurred in the MEGS samples adding up to 15.4 % wrong results in this survey, while all results from the Windfarm project were considered correct. However, results for the 2 MEGS target species, mackerel and horse mackerel, were in 98 % of the 138 cases correct.

Discussion and conclusions

The return of fish eggs for molecular identification from the MEGS was lower than expected. Only 4 of the 8 participating nations provided samples. As it also turned out, quality of the egg samples was also very limited, resulting in a high number of eggs, which were either difficult or impossible to analyze. Even though a protocol for standard operational procedures was in place and provided to all participating nations in time before the surveys, it became apparent that it was difficult for most to provide good quality samples for the analysis. The major sources for these issues may be found in the tight survey program and in limited funding necessary for additional staff in order to carefully process the samples for later analysis. Also, the long process of shipping samples from the different labs to Germany may have caused deterioration of sample quality.

In contrast, samples from the German windfarm surveys were of better quality and also showed results of higher consistency, which was partly founded on the fact that in the North Sea, egg identification based on MALDI-TOF MS had already been established and recently published (Rossel et al. 2021). During that study, which describes egg sampling and identification in winter 2018, similar problems comparable to the above-mentioned quality issues for molecular fish egg identification occurred during sample analyses. It showed that eggs, which were kept too long in warm lab conditions before preserving, or were kept in too warm conditions during storage (> -18 °C) very often showed low quality spectrograms, which were difficult or impossible to assign to a specific species. In this study, it also showed, that in some cases even DNA sequencing was impossible when sample quality couldn't be ascertained. These findings were unknown when the studies for the MEGS were planned.

Nevertheless, and despite the described shortcomings, the study was successful in that it helped assuring quality of egg identification of the 2 target species, *Scomber scombrus* and *Trachurus trachurus*. Also, spectrograms of 5 more species from the Northeast Atlantic, which didn't occur in the recently established database for winter-spawning North Sea fish, could be added to the reference library.

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Predation by cephalopods on North Sea fishes – genetic identification of stomach contents

Introduction

Under the conditions of ongoing climate change, abundances of cephalopods have been observed to increase in marine ecosystems. In the European Seas, and specifically in the North Sea and the Baltic Sea, individual cephalopod species have at the same time expanded their distribution ranges (Oesterwind & Schaber 2019). In the North Sea, one of these species has recently been shown to be able to produce offspring and hence sustain a viable population in this newly acquired habitat (Oesterwind et al., 2020).

So far, the ecosystem effects of the increasing numbers of cephalopods have not been fully evaluated. This pilot study therefore aimed at gaining an insight into the potential predatory impact of cephalopods in the North Sea, and particularly with respect to fishes. Genetic methods were applied for the identification of prey items, because squids decompose their prey before swallowing them, which often limits cues for microscopic identification of prey to their hard substances, such as otoliths, bones or cephalopod beaks. Hence, even identification of fish species or other squid is difficult, and the traditional methods result in a bias against soft-bodied organisms.

Material and methods

Specimen of several squid species have been collected on several fisheries research surveys conducted under the Data Collection Framework (DCF), specifically within the International Bottom Trawl Survey (IBTS) during Q1 and Q3. Sampling of the cephalopod was performed in the northern, central and southern North Sea to explore potential regional differences.

Specimen were kept on ice after collection, and frozen aboard after the initial data acquisition for the purpose of the survey. In the laboratory, individuals were thawed, measured and weighed. Tissue samples were taken to verify the visual species identification through barcoding. Subsequently, the cephalopods were dissected to determine the sex and to extract the stomach. Gut fullness was reported based on visual inspection, using a semi-quantitative scoring scheme.

The entire stomach was transferred to ethanol (96%). The first batch of samples from cruises in 2019 was stored in this this way for several weeks before further processing, i.e. separation of the stomach contents. This turned out to be detrimental for the preservation of the samples, presumably because the ethanol shrunk and hardened the stomach wall, sealing the contents and preventing them from being thoroughly infused by ethanol. The entire batch had to be discarded. Therefore, for the second batch from (2020, Q1 + Q3), the individual ethanol-preserved stomachs were dissected within two days, weighing the

Genetic identification of species from mixed samples with metabarcoding

Metabarcoding involves extraction and simultaneous amplification of gene segments from a sample of unknown content. This can be a mixed sample of small-sized organisms such as plankton, or a mix of partial individuals, as in stomach contents.

The identification of organisms is based on the reconstruction of their species-specific genes through bioinformatic “pipelines” which collate the sequences from the gene snippets. The allocation of taxa occurs through comparison against a genetic reference library, which is constructed through barcoding (DNA sequencing) of traditionally identified individuals of the known taxa.

Whereas barcoding targets one particular species, metabarcoding is suitable to analyse entire communities.

stomach content and transferring it separately to fresh ethanol. Samples were subsequently kept at ca. 4°C until further processing for genetic identification of prey items through metabarcoding (see infobox). This involved DNA extraction from each analyzed sample of mixed stomach contents. Subsequently, a PCR (polymerase chain reaction) amplified a fragment of the mitochondrial cytochrome c oxidase subunit I gene (COI), which was then purified and sequenced. Bioinformatic analysis were applied for processing of the raw data and for the final DNA-metabarcoding analysis. The resulting Operational Taxonomic Units (OTUs), obtained by using a 3% similarity threshold, were assigned to taxa by comparing their sequences to the Barcode of Life Datasystem reference database (boldsystems.org), which also includes reference sequences previously identified in the North Sea (e.g., Knebelsberger et al. 2014, Gebhardt & Knebelsberger 2015). For the interpretation of results as presented below, only prey taxa were considered, for which more than 30 sequences were obtained.

After successful DNA extraction and PCR-based amplification, 24 samples were selected to be processed with metabarcoding. These included samples of 18 cephalopod stomachs from 2020 Q1 and six from 2020 Q3. All samples stemmed from four of the larger cephalopod species: *Illex coindetii, Loligo forbesii, Loligo vulgaris* and *Todaropsis eblanae.*

Results and discussion

The analysis of stomach contents revealed that cephalopods in the North Sea consume a wide variety of prey items. Overall, 53 different taxa were detected in the analysed stomach samples, a few of which were apparently ingested while associated with the targeted prey, e.g. parasites or phytoplankton cells. Yet, after their exclusion, between 4 and 16 - on average 8 - plausible prey taxa were recorded per individual. This estimate of prey diversity is rather conservative, as a cut-off for at least 30 identical sequences was used to define a reliable identification of the respective taxon.

Fish played an important role in the prey of all four cephalopod species, and overall 19 fish species have been recorded in the diet of the analysed individuals. Differences in diet composition existed between species investigated, as well as between regions. In the northern North Sea, Norway pout (*Trisopterus esmarkii*) regularly constituted one of the three main prey items found, particularly in stomachs of *Illex coindetii*, but also in *Todaropisis eblanae*. Yet, in all three investigated specimen of the *Todaropsis*, the northern krill *Meganyctiphanes norvergica* was represented among the dominating traces of prey species. In the central and southern North Sea, various fish species occurred among the key prey items, including sandeel (*Ammodytes marinus*), sprat (*Sprattus sprattus*), herring (*Clupea harengus*) and whiting (*Merlangius merlangus*).

The protocol of dissecting and preservation of the cephalopod stomachs has been optimized during this pilot study. Lack of preservation of the first batch of samples led to adaptation of the processing protocol for further investigations, where the ethanol-stored stomachs are further dissected to separate the stomach contents on the day following the preparation of cephalopods in the wet lab.

Outlook

After development of a processing protocol and successful application of metabarcoding to identify organisms from cephalopod stomach contents, different aspects regarding the predation impact of this group can easily be addressed. In order to derive a more detailed picture of the potential predation pressure exerted by cephalopods, further information about species-specific prey selection would be needed, as well as about ontogenetic shifts in diet within the same predator species. Furthermore, it remains to be clarified whether the cephalopods are consuming prey quantities, which are a relevant source of mortality for any of the North Sea fish stocks. This task however bears further difficulties, because for one, the (genetic) approaches used would need to be able to determine the quantitative composition of stomach contents. Different digestion times for different prey items could obscure their true proportion on the diet. However, assuming that digestion times would not differ substantially between fish species, further detailed investigations involving quantitative methods could provide important information regarding natural mortality exerted by cephalopod predation.

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Improvement of biological knowledge on tope *(Galeorhinus galeus)* in the North Sea

Introduction

Tope (*Galeorhinus galeus*) is a medium-sized shark with a widespread distribution across almost all major oceans. Tope mainly occur in cold to warm temperate coastal areas, but have been recorded in depths exceeding 500 m as well as in open ocean areas (Compagno, 1984). Globally, tope are amongst the most extensively fished shark species, and across their distribution range populations are decreasing. No analytical assessment is available for the Northeast Atlantic population, but survey data trends from different parts of that area indicate declines of 38% over a three-generation period of 90 years (McCully et al, 2015). Recently, tope has been assessed critically endangered globally according to the IUCN Red List of endangered species (Walker et al., 2020).

Altogether, tope are known to undertake extensive migrations (including oceanic migrations) in most parts of their distribution range, including the Northeast Atlantic. However, consistent and recurrent underlying patterns and drivers have not yet been described, and are possibly confounded by a high ontogenetic plasticity and multiple possible strategies regarding migration, site fidelity, home range etc. (Thorburn et al., 2019). There also is a lack of knowledge of spatially explicit pupping and nursery grounds. Groundfish surveys occasionally catch pups and juveniles, and such data might be able to assist in the identification of general pupping and/or nursery grounds (see Thorburn et al., 2019). However, the lack of more precise data on the location of corresponding grounds and of their importance to the stock so far precludes spatial management for this species (ICES, 2020). Knowledge on the abundance and distribution of adult tope within their Northeast Atlantic distribution range is also patchy at best, since the data collected from e.g. groundfish surveys are not representative for tope assuming reduced catchability of this highly mobile, often pelagic shark species.

Annual aggregations of adult tope have been recorded around the German offshore island Helgoland in the southeastern German Bight of the North Sea. The seasonal appearance of those adult sharks is in line and temporal progression with anecdotal observations of large specimens further southeast along the Dutch North Sea coast. Reasons for the observed aggregations as well as possible migration pathways including reasons for migration or recurring migrations and site fidelity so far have not been identified. Knowledge on migration paths, distance, and connectivity of possible "hotspots" is crucial for identifying and assessing e.g. the local extirpation risk of this vulnerable species (Fock et al., 2014).

Material and methods

During their seasonal aggregation in the area around Helgoland Island in the German Bight of the North Sea, tope were caught with rod and line and marked with both satellite pop-up tags as well as conventional spaghetti tags. To investigate migration pathways, possible recurring patterns, "hotspots" of tope aggregations and general behaviour patterns, Wildlifecomputers MiniPat satellite pop-up tags were employed that recorded time series of depth, temperature and light for a pre-programmed deployment duration of 270 days until the tags detached and transmitted sample data via the Argos satellite network link.

Based on the transmitted time-series data, geolocation of the tags deployed was conducted using the Wildlife Computers GPE3 state-space model (Wildlife Computers, 2015) that combines in-situ measurements of twilight, sea surface temperature and dive depths from the tag data and validates these through comparison with observation data from other sources (Sea Surface Observation via remote sensing, Bathymetry reference dataset). The model further incorporates a shark movement model based on user defined swimming parameters. Altogether, the model provides maximum likelihood positions through a gridded hidden Markov Model (0.25 by 0.25 degree grid spacing) including location probabilities.

Results

Altogether, 14 adult tope sharks (TL range 132 – 160 cm, 3 males, 11 females) were caught, marked and released in August/September of the years 2018-2020. By May 2021, 8 of the tags have reported and transmitted data, 4 tags failed to report and 2 tags are still deployed recording data and are due to detach and transmit by end of May/June. Several of the available satellite tags have not yet been deployed yet due to delays in the annual tagging campaigns due to partly inclement weather etc. Further tagging campaigns are planned for summer 2021.

From the time series transmitted and location models processed, mostly common migration pathways of the adult sharks in the German Bight were evident. All tagged sharks left the German Bight area by autumn and followed a mostly westerly and southwesterly trajectory into the English Channel. In that area, the sharks displayed increased residency over the winter months (Schaber et al., in prep.).

Few individuals migrated further west into the Celtic Sea, crossed the European continental shelf slope and followed a southward trajectory into the Bay of Biscay and further. One tag detached near the oceanic island of Madeira, another on the Atlantic side of the Strait of Gibraltar at the entrance to the Mediterranean. No obvious return migration to the German Bight became evident from the transmitted time series data and corresponding geolocations.

While no clear depth preference or pattern in depth use was evident for the majority of the sharks that remained on the continental shelf area and in the English Channel area, the few sharks that crossed into oceanic areas engaged in regular diel vertical migration behavior and displayed nocturnal ascents to the surface layers and descents into mesopelagic layers of > 500 m depth (greatest depth recorded: 730 m) during daytime. The sharks obviously follow mesopelagic organisms that are aggregated in deep scattering layers and also engage in diel vertical migrations to possibly utilize this abundant food source in regions otherwise poor in epipelagic prey (Schaber et al. under review).

Discussion and conclusions

While no clear overall and recurrent pattern of migration was evident from the tag data that had been transmitted, it became obvious that two (preliminary) results of the study could have implications for conservation and management measures of this critically endangered shark species: A common trait of all sharks was the temporally increased residency in the English Channel area that lasted from several days (seemingly slower transition through that area) to weeks (winter residency?). Despite no targeted fishery in the EU, France is one of the main nations landing tope, accounting for ca. 80% of the total catches – with the English Channel and Celtic Sea representing the most important fishing grounds (ICES, 2020). Accordingly, the largest fraction of tope landings in the EU origins from an area with seasonally increased residency of this shark species.

Additionally, while incidentally taken through a variety of fishing gear, the habitat expansion of adult tope into mesopelagic layers of oceanic areas further increases their risk of fisheries capture in midwater trawl gears employed in many pelagic fisheries - large scale fisheries often operating in deep layers of the open ocean without regulations on tope bycatch.

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Relevance of continentally accumulated organic contaminants for the reproductive capacity of out-migrating silver eels

Introduction

After severe declines in recruitment since the late 1970s, the stock of the European eel is considered critically endangered and reasons for this alarming situation are not fully understood. A number of different stressors including fisheries, habitat degradation, mortality associated with hydropower, parasites and diseases but also impairment of health and reproduction caused by chemical pollution are among the scientifically most discussed possible reasons that may have contributed to the situation.

Due to their peculiar and specialized biology as semelparous predatory fish with high body fat contents, eels can accumulate considerable concentrations of a variety of toxic chemicals during their lives. The group of dioxin-like contaminants, and here especially the dioxin-like polychlorinated biphenyls (dl-PCBs) are halogenated, lipophilic compounds that constitute some of the most toxic human-made substances known to man. The Thünen Institute for Fisheries Ecology has dealt intensively with the importance of pollutants for eels and their populations in recent years. This resulted in numerous publications, in which eels obtained in line with the DCF data collection were used (Sühring et al. 2013,2014,2015,2016; Kammann et al., 2014; Brinkmann & Freese et al. 2015; Michel et al. 2016; Freese et al., 2016; 2017; 2018).

Our research has shown that migrating silver eels from many German river basin districts have problematic high body concentrations of organic pollutants, which evidently could impair successful reproduction after migration to their spawning grounds. This would be of great importance in the national and international management of this endangered species. In cooperation with several partners, the Thünen Institute is currently developing an accurate assessment model, which would allow to evaluate spawner quality of eels by estimating contaminant concentrations of lipophilic contaminants in eel eggs after spawning based on muscle concentrations in out-migrating silver eels.

Study design & methods

The Thünen Institute planned to collect samples of 20-30 silver eels caught with stow nets in the lower sections of every German eel management unit and measure dl-PCB contaminants in the eels' muscle tissue to obtain representative concentration ranges for each origin and assess the potential reproductive capacity of eels from these habitats.

Even though the necessary equipment such as a gas chromatograph time-of-flight mass spectrometer (GC-TOF-MS), extraction- and clean-up instruments as well as necessary laboratory infrastructure for dl-PCB analysis methodology exists already at the Thünen Institute of Fisheries Ecology, personnel needed for the respective method development was not available at the time. For this reason, a specialist was hired for a period of 18 months in order to establish the needed laboratory methodology, create appropriate documentation and then hand over the handling of a functional method to the existing technical staff. Besides this job creation, consumables were also required for the comparatively expensive measurement methods, for example high-purity solvents, chemical standards, sample vessels and separation columns.

Results

Sample material of 20-30 silver eels each from most (5 of 8) German Eel management units (EMU) were obtained from commercial fisheries since beginning of the project. In the three missing EMUs, appropriate eel samples meeting the necessary criteria were not available due to low catches and / or restrictions caused by the COVID-19 pandemic in the country. Missing samples are planned to be collected in 2021 in order to fulfill the project goals. The development and implementation of a functional detection and quantification method for dl-PCBs in the Thünen Institute of Fisheries Ecology, however, was not successful during the course of the project duration. As a result, the representative dl-PCB concentration data in muscle samples of silver eels from different German bodies of water were not achieved as planned.

Discussion and conclusions

Originally it was planned to hire a full-time scientist for 18 months to fulfill above stated project goals. Due to the availability of eligible candidates after the assessment of applicants in job interviews, two candidates were hired on part-time (50%) positions. Due to personal reasons one of the candidates did not start her/his assignment leaving the institute with one part-time employee for the project. The evolving pandemic did not allow the institute to run another job advertisement procedure.

Diverse technical issues with the available GC-TOF-MS device demanded intensive care and support by the manufacturer and several appointments with external technicians. Even though parts of the issues could be solved in line with these repair and maintenance procedures, the COVID-19 pandemic hindered timely and efficient support by the manufacturer which severely delayed the scheduled project timeline. Adding to this, also general lab work at the Thünen Institute was severely restricted during the past 14 months. Laboratory operations were generally reduced to a much-reduced capacity. Distancing and strict hygiene rules (reduced personnel allowed in the facilities) prevented lab work and slowed down and complicated the achievement of milestones and progress in this project.

The development of a functional method in our house is still subject of ongoing work. In the case of unforeseeable further delay, sample analyses will be outsourced to project partners using the acquired consumables and results will be reported at a later stage.

References

Sühring et al. 2013: Flame retardants in eels from German rivers

Kammann et al. 2014: Contaminants as indicators for eel habitat quality in German rivers

Sühring et al. 2014: Flame retardants in European and American eels in different life stages

Brinkmann et al. 2015: Toxicokinetic model for organic chemicals in European eel

Sühring et al. 2015: Maternal transfer of flame retardants in European eels

Michel et al. 2016: Fipronil and in water and European eel from the river Elbe

Freese et al. 2016: Dioxin-like PCBs and their relevance in eel stock management

Sühring et al. 2016: Evidence for maternal transfer of diphenylamines in European eels

Freese et al. 2017: Maternal transfer of dioxin in European eels

Freese et al. 2019 : Demineralization in maturing European eels leads to maternal transfer of toxic metals

Environmental DNA (e-DNA) as an alternative monitoring method to quantify (silver-) eel abundance

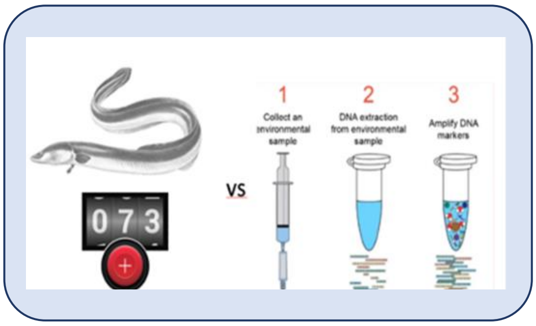
Introduction

The stock of the European eel has suffered dramatic declines in recruitment and abundance throughout its distribution range in the last decades. To counteract this decline, the European Union has initiated the implementation of national eel management plans, aiming at an increase of silver eel escapement in order to secure sufficient reproduction and recruitment. As for other fish stocks, successful management of a fish species, relies on standardized surveys to estimate quantity and distribution of fish stocks. Collected data for diadromous species under the Data Collection Framework (DCF), besides reporting of commercial landings data, comprises various biological stock variables and includes data on recruitment, abundance and escapement. These data enable end-users to assess regional contributions to the single, panmictic stock of the European eel. Scientific data collection usually makes use of scientific surveys implementing catch-techniques such as electrofishing, fish counters, fish traps and others to achieve valid estimates. However, a lot of scientific effort has recently been directed towards the development of non-invasive biomolecular methods, meant to detect or quantify organisms by extracting specific, free roaming DNA from water, sediment & soil or air samples.

Methods targeting environmental DNA (eDNA) have thus emerged as potentially powerful alternatives for studying ecosystem dynamics. The constant loss and shedding of genetic material from organisms including fishes due to excretion of feces, mucus, gametes, shed skin, carcasses and other expelled body cells, leaves a molecular footprint in environmental samples that can be analyzed to determine either the presence or potentially even abundance of a specific target species.

Study design and methods

The German federal Thünen Institute of Fisheries ecology currently conducts an externally funded acoustic-telemetry supported catch-mark-recapture study at the (North Sea-discharging) river Ems. The project allows to precisely quantify silver eel escapement from this river to the sea. For this, a commercial-style stow-net is scientifically monitored for a time-span of more than an entire year, which provides daily information on eel abundance in the respective part of the river and thus reveals expected seasonal changes in numbers of (out-migrating) silver eels. This project generated the opportunity to combine precise silver eel abundance data with an eel-specific eDNA quantification approach in the river Ems.



Aim of this pilot study was to assess the feasibility of quantitative eDNA methodology to detect and potentially quantify seasonal changes in silver eel migration. After preliminary laboratory experiments with eels in holding tanks in our aquaculture facilities to test the general functionality and potential restrictions of our methodological setup, we regularly (every 1-2 weeks) collected 1-L surface water samples upstream from the monitored catch gear. Samples were then filtered, eDNA was extracted from the filters and eel eDNA was quantified by qPCR using a standard curve of genomic eel DNA from European Eel with known concentration, in order to test whether found eDNA concentrations would correlate with seasonal changes in the abundance of (out)migrating silver eels.

Results

In preliminary tests, we sampled 1-L water samples in two 1200 L experimental tanks with different numbers of eels before and at different points in time after introducing n=1 and n=5 eels into the tank. Under these experimental conditions, DNA extraction and quantification worked well and revealed that eel eDNA increased with time and eel abundance in the tank. However, the experiment revealed that after a certain time span eDNA concentration in the experimental tanks peaked and did not increase any further, most likely due to time- and temperature-dependent degradation of measurable DNA in the water column. This observation was expected and well in line with published findings in scientific literature.

In the field experiment, all analyzed 1-liter surface water samples taken before, during and after silver eel migration peak in in fall & winter 2020/2021 did not reveal satisfying results and did not correlate with observed catch numbers in the stow net. Even though the presence of eel eDNA was confirmed in some of the analyzed samples, it could not be extracted and quantified in sufficient amounts in the standard water samples. Eel eDNA concentrations were also below quantification limits in positive control samples taken in close proximity to holding nets containing eels from the Ems river upstream from our catch gear.

Discussion and conclusions

Even though the here applied methodology and the general approach remains promising, its application in this pilot study turned out to be unsuitable for this particular setup. The Ems river in the tidal zone, where the catch gear for quantifying actual silver eel abundance is located, is extremely murky and contains an enormous degree of clay and sediment. As a result, the filtration also of comparably small water samples (2x 0,5 L simultaneously) took up to 6 hours which, in combination with the time-delay between sampling and filtration of water samples, exceeds the desired handling time of each sample and strongly increases the probability of DNA degradation and thus loss of eel eDNA.

Also, even though “positive” control samples, taken in direct proximity of nets containing eels, did amplify and thus indicated the sheer presence of eel DNA in the water samples, amounts of detected eel eDNA were only detected in very low concentrations compared to positive control standards. Considerably larger volumes of Ems water would have to be filtered to be able to achieve sufficient amounts of eel eDNA and register concentration changes that possibly could be found in course of the different abundance of eels during changing seasons of eel migration. The water conditions in the Ems, however, do not allow larger water volumes to be filtered following our current sampling methodology. An alternative approach for future studies could be, to collect larger volume water samples further upstream of the tidal zone, where the water is much clearer and investigate, whether seasonal changes in silver eel migration, as revealed by stow net catch numbers, can also be registered in changes in eel eDNA concentration in the water here.

Genomics for recording North Sea fish stocks

Introduction

Ensuring sustainable marine fisheries requires regular assessment of the status of fish stocks. Environmental DNA (eDNA) technology has the potential to improve the monitoring of marine fish populations[1,2]. This requires, however, a better understanding of how eDNA is related to the presence and abundance of fish by testing the ability of these methods to provide an informative and cost-effective approach compared to traditional methods[3].
The goal of this pilot project was to evaluate the performance of eDNA methods for recording North Sea fish stocks from sediment and water samples in the North Sea, comparing them to trawl catches.

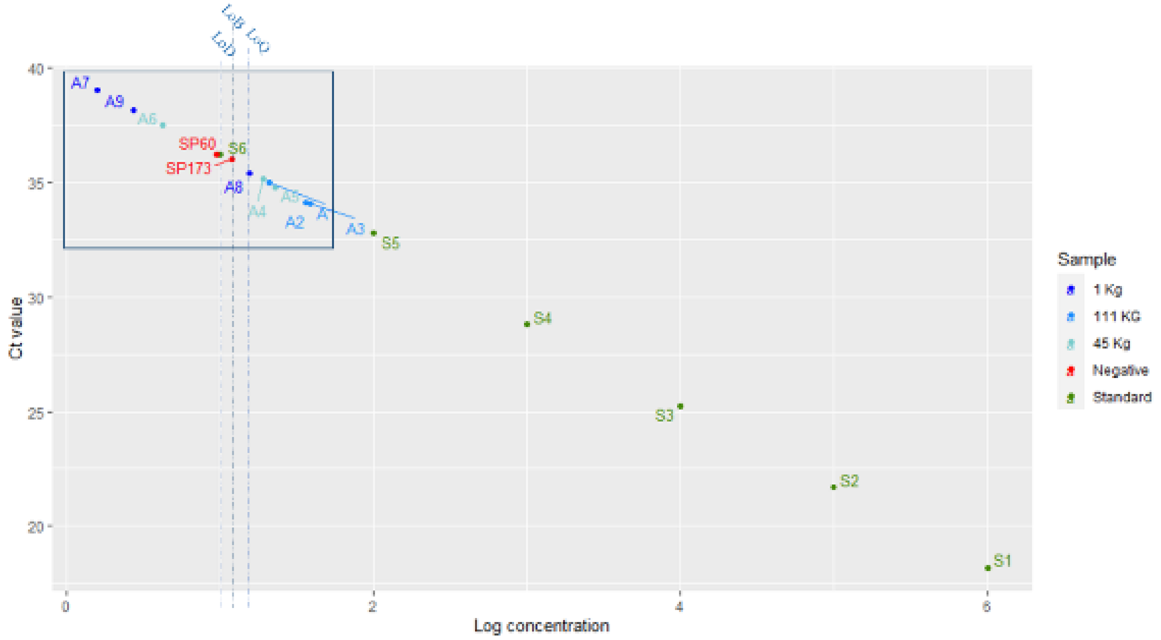
Material and methods

To achieve our main objective, we used two molecular biological methods, metabarcoding to reveal diversity of fish species in sediments and waters collected from the North Sea, and real-time quantitative polymerase chain reaction (PCR) to analyse the specific abundance of cod *(Gadus morhua)* in these samples.
Sediments and water samples were collected during a research cruise undertaken in summer 2019 from the North Sea with the research vessel Walther Herwig III (cruise WH 428).
eDNA was extracted from sediment samples using the the PowerSoil Pro (Qiagen, Hilden, Germany) kit according to the producer's protocol. For water samples, the eDNA was extracted by combining CTAB-PCI extractions[4] (Renshaw et al. 2015), with a purified and concentrated by a spin-column procedure included in the Monarch PCR & DNA Cleanup Kit (Frankfurt, Germany, New England Biolabs). Extracted DNA was stored at -20°C until use.
To achieve the objectives for cod, we first developed cod-specific primers amplifying the CytB gene. Subsequently, we used these primers to analyse water and sediment samples collected from different locations during the WH428 cruise. While, to accomplish the metabarcoding part objectives, we used the mitochondrial 12S rRNA gene according to the protocol of Miya et al., 2015 using MiFish primer[5].

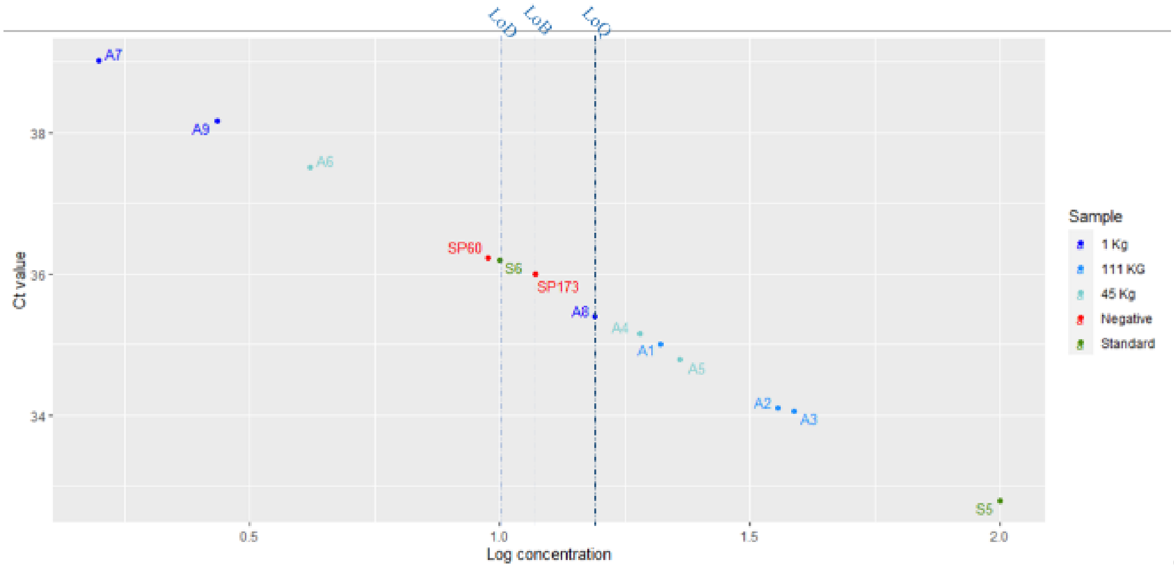
Results and discussion

<u>qPCR</u>

10 pairs of primers were tested to select the most specific pair for cod with high sensitivity. Three pairs of primers were obtained from published work (Technee primer, Knudsen et al., 2019 and Salter et al., 2019), and 7 pairs were designed in the Molecular Genetic Lab of the Thünen Institute of Fisheries Ecology, Bremerhaven, Germany. The best pair of primers was selected based on the value of Limit of Detection (LoD) and limit of Quantification (LoQ). As Figure 1 demonstrates, the combination of the couple “GmCytb-LNA-P_alte Primer_LNA” with Applied Biosystems™ TaqMan™ Environmental Master Mix 2.0 Kit (FisherScientific, Schwerte, Germany), allowed to achieve the best results in terms of specificity (linked to LoQ) and sensitivity (related to LoD).
According to our water sample results, this method is valid when a copy number equivalent to or greater than 17 copies/reaction is available in the eDNA samples. In other words, any positive signal below the Ct (threshold cycle) value of 35.4 is considered negative. This is due to the high risk of false positives after Ct = 36. We were able to detect a positive and highly speculative signal for cod up to a catching limit equivalent to 12 kg. Below 10 kg, the risk of false positive signals increases. On other hand, for sediment samples, we were unable to detect any signal for cod in our qPCR assays. These results demonstrate that water samples are the best source for monitoring the fish stock of cod, supporting the idea that eDNA can provide reliable results on marine species in the North Sea, especially for cod.



(a)



(b)

Figure 1. a) Standard curve of threshold cycle number (Ct values) plotted against the log concentration (copies number). Dark green dots represent 9 replicates of each dilution. In the square results from different qPCR assays are shown. b) Detail of (a) including standard (dark green dots) - the last dilution represented coincides with LoD value – non-target samples (red dots), eDNA sediment samples (blue dots). Dotted lines indicate LoB, LoD and LoQ values. In this assay, the standard equation is $Ct = -3.57 * (\log_{10} concentration) + 39.73$.

Sediment metabarcoding

In analyses of the sediment samples by the metabarcoding method according to the MiFish protocol, we were able to detect 158 species in our sediments, belonging to 68 families (Figure 2), of which 15 species were also detected in the trawl catches. This difference in sediment results is essentially due to the fact that the sediments are considered to be an archive of station diversity rather than a record of the current state of biodiversity at these stations, and therefore the water sample results will reveal more about the current state of station sampling.

Figure 2. Fish richness of sediments samples, based on metabarcoding approach. The y-axis is percentage of species per sample and the x-axis presents the sample name.

The goal of the present project was to evaluate the performance of eDNA methods for recording North Sea fish stocks from sediment and water samples in the North Sea, comparing them to trawl catches. For this purpose, we developed a specific qPCR test for cod and metabarcoding approaches to reveal the fish diversity in North Sea and different matrices were analysed. The present data set shows that we could detect cod, even if it is present in low amounts in the trawl hauls (up to 12 kg), using the qPCR approach and eDNA. On the other hand, the metabarcoding approach applied to sediments reveal a high diversity in the sediment samples analysed. This diversity is varing from one sample to the other, depending on the richness of sampling stations.

These results support our initial hypothesis regarding the ability of eDNA to provide effective and reliable information for the fish monitoring in the North Sea.

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Typical farms of the German aquaculture

Introduction

In accordance with the EU regulation 2017/1004, economic and social data on the German aquaculture sector is collected annually by the Thünen Institute of Fisheries Ecology. The results of this quantitative survey picture the economic situation of the sector and form not only a basis to monitor its developments but also to assess the impacts of political measures on the German aquaculture. Notwithstanding, the effort to conduct the survey is relatively high - as measured by the small size of the sector. Additional hindering factors such as the lack of accessible business registers and the skeptical attitude of some fish farmers towards the survey spur discussions on alternative data collection methods such as the *typical farm approach*. Thus, the aim of the EMFF pilot project "Typical farms of the German aquaculture" was to apply the *typical farm approach* to the German aquaculture sector and to develop datasets of four representative German trout and carp farms. The data collection and evaluation processes were accompanied by continuous considerations on potential adjustments to meet the underlying aim of the project to advance the approach.

Material and methods

Up until now, only few data are available on the economic situation of the German aquaculture sector. The *typical farm approach* addresses this deficit: The virtual data sets of typical farms consist of information on real prices, costs and volumes that can be considered "typical" for enterprises of a certain size in a specific region. These characteristics are defined via consensus building between producers, advisors and scientists during focus groups. The multitude of discussed variables allows realistic insights into the economic situation of the sector. But typical farms are not only valuable tools to analyze the status quo of the sector. Furthermore, they enable the analysis of impacts of political, climatic and technical changes on the farm level.

Following the *typical farm approach*, the national aquaculture production statistic "Fachserie 3 Reihe 4.6 Land und Forstwirtschaft, Fischerei – Erzeugung in Aquakulturbetrieben 2018" of the Federal Statistical Office of Germany was evaluated to decide on the species under consideration and to identify their most important production regions: In 2018, 2.584 aquaculture enterprises were registered in Germany producing a total of 18.108,6 t. Of this volume 35% was rainbow trout (*Oncorhynchus mykiss*) and 26% carp (*Cyprinus carpio*). 31% of the German rainbow trout production was located in Baden-Württemberg and 26% in Bavaria. The total production volume of carp in Germany amounted to 4.745,6 t of which 40% was produced in Bavaria and 36% in Saxony. Based on this evaluation, trout production in Baden-Württemberg and carp production in Saxony were set as case studies to develop a national set of typical farms. Bavaria as another significant production region could not be covered during the project as the global Covid-19 pandemic made data collection impossible. During a previous project typical Bavarian carp farms were already developed.

Hereon, in February 2020, we organized a field trip to Saxony in cooperation with the regional fishers' association "Sächsischer Landesfischereiverband e. V.". During this trip, thirteen fish producers, the advisor and one researcher of the Thünen Institute of Fisheries Ecology developed the typical carp farms DE-FCP-80 and DE-FCP-200. In addition to the focus group, several regional fish farms were visited to gain a better understanding of the regional peculiarities of Saxonian carp production. It was the first time to apply the approach to the region. The same month, we conducted a field trip to Baden-Württemberg of several days' duration in cooperation with the scientific partner "Fischereiforschungsstelle des Landes Baden-Württemberg" (a local fisheries research institute). It consisted of visits of regional trout farms and a group discussion with four trout producers, two advisors and one researcher of the Thünen Institute of Fisheries Ecology. Together we developed the typical trout farms DE-TRR-50 and DE-TRR-150 and updated the top-farm DE-TRR-500.

All information gathered during the focus groups picture 2019 as the reference year of operation. The following paragraph presents the key characteristics of each farm. The specific costs structures can be extracted from the annex. To guarantee the comparability of the typical farms that differ strongly regarding their degree of vertical integration, production systems and distribution, the presented results refer only to the grow-out level.

Results

DE-FCP-80 produces a carp volume of 80 t in earthen ponds. As typical for the region, the enterprise produces its own stock to avoid the transmission of diseases between fish farms. Of its total returns, only 2% are generated through the sale of fingerlings. The focus lies on the distribution of three summer old fish that adds up to 70% of total returns. The distribution of table fish divides into the following shares and channels: 70% are sold via wholesaler, 10% to angling clubs, 5% via restaurants and 5% to other fish farms. The remaining 10% are processed and sold directly to the consumers: Direct marketing generates 28% of the total farm returns.
With the returns from the sales of table fish, DE-FCP-80 can only cover its cash costs that consist of fixed and variable costs and wages (see figure 2). These three cost factors form the farm's short-term profitability within the *typical farm approach*. Mid-term profitability is guaranteed when the enterprise can not only cover its cash costs but also the expanses for depreciation: For DE-FCP-80, the costs for depreciation are low as the infrastructure is old. Same applies for the opportunity costs (such as unpaid labor, capital and land) as the majority of the pond area is leased and not owned – a fact that on the other hand increases the operating costs (see figure 1). Nevertheless, considering depreciation and opportunity costs, DE-FCP-80 becomes unprofitable. As 90% of the pond surface of Saxony is under nature conservation, receiving public payments for services of nature protection can be considered typical for enterprises of the region. But even including the typical share of received public payments, DE-FCP-80 is not profitable in the long-term (see figure 2). This fact must be understood against the background of the high losses of up to 20% (during grow-out) the fish farm has to cover due to protected predators. This economic situation results in an investment backlog and makes it difficult to find successors for the regional carp production.

DE-FCP-200 produces 200 t carp under similar circumstances. The main share of returns (80%) is generated through the sale of table fish of which 80% are distributed via wholesale, 10% via angling clubs and 5% via other fish farms. The sales of fingerlings generate 5% of total returns. The 5% of the production volume that is processed and sold via direct marketing represents 15% of it. Due to its higher production volume, DE-FCP-200 consists of bigger ponds that are harder to protect from predators. Thus, the enterprise has to cover even higher losses and correspondingly higher stocking costs. This factor and the focus on wholesale distribution where the lowest prices are paid result in a profitability that is only short-term (even including the receipt of public payments for nature protection) - the enterprise cannot cover its depreciation and opportunity costs in medium- or long-term (see figure 1 & 2).

DE-TRR-50 is an aquaculture enterprise with own processing facilities with fish production in raceways and ponds. It has a production volume of 30 t rainbow trout, 15 t salmon trout and 5 t char. 80% of the produced fish are distributed via direct marketing. Another 10% of rainbow trout and 15% of salmon trout and char is sold to restaurants, while 10% of rainbow trout and 5% of salmon and char are bought by angling clubs. The strong focus on direct marketing and the high share of processed fish results in relatively high personnel and energy costs (see figure 1). On the other hand, the sale of processed products correlates with high added value (87% of its total returns are generated through direct marketing). As 67% of the input hours are unpaid labor of the farm owner and family members, DE-TRR-50 consists of relatively high opportunity costs (unpaid labor, capital, land), even more as the enterprise is not leased but completely owned (see figure1). Despite this, the farm is profitable in the long-term (see figure 2).

The fish production of **DE-TRR-150** is fully vertically integrated. It covers every production step from egg to the grown fish. Like this, 150 t rainbow trout are produced in a partly, cold-water recirculating aquaculture system (RAS) that is gaining importance as a possible adaption to climatic changes. 80% of its production volume is distributed via wholesale the remaining 20% sold to angling clubs. Automated production processes result in lower costs for labor, but correlate with higher investments in infrastructure and technology and thus high depreciation costs (Figure 1). Nevertheless, DE-TRR-150 is profitable in the long-term (Figure 2).

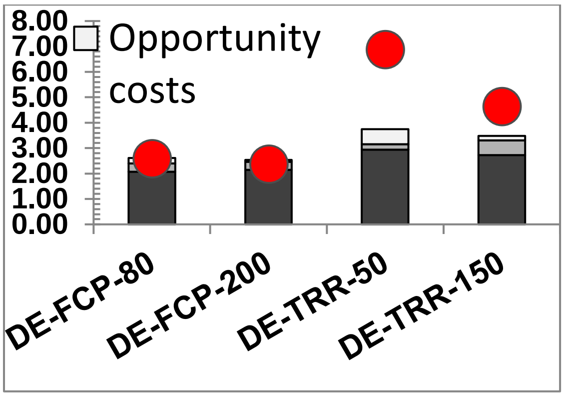

Figure 1: Cash costs and non-cash costs, market returns and profitability (€/kg LW) in selected grow out systems (including Public Payments)

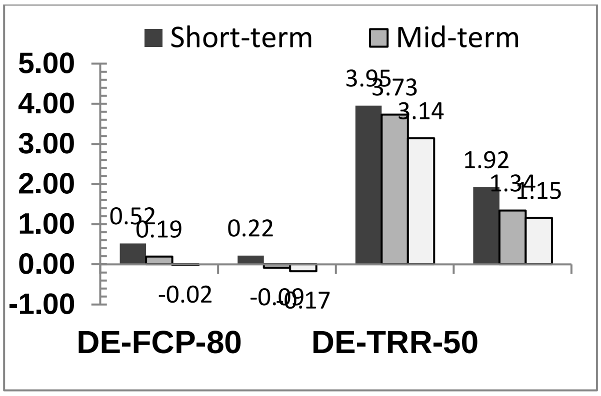

Figure 2: Short-, mid-, and long-term profitability (€/kg LW) of selected grow-out systems (including Public Payments)

Discussion and conclusions

Reliable data is needed to identify the drivers that determine the economic situation of the German fish production. Up to now, the statistical data base is not sufficient to develop measures to foster German fish production and to exploit its unused potentials. Within this discourse, typical farms are valuable tools as they enable the analysis of structural weaknesses of the sector that hinder expansions and investments. Undoubtedly, typical farms as data sets that are representative for a selected group of producers and that are not based on statistical averages remain only models. But precisely the combination of quantitative and qualitative data collection methods within the *typical farm approach* underlines the relevance of the project: its core element, the conducted focus group discussions are a productive frame to explore not only challenges and problems the field is facing but also trends and upcoming innovations. As such, the developed typical farms are a fundamental starting point to develop political measures for counteraction and support.

Furthermore, even after the ending of the project the typical farms can be of use to analyze the impacts of political, technical, climatic and market changes on the farm level. In this context, the developed data sets were used to analyze the economic impacts of the restrictions on social and public life to contain the Covid-19 pandemic on the German aquaculture sector.

Investigations on the importance of contamination from dumped munitions in the Baltic Sea for bottom-dwelling fish species

Introduction

German waters in the Baltic Sea contain approximately 300,000 tons of conventional munitions, while the quantities in the North Sea are probably even larger with 1.3 million tons (Böttcher et al., 2011). The goal of this pilot project was to make a first statement on the contamination of bottom-dwelling fish species such as dab, flounder and plaice with explosive compounds from dumped munitions in the Baltic Sea. Furthermore, the possible contamination of gonads, which are important for the reproduction of bottom-dwelling fish stocks, should be investigated. The results are valuable and applicable for various stakeholders who are involved in the discussion about future management of dumped munitions in the marine environment and who have to participate in the decision-making progress.

Material and methods

Sampling sites for investigating explosive compounds from dumped munitions in fish

Kolberger Heide (KH), a designated munition dumpsite was chosen as it is known to contain high amounts of conventional munitions (Kampmeier et al., 2020). B01 was the reference site (see Figure 1).

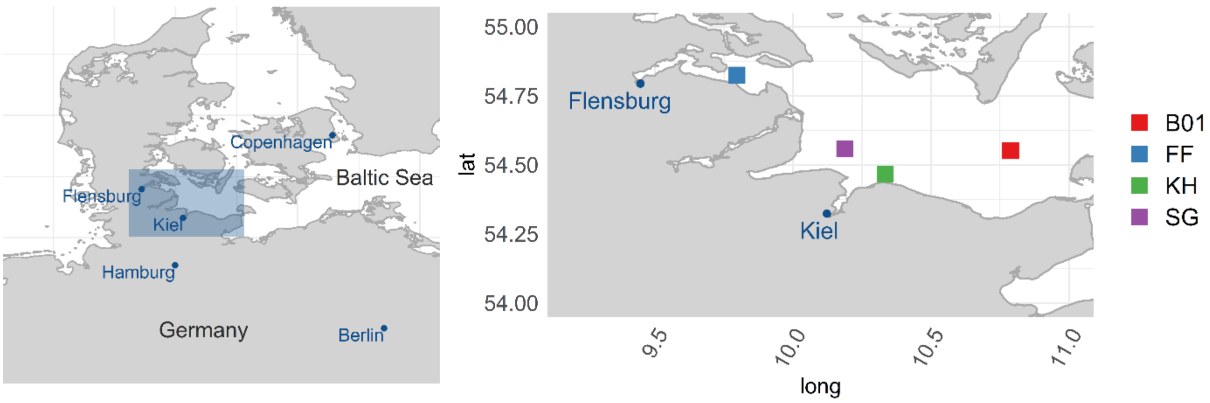

Figure 1: Location of sampling sites. Kolberger Heide, KH; Flensburg Firth, FF; Stoller Ground, SG; B01.

Chemical analysis of explosive compounds

The extraction of explosives from the bile was carried out by liquid-liquid extraction using acetonitrile. The identification of the explosives was performed by HPLC-MS. The method is described in Koske et al. (2020) and was also used for the matrices filet and gonads too. Recovery efficiencies for the explosive compounds octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), 2,4,6-trini-trotoluene (TNT), 2,4-dinitrotoluene (2,4-DNT), 2,5-dinitrotoluene (2,5-DNT), 2-amino-4,6-dinitrolouene (2-ADNT) and 4-amino-2,6-dinitrolouene (4-ADNT) were between 70% to 96% in bile, between 59% to 74% in filet and between 55% to 81% in gonads.

Results

The concentrations of 4-ADNT in bile from KH in the three different bottom-dwelling fish species reveals mean concentrations between 14.4 ng/mL (flounder) and 20.6 ng/mL (plaice). The mean concentration of 4-ADNT in dab from KH was 16.6 ng/mL (Fig. 2).

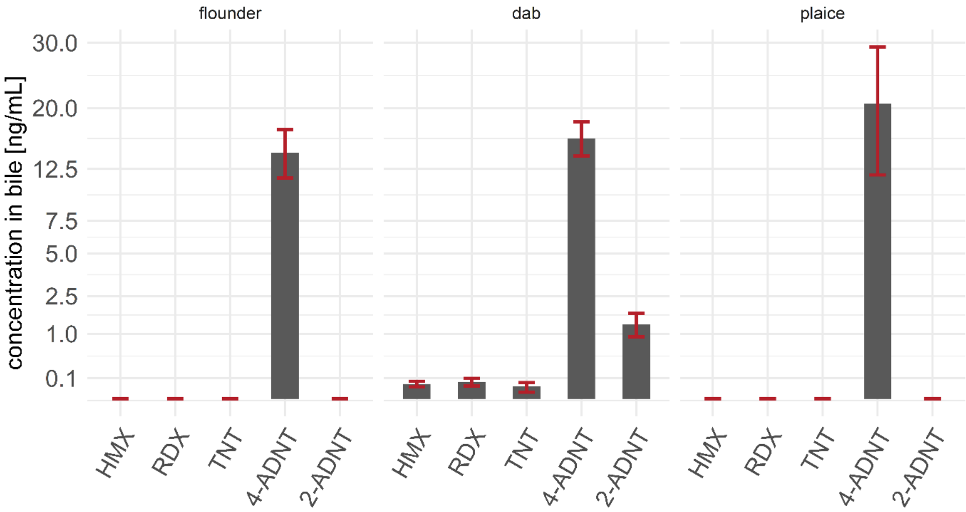

Figure 2: Explosive compounds (ng/mL) in bile of dab, plaice and flounder from the Kolberger Heide dumpsite. Bars represent the mean concentrations. Error bars (red) represent the standard error of the mean (SEM). Sample sizes: Flounder, n = 9; dab, n = 194; plaice, n = 21.

Fish filet and gonads were analysed in order to detect possible explosive compounds in these matrices. None of the 221 filet samples contained any explosive compound including 98 samples from the munition dumpsite KH. Likewise, gonads from dab, plaice and flounder were analysed for explosives. In total, 31 gonad samples from KH and the reference site B01 were analysed. None of the samples contained any explosive compound.

Discussion and conclusions

The goal of the present pilot project was to make a first statement on the contamination of bottom-dwelling fish species such as dab, flounder and plaice with explosive compounds from dumped munitions in the Baltic Sea. For this purpose, fish from the vicinity of the munition dumpsite KH and from different reference sites in the western Baltic Sea and different matrices were analysed. The present data set shows an overall contamination level of 51% in the bile of fish from KH, the bile from reference sites contained explosives in considerably lower levels. This demonstrates on the one hand that fish from KH are exposed to an extraordinary amount of explosives. These findings can be integrated in a monitoring of sites affected by dumped munitions. Adverse effects in fish exposed to leaking dumped munitions must still be expected, as the uptake and contamination of the organism is evident.

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