Title:Results of the flyshoot fishery sampling Programme 2021-2023

Kennisproject "VISwijzer en flyshootvis" & BO "Additionele Flyshoot Waarnemersreizen".

Author(s): Author(s): Van de Pol, L.[a], Winter, A.M.[a], Bangma, T.[a], Bleijenberg, J.[a], Rademakers, A.[b] Wageningen University &

[a]Wageningen Marine Research

[b]Good Fish Foundation

Research report: C071/23

Europees Fonds voor Maritieme Zaken en Visserij

Results of the flyshoot fishery sampling programme 2021-2023

Kennisproject 'VISwijzer en flyshootvis' & BO 'Additionele Flyshoot Waarnemersreizen'

Author(s): Van de Pol, L.[a], Winter, A.M.[a], Bangma, T.[a], Bleijenberg, J.[a], Van Zwol, J., Van Es.[a], Y., Zawadowski.[a], T., Molenaar.[a], P, Rademakers, A.[b]

[a]Wageningen Marine Research
[b]Good Fish Foundation

This research project was carried out by Wageningen Marine Research and subsidized by the ministry of Agriculture, Nature and Food Quality for the purposes of Policy Support Research Theme '***Duurzame voedselvoorziening & -productieketens & Natuur***' (project no. BO-43-119.01-048).

Wageningen Marine Research
IJmuiden, November 2023

CONFIDENTIAL no

Wageningen Marine Research report C071/23

Europees Fonds voor
Maritieme Zaken en Visserij

Keywords: Flyshoot, Sampling programme

Client: Rijksdienst Voor Ondernemend Nederland
Pr. Beatrixlaan 2
2595 AL Den Haag

BAS-code: BO-43-119.01-048

This report can be downloaded for free from https://doi.org/10.18174/642209
Wageningen Marine Research provides no printed copies of reports

Wageningen Marine Research is ISO 9001:2015 certified.

Contents

Summary

The rationale for the project 'VISwijzer en flyshootvis' (FISHguide and flyshoot fish) stems from the increasing demand for transparency regarding the production and origin of food. Despite the general impression that fish stocks in the North Sea are doing well, certain fish species in the North Sea and the English Channel currently do not qualify for favourable ratings on the 'VISwijzer' and/or MSC certification. This pertains, among others, to commercially less attractive fish species in the Netherlands, such as gurnard, cuttlefish, and red mullet. There is insufficient data on fish stocks and fishing pressure for these data-deficient species, making it currently impossible to assert the sustainability of fisheries on these species. The project was set up as an initiative from the fisheries industry (Jaczon-Vrolijk), to partner with the Good Fish Foundation and Wageningen Marine Research. The primary objective of the partnership project was to pave the way for improved data collection in flyshoot fishing. The second objective was to adapt the VISwijzer method to make it more suitable for assessing mixed fisheries. The third objective is the dissemination of project results and the knowledge gained about flyshoot fishing. This report focuses mainly on the results of the first objective.

A total of fifteen observer trips were conducted. During these trips, which took place on board three different vessels from Jaczon-Vrolijk, discard samples were collected and sorted, the total catch was estimated, the presence of ETP (Endangered, Threatened, or Protected) species was recorded, and the length distribution of selected species in the marketable catch was determined. This data was used to study the catch composition and efficiency of the Dutch flyshoot fishery, calculate the mean length-at-catch and identify the risk of catching ETP species.

The majority of the sampled hauls were in the eastern Channel. Additionally, sampling was conducted in the southern North Sea, as well as a small number of hauls in the central North Sea. In the winter months effort was concentrated in the Eastern Channel. In quarters 2 and 3, effort shifted to the southern North Sea. Landings clearly display a seasonal pattern, with squid being the dominant catch in winter months, and mackerel in summer. Discards were almost entirely composed of fish, with few benthos, invertebrates and debris being caught. The most dominant species in the discards included whiting, herring, dab, bib, horse mackerel, mackerel, as well as sharks. Both landings and discards vary throughout the seasons. Several species had a ratio between length-at-catch and maximum length that was above the 2/3 limit set by the GoodFish Foundation, namely red gurnard (69%), mackerel (77%), and herring (90%). For tub gurnard (57%), red mullet (65%), whiting (60%), and horse mackerel (52%) mean length-at-catch/L_{inf} was below the 2/3 limit. In total, three ETP species were reported as incidental bycatch: twait shad, seahorse and small-spotted catshark. Discard ratios were found to be highly variable between hauls, trips, quarters and areas. Overall discard percentages were found to be between 45.49 and 50.04%.

The protocol developed in this project was evaluated positively, though certain lessons learned during the sampling period should be taken into account when sampling in the Dutch flyshoot fishery. Total catch was estimated using the volume in the hopper, and even though this method proved workable, it did pose several problems. Firstly, this method sometimes resulted in negative discards weights. Also, in case of small catches, the hopper could be split into smaller compartments to more accurately read the height of the catch, however, this was often impractical. Alternatives to the hopper-volume method are considered. Another issue in the protocol was encountered in the length measurements of the landings. In the protocol the length of the most common species in each haul was sampled. However, this posed problems for the data analysis.

The lack in spatial coverage in the presented project is probably mainly caused by the fact that very few trips were sampled in summer. To improve the coverage of future sampling programmes, (observer) trips should also be carried out in other areas, such as the central and northern North Sea. It should also be noted that sampling took place on board three vessels of the same shipping company, and to fully understand the fishing practices, sampling should be extended to other vessels in the Dutch fleet.

The results of this project can be used to inform science and policy, especially on data deficient target species of the flyshoot fishery. The data has already been used in a sustainability assessment by the GoodFish Foundation, and the project is a good example of how cooperation between the scientific community, industry, and NGOs can increase data availability and transparency in a fishery.

1 Introduction

1.1 Project rationale

The rationale for the Knowledge Project 'VISwijzer en flyshootvis' (FISHguide and flyshoot fish) stems from the increasing demand for transparency regarding the production and origin of food. Greater transparency enables consumers to make more targeted choices for sustainable and responsibly produced products. Government procurement guidelines provide a tangible framework for sustainability, referencing the 'VISwijzer' (FISH guide) and the MSC and ASC certifications for seafood.

Despite the general impression that fish stocks in the North Sea are doing well, certain fish species in the North Sea and the English Channel currently do not qualify for favourable ratings on the 'VISwijzer' and/or MSC certification. This pertains, among others, to commercially less attractive fish species in the Netherlands, such as gurnard, cuttlefish, and red mullet. There is insufficient data on fish stocks and fishing pressure for these species, also referred to as data-deficient species. Without estimates of fishing pressure and fish stocks, it is not yet possible to assert the sustainability of fisheries on these species.

The European Commission's ambition is to effectively manage data-deficient species. Therefore, it is crucial to establish relevant time series for these species. One fishery that lands considerable amounts of data-deficient, unmanaged species, is flyshoot fishing, where the main target species are red mullet, gurnards, squid and cuttlefish. However, there is limited knowledge concerning the catch composition, size distribution and discard ratios of flyshoot fishing, as well as other information related to this fishing practice, such as trawling time, location and catch efficiency. Flyshoot fishing has become an important alternative to beam trawling for several fishing enterprises due to its reduced impact on the seabed and, consequently, significantly lower fuel consumption (Eigaard et al., 2015). As a result, the Dutch flyshoot fleet has substantially increased in recent years.

It is possible for a fish stock not to be at risk, despite its data-deficient status. This led to the increasing interest by the fishing sector and labelling agencies into the reasons for red (negative) rating on the VISwijzer for species such as gurnard and red mullet. In response, the Good Fish Foundation, commissioned by the Ministry of Economic Affairs, introduced a temporary incentive called the 'Bijvangstwijzer' (Bycatch Guide); a sort of exception to the VISwijzer (no longer available). Underexploited fish species thereby gained better access to consumer markets. However, the Bijvangstwijzer does not provide a lasting solution because the data required for effective management are lacking. With the implementation of the landing obligation, it is essential to adapt the VISwijzer and Bijvangstwijzer methods to make the assessment method suitable for mixed fisheries.

In order to more adequately assess the status of data-deficient fish stocks exploited by the flyshoot fishery and revise the VISwijzer scores of these species, more data on the operation of this fishery and the exploitation of the relevant species is needed. Currently, the Dutch flyshoot fishery is not part of any permanent sampling programme, leading to knowledge gaps on the business operation of the fishery and the ecology of its target species. The partnership project 'VISwijzer en flyshootvis' was set up as an initiative from the fisheries industry, to partner with the Good Fish Foundation and gather data from the Dutch flyshoot fishery and fill these knowledge gaps, allowing for more informed sustainability assessments.

1.2 Aims

1. The primary objective of the partnership project was to pave the way for improved data collection in flyshoot fishing. Ultimately, this could lead to better fisheries management and enhanced sustainability assessments of catches. To achieve this goal, an appropriate data collection protocol for flyshoot fishing was developed. The ambition was to establish a sampling protocol that could be deployed across the entire Dutch flyshoot fleet. The sampling involved observer trips.
2. The second objective was to adapt the VISwijzer method to make it more suitable for assessing mixed fisheries. The data generated from the sampling efforts from objective 1 were used for VISwijzer assessments with the intention of improving the transparency and data availability of the VISwijzer scoring. The adjustments also aimed to ensure that the method aligns with the fundamental principles of the Global Seafood Ratings Alliance (GSRA), thereby garnering international support from key NGOs. The modified method was applied to several North Sea fisheries. For flyshoot assessments, newly collected data and, to the extent possible, previously unavailable historical data series were utilized.
3. The third objective is the dissemination of project results and the knowledge gained about flyshoot fishing. Flyshoot fishermen expressed the wish to remain well-informed throughout the project's duration. By involving the sector in the status of the results, greater support is generated for organizing data collection and the additional time required onboard in the future. We are launching a knowledge program for fish retailers and restaurateurs who have the potential to become ambassadors for flyshoot fishing.

This report mostly covers the outcomes of objective 1, the sampling programme, though a short overview of the methods and results of the VISwijzer assessments by the Good Fish Foundation (objective 2) are given Annex 2. Objective 3 is not discussed in this report.

1.3 Project phasing

The project (objective 1) was globally divided into three phases. In Phase 1, a preliminary sampling protocol was designed and tested by a scientific observer on board one of the participating flyshoot vessels. Additionally, the suitability of a Fisheries Improvement Program (FIP) for flyshoot fishing was investigated.

In Phase 2, the initial data was analysed, and the basic protocol was refined into a final protocol. During this phase, observers were onboard to collect data. Initially, this was intended for the validation of self-sampling, but since no exception was granted for the landing of undersized sea bass, self-sampling was not allowed. Therefore, the initially planned self-sampling trips were substituted with observer trips. Due to the higher costs of the observer trips and thus limited number of trips, this part of the EFMZV project was expanded through an additional BO project 'Additonele Flyshoot Waarnemersreizen,' in which the originally nine planned observer trips were supplemented with six extra trips. The findings from all observer trips were coordinated with ICES. The collected data were used to adjust VISwijzer assessments and explore how the VISwijzer assessment method could be updated. This was also coordinated with international NGO partners.

In Phase 3, VISwijzer assessments for 15 stocks for the North Sea and English Channel were conducted according to the adjusted method. These findings were shared with international NGO partners. The results of the program were disseminated to chain partners in the hospitality and seafood retail sectors through a knowledge dissemination program by the Good Fish Foundation.

This report exclusively discusses the execution and results of the sampling program. Other matters, such as the adaptation of the VISwijzer method and the knowledge dissemination program, are not addressed here in detail.

1.4 Project organisation

This was a collaborative project between three organisations, who signed a partnership agreement at the start of the project.

1.4.1 Participants

1.4.1.1 Good Fish Foundation

The Good Fish Foundation ("Good Fish") is an environmental organization and publisher of the VISwijzer. The VISwijzer is currently being published in 28 countries through the World Wildlife Fund (WWF). The organization is the secretary and project coordinator for this project. Good Fish Foundation is committed to the further transition to sustainable fishing and aquaculture. Website: https://www.goodfish.nl/en/

1.4.1.2 Wageningen Marine Research

Wageningen Marine Research (WMR) focuses on strategic and applied marine ecological research with a focus on Marine Living Resource Management (the sustainable protection of, harvesting from and multiple use of marine and coastal areas). The institute was founded in 2006 and is composed of the former Netherlands Institute for Fisheries Research (RIVO) and parts of Alterra and TNO. Website: https://www.wur.nl/nl/onderzoek-resultaten/onderzoeksinstituten/marine-research.htm

1.4.1.3 Vrolijk-Jaczon

Cornelis Vrolijk is an international family business with the fifth generation at the helm. They are active in the catching, farming, processing and trading of fish and shrimp, with the aim of producing a high-quality and sustainable product for human consumption. The core activity is fishing and trading in pelagic fish species (such as herring and mackerel). Other important activities are demersal fishing (such as sole and plaice) and the catching and farming of (tropical) shrimps. The takeover of shipping company Jaczon BV by Cornelis Vrolijk in 2005 meant an expansion of the fleet of freezer trawlers and the addition of four flyshoot cutters in the North Sea, three of which participated in this project. Website: https://www.cornelisvrolijk.eu/nl/

2 Materials and Methods

The aim of this project was to design and execute a sampling programme suitable for the Dutch flyshoot fishery, in order to collect data on this fishery to inform sustainability assessments. As there was no sampling protocol for the flyshoot fishery in place at the start of the project, this was first developed and tested. Besides collecting data during observer trips, historical logbook data were also analysed to help inform sustainability assessments. Observer trips were carried out on board three vessels of the Jaczon-Vrolijk flyshoot fleet. Vessels were anonymized (V01, V02, and V03).

2.1 Historical data

Using historical logbook and Vessel Monitoring System (VMS) data from the flyshoot fleet, the characteristics of the fleet were visualized. The logbook and VMS data is provided to WMR by the Netherlands Enterprise Agency (RVO) and stored in the WMR VISSTAT database. First, an examination was conducted regarding the spatial distribution of the fleet and how it evolved during the period from 2011 to 2020. This analysis considered the effort (in Days at Sea) of the fleet at the level of ICES statistical rectangles, measuring 0.5 degrees latitude by 1 degree longitude.

In addition to spatial distribution, trends in landings per unit effort (LPUE) for the target species and other important species were analysed by ICES subdivision using logbook data from the Jaczon-Vrolijk flyshoot fleet was used. For squid (*Loligo vulgaris*), no logbook data was available, so this data was provided by the records of Jaczon-Vrolijk. The analysis considered the Central and Southern North Sea (27.4.b-c), the Eastern and Western English Channel (7d-e), the Bristol Channel (7f), and the Celtic Sea (7g-h). The analysis included the four target species (cuttlefish (*Sepia officinalis*), red mullet (*Mullus surmuletus*), tub gurnard (*Chelidonichthys lucerna*), and squid) and eleven other species, namely bib (*Trisopterus luscus*), black seabream (*Spondyliosoma chantharus*), European sea bass (*Dicentrarchus labrax*), Atlantic cod (*Gadus morhua*), dab (*Limanda limanda*), grey gurnard (*Eutrigla gurnardus*), red gurnard (*Chelidonichthys cuculus*), Atlantic horse mackerel (*Trachurus trachurus*), Atlantic mackerel (*Scomber scombrus*), European plaice (*Pleuronectes platessa*), and whiting (*Merlangius merlangus*).

2.2 Sampling programme design

2.2.1 Requesting discard exemption

Initially, the project was designed to use the self-sampling methodology to collect data on the flyshoot fishery, supplemented with observer trips for validation purposes. To conduct self-sampling, an exemption for the landing of discards had to be granted. However, this exemption was not granted because landing undersized sea bass would have been in violation of the existing European regulation concerning this species (European Commission, 2023). In response to this decision, the project implementation was adjusted by shifting the focus from self-sampling, which was originally planned for 39 trips, to observer trips. Initially, nine observer trips were conducted in the EFMZV project. This was expanded with an additional six trips in the BO project.

2.2.2 Data collection protocol meeting

During a meeting with a WMR fisheries researcher and the crew of a flyshoot vessel, the onboard process and the implementation of the protocol were discussed. They assessed where potential bottlenecks existed and worked on solutions. The emphasis was on creating a protocol that would not disturb normal fishing activities onboard while simultaneously meeting scientific requirements.

2.2.3 Determining hopper volume for catch estimation

To be able to estimate total catches before sorting, the hopper volumes of the vessels were determined. V01 and V02 had identical hoppers, so only the hopper volume of V01 and V03 were determined. This was done by filling the hopper with a non-permeable tarp and installing a measuring stick to measure the height in the hopper. Next, the hopper was filled with water from a hose, and every 15 seconds the height of the water in the hopper was noted. Using the water flow of the hose, the total volume at each sampling point could be determined. This data was used to calculate the relationship between hopper fill height and volume. To be able to adequately assess the volume of smaller catches, the hopper was divided into two sections, which could be separated using a separation panel. The height-volume relationship was determined for both the total hoppers and the smaller hopper compartments.

2.2.4 Testing protocol

During the first trip, the established protocol was tested on board a flyshoot vessel by a researcher from WMR. The knowledge gained during this initial sampling week was utilized to make any necessary adjustments to the protocol. During the consecutive observer trips, the protocol was continuously evaluated and minor changes to the protocol were made throughout the project.

2.3 Observer trips

A total of fifteen observer trips were conducted.' During these trips, discard samples were collected and sorted, the total catch was estimated, the presence of ETP (Endangered, Threatened, or Protected) species was recorded, and the length distribution of selected species in the marketable catch was determined. The protocol is included in a more extensive handbook for observers, which also contains information about flyshoot fishing, safety procedures, onboard behaviour, and discretion. The trips were done on board of three different flyshoot vessels of the Vrolijk-Jaczon fleet (Table 1).

In order to cover the full range of the fleet’s activity and ensure data collection on different (seasonal) target species, a multi-year sampling plan was set up, which was stratified over subdivisions and quarters. The participating vessels were asked to take scientific observers on board accordingly. At the beginning of the first trip, the protocol was explained to the fishers, to allow them to aid the observer, for example in the total catch estimation. Sampling took place on board of three flyshoot vessels (Table 1). The Dutch flyshoot fleet (excluding Dutch vessels flying different flags), consisted of 20 vessels in 2022. Participating fishers received compensation for the added workload that came with having an observer on board.

Table 1: Overview of vessels participating in the sampling project, with specifications.

Vessel code	Mesh size (mm)	Engine power (kW)	Length (m)
V01	80	500	34.3
V02	80	500	34.5
V03	80	769	34.3

2.3.1 Haul list

The observer requested the skipper to fill out a haul list. It was essential that the haul list was meticulously completed for each haul. The haul list included haul data, location, and the quantity of the catch based on the estimated volume in the hopper (Section 2.2.3). It was the responsibility of the observer to regularly verify that the entire haul list was being filled out by the skipper for each individual haul.

2.3.2 Total catch estimation

After the catch was brought on board, it was deposited into the hopper. In case of small catches, the observer could decide in consultation with the crew to install the separation panel to split the hopper into smaller parts. The observer noted whether the panel was used. This allowed for more accurate reading of the hopper fill height. The observer and/or crew noted the fill height of the catch in the hopper from measuring sticks installed by WMR. Later, the fill height was converted to volume using the height-volume relationship (Section 2.2.3) and next to the total catch weight using a density of 0.8 kg/L. Large quantities of stones or shells were noted as comments on the haul list. If the catch could not be completely smoothed out or was uneven in the hopper (e.g. due to waves), this was also noted, and if possible, a photo was taken to facilitate the registration of the total catch in the haul list later. If a haul was sampled, the volume of the total catch was measured by the observer. If a haul was not sampled, the total catch was measured by the crew.

2.3.3 Marketable catches per haul

At the end of each trip, a printout of marketable catches from the catch registration system was generated in collaboration with the skipper. Some species were not individually recorded per haul. The observer monitored these species and recorded the marketable catches per haul. Sometimes, at the end of the day, the remainder was registered as bulk. In this case, the observer attempted to match the species with their corresponding hauls. Based on these notes from the observer, the species were added to the haul list under the correct haul.

2.3.4 Discards sampling

Discards, in a broad sense, refer to all catch that is returned to the sea after being caught. In a strict sense, discards include undersized fish, non-commercial species, benthos, debris, offal, (dead) birds, and (dead) mammals. Starting from January 1, 2019, the landing obligation has been fully enforced for demersal fisheries. This obligation, mandated by the European Union, requires that all undersized individuals of quota species that were previously discarded must now be retained on board and landed.

The goal of observer trips was to sample as many hauls as possible for discards. When the landings for one haul were sampled (see section 2.3.5), it was essential to also sample the discards from the same haul to obtain an accurate picture of the entire catch.

After the landings were sorted from the total catch by the crew, a discard sample was collected. The discard sample was collected in parts, with preferably 5 to 7 times 1-1.5 baskets of approximately 50 litres taken from the end of the sorting conveyor during the entire processing time of the haul. This approach ensured that the sample was representative of all discards. The discard sample consisted of 35 to 40 kg. The basket was weighed on the sea-calibrated scale before collecting the discard sample and was recorded, to be able to subtract the weight of the basket. While collecting a discard sample, the observer, in collaboration with the crew, checked if any incidental bycatches were present in the catch (mainly ETP species, see section 2.3.6). These were removed from the catch, measured, and recorded on the sample form (with a subfactor x1 since they came from the total catch; see also section 2.3.5). If there were few discards in the entire catch, this was noted on the haul list. In this case, the total discard weight was known, and total catch could be calculated by adding the landings and discards, rather than using the total catch from the measured hopper volume to obtain the discard weight.

All individuals in the discard sample were sorted by species and total species weight was taken, as well as the weight of the debris. Then, the benthos were counted, and the fish were measured by length. The measurement of fish was done up to the lower centimetre (e.g., 15.0-15.9 cm = 15 cm). For some species (e.g., squid), the protocol deviates slightly from the above general rules, which is documented in the protocol. For herring, individuals were measured to half centimeter below (in line with general DCF guidelines). The length measurements and counts of benthos were recorded on the measurement lists. If there were many individuals of a particular species, a decision could be made to count or measure only a fraction of them (subsample; for example, one-fourth). However, where possible at least fifty individuals were always measured per species to obtain a representative length distribution. In principle, the gender of the animals whose length was determined was not recorded. Exceptions to this are rays, sharks, brown crabs, and Norway lobsters.

2.3.5 Landings size sampling

For the target species mullet, red mullet, cuttlefish, and squid, as well as for any other commonly encountered species, landing samples were collected. These samples were intended to provide insights into the length distributions of the landings per haul. Throughout the day, at least five landing samples were taken of the species that were most abundant in a haul. The number of species sampled varied per haul. For the selected species, at least fifty individuals were measured to the lower centimetre. The total weight of the sampled fish was recorded. Since some species were divided into length categories (1-4) on board the vessel, each category was measured separately for these species (with a minimum of fifty individuals per category whenever possible).

2.3.6 Bycatch of ETP species

Within the project, incidental bycatches of ETP (Endangered, Threatened, or Protected) species were also documented. In principle, this includes species that appear on one of the lists of protected animal species (e.g., IUCN red list) or are protected by European legislation (Habitats Directive). The observers were provided with a list of relevant bycatch species in the flyshoot fishery to record separately.

When the cod-end was opened, the observer checked for bycatch of birds, marine mammals, and reptiles, as well as unusually large fish (sharks, rays, etc.) that were not part of the expected catch. This was observed because these species might be too large to fit in a sample basket or might be removed by the crew during catch processing. In the case of marine mammals, birds, and reptiles where the species could not be identified, a photo was taken to determine the species later. To sample the incidental bycatch of rare fish species, the observer observed the sorting conveyor when possible and selected individuals of species listed as ETP species (Table 2).

Table 2: List of ETP (Endangered, Threatened, Protected) species relevant in the flyshoot fishery that was provided to observers.

Dutch name	**Scientific name**
Salmon	*Salmo salar*
Sea trout	*Salmo trutta trutta*
Smelt	*Alosa alosa*
Twait shad	*Alosa fallax fallax*
Sea lamprey	*Petromyzon marinus*
River lamprey	*Lampetra fluviatilis*
Porbeagle	*Lamna nasus*
Basking shark	*Cetorhinus maximus*
Angel shark	*Squatina squatina*
Common skate	*Dipturus* sp.
Undulate ray	*Raja undulata*
Sturgeon	*Acipenser sturio*

2.3.7 Data entry

The collected data was entered by the observer into Excel (in the case of the haul list) and BillieTurf 8.1 ("Billie"), software used by WMR to standardize the input and archiving of data collected during surveys and research. For each haul, the collected data on sampled discards, total landings, sampled landings, and incidental bycatch were stored in a single file. The entered data was then reviewed for inaccuracies by a data manager within WMR and thereafter imported into the WMR database. Where necessary, the data manager provided feedback to the observer on the entered data. The observer could then make adjustments to the entered data and resubmit it to the data manager. At this point, the data for the total catch estimates was reviewed. In some cases, the landings weighed more than the total catch estimate, which would result in negative values for total discard weight (i.e. total discards = catch estimate – total landings). In such instances, multiple actions would be taken. First, as described in Section 2.3.3, the catches registered at the end of the day, which in reality were often caught during the day and weighed at the end of the day, would be redistributed across all hauls of that day. Next, the observer could consider using the total discard sample weight to calculate total catch, in case the discard sample represented the majority of the discards (i.e. total catch = discard sample + landings). Finally, to account for total catch estimate errors, a margin of 5 cm could be added to the hopper fill height when calculating total catch volume and weight. If none of these steps resulted in positive discard values, the haul was declared invalid.

2.4 Processing and analysing data

All data were analysed in R (RStudio). During some trips (mainly 2021_10_V02), the sea-calibrated scale onboard the vessel did not function properly, and there was no information on discard weights. For these trips, the discard weights were determined using a length-weight relationship. The length-weight relationship was obtained from a WMR database, and the following formula was used:

$$W = a \times L^b$$

If there was no known length-weight relationship (which was the case for many invertebrates), the weight was estimated by taking the average weight of an individual in the dataset. For these weights, length could not be taken into account.

2.4.1 Spatial distribution

First, the spatial distribution of sampling was mapped out. To do this, the fishing effort (the number of fishing hours) was aggregated to the level of ICES rectangles. This was done for all trips combined and broken down by quarter.

2.4.2 Catch composition

The composition of landings and discards was determined for each sampled trip. To do this, the landings per species and per trip were summed, as well as the total fishing effort per trip (number of active fishing hours). Then, the total landings per trip was divided by the fishing effort to calculate landings per unit effort (LPUE), expressed as kg/hour. The same process was applied to discards, but here, the summed discards (per species and trip) was divided by the number of fishing hours of the hauls where discards were sampled. This allowed both landings and discards to be expressed in kg/hour. It is important to note that the total absolute catch compositions (i.e. landings and discards) per trip were not considered, as this was not measured for discards (since only the discard compositions of the *sampled* hauls were known). The catches were categorized into new groups (e.g., demersal fish, sharks, benthos, etc.). To compare the composition of the catch between trips, it was also expressed as percentages of the total. The percentages per group in landings and discards were then determined per quarter and per ICES subdivision (central North Sea (4b), southern North Sea (4c), and eastern Channel (7d)).

2.4.3 Length frequencies

The length distribution in the catch was determined for several species, namely sea bass, cuttlefish, grey gurnard, red gurnard, tub gurnard, herring, mackerel, horse mackerel, red mullet, plaice, squid, and whiting. To do this, the landings and discards per length were converted to quantities per hour of fishing. Since the sampling protocol stipulated that the most common species in each haul would be sampled by length, an adjustment was made to calculate the *total* landings with the ratio between the total weight of the length-sampled fish and the total weight of that species in the landings per trip. The total weight of the species in the landings was not recorded by length category (1, 2, 3, or 4), but the length-sampled fish were only recorded by category in some cases. In these cases, an extrapolation to the total landed weight was made using the ratio of weights between the categories in the length-sampled landings. The total landed count by length was then divided by the total trip duration (in fishing hours), and the average across all trips was taken. For discards, the length-measured counts were extrapolated to total counts per trip using the sampled weight per trip and the total weight of that species per trip. This was divided by the duration (fishing hours) of the sampled trips (for the length of that species) and divided by the number of trips.

The data for discards and landings were combined to assess the length frequency in the entire catch. Additionally, the average length-at-catch per species was calculated, along with the ratio between the mean length-at-catch and the asymptotic length (L_{inf}) (the theoretical maximum length that a fish approaches according to the growth curve). This information was used as a sustainability indicator for the VISwijzer: The Good Fish Foundation uses this ratio as an indicator for (fishing-induced) growth truncation, and maintains a ratio of 2/3 (and above) mean length-at-catch to L_{inf} as a healthy catch pattern, with lower ratios indicating too much fishing on young individuals. The asymptotic lengths came from an dataset on life history parameters (Greenstreet et al., 2012) and can be found in Table 3. This could only be determined for fish, but not for cuttlefish and squid because these species exhibit different growth patterns, and there are few known growth curves for them. Length-at-catch could only be determined for species where both discards and landings were sampled.

Table 3: Species sampled for size during the observer trips and their respective asymptotic lengths (Greenstreet et al., 2012).

Species	**ICES-code**	**L_{inf} (cm)**
Red mullet	MUR	31.07
Grey gurnard	GUG	36.95
Red gurnard	GUR	34.43
Tub gurnard	GUU	47.77
Plaice	PLE	54.17
Sea bass	BSS	74.33
Whiting	WHG	44.34
Mackerel	MAC	41.25
Horse mackerel	HOM	39.65
Herring	HER	30.31

2.4.4 ETP species

The ETP species that were present in the catch were aggregated by ICES subdivision and quarter. All incidental bycatch was recorded at the species level with a subfactor of 1, meaning these weights/numbers would not be extrapolated from the discard sample to total catch, as the observed number was considered the true total.

2.4.5 Discard ratios

The ratio between total landings and discards was also determined. As mentioned before, in some cases total discard weights were negative (Section 2.3.7). As a result of this, the calculation of discard ratios could be done in several ways in relation to these negative values, and these methods were tried to compare the difference in outcomes:

- Excluding negative discards: In this method, all hauls where discards are negative are omitted. The assumption here is that these hauls are entirely erroneous.
- Including negative discards: In this method, all hauls are used to determine an average discard percentage, assuming that the underestimation of the total catch in some hauls (where discards are negative) is compensated for by an overestimation in other hauls.

Subsequently, an average discard percentage could be calculated in several ways:

- Calculating the ratio between discards and landings per haul and determining the average per trip. The average across all trips is the overall discard percentage. In this method, each haul within a trip carries equal weight, and then each trip carries equal weight.
- Calculating the ratio between the average amount of discards in a trip and the average amount of landings on a trip. The average across all trips is the overall discard percentage. This method gives more weight to hauls with large amounts of landings and/or discards.

In addition to a total discard percentage, discard percentages were also calculated per ICES subdivision and per quarter.

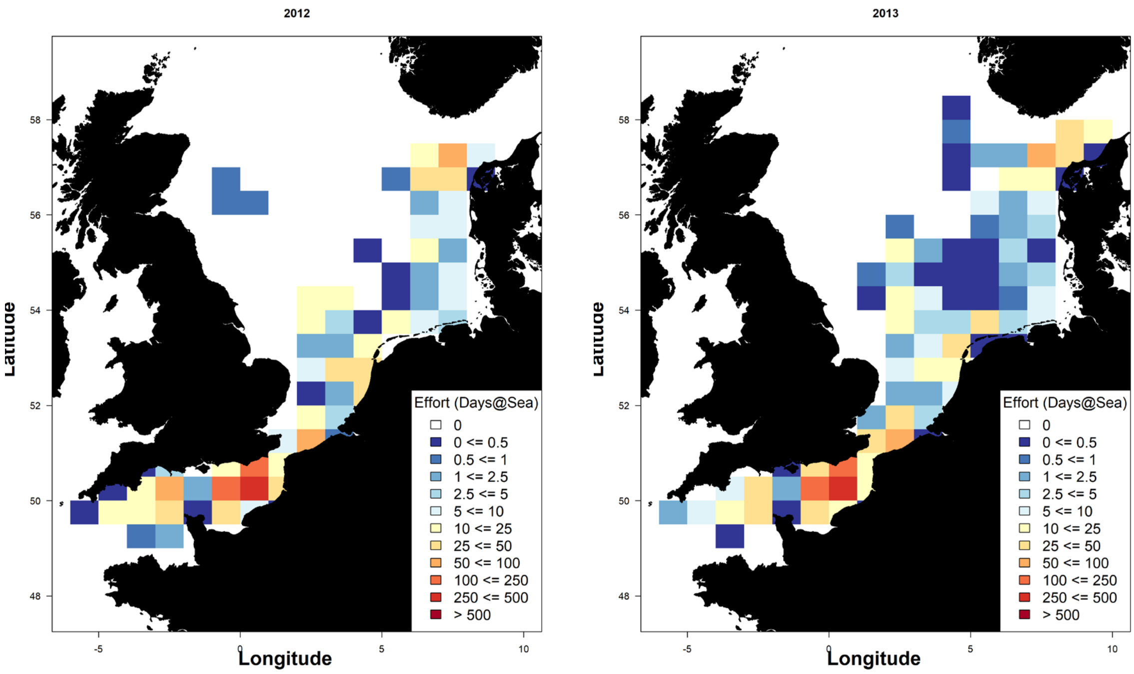
3 Results

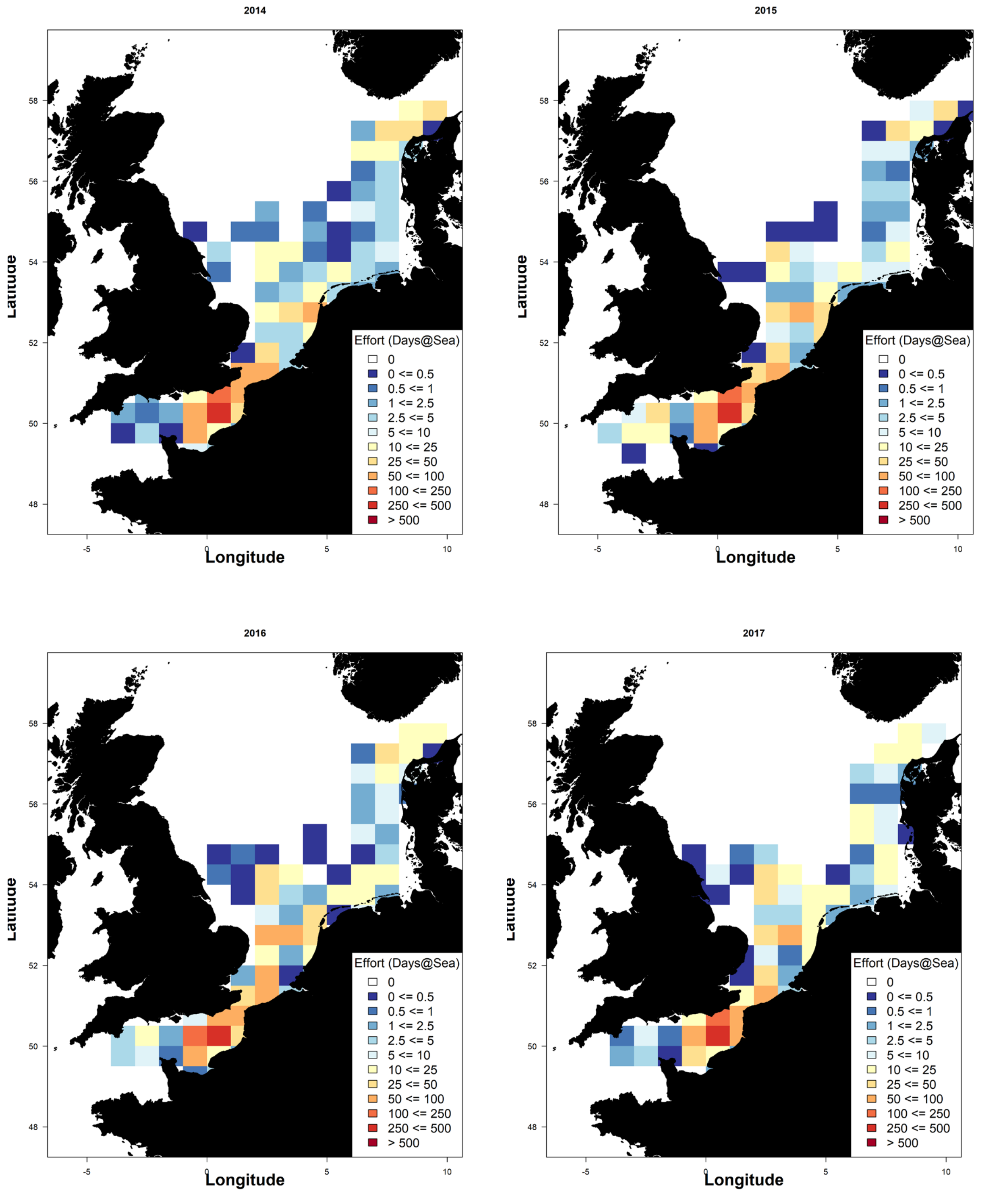
The results of the data are reported with a decimal point (.) instead of a comma (,) (in derogation of the Dutch SI).

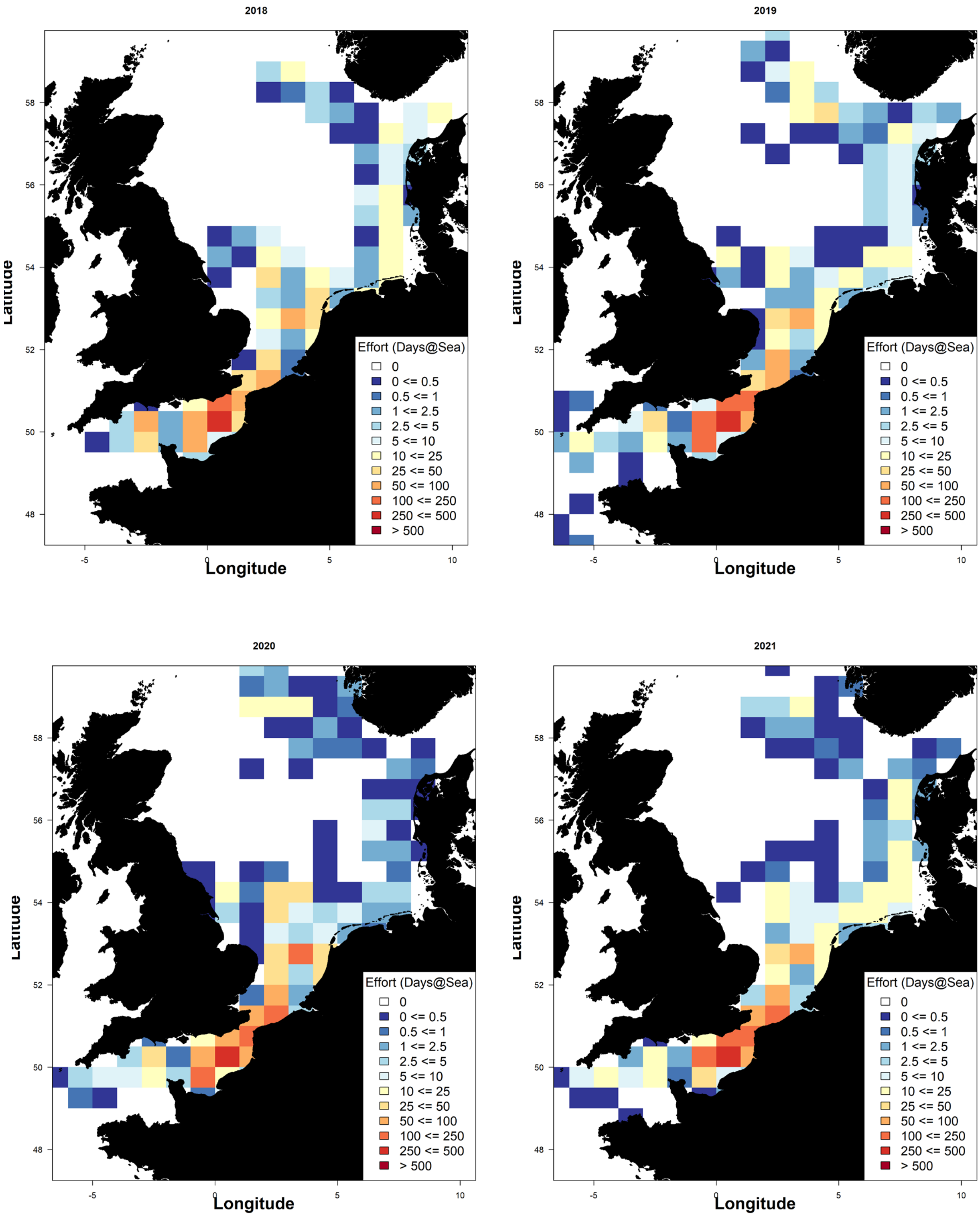
3.1 Historical data

3.1.1 Spatial distribution

First, fishing effort (in days at sea) from VMS data was aggregated at the level of ICES rectangles, by year and by quarter. From this, it can observed that over the period 2011-2022, the effort of the Dutch flyshoot fleet is generally concentrated in the Eastern Channel (27.7.d), followed by the Southern North Sea (27.4.c). In the period 2012-2021, the effort shifts northward and westward, with the waters around Norway and the Celtic Sea, which were initially not or barely fished, being fished in recent years (Figure 1).




2014
58
56
54
52
50
48
Latitude
-5
0
5
10
Longitude
Effort (Days@Sea)
0
0 <= 0.5
0.5 <= 1
1 <= 2.5
2.5 <= 5
5 <= 10
10 <= 25
25 <= 50
50 <= 100
100 <= 250
250 <= 500
> 500
2015
2016
2017


2018
2019
2020
2021
Latitude
Longitude
58
56
54
52
50
48
-5
0
5
10
Effort (Days@Sea)
0
0 <= 0.5
0.5 <= 1
1 <= 2.5
2.5 <= 5
5 <= 10
10 <= 25
25 <= 50
50 <= 100
100 <= 250
250 <= 500
> 500

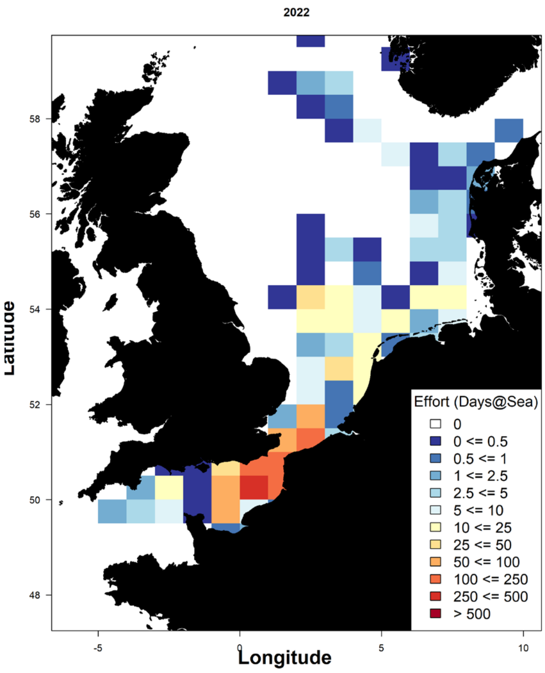
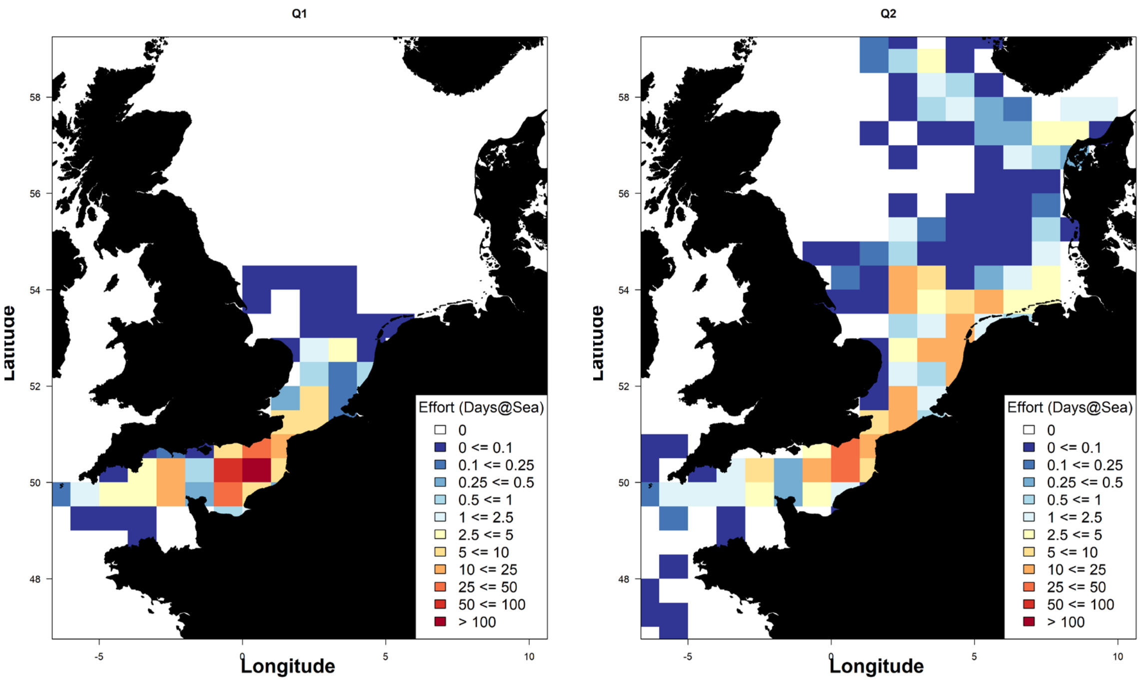


Figure 1: Yearly fishing effort (in Days at Sea) of the Dutch flyshoot fleet in the period 2012-2022.

By quarter, it becomes clear that during the winter months (quarters 1 & 4), the effort is concentrated in the eastern Channel (27.7.d) (Figure 2). In the second quarter, the focus of effort shifts to the southern North Sea (27.4.c), and in quarter 3, the fleet is mainly in the southern and central North Sea. Subdivisions 27.7.d and 27.4.c are by far the most important for the fleet throughout the year, followed by 27.7.e and 27.4.b (Figure 2).



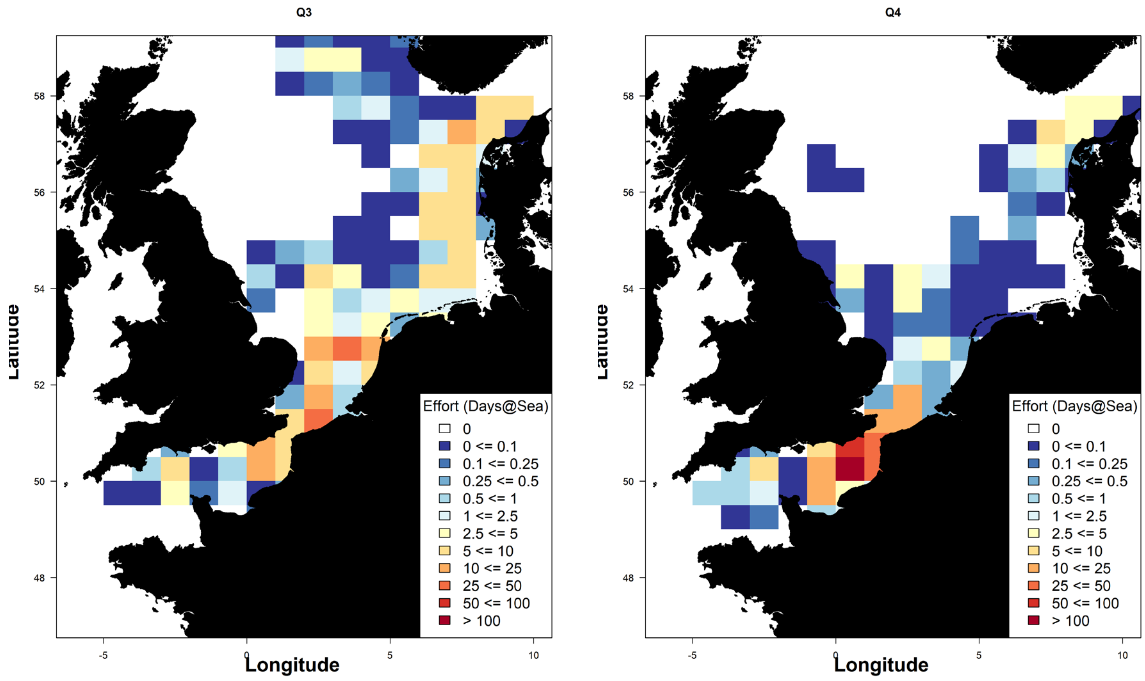
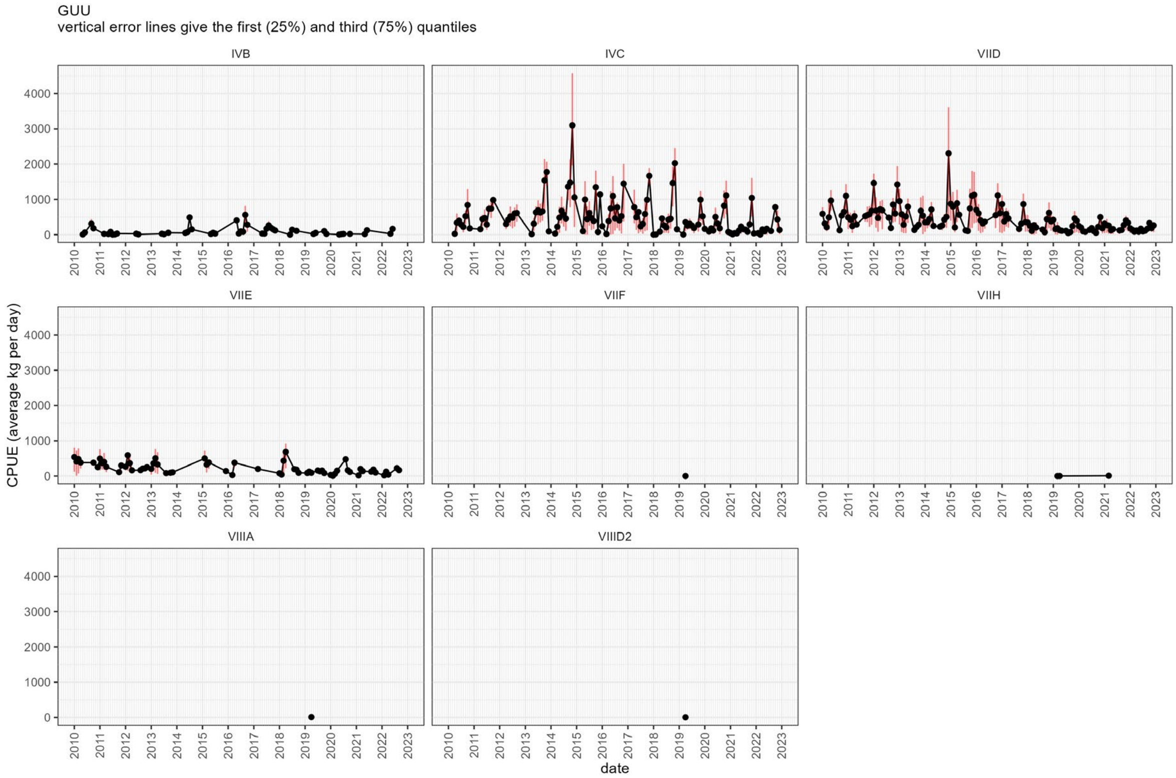
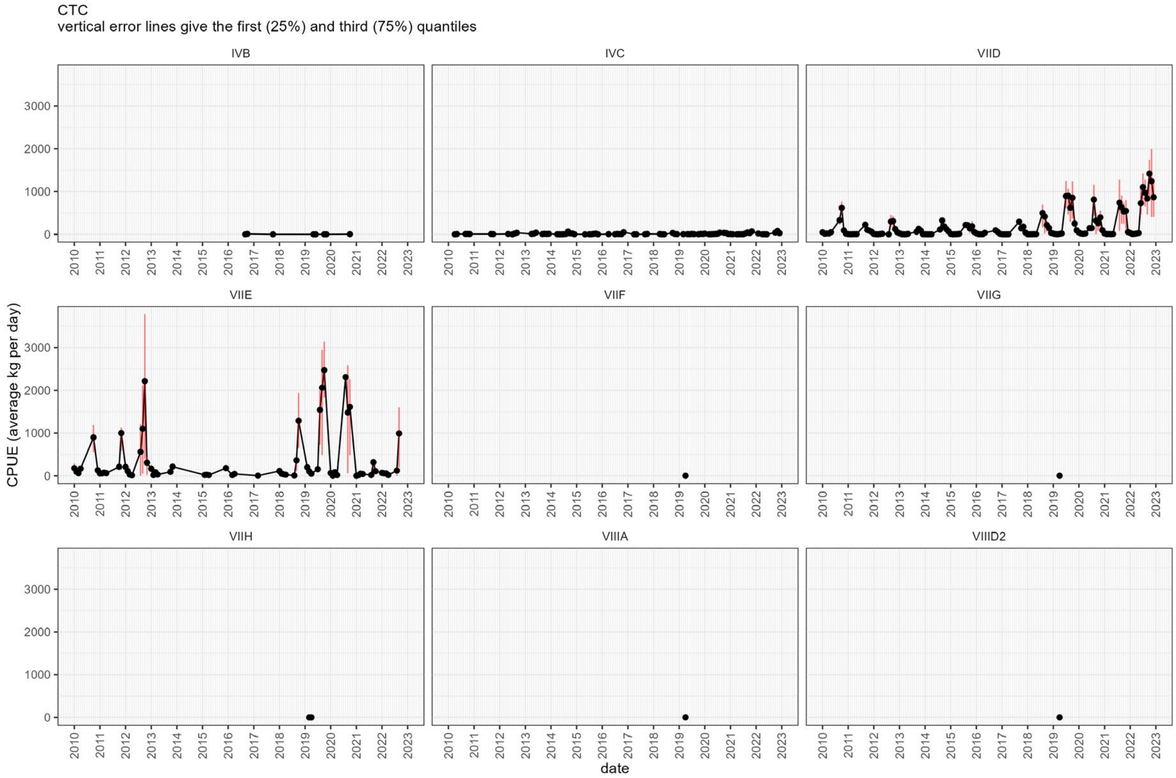


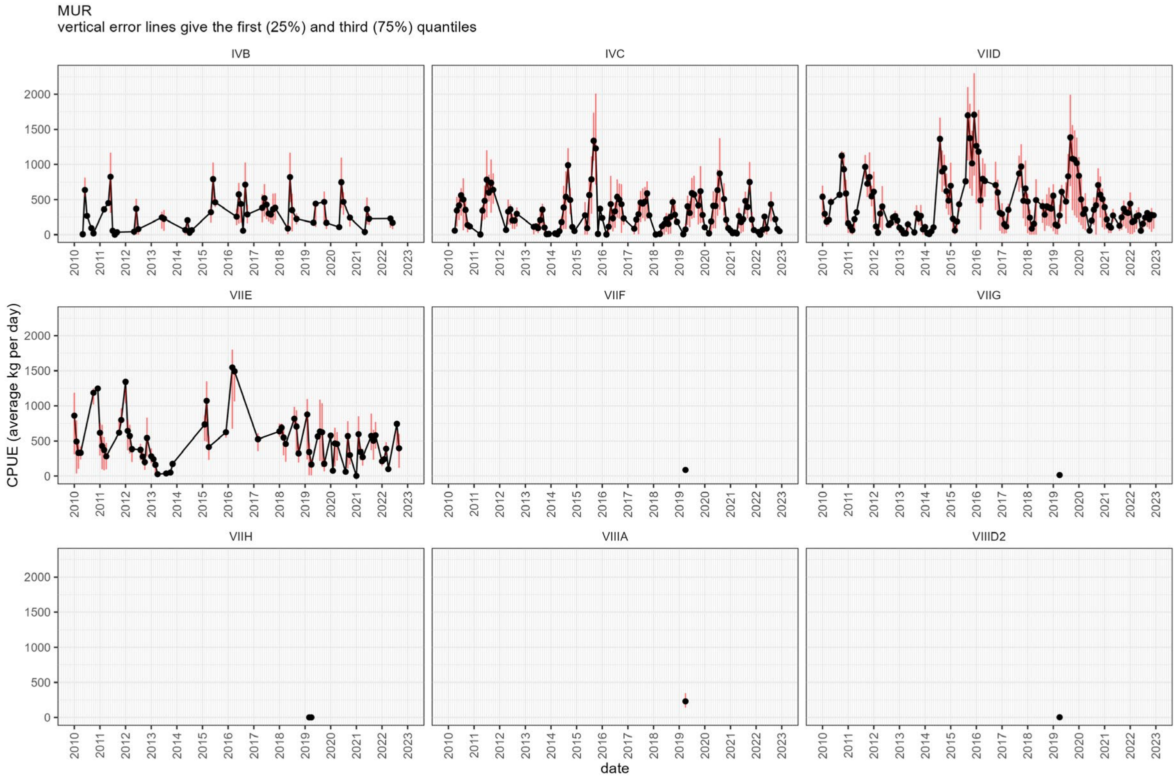
Figure 2: Quarterly fishing effort (in Days at Sea) of Dutch flyshoot vessels, averaged over the period 2012-2021.

3.1.2 LPUE trends

For several species, the LPUE trends of the Jaczon-Vrolijk flyshoot fleet were determined for each ICES subdivision (ICES, 2023; See also Annex 1). Figure 3 shows these trends for the target species red mullet, sole, cuttlefish, and squid. For squid, this data comes from the logbooks of Vrolijk-Jaczon, rather than the VISSTAT database. It can be seen that for the target species, the highest CPUEs are achieved in subdivisions 27.7.d and 27.4.c, followed by 27.7.e and 27.4.b. This is in line with the distribution of effort. For red mullet (GUU), it can be seen that the CPUE is largely seasonal in 27.4.c, where this species is mainly caught in the summer. LPUE peaked around 2015 and then declined somewhat, both in 27.4.c and 27.7.d. There are limited catches in 27.4.b and 27.7.e. For cuttlefish (CTC), the highest catches are in 27.7.e, although they are fairly sporadic (in 2012, 2019, and 2020). LPUE has increased mainly in 27.7.d in the autumn in recent years. For red mullet (MUR), the yields are fairly equal for subdivisions 27.7.d, 27.7.e, 27.4.c, and 27.4.b. The highest CPUEs were in 27.7.d in 2015. Squid (SQU) is mainly caught in 27.7.d in the winter months, followed by 27.4.c during the same period (note: the y-axis differs per plot). Squid is caught in smaller quantities in 27.7.e and sporadically in 27.4.b. The plots for bycatch species can be found in Annex 3.


GUU
vertical error lines give the first (25%) and third (75%) quantiles
IVB
IVC
VIID
VIIE
VIIF
VIIH
VIIIA
VIIID2
CPUE (average kg per day)
date


CTC
vertical error lines give the first (25%) and third (75%) quantiles
IVB
IVC
VIID
VIIE
VIIF
VIIG
VIIH
VIIIA
VIIID2
CPUE (average kg per day)
date



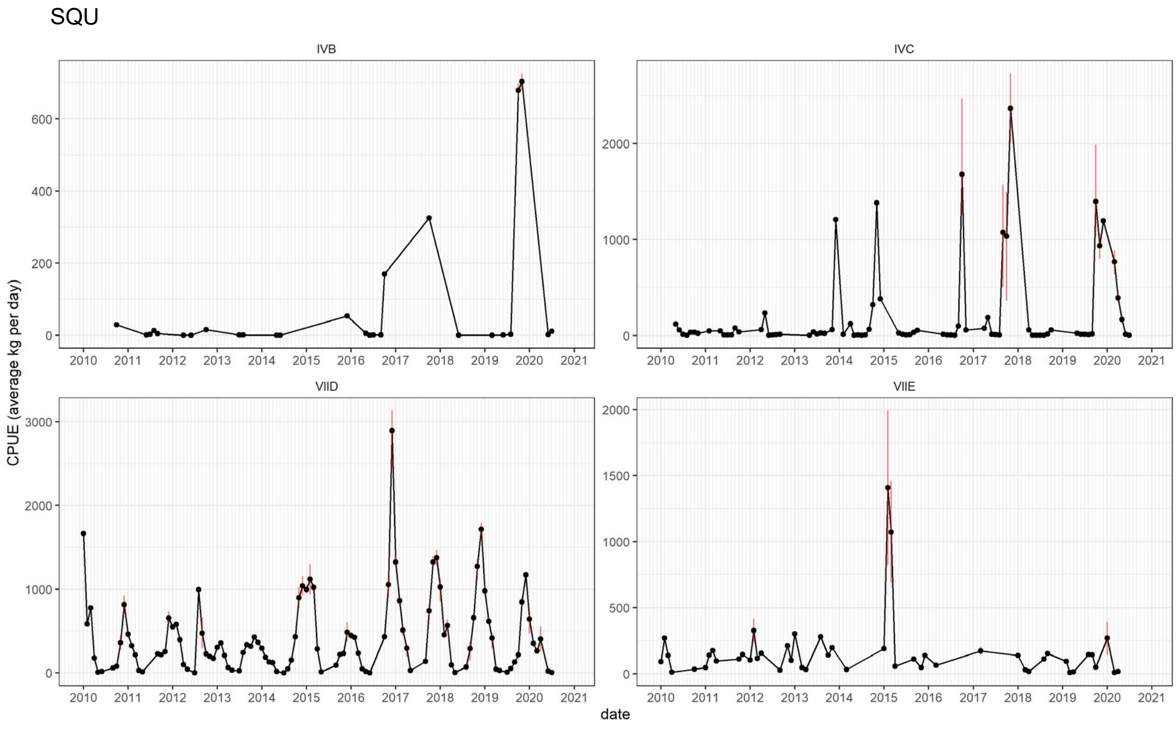


Figure 3: average LPUE (in kg per day) of the main target species of the Dutch flyshoot fleet, namely tub gurnard (GUU), red mullet (MUR), cuttlefish (CTC) and squid (SQU) in the period 2010-2022.

3.2 Protocol testing

The initial protocol was tested by a scientific observer from WMR onboard V01 in June 2021 (week 24). The protocol received a positive evaluation during this trip, and no further changes were made. This trip is also included in the subsequent discussion of the results. For the duration of the project, the protocol was continuously improved, for example which species in the landings were measured and what information was recorded on the haul list.

3.3 Results sampling programme

A total of fifteen observer trips were conducted from June 2021 to February 2023. Despite some trips having to be postponed, e.g. due to bad weather, all planned trips were successfully performed. The number of hauls per week ranged from 15 to 64, with the number of sampled hauls varying between 5 and 44 (Table 4).

Table 4: Overview of observer trips, when they took place, on which vessel, the code used to refer to the trip, how many hauls were performed and sampled, and which project financed the trip.

Trip number	Year-Month	Vessel	Trip code	Number of hauls	Number of hauls sampled	Project
1	2021-06	V01	2021-06 V01	37	17	EFMZV
2	2021-08	V03	2021-08 V03	29	29	EFMZV
3	2021-10	V02	2021-10 V02	22	13	EFMZV
4	2021-11	V01	2021-11 V01	31	26	EFMZV
5	2022-01	V02	2022-01 V02	32	19	EFMZV
6	2022-02	V03	2022-02 V03	49	44	EFMZV
7	2022-03	V01	2022-03 V01	29	26	EFMZV
8	2022-04	V01	2022-04 V01	34	14	EFMZV
9	2022-05	V03	2022-05 V03	59	44	EFMZV
10	2022-11	V01	2022-11 V01	15	5	BO
11	2022-12	V02	2022-12 V02 1	38	30	BO
12	2022-12	V02	2022-12 V02 2	64	43	BO
13	2022-12	V03	2022-12 V03	64	40	BO
14	2023-02	V01	2023-02 V01	35	26	BO
15	2023-02	V03	2023-02 V03	54	29	BO

3.3.1 Spatial distribution

The majority of the sampled hauls were in the eastern Channel (Figure 4). Additionally, sampling was conducted in the southern North Sea, with a small number of hauls in the central North Sea. There were unsampled subdivisions where the entire Dutch flyshoot fleet does operate, mainly in 27.7.e and 27.4.a. On a quarterly basis, it is evident that sampling effort was concentrated in the winter months, quarters 4 and 1, in the Eastern Channel (Figure 5). In quarters 2 and 3, some of the sampling effort shifted to the Southern North Sea. It is also noticeable that sampling was limited in the third quarter.

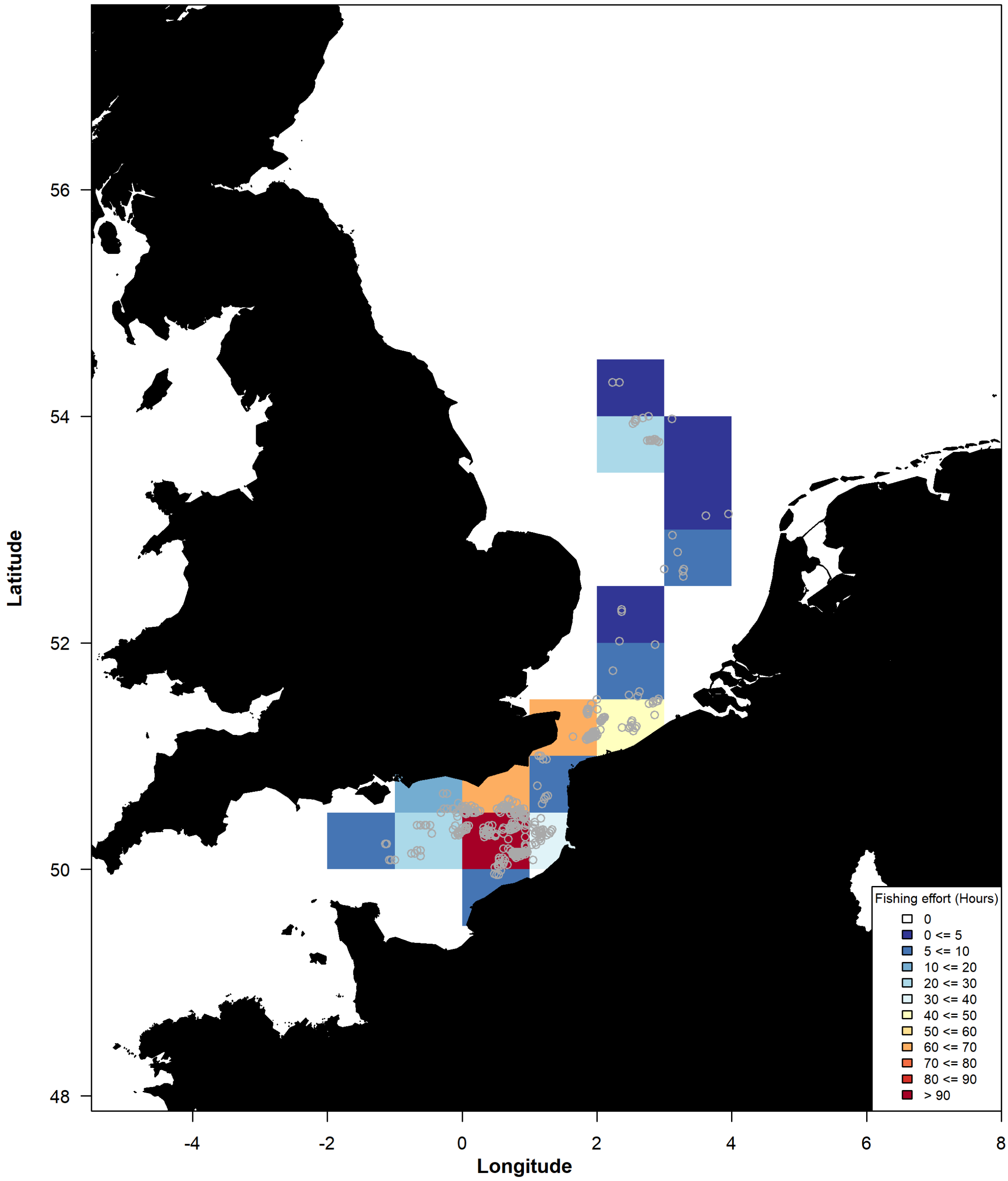


Figure 4: Spatial distribution of sampled hauls (points) and aggregated effort per ICES rectangle.

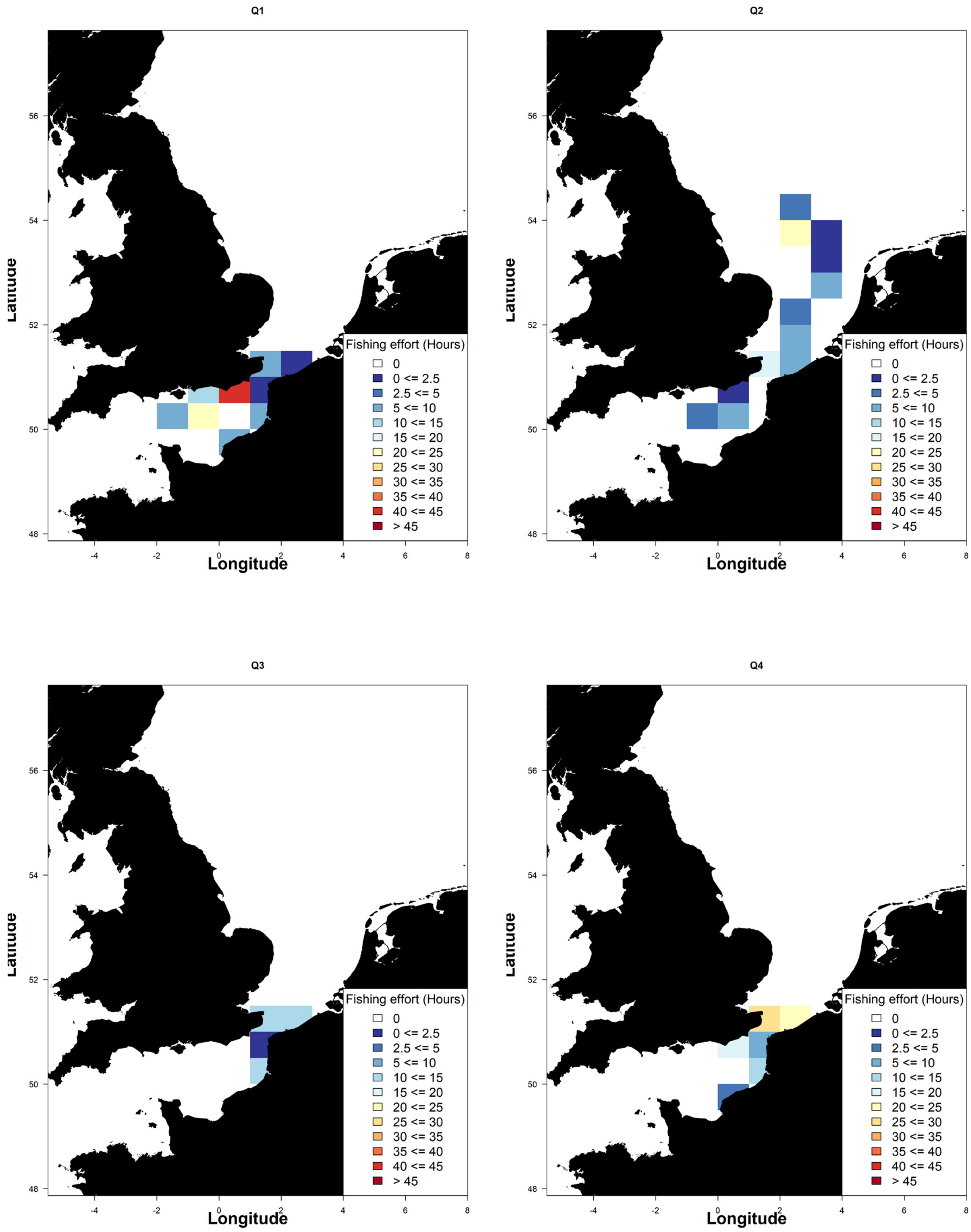


Figure 5: Spatial distribution of effort aggregated per ICES-rectangle by quarter.

3.3.2 Catch composition

The composition of landings per trip as shown in Figure 6. It can be observed that total landings generally increased over the course of the sampling program. Whereas in 2021 and the beginning of 2022, catches usually remained under 10 tonnes, by late 2022 and early 2023, they were mostly exceeding 10 tonnes, with the largest marketable catches in December 2022 (2022-12 V03). These large catches primarily consisted of squid. Other important species include mackerel, tub gurnard, cuttlefish, and whiting. It is unclear what caused this increase in total landings. The landings clearly display a seasonal pattern, with squid being the dominant catch in winter months, and mackerel in summer months.

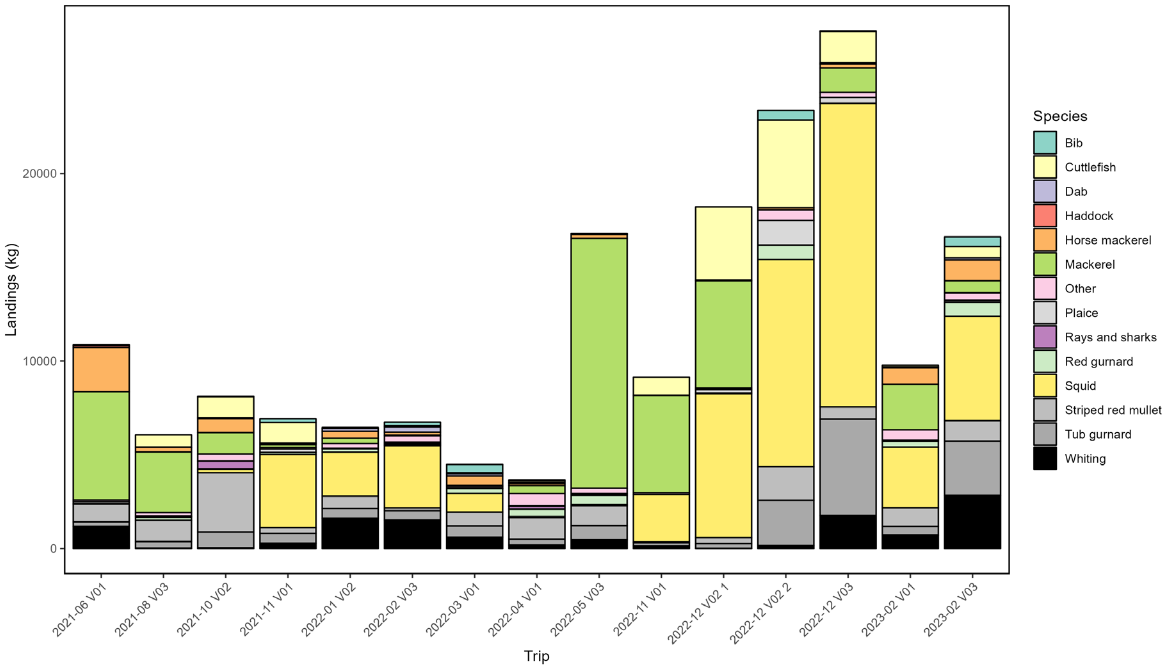
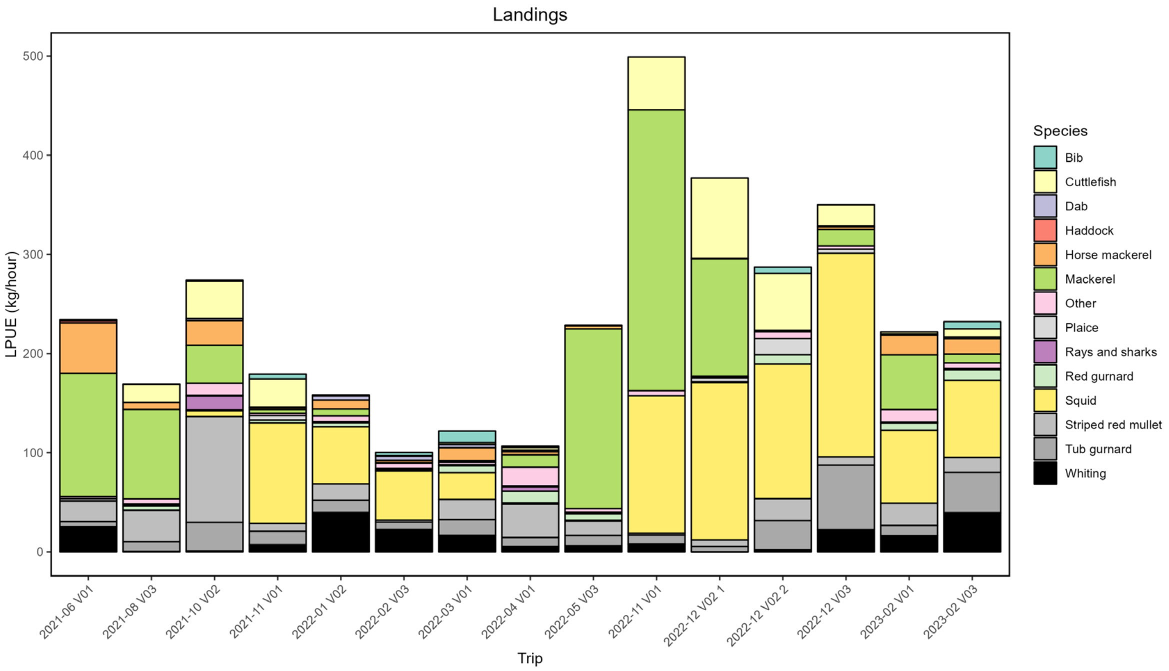


Figure 6: Total landings per observer trip, in kg, of target and bycatch species.

Landings expressed in kg/hour (active fishing time per trip) show a similar pattern (Figure 7): yields (and thus catch efficiency) have increased over the years. In terms of yield per hour, trip 2022-11 V01 had the highest yield. This is primarily because this trip was very short (only 15 tows) due to adverse weather conditions. Total landings per hour varied from approximately 100 kg/hour to 500 kg/hour. Discards expressed in kg/hour show a highly variable pattern with significant differences between trips, ranging from less than 30 kg/hour to over 400 kg/hour (Figure 7). Discards almost entirely consisted of fish, with few benthos, invertebrates and debris being caught. The most dominant species in the discards included whiting, herring, dab, bib, horse mackerel, and mackerel.



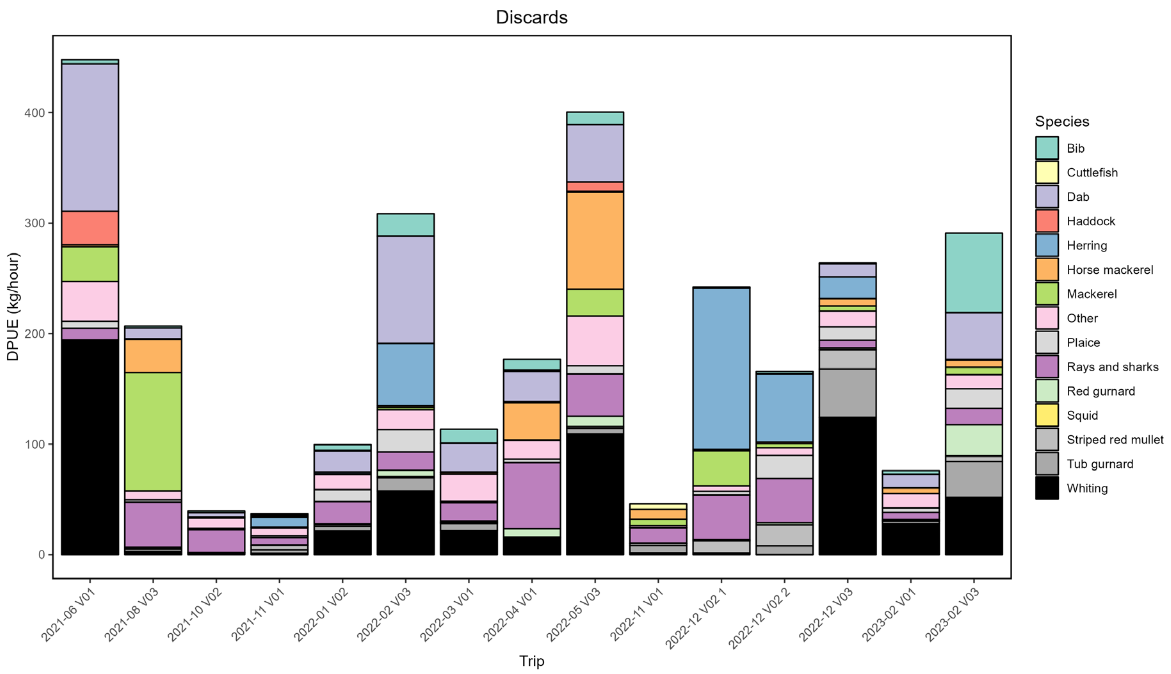
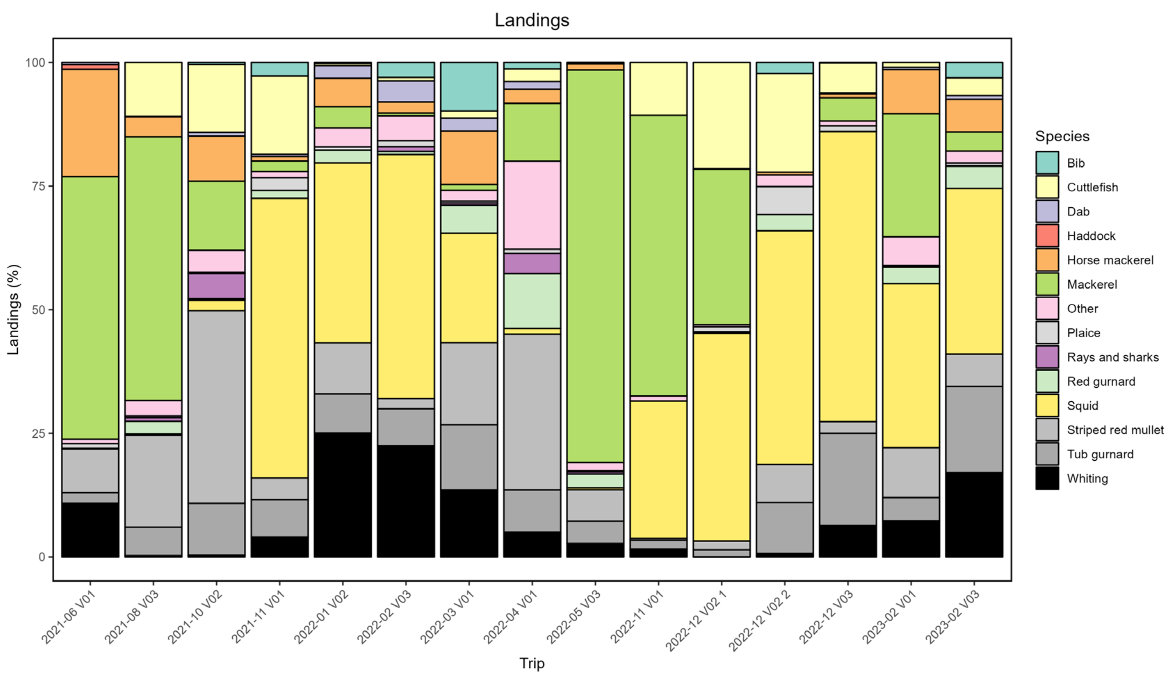


Figure 7: Landings per unit effort and discards per unit effort per observer trip, in kg/hour.

Looking at the catch composition (landings and discards) expressed as a percentage of total landings and discards, patterns in the catches become more evident (Figure 8): generally, the landings in the summer and autumn consists largely of mackerel and, to a lesser extent, mullet, while in winter, more squid, whiting, and cuttlefish are caught. Trends can also be observed in the discards, although they are variable. For example, it can be seen that discards mainly consist of mackerel, horse mackerel and whiting in the summer and autumn months (Figure 8). In winter, when squid is targeted, more herring is discarded. It is also noteworthy that a significant proportion of rays and sharks were observed in most trips. The main species in this was small spotted catshark.



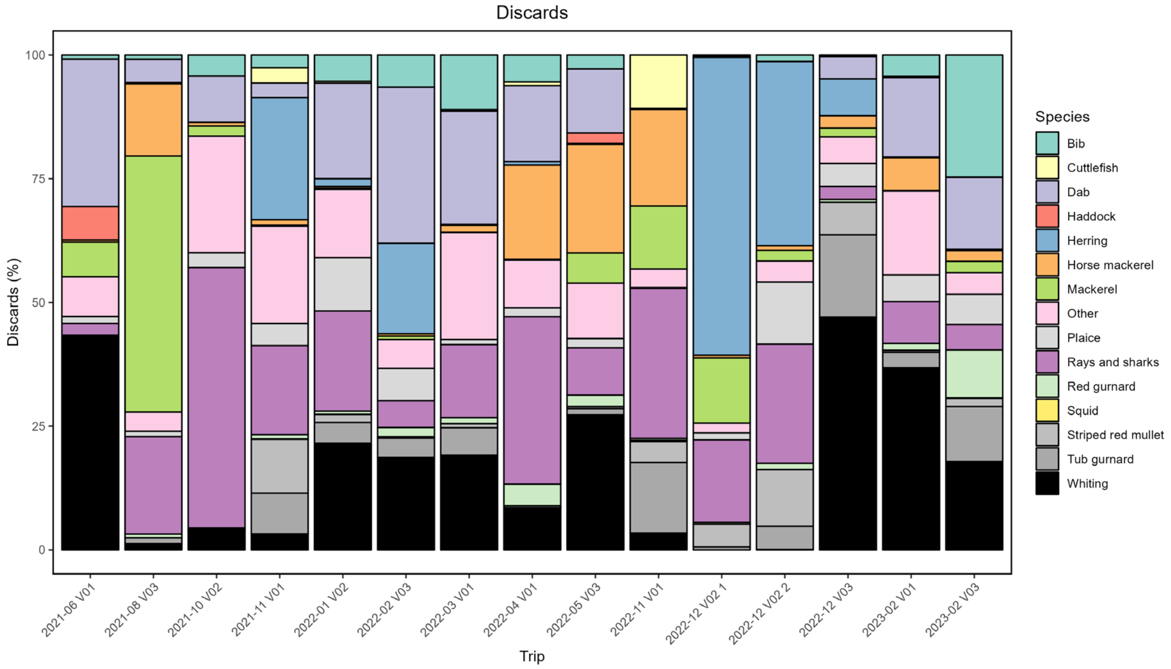


Figure 8: Landings and discards expressed as a percentage of the total, per observer trip.

Looking at the composition of landings per quarter (for all years combined), it is clear that in the winter months, the focus is mainly on squid, while in the summer months, mackerel dominates the landings (Figure 9). It is important to note that the catch composition of quarter 3 is based on only a limited number of hauls (during trips 2021-06 V01 and 2021-08 V03). Among the other target species, cuttlefish are mainly caught in quarter 4, mullet in quarter 3, and tub gurnard in quarters 1 and 4. The discards in quarter 1 consists mainly of whiting, dab, plaice, horse mackerel, herring, and sharks. The discard composition in quarter 2 is similar but without herring and with more horse mackerel, mackerel, and rays. In quarter 3, discards were predominantly made up of mackerel, followed by horse mackerel and sharks. In the fourth quarter, herring and whiting accounted for a large part of the discards. Horse mackerel, sharks, mackerel, and rays were also frequently found in the discards.

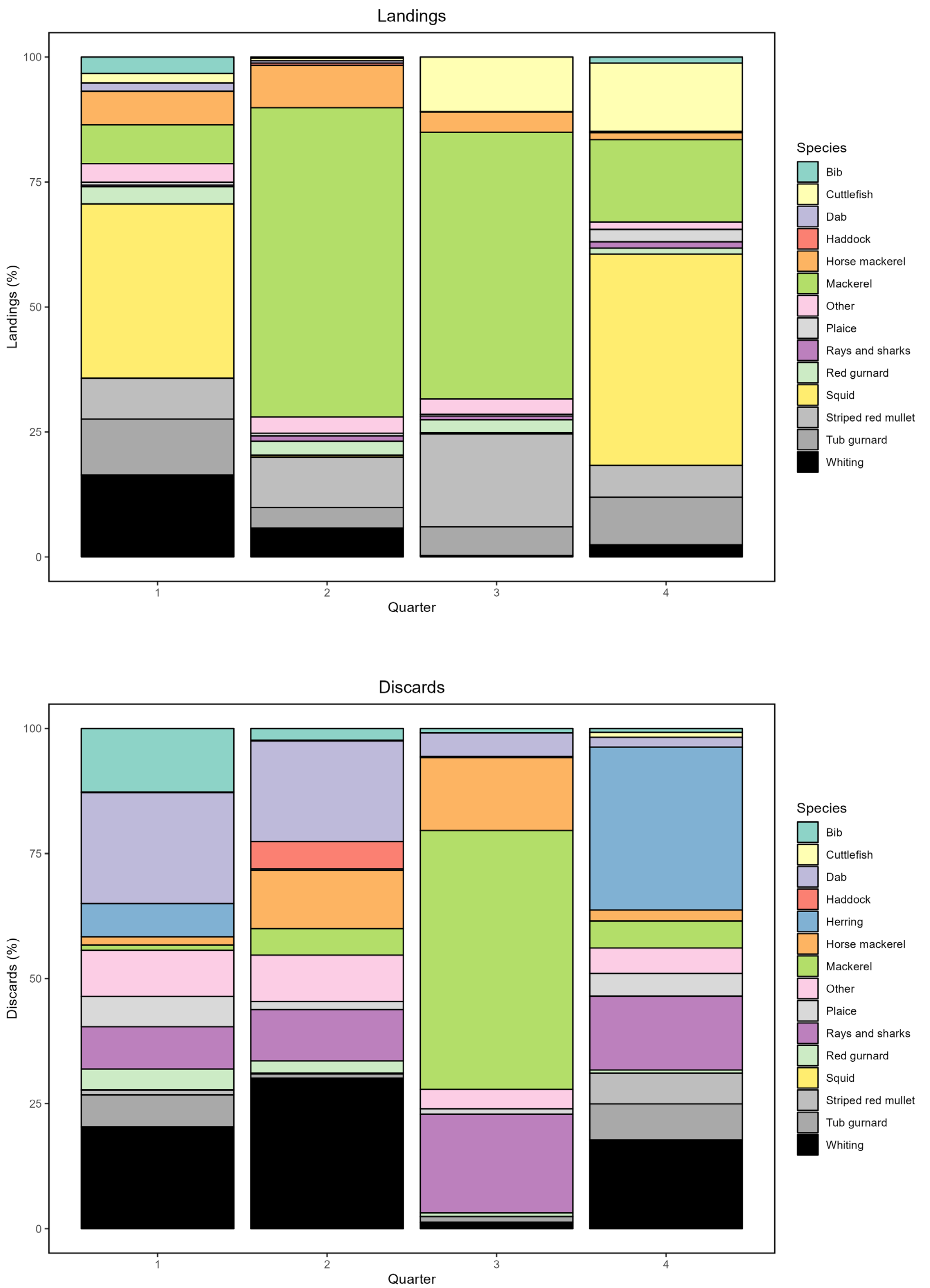


Figure 9: Landings and discards expressed as a percentage of the total, per quarter.

In the catch composition per ICES subdivision, central North Sea (4b), southern North Sea (4c), and eastern Channel (7d), the seasonal dynamics are also clearly visible (Figure 10). Fishing in the Channel is mainly done in the fall and winter months, after which the participating vessels move to the North Sea in spring and summer. In 4b, mackerel is mainly caught, while the discards consist mostly of whiting. It is important to note that only a small number of hauls in the central North Sea were sampled (23 hauls). In 4c, the marketable catch consists largely of mullet and squid, and the discards include mackerel, whiting, horse mackerel, herrings, and sharks. Here, 104 hauls were sampled. In 7d, a significant amount of mackerel, cuttlefish, and squid is caught, and discards mainly include herring, whiting, other flatfish, gadoids, sharks, and rays. This subdivisions has the most diverse discards, and it was also the most sampled (277 hauls).

Values of catch per unit effort (CPUE) for the landings (in kg/hour) and discards (in both kg/hour and numbers/hour), aggregated by quarter and ICES subdivision are given in Annex 4.

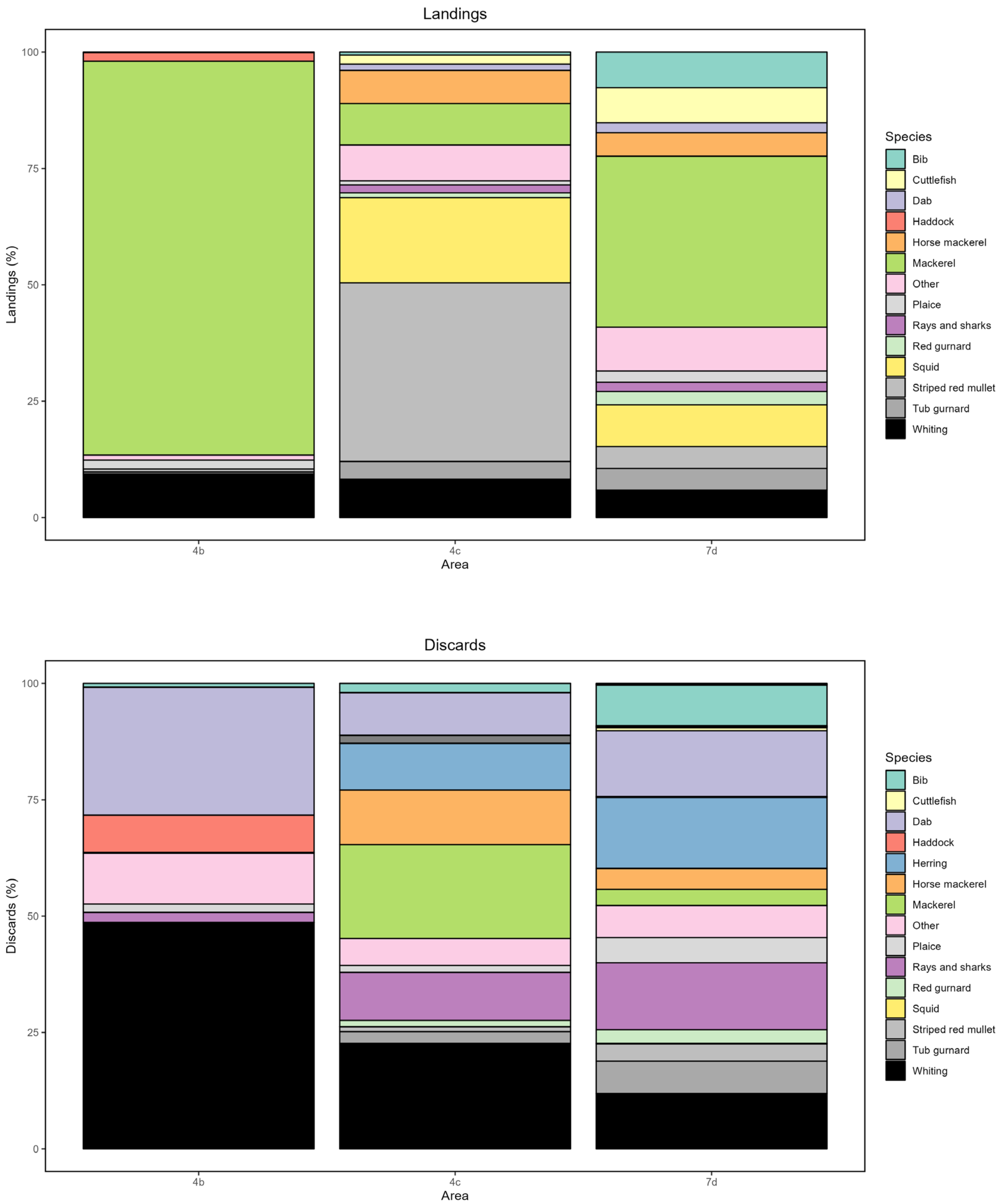


Figure 10: Landings and discards expressed as a percentage of the total, per ICES subdivision. 4b is the central North Sea, 4c is the Southern North Sea, and 7d the eastern English Channel.

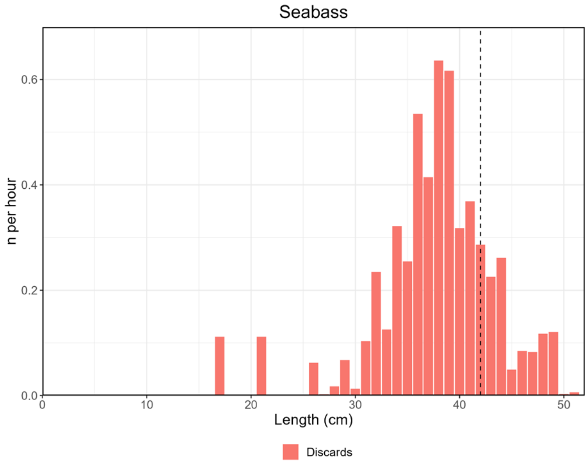
3.3.3 Length-frequency distributions

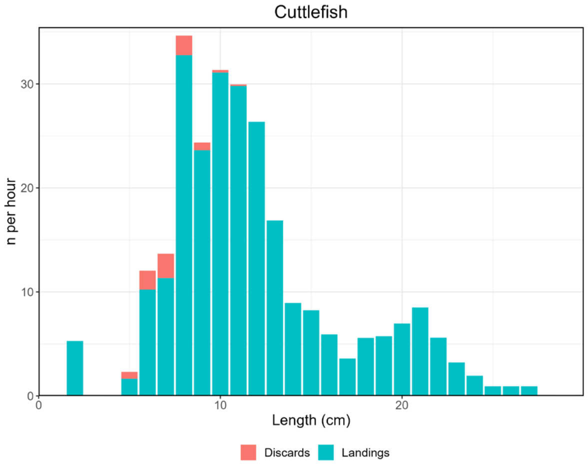
The length distribution was examined for sea bass, cuttlefish, grey gurnard, tub gurnard, red gurnard, herring, mackerel, horse mackerel, mullet, squid, plaice, and whiting (Figure 11). Where possible, the length distribution of both the landings and discards was assessed. However, for sea bass, grey gurnard, and plaice, it was only possible to determine the length distribution of the discards as the marketable catch of these species was not sampled. For these species the mean length-at-catch could consequently not be determined. For the other species, both landings and discards were sampled and therefore, the mean length-at-catch was determined, as well as the ratio between the mean length-at-catch and the theoretical maximum length (L_{inf}). For herring, the mean length-at-catch (and ratio between that and L_{inf}) could be determined based on just the discard measurements because this species was never present in the landings. Table 5 gives the number of observations on which the length-frequency distributions are based.

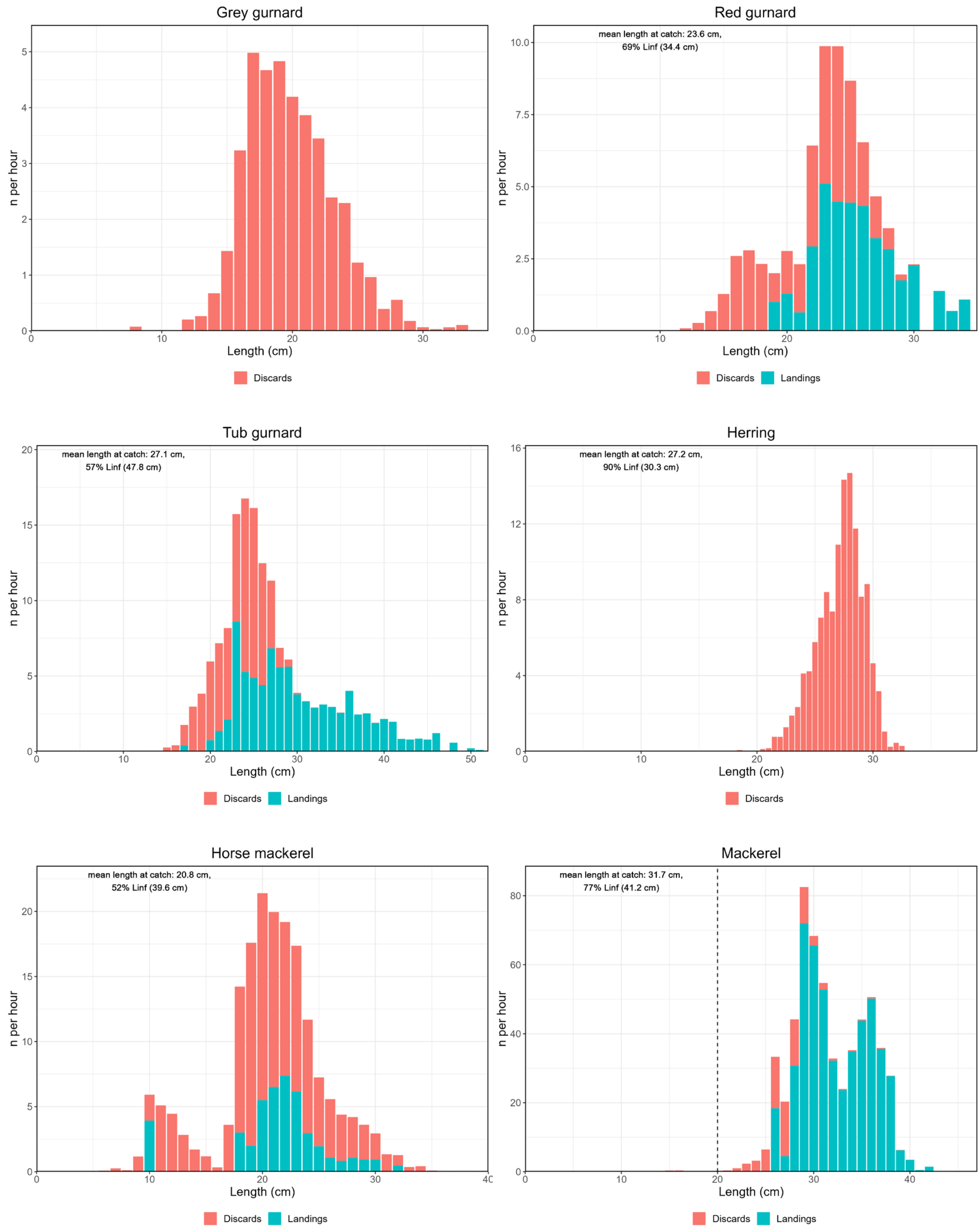
Table 5: The number of sampled individuals and number of sampled hauls on which the length-frequency distributions are based, per species, in the discards and landings. Some species (sea bass, grey gurnard, herring and plaice, were only sampled in the discards.

	Discards		Landings	
Species	**Number of sampled individuals**	**Number of sampled hauls**	**Number of sampled individuals**	**Number of sampled hauls hauls**
Seabass	574	163		
Cuttlefish	732	127	795	16
Grey gurnard	2094	166		
Red gurnard	2767	245	151	4
Tub gurnard	5394	286	1405	22
Herring	3800	183		
Horse mackerel	6272	296	205	5
Mackerel	2494	172	1372	26
Red mullet	6496	270	3707	44
Plaice	6884	320		
Squid	63	37	5998	52
Whiting	8079	276	521	10

Several species had a ratio between length-at-catch and L_{inf} that was above the 2/3 limit set by GoodFish, namely red gurnard (69%), mackerel (77%), and herring (90%). For tub gurnard (57%), red mullet (65%), whiting (60%), and horse mackerel (52%) mean length-at-catch/L_{inf} was below the 2/3 limit.






Grey gurnard
n per hour
Length (cm)
Discards
Red gurnard
mean length at catch: 23.6 cm,
69% Linf (34.4 cm)
n per hour
Length (cm)
Discards
Landings
Tub gurnard
mean length at catch: 27.1 cm,
57% Linf (47.8 cm)
n per hour
Length (cm)
Discards
Landings
Herring
mean length at catch: 27.2 cm,
90% Linf (30.3 cm)
n per hour
Length (cm)
Discards
Horse mackerel
mean length at catch: 20.8 cm,
52% Linf (39.6 cm)
n per hour
Length (cm)
Discards
Landings
Mackerel
mean length at catch: 31.7 cm,
77% Linf (41.2 cm)
n per hour
Length (cm)
Discards
Landings

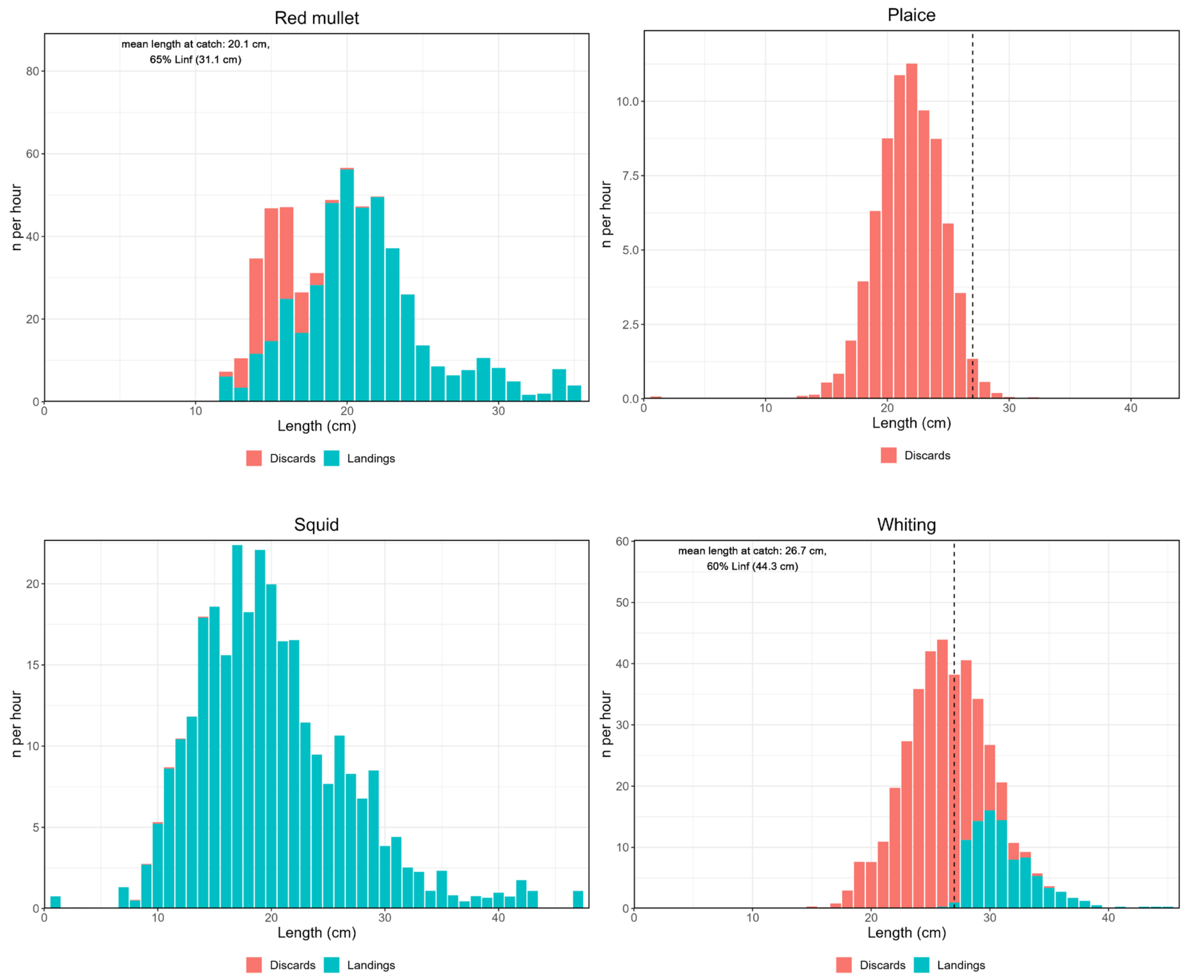


Figure 11: Length-frequency distributions for target and bycatch species, showing the distinction between landings and discards. For several species (seabass, herring, grey gurnard, plaice) only the lengths in the discards were sampled. Wherever possible, the ratio between mean length-at-catch and L_{inf} was calculated, and given in each plot. For some species, Minimum Conservation Reference Sizes (MCRS) are given by a dashed vertical line.

3.3.4 ETP-species

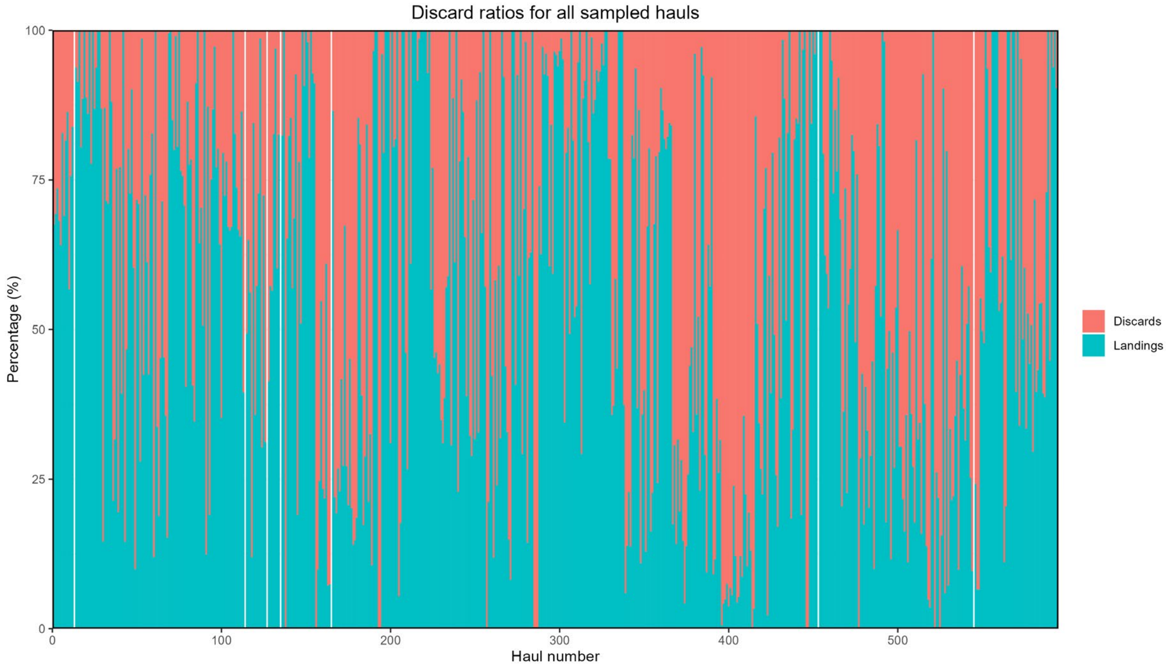
Per ICES subdivision and quarter, the following quantities of ETP-species were reported in the catch (Table 6). In total, four ETP species were reported as incidental bycatch: twait shad, seahorse, small-spotted catshark and undulate ray. Undulate ray was the most common ETP-species, and it was found most often in quarter 2 in the eastern English Channel. Most of ETP-species were caught in the fourth quarter and, apart from twait shad and undulate ray in the southern North Sea, all were caught in the eastern English Channel.

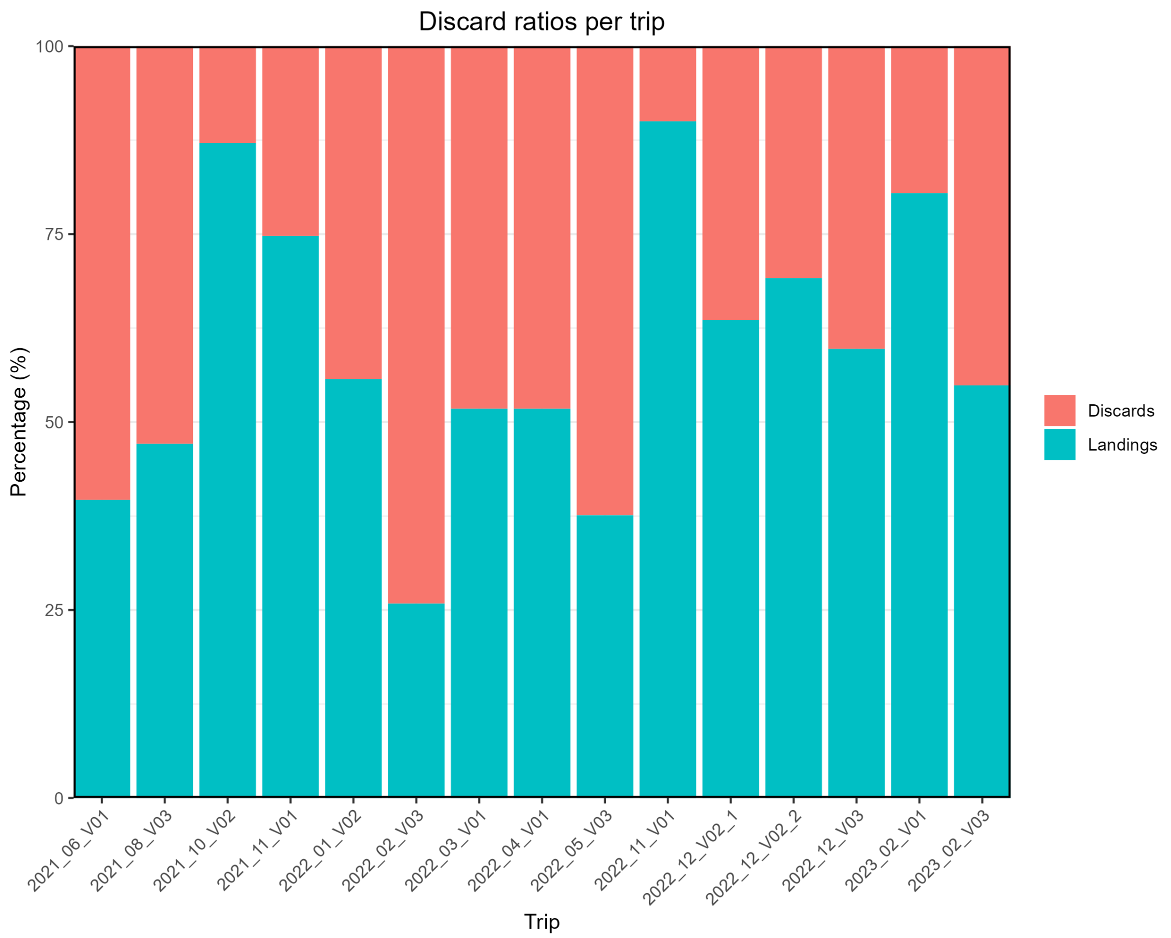
Table 6: Overview of the total number of observed ETP-species in the catch, per ICES subdivision and quarter.

		Quarter			
Soort	**ICES subdivision**	**1**	**2**	**3**	**4**
Twait shad	4c			2	1
Undulate ray	4c				6
Twait shad	7d	5			6
Seahorse	7d				1
Small-spotted catshark	7d				19
Undulate ray	7d	25	48	3	9

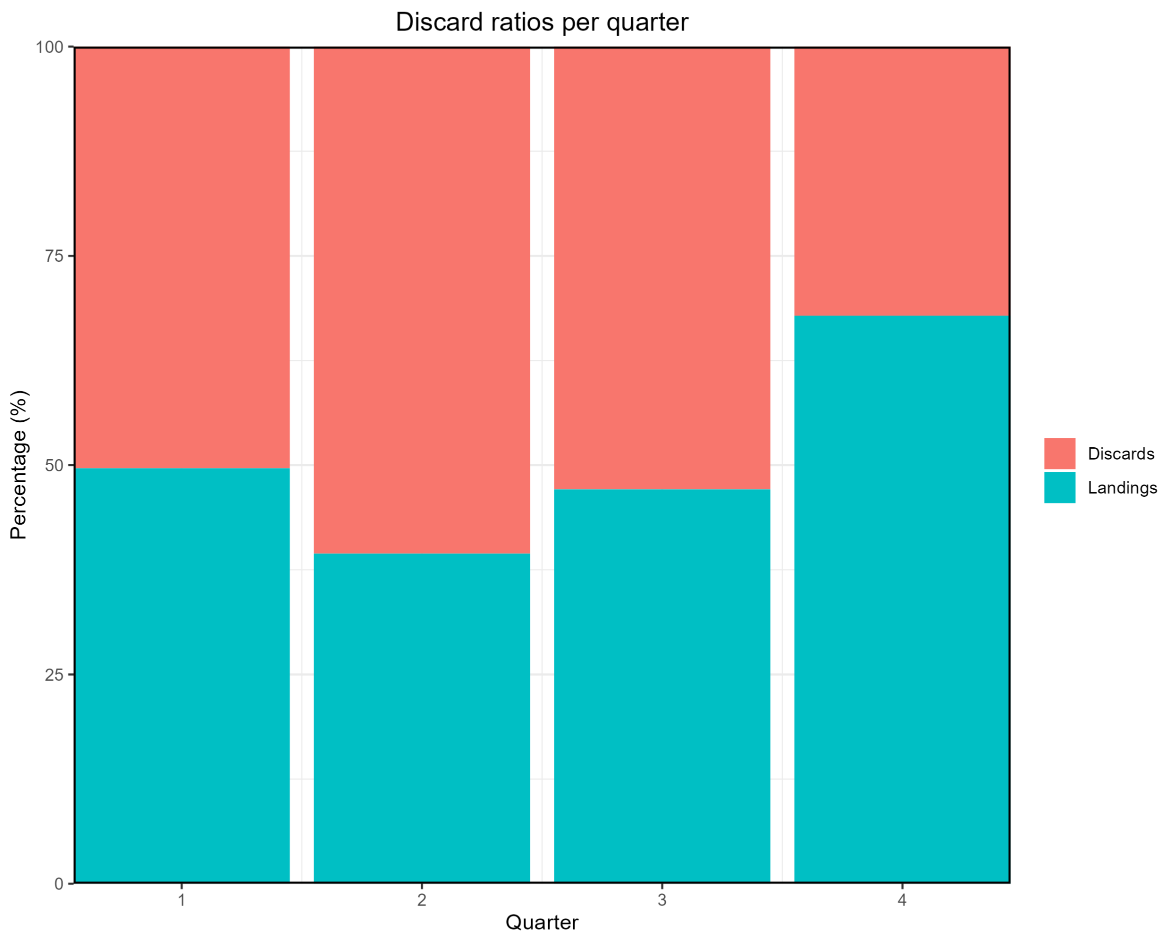
3.3.5 Discard ratio

When looking at the ratio between discards and landings per haul, a varied distribution emerges (Figure 12): some hauls (almost) entirely consist of landings, and others almost entirely consist of discards. Large variation is also visible between trips, with discard ratios between 10 and 75% (Figure 12). Per quarter, it becomes clear that the highest discard ratios occur in Q2, and the lowest in Q4 (Figure 12). Of the three ICES subdivisions in which the observer trips took place, discard ratios are highest in the central North Sea, though sampling in this area was limited to several hauls during two observer trips (2021-06 V01 and 2021-08 V03)





Discard ratios per trip
Percentage (%)
100
75
50
25
0
2021_06_V01
2021_08_V03
2021_10_V02
2021_11_V01
2022_01_V02
2022_02_V03
2022_03_V01
2022_04_V01
2022_05_V03
2022_11_V01
2022_12_V02_1
2022_12_V02_2
2022_12_V03
2023_02_V01
2023_02_V03
Trip
Discards
Landings



Discard ratios per quarter
Percentage (%)
100
75
50
25
0
1
2
3
4
Quarter
Discards
Landings

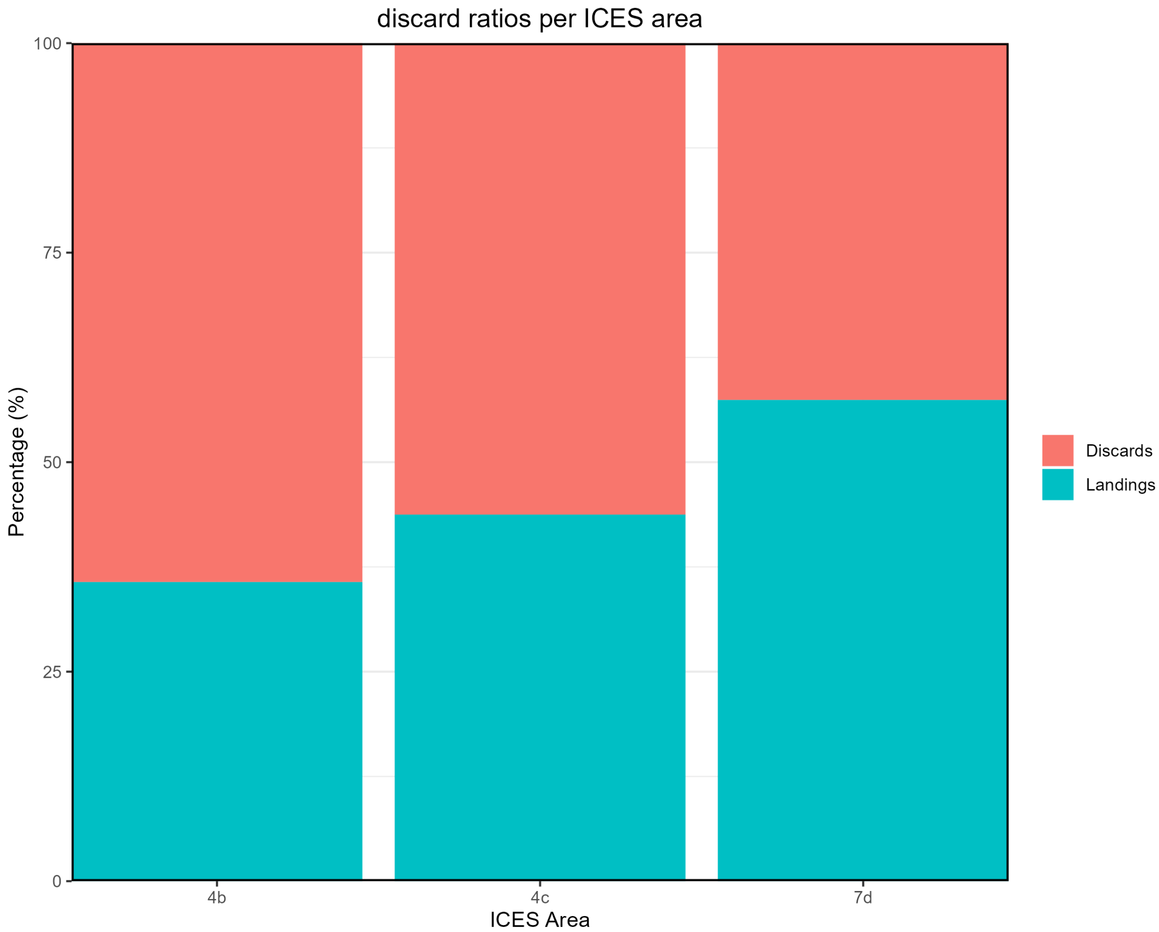


Figure 12: Discard ratios per haul, per trip, per quarter and per ICES subdivision. The method using no negative values and with weighted aggregation was used.

Depending on the chosen calculation method, discard percentages vary between 45.49 and 50.04% of total catches. The method with negative values included and unweighted aggregation did not produce a meaningful (positive) value. When comparing this to discard percentages in other métiers, it should be noted that the discards in the flyshoot metier mostly consist of fish, rather than benthic material and invertebrates (crabs, starfish, etc.) (Verkempynck, 2018).

Table 7: Discard percentage (with standard error) for the different calculation methods. Methods either included or excluded negative values, and aggregation was done either weighted or unweighted.

Method	Percentage (± standard deviation)
No negative values, weighted	50.04 (± 129.65)
No negative values, unweighted	47.45 (± 29.77)
Negative values, weighted	45.49 (± 155.20)
Negative values, unweighted	-

4 Discussion

This work describes a comprehensive sampling programme of catches in the Dutch flyshoot fishery. Given the increasing importance of this métier in the Dutch fishing fleet, knowledge on the catch composition of the flyshoot fishery will likely be important for future fisheries management.

Compared to other metiers, there is little benthos in the discards, with most discards consisting of fish species. It should be noted that though discards of certain fish species can be high, studies have found that the condition of discarded fish is usually better than in some other métiers. For example, Schram et al. (2023) found an increased survival rate of thornback and spotted rays discarded in the flyshoot fishery compared to the beam trawl fishery. The mean length-at-catch was above 2/3 of the maximum length for red gurnard, mackerel, and herring, and below 2/3 of the maximum length for tub gurnard, red mullet, whiting, and horse mackerel. ETP-species in the catches were rare, with incidental bycatch of twait shad, seahorse and small-spotted catshark. These mainly occurred in the eastern English Channel in the fourth quarter, though this is also where most of the sampled hauls in the project took place.

Sampling in this fishery has been limited to a short-running self-sampling project in 2015-2016, in which the discards were sampled in a total of 11 trips for mesh size 70-99 mm, with two hauls sampled in each trip (Verkempynck et al., 2018). This sampling scheme only considered trips in the North Sea. In these sampled trips, the flyshooters landed mainly mackerel, mullet and tub gurnard. This is mostly in line with our findings, where mackerel was the majority of landings in the central North Sea, and mullet was the most common species in the southern North Sea. After mullet, the most common species landed in this project was squid. This increasing importance of squid in the North Sea catches is in line with the multi-year CPUE trends. The most important discarded species found by Verkempynck et al. (2018) varied between years, with whiting and horse mackerel being most frequent in 2015, followed by dab, grey gurnard and bib, and dab, grey gurnard and whiting being most frequent in 2016. Almost no benthos was caught in these trips. Again, this is mostly in line with our observations, where whiting and other flatfish (e.g. dab) were the most commonly discarded species in the central North Sea, and whiting, mackerel, horse mackerel and herring were most the commonly discarded species in the Southern North Sea. Verkempynck et al. (2018) do not find high discards of herring. This is probably due to the strong seasonality of herring in flyshoot discards, as well as the fact that herring is mostly seen in discards when the vessels target squid, while squid was not as important in the landings in 2015-2016.

4.1 Protocol evaluation

In this project, a protocol for observer trips specifically designed for the Dutch flyshoot fishery was developed, taking into account the large variations in total catch size, as well as the relatively large number of landed species. This protocol was evaluated positively, though certain lessons learned during the sampling period should be taken into account when sampling in the Dutch flyshoot fishery and obstacles regarding the total catch estimation remain to be solved.

This project developed a method for total catch estimation in which the volume of the catch was derived from the height of the catch in the hopper, and converted to the total weight using a set volume-to-weight ratio. This was done to improve upon the conventional method of visual catch estimation by the observer and skipper. Though this method proved workable, it did pose several problems: Firstly, subtracting the total landing weights from the total catch sometimes resulted in negative discards weights. This could have several causes. For instance, the volume-to-weight ratio used (0.8 kilograms to a litre) could be inaccurate, especially when the catch consisted mostly of dense animals, such as squid and cuttlefish. Furthermore, not all landings were immediately registered in the vessel's catch registration system, leading to an overestimation of landings for the hauls where landings were registered for multiple hauls (and a possible underestimation for the other hauls of that day). Though this was accounted for by spreading those catches over the previous hauls during data analysis, this could still have resulted in inaccurate catch estimations. It could also be difficult to precisely read the height of the catch in the hopper when catches were small or uneven, or when the hopper contents moved due to wave action or the movement of the vessel. In case of small catches, the hopper could be split into smaller compartments to more accurately read the height of the catch, however in practice, this was often impractical and dangerous to the crew member working underneath the full cod-end. Van Mens et al. (2023) evaluated the accuracy and precision of multiple catch estimation techniques by comparing them to the weighed total catch. Here, hopper volume was found to be the most precise method of total catch estimation, though it often underestimated the catch. An alternative would be to install a loadcell that can measure both the empty and full cod-end. However, this method often overestimated total catch. In future, the most appropriate method for the flyshoot fishery needs to be investigated further. For this, it should also be taken into account that the hopper volume method used in this project has only been developed and tested on board three similarly sized vessels, and it is not at all certain it can be applied across the Dutch flyshoot fleet.

Flyshooting is a fishing technique with a relatively large number of species in the landings, several of which are data-deficient (e.g. mullet, gurnards, and squid). For these species, more data on the catch rates and discards is very valuable. For this reason, the protocol used in this project was designed to sample the lengths in the landings of as many of these data-deficient species as possible. In the protocol this was realised by sampling the length of the most common species in each haul. However, this posed problems for the data analysis, as the resulting data was biased towards hauls in which these species are very abundant. This meant that a correction was needed to link discard and landing length information. In future, it is advised to either limit the number of length-sampled fish in the landings to a fixed selection of species of high interest (i.e. data deficient species), or to develop a sampling scheme where the species to be sampled is picked randomly from a predetermined list.

4.2 Coverage

Most sampling in this project took place in the eastern English Channel, followed by the southern North Sea, and though these areas are the most important for Dutch flyshooters, the fleet does not exclusively fish there. Therefore, in future sampling programmes, (observer) trips should also be carried out in other areas, such as the central and northern North Sea. This lack in spatial coverage is probably mainly caused by the fact that very few trips were sampled in summer, when the flyshoot fleet moves further North. It should also be noted that sampling took place onboard three vessels of the same fishing company, and to fully understand the fishing practices, sampling should be extended to other flyhoot vessels in the Dutch fleet. This would also help account for variation within the Dutch flyshoot fleet: for example, there are several flyshoot vessels in the fleet that are larger than the ones on which the observer trips took place. Other vessels may also exhibit different fishing behaviour, such as fishing at night, which may influence the catch composition.

In total, the observer trips covered 31.1 days at sea (of active fishing) from June 2021 until February 2023. From logbook data it was calculated that in the period between June 2021 and February 2023, the Dutch flyshoot fleet’s fishing effort was 2963.7 days at sea (only active fishing). This means the sampling programme covered ~1.05% of all Dutch flyshoot effort.

5 Conclusion

The results of this project can be used to inform science and policy, especially on data deficient target species of the flyshoot fishery, such as mullet, tub gurnard, squid and cuttlefish. The data also provides a valuable insight into the industry practices and can provide fishers with tools to increase the sustainability of their fishery. The data has already been used in a sustainability assessment by the GoodFish Foundation, and the project is a good example of how cooperation between the scientific community, industry, and NGOs can increase data availability and transparency in a fishery. However, given the limited number of executed trips and issues with coverage (both spatially and temporally), results should be interpreted with care and many uncertainties exist in raising this data to the level of the entire (Dutch) flyshoot fleet.

6 Acknowledgements

We would like to sincerely thank:

- the skippers and crew of the participating vessels for welcoming the observers on board and assisting them in their work.
- the consortium partners at Vrolijk-Jaczon and GoodFish Foundation for their continued work on this unique four-year collaboration between science, industry and NGO.
- Martin Pastoors (Fish & Fisheries / Facts and Figures) for his contribution to the data analysis and VISwijzer assessments.

7 Quality Assurance

Wageningen Marine Research utilises an ISO 9001:2015 certified quality management system. The organisation has been certified since 27 February 2001. The certification was issued by DNV.

References

Eigaard, O. R., Bastardie, F., Breen, M., Dinesen, G. E., Hintzen, N. T., Laffargue, P., ... & Rijnsdorp, A. D. (2016). Estimating seabed pressure from demersal trawls, seines, and dredges based on gear design and dimensions. ICES Journal of Marine Science, 73(suppl_1), i27-i43.

European Commission (2023). COUNCIL REGULATION (EU) 2023/194 of 30 January 2023 fixing for 2023 the fishing opportunities for certain fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, as well as fixing for 2023 and 2024 such fishing opportunities for certain deep-sea fish stocks.

Greenstreet, S. P., Rossberg, A. G., Fox, C. J., Le Quesne, W. J., Blasdale, T., Boulcott, P., ... & Moffat, C. F. (2012). Demersal fish biodiversity: species-level indicators and trends-based targets for the Marine Strategy Framework Directive. ICES Journal of Marine Science, 69(10), 1789-1801.

ICES (2023). https://www.ices.dk/data/maps/pages/default.aspx. Visited 27-10-2023.

Schram, E., van de Pol, L., Molenaar, P., van Mens, A., Bleeker, K., Molla Gazi, K., van Dalen, P., Suykerbuyk, W. & Batsleer, J. (2023). Survival probabilities of thornback and spotted rays discarded by beam trawl and flyshoot fisheries (No. C018/23). Wageningen Marine Research.

Van Beek, F. A. (1998). Discarding in the Dutch beam trawl fishery. ICES CM, 5, 1-15.

Van Mens, A., Van de Pol, L., Molenaar, M. (2023). Improving discard quantification on commercial fishing vessels (No. 23.020). Stichting Wageningen Research, Centre for Fisheries Research (CVO).

Verkempynck, R., van Overzee, H., & Dammers, M. (2018). Discard self-sampling of Dutch bottom-trawl and seine fisheries in 2014-2016 (No. 18.007). Stichting Wageningen Research, Centre for Fisheries Research (CVO).

WWF (2023). Marine Common Assessment Methodology. Available at: https://wwf.panda.org/act/live_green/out_shopping/seafood_guides/methodology/

Justification

Report C071/23
Project Number: 43.119.01.048

The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of Wageningen Marine Research

Approved: Harriet van Overzee MSc
Researcher

Signature: 

Date: 20/11/2023

Approved: Dr. ir. Tammo Bult
Director

Signature: 

Date: 20/11/2023

Annex 1 VISwijzer assessments (Good Fish Foundation)

Methods

New and updated seafood ratings for the VISwijzer were made through utilisation of the Marine Common Assessment Methodology (CAM), the methodology Good Fish uses to update her seafood guide (WWF, 2023). Wild-caught marine fisheries are assessed according to A) stock status and fishing pressure, B) ecological impact including bycatch, discard mortality and habitat, and C) fisheries management, which assesses both monitoring and management. The assessment process is further described in Figure 13.

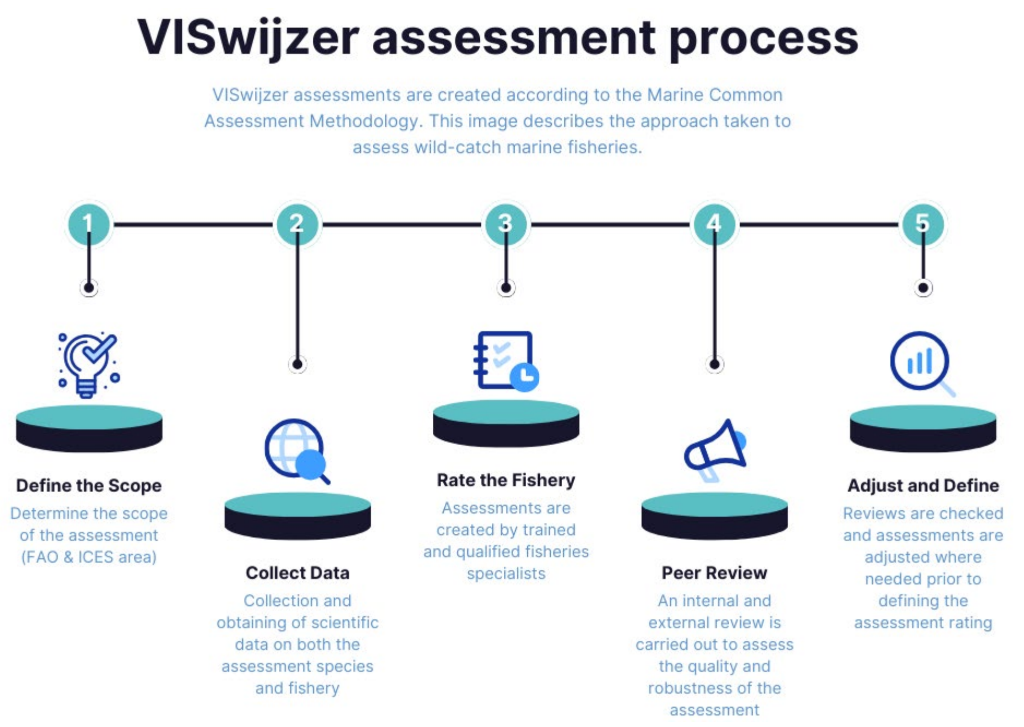


Figure 13: Assessment process of seafood ratings on Good Fish' seafood guide, the VISwijzer, based on the Marine Common Assessment Methodology.

For this project, ten species that are regularly caught by Dutch flyshooters were assessed by Good Fish according to the CAM (Table 1). The scope of these assessments were defined by consulting both spatial distribution of fishing effort, as analysed by WMR, and scopes used by ICES to provide her catch advice (for species where this was available).

Table 8: Units of Assessment for species regularly caught in the Dutch flyshoot fishery, as used for the scopes of seafood sustainability assessments by Good Fish on the VISwijzer.

Common name	Latin name	Area of capture
European squid	*Loligo vulgaris*	FAO 27*, ICES IV ; VIId ; VIIe*
European cuttlefish	*Sepia officinalis*	FAO 27*, ICES IV ; VIId ; VIIe*
Tub gurnard	*Chelidonichthys lucerna*	FAO 27*, ICES IV ; VIId ; VIIe*
Grey gurnard	*Eutriglia gurnardus*	FAO 27*, ICES IIIa ; IV ; VIId*
Red gurnard	*Chelidonichthys cuculus*	FAO 27*, ICES III ; IV ; V ; VI ; VII ; VIII*
Striped red mullet	*Mullus surmuletus*	FAO 27*, ICES IIIa ; IV ; VIId*
European plaice	*Pleuronectes platessa*	FAO 27*, ICES 20 ; IV*
European seabass	*Dicentrarchus labrax*	FAO 27*, ICES IVb ; IVc ; VIIa ; VIId ; VIIe ; VIIf ; VIIg ; VIIh*
Whiting	*Merlangius merlangius*	FAO 27*, ICES IV ; VIId*
Atlantic mackerel	*Scomber scombrus*	FAO 27*, ICES IV ; VIId ; VIIe*

Update of ratings methodology to accommodate for mixed fisheries

To be able to appropriately assess the flyshoot fishery on the VISWijzer, it was necessary to update the Marine CAM to make it more accessible for rating mixed fisheries. It is important to address the fact that green and red rated species can both be caught in the same fishery and/or net, which needs to be taken into account when assessing a fisheries' ecological impact. Where the ratings methodology previously assessed fisheries on the percentage of non-target species in their catches, landings of non-target species are now assessed if they categorise as unmonitored, unmanaged and/or overfished.

Flyshoot survey results as input for the VISwijzer

To be able to assess a species stock status with the CAM, some indication of stock biomass and fishing pressure is needed. The data collection programme, in combination with long-term LPUE data, provided input for addressing stock status of the ten species that were assessed in this project by Good Fish. Additionally, this input was supported and supplemented by consulting both ICES' catch advices and an independent evaluation of IBTS Q1 and Q3 and French CGFS Q4 survey results (M. Pastoors, personal communication, May 2023). Length frequency distributions further aided in determining whether fishing pressure had any unfavourable effects on stock structure.

The ecological impact of the fishery was in part determined by Good Fish by identifying bycatch of Endangered, Threatened and Protected (ETP) species in absolute numbers across the entire data collection programme. An unpublished CAM guidelines document was used by Good Fish for determining which species could be defined as ETP. Please note that these guidelines are not solely based on IUCN statuses, as they often fail to reflect current situations. Additional documents published by the ICES Bycatch Working Group (WGBYC) were used as support.

Mortality rates, obtained through literature consultation, and discard percentages for each species or taxon, which were obtained through the flyshoot data collection programme, were used to identify the discard mortality percentage. Lastly, landing compositions were consulted when determining the percentage of unmonitored, unmanaged and/or overfished species. These figures were subsequently compared with EU-registered landings for Dutch flyshooters in the same ICES subdivisions.

Results

Use of data obtained from the flyshoot data collection programme has greatly improved the assumptions that could be made regarding stocks for cephalopods, mullet and gurnards, as well as the ecological impact of the flyshoot fishery. This has resulted in several improved ratings on the VISwijzer (Table 9).

Table 9: Overview of updated seafood ratings on the VISwijzer for species caught by the Dutch flyshoot fishery, partially based on survey results as part of the EMFZV funded project 'VISwijzer and Flyshootvis

Common name	Latin name	Area of capture	Previous rating (2020)	New rating (2023)
European squid	*Loligo vulgaris*	FAO 27, *ICES IV ; VIId ; VIIe*	RED	YELLOW
Common cuttlefish	*Sepia officinalis*	FAO 27, *ICES IV ; VIId ; VIIe*	RED	YELLOW
Tub gurnard	*Chelidonichthys lucerna*	FAO 27, *ICES IV ; VIId ; VIIe*	RED	YELLOW
Grey gurnard	*Eutriglia gurnardus*	FAO 27, *ICES IIIa ; IV ; VIId*	RED	RED
Red gurnard	*Chelidonichthys cuculus*	FAO 27, *ICES III ; IV ; V ; VI ; VII ; VIII*	RED	YELLOW
Striped red mullet	*Mullus surmuletus*	FAO 27, *ICES IIIa ; IV ; VIId*	RED	YELLOW
European plaice	*Pleuronectes platessa*	FAO 27, *ICES 20 ; IV*	YELLOW	YELLOW
European seabass	*Dicentrarchus labrax*	FAO 27, *ICES IVb ; IVc ; VIIa ; VIId ; VIIe ; VIIf ; VIIg ; VIIh*	RED	YELLOW
Whiting	*Merlangius merlangius*	FAO 27, *ICES IV ; VIId*	YELLOW	YELLOW
Atlantic mackerel	*Scomber scombrus*	FAO 27, *ICES IV ; VIId ; VIIe*	YELLOW	YELLOW

Increasing index trends were found for European squid, Red gurnard and red mullet, with red mullet also having a recently updated ICES catch advice indicating an improved stock status. For common cuttlefish and tub gurnard, index trends were found to be stable.

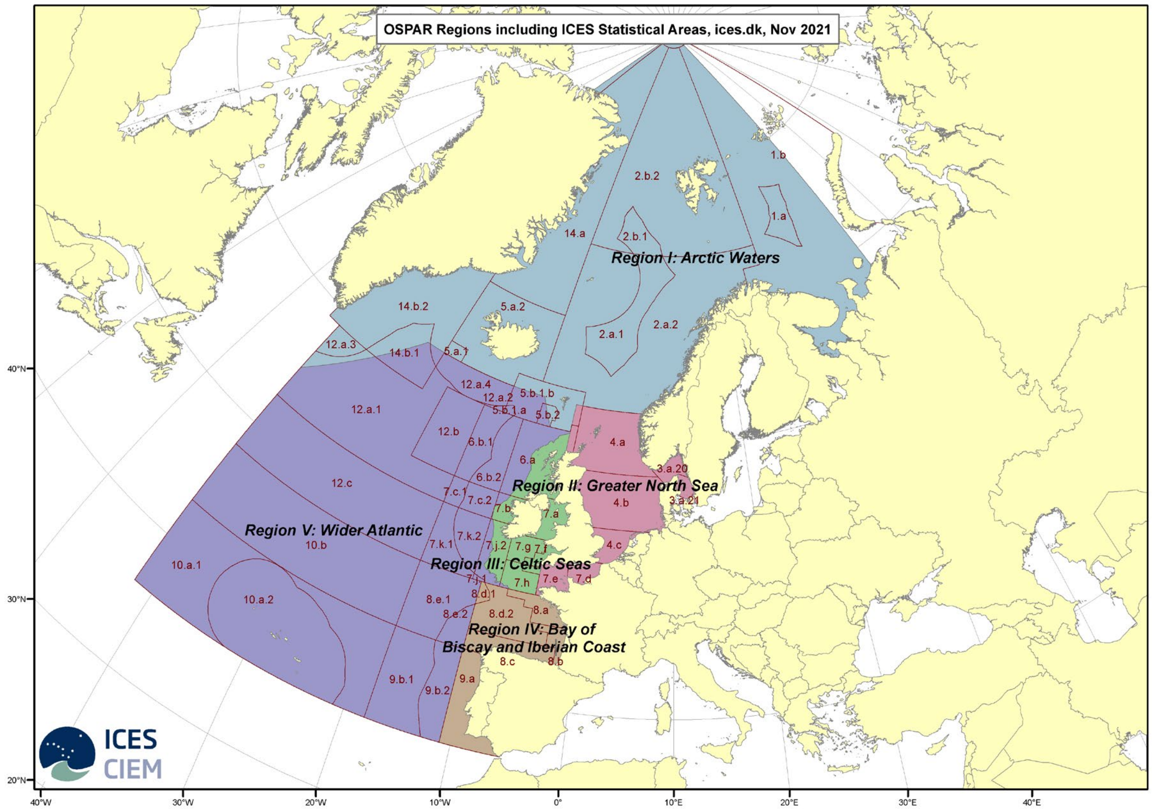
The flyshoot fishery was found to have a relatively low impact on ETP species. However, due to a significant proportion of catches being unmonitored and unmanaged, the ecological impact of this fishery remains largely unknown. When looking at the carbon footprint of the flyshoot fishery, it was identified as a light demersal fishery with a relatively low footprint of 1 kg CO_2 / kg catch. Note that impacts on carbon sinks were not taken into consideration due to ongoing discussions regarding calculations.

For cephalopod and gurnard stocks, data remains limited and fishery monitoring is considered inadequate. This is additionally inadequate for mullet.

Discussion

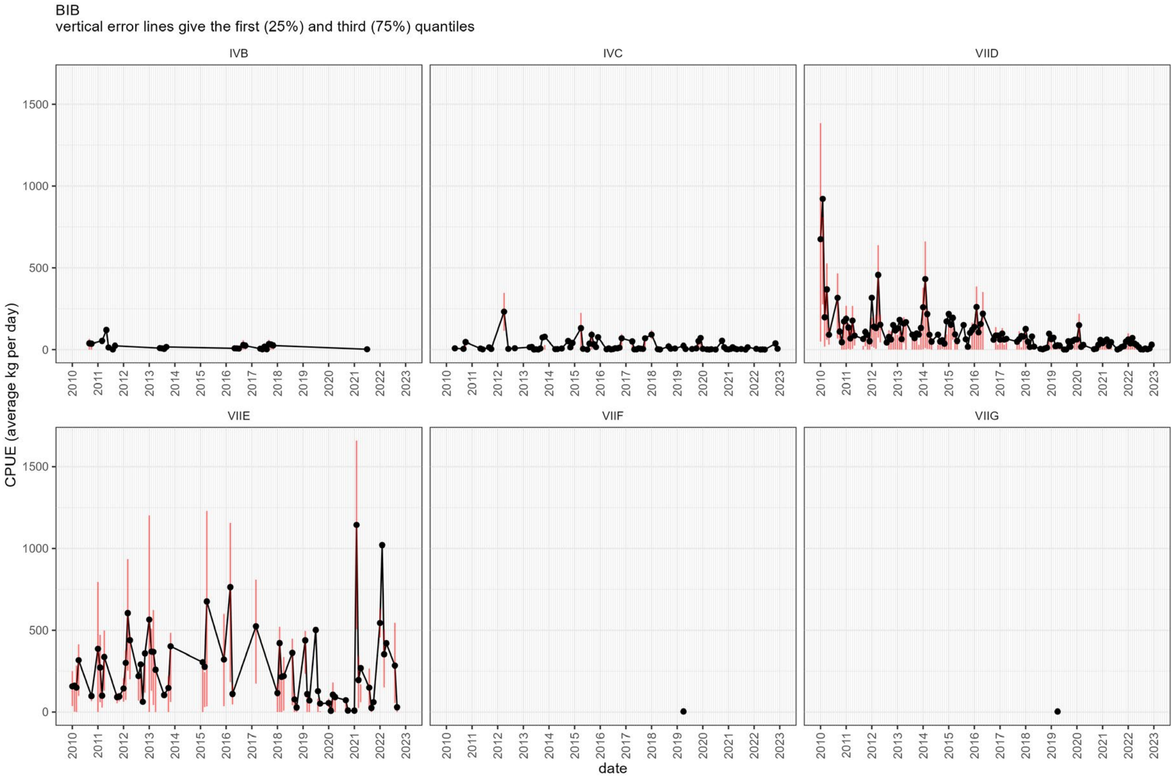
The VISwijzer plays a crucial role in raising awareness about sustainable seafood consumption, influencing consumer choices, and encouraging positive changes within the seafood industry. Due to the presented improved ratings for the flyshoot fishery made by Good Fish, Good Fish is now able to provide a more sustainable alternative to bottom otter trawls and beam trawls when advising on these species. Not only do these new and updated ratings provide a basis for further improvement regarding sustainability, they also stress the need for implementation of fisheries management. Although the establishment of management was not defined as an outcome for this particular project, by increasing the availability of scientific information on this fishery and its target species, the first step towards ensuring sustainable fishing practices has been made.

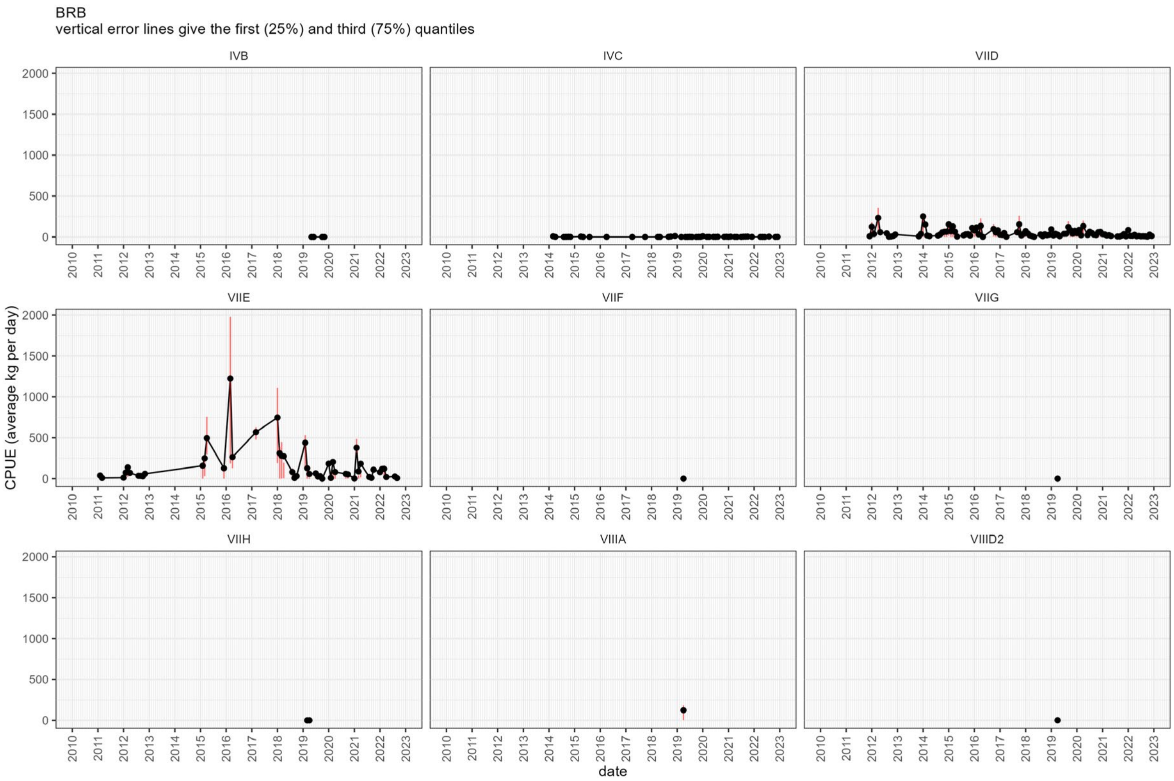
Annex 2 ICES areas

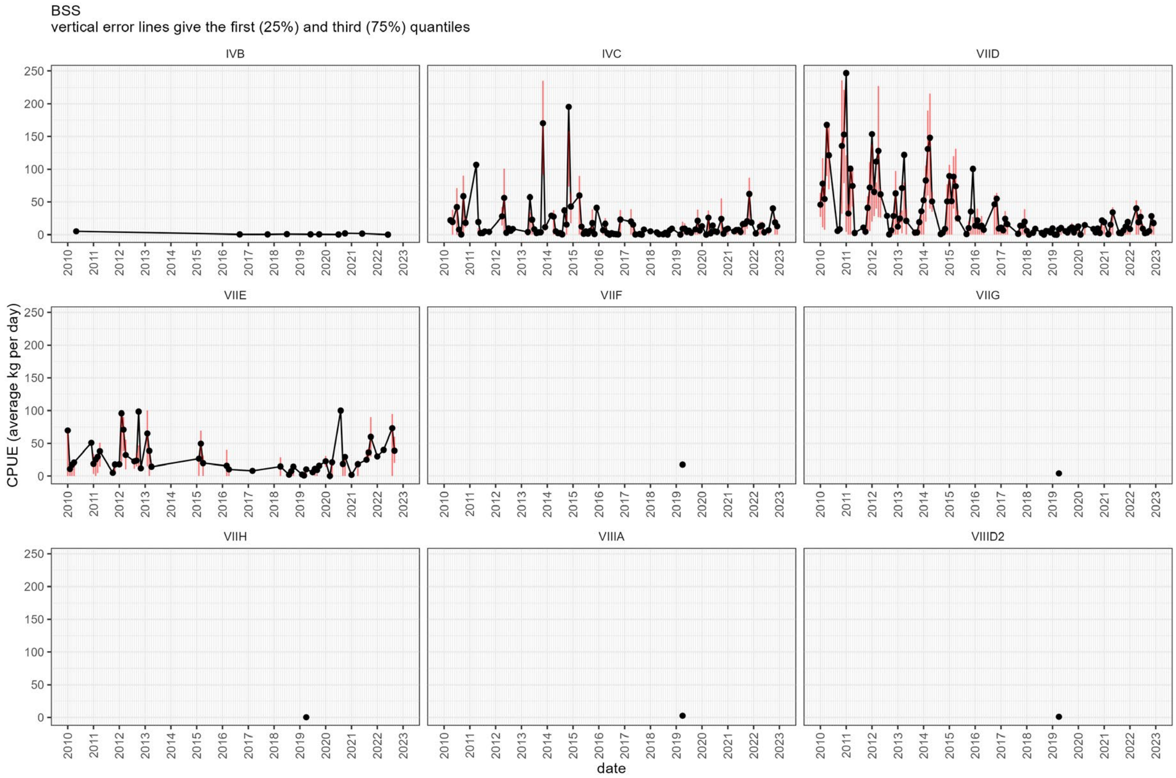


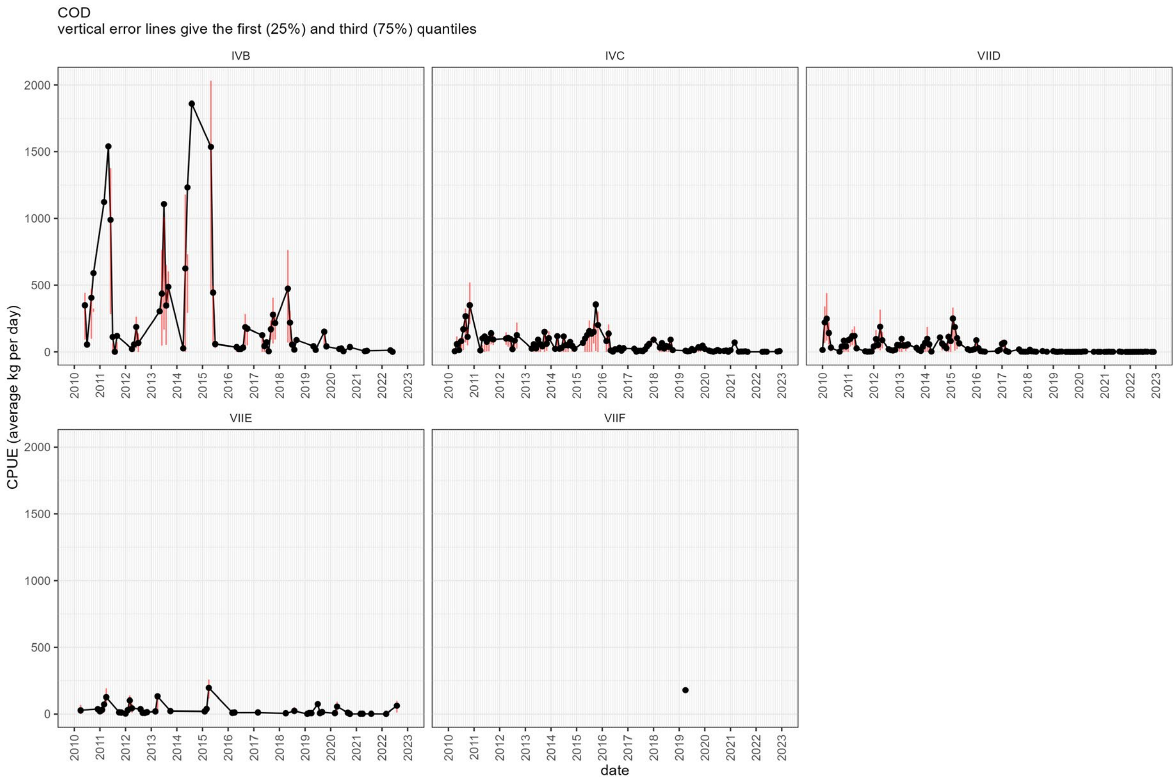
Source: ICES, 2023. https://www.ices.dk/data/maps/pages/default.aspx. Visited 27-10-2023.

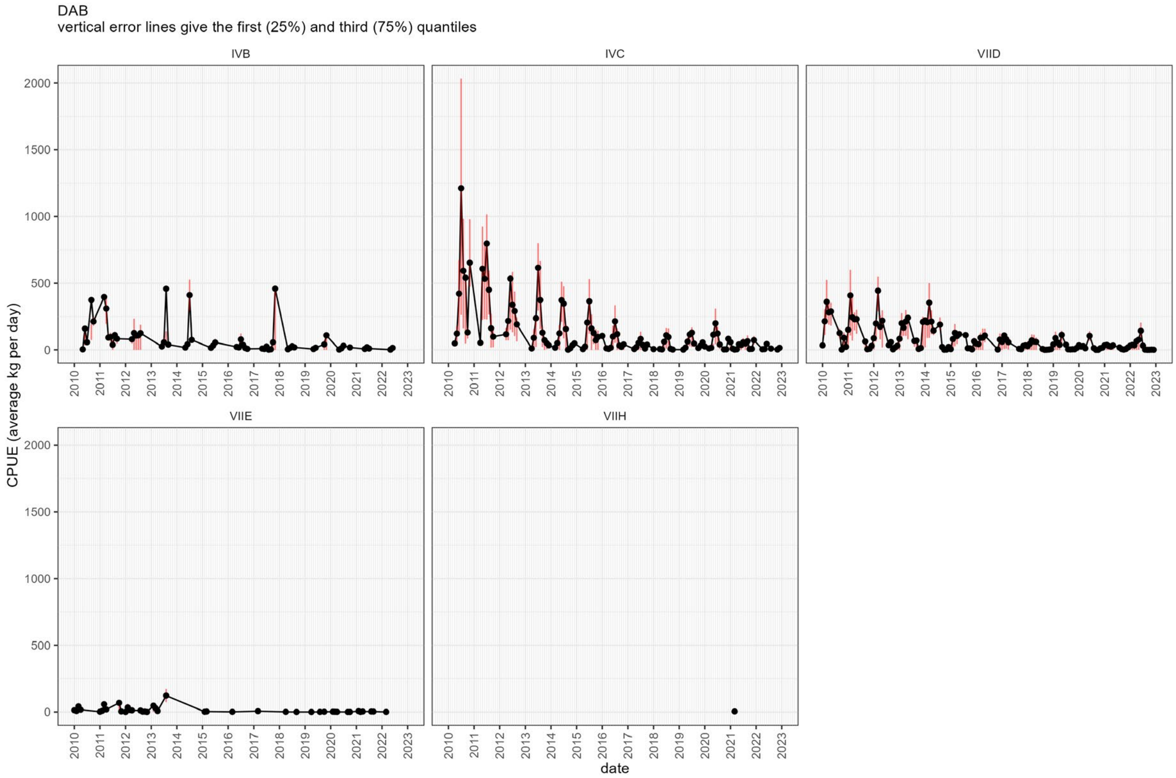
Annex 3 CPUE trends for other species

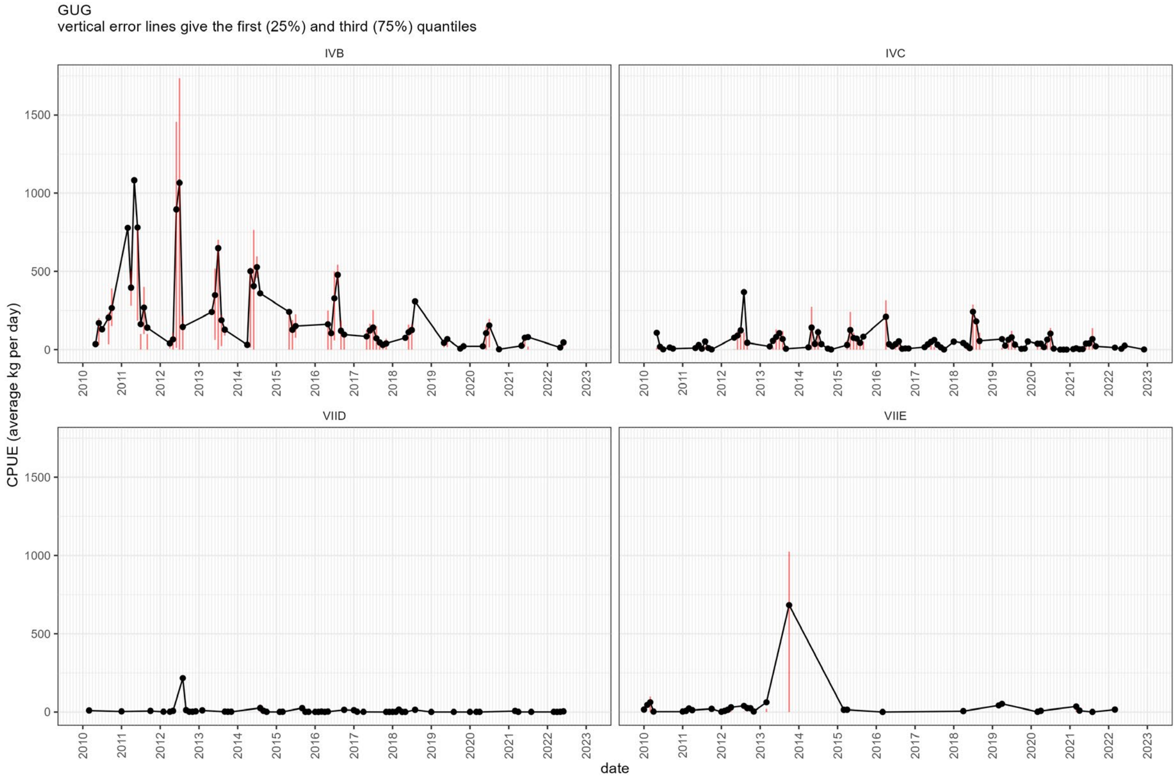


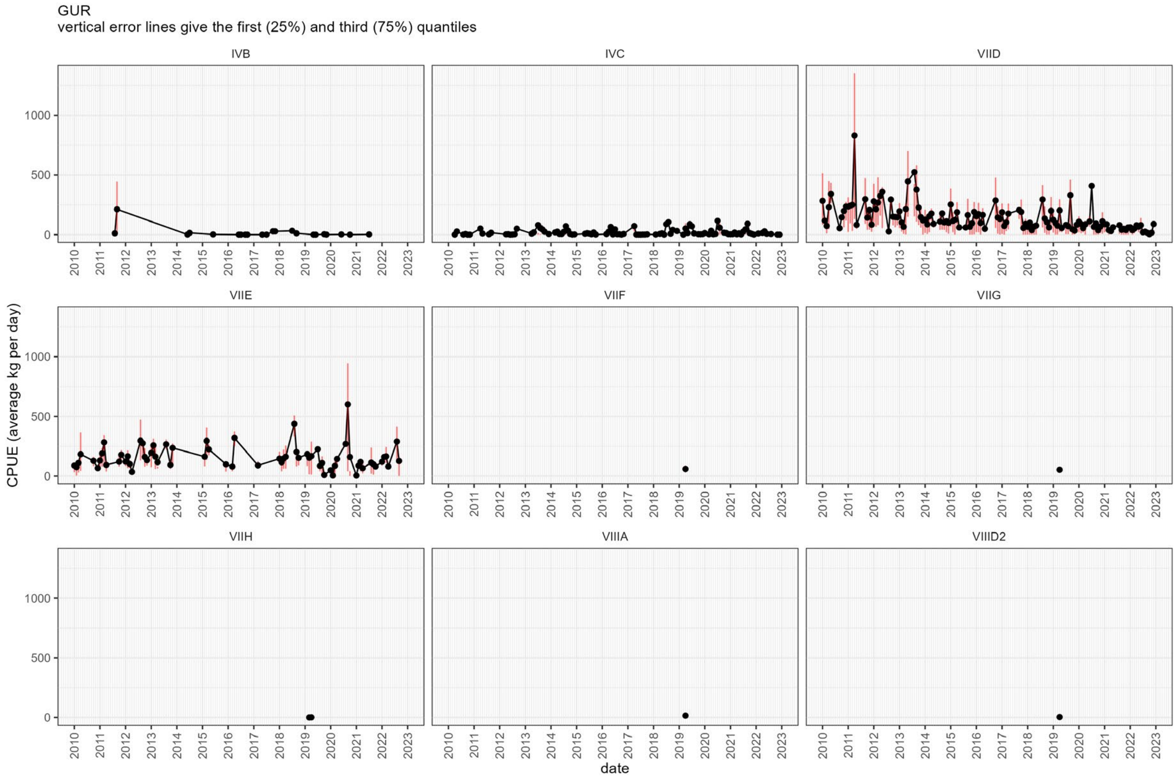


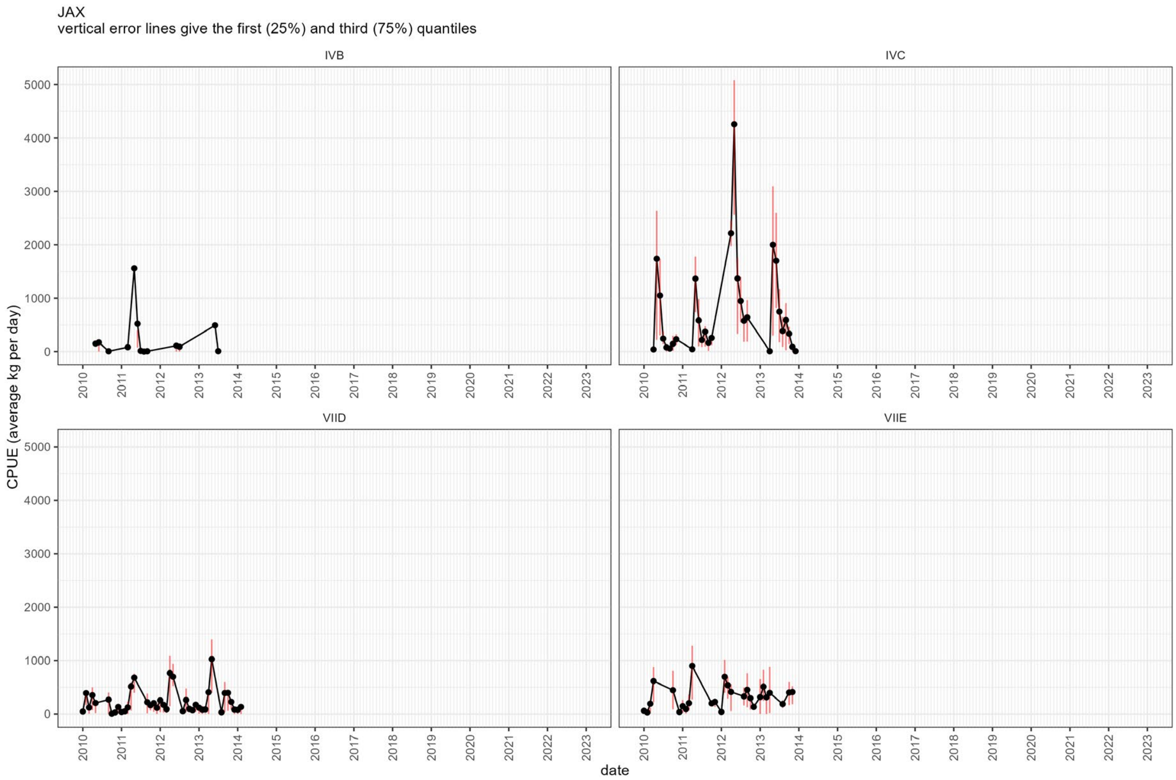

BSS
vertical error lines give the first (25%) and third (75%) quantiles
IVB
IVC
VIID
VIIE
VIIF
VIIG
VIIH
VIIIA
VIIID2
CPUE (average kg per day)
date


COD
vertical error lines give the first (25%) and third (75%) quantiles
IVB
IVC
VIID
VIIE
VIIF
CPUE (average kg per day)
date

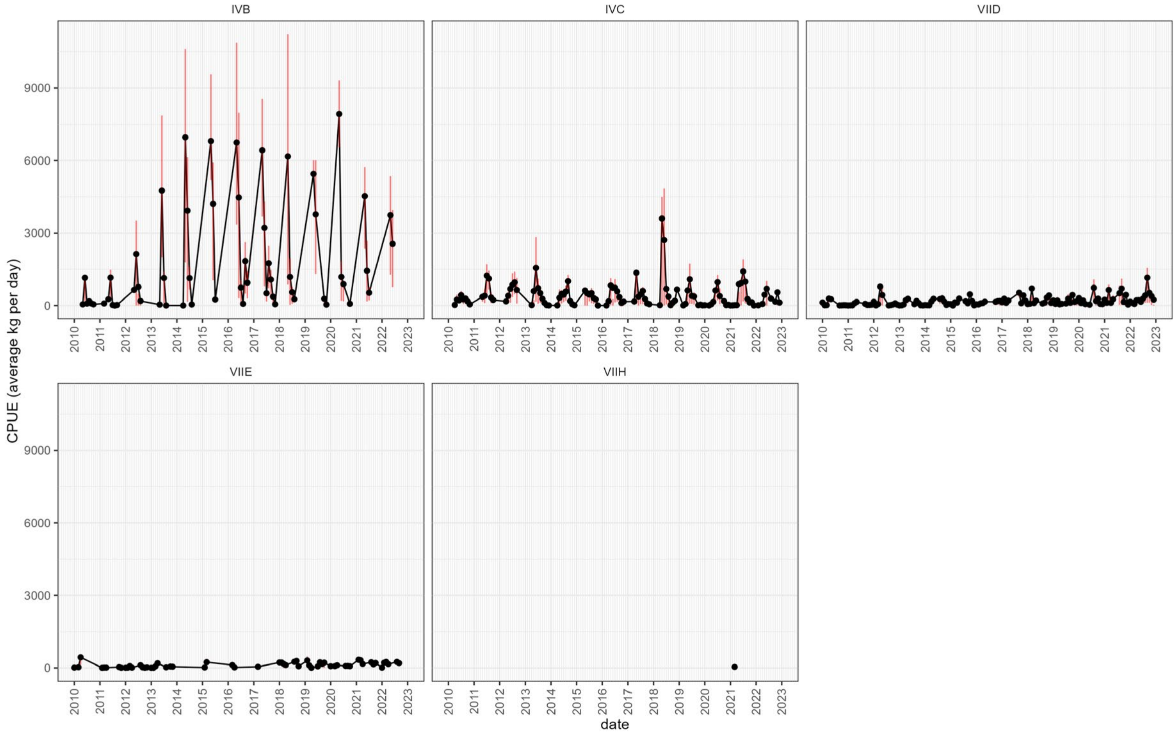

DAB
vertical error lines give the first (25%) and third (75%) quantiles
IVB
IVC
VIID
VIIE
VIIH
CPUE (average kg per day)
date
0
500
1000
1500
2000
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023


GUG
vertical error lines give the first (25%) and third (75%) quantiles
IVB
IVC
VIID
VIIE
CPUE (average kg per day)
date
0
500
1000
1500
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

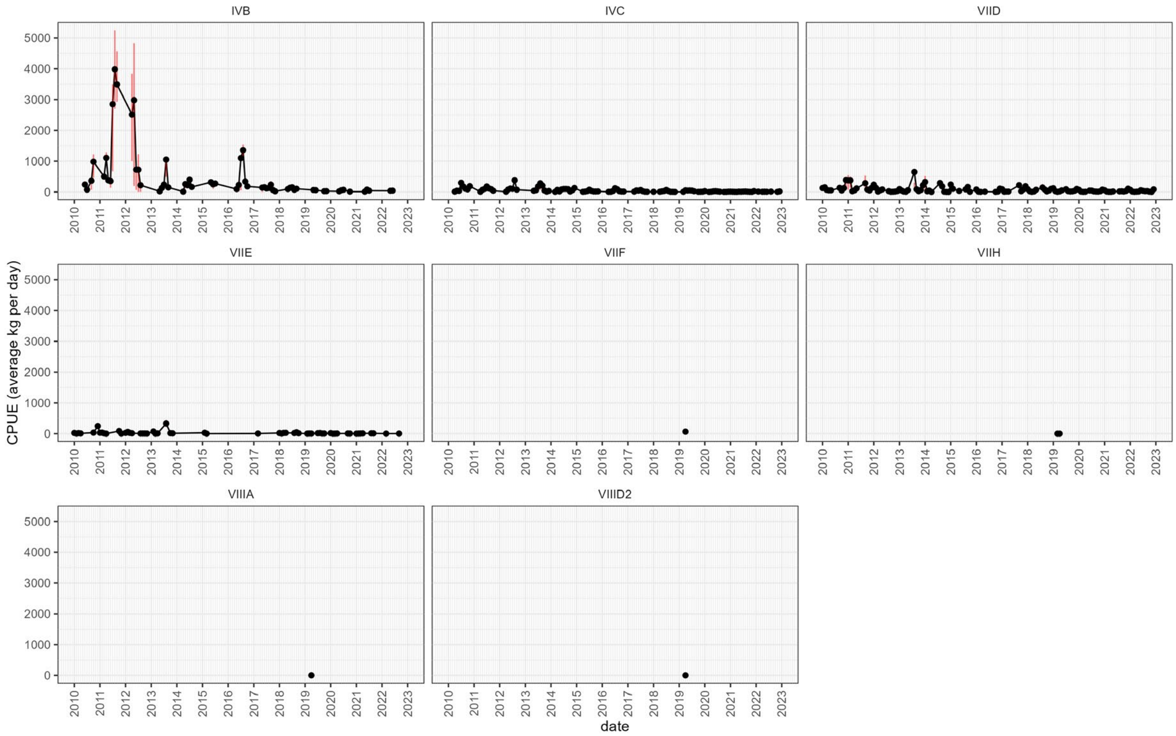

GUR
vertical error lines give the first (25%) and third (75%) quantiles
IVB
IVC
VIID
VIIE
VIIF
VIIG
VIIH
VIIIA
VIIID2
CPUE (average kg per day)
date

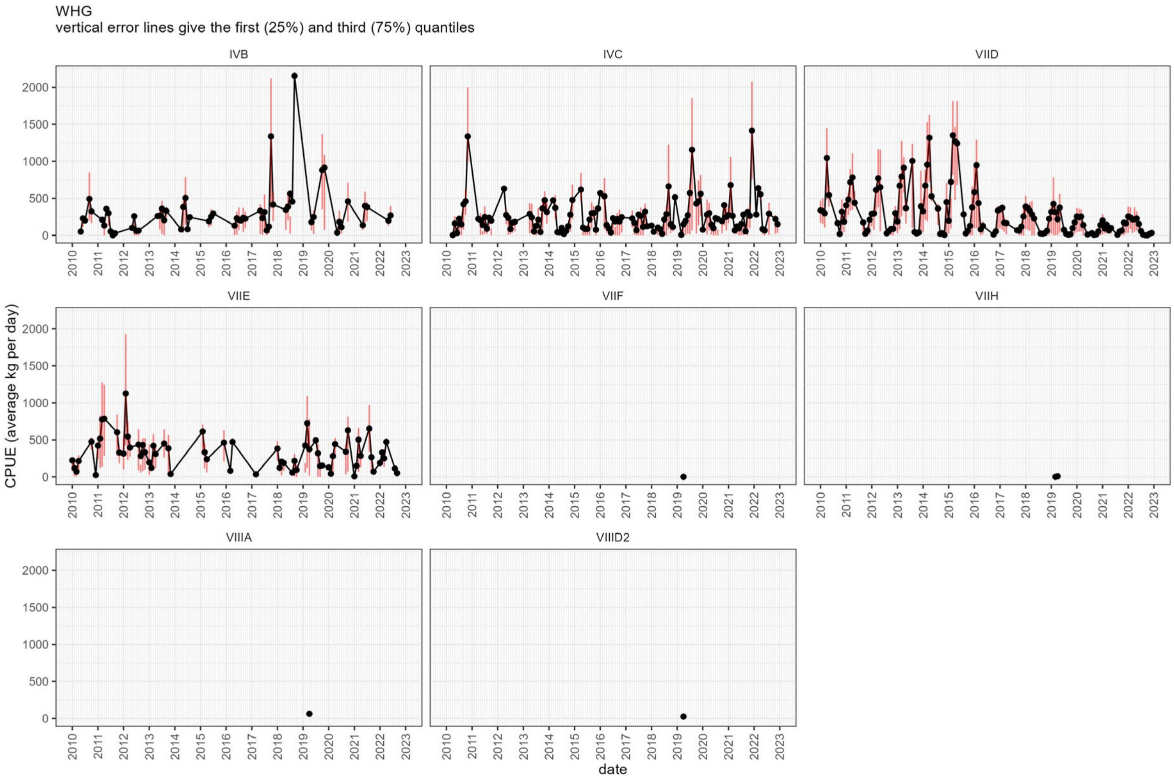

JAX
vertical error lines give the first (25%) and third (75%) quantiles
IVB
IVC
VIID
VIIE
CPUE (average kg per day)
date

MAC
vertical error lines give the first (25%) and third (75%) quantiles



PLE
vertical error lines give the first (25%) and third (75%) quantiles




WHG
vertical error lines give the first (25%) and third (75%) quantiles
IVB
IVC
VIID
VIIE
VIIF
VIIH
VIIIA
VIIID2
CPUE (average kg per day)
date
0
500
1000
1500
2000
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

Annex 4 Average landings and discards per hour

Table 10: Total effort sampled (in hours fished) per ICES subdivision and quarter, for landings and dicards. It is important to consider the effort sampled when intepreting the LPUE and DPUE values presented in Tables 11-13.

	Landings			Discards		
	ICES subdivision			ICES subdivision		
Quarter	**7d**	**4c**	**4b**	**7d**	**4c**	**4b**
1	252,2	8,3		178,5	5,5	
2	34,3	72,5	47,4	13,7	48,8	27,7
3	11,4	24,5		11,4	24,5	
4	221,0	74,0		148,1	50,8	

Table 11: Average LPUE (in kilograms per hour) per species, quarter and ICES subdivision (7d = eastern English Channel. 4c = southern North Sea and 4b = central North Sea). If LPUE = 0. landings totalled less than 0.05 kilograms per hour.

			ICES subdivision		
Common name	**Scientific name**	**Quarter**	**7d**	**4c**	**4b**
Bernhard's hermit crab	*Pagurus bernhardus*	1	0.2		
		3		0.3	
		4	0		
Bib	*Trisopterus luscus*	1	4.6	0.6	
		2	1.4	0	
		4	3.3	0.5	
Brill	*Scophthalmus rhombus*	1	0.2	2.8	
		2	0.4		
		3	0.1		
		4	0	0	
Black seabream	*Spondyliosoma cantharus*	1	2.6	0.2	
		3	1.4	1.2	
		4	1	0.1	
Sea bass	*Dicentrarchus labrax*	2	0.6	1.6	
		3		1.8	
		4	0.7	2.4	
Various sharks	*Chondrichthyes*	4		3.4	
Various cephalopods	*Cephalopoda*	1	0.1		
Cod	*Gadus morhua*	1	0.1		
		2	0.1	0.3	0
		4		0.6	
Conger	*Conger conger*	1	0		
Common cuttlefish	*Sepia officinalis*	1	3.3	2.3	
		2	2.7	0.2	
		3	57.8	0.1	
		4	59.3	4.4	
Streaked gurnard	*Chelidonichthys lastoviza*	4	0		
Dab	*Limanda limanda*	1	2.8	2.5	
		2	1.7	0.9	0.4
		3	0.4		

		4	0.2	1.6	
Flounder	*Platichthys flesus*	1	0.8	14.9	
		2		0	
		4	0	0	
Grey gurnard	*Eutrigla gurnardus*	2		0.4	2.3
Red gurnard	*Chelidonichthys cuculus*	1	6	1.2	
		2	11.8	6.7	
		3	5.2	4	
		4	4.2	0.4	
Tub gurnard	*Chelidonichthys lucerna*	1	19.5	5.4	
		2	9.1	12	2.5
		3	15.2	7.1	
		4	35	21.9	
Haddock	*Melanogrammus aeglefinus*	2		0	2.2
		4		0	
Horse mackerel	*Trachurus trachurus*	1	11.8	0.8	
		2	3	35.3	
		3	10.8	5	
		4	0.6	12.9	
Scads and horse mackerels	*Trachurus*	4	0.3		
John Dory	*Zeus faber*	1	0.1		
		2	1.6	0	
		4	0.4	0.2	
Lemon sole	*Microstomus kitt*	1	0.2	1.8	
		2	0.4	0.2	
		3	0.8		
		4	0.1	0.1	
Mackerel	*Scomber scombrus*	1	13.6	1.2	
		2	12.5	72.4	292.1
		3	12.6	126.4	
		4	54.5	19.7	
Anglerfish	*Lophius piscatorius*	1	0.2	0.8	
		2	0.3	0	
		4	0		
Striped red mullet	*Mullus surmuletus*	1	14.2	4.6	
		2	33.6	13.4	22.2
		3	25.9	34.1	
		4	13	45.9	
	Gnathostomata	1	0.3		
		4	1.7	0	
Pilchard	*Sardina pilchardus*	1	0.1		
		2	13.8	0.8	
		3	0.2	1.7	
		4		3.1	
Plaice	*Pleuronectes platessa*	1	1	1.5	
		2	0.9	0.4	2.3
		3	1.8		
		4	8.7	1.3	
Queen scallop	*Aequipecten opercularis*	4	0		
Roker	*Raja clavata*	1	0.1		

		4	0.4	0.6	
Blonde ray	*Raja brachyura*	1	0.3	0.7	
		2		1	
		3	1.8	0.2	
Sea breams	*Sparidae*	1	0.8		
		2	0.7		
Spinous spider crab	*Maja squinado*	1	0		
Raja rays nei	*Raja*	1	0.1		
		2	4.4		
		3	1.7		
		4		0.5	
Various squids nei	*Loliginidae*	1	60.1	39.2	
		2	1.3	1	
		3	0.9	0.1	
		4	123.1	193.1	
Starfish	*Asterias rubens*	4	0		
Lesser spotted dogfish	*Scyliorhinus canicula*	4	0		
Turbot	*Scophthalmus maximus*	1	0	1	
		2		0	
		3	0.4		
		4	0	0	
Greater weever	*Trachinus draco*	1	0	0.7	
		2	1.2	0.2	
		3	3.1		
		4	0.3	0.3	
Whelk	*Buccinum undatum*	1	0		
		4	0		
Whiting	*Merlangius merlangus*	1	27.8	33.7	
		2	5.4	4.8	27.2
		3	1.5		
		4	6.3	13.2	

Table 12: Average DPUE (in kilograms per hour) per species, quarter and ICES subdivision (7d = eastern English Channel. 4c = southern North Sea and 4b = central North Sea). If DPUE = 0, discards totalled less than 0.05 kilograms per hour.

			ICES Area		
Common name	**Scientific name**	**Quarter**	**7d**	**4c**	**4b**
Bernhard's hermit crab	*Pagurus bernhardus*	1	0,4	2,7	
		2	0,2	0,5	1,3
		3	0,4	0,3	
		4	1	0,3	
Black-bellied angler	*Lophius budegassa*	4	0		
Bib	*Trisopterus luscus*	1	24,3	38,3	
		2	9,6	12,8	3,1
		3	0,2	2,5	
		4	0,6	0,3	
Brill	*Scophthalmus rhombus*	1	0		
Black seabream	*Spondyliosoma cantharus*	1	1,2		
		2		0,1	0,1
		3	1,2	0,4	
		4	0,7	0	

Blackbelly rosefish	*Helicolenus dactylopterus*	2			0
		4	0		
Sea bass	*Dicentrarchus labrax*	1	5,3	5,5	
		2	5,3	3,6	
		3		1,9	
		4	2	2,1	
Cod	*Gadus morhua*	1	0,1	87,7	
		2	1,2	9,1	29,8
		3		0,2	
		4	0	0,3	
Conger	*Conger conger*	1	0		
		4	0,4		
Various congers	*Congridae*	4	0		
Cockles	*Cardiidae*	4	0		
Blue crab	*Callinectes sapidus*	2			0
		4	0		
Edible crab	*Cancer pagurus*	4	0	0	
Common cuttlefish	*Sepia officinalis*	1	0,2		
		2	0,8	0	
		4	0,7	0,1	
Streaked gurnard	*Chelidonichthys lastoviza*	1	0,3		
		2	0,1		
		3	0,5	0,1	
		4	0,3	0	
sea cucumbers	*Holothuroidea*	1	0		
		2	0	0	
		3	0		
		4	0		
Dab	*Limanda limanda*	1	46,9	100,5	
		2	27,1	52,6	113,4
		3	1,7	13,5	
		4	0,4	11,4	
Spurdog	*Squalus acanthias*	2			3,4
Horned octopus	*Eledone cirrhosa*	1	0		
		4	0		
Flounder	*Platichthys flesus*	1	0,3	8,1	
		2		0	
		3		0,1	
		4		0,2	
Tope	*Galeorhinus galeus*	3		1,1	
		4	0,1		
Grey gurnard	*Eutrigla gurnardus*	1	1	0,1	
		2	0,4	9,7	28,6
		3	0,1		
		4	0,1	6,7	
Red gurnard	*Chelidonichthys cuculus*	1	8,4	1,4	
		2	7,7	10,6	
		3	1,2	1,7	
		4	1,5	0,1	
Tub gurnard	*Chelidonichthys lucerna*	1	12,9	2,7	

		2	0,7	5,6	0,1
		3	2,2	2,4	
		4	12,5	13,1	
Haddock	*Melanogrammus aeglefinus*	1	0		
		2		0,1	39,8
		4	0		
Herring	*Clupea harengus*	1	0,7	604,6	
		2	1,3	1	0,1
		3	0,4	0,5	
		4	59,1	7	
Horse mackerel	*Trachurus trachurus*	1	2,8	2	
		2	33,7	99,8	0,2
		3	38,1	26,5	
		4	2	4,1	
Stingray	*Dasyatis pastinaca*	4	0		
John Dory	*Zeus faber*	1	0		
		2		0,1	
		3	0,3		
		4	0	0	
Lemon sole	*Microstomus kitt*	1	0,2	0,1	
		2	0	0,4	0,6
		3		0,7	
		4	0,1	0,3	
Velvet swimcrab	*Necora puber*	1	0	0	
		2		0,4	0
		3	0,4	0,9	
		4	0	0,1	
Dragonet	*Callionymus lyra*	1	0,5		
		2	0,5	0,6	2,1
		3	5,6	0,4	
		4	0,2	0,2	
Mackerel	*Scomber scombrus*	1	2,2		
		2	0,3	41	0,5
		3	17,9	148,7	
		4	9,9	2,7	
Anglerfish	*Lophius piscatorius*	1	0		
		3	0,1		
		4	0		
Scaldfish	*Arnoglossus laterna*	1	0		
		4	0		
Striped red mullet	*Mullus surmuletus*	1	1,7	0	
		2	0	1,6	0,2
		3	0		
		4	13,3	5	
Common mussel	*Mytilus edulis*	1	0		
		2	0		
		3	0		
		4	0		
Norway pout	*Trisopterus esmarkii*	2			0,3
		4	0		

Horned and musky octopuses	*Eledone*	1	0		
European common squid	*Alloteuthis subulata*	2		0	
		3	0	0	
Cupped oysters nei	*Crassostrea*	4	0		
common oyster	*Ostrea edulis*	1	0		
		2		0	
		3	0,1	0	
Pandora	*Pagellus erythrinus*	1	0		
		2	0,5		
		4	0		
Pilchard	*Sardina pilchardus*	1	0		
		2	0,7	0,1	
		3		0	
		4	0	0	
Plaice	*Pleuronectes platessa*	1	11,9	2,1	
		2	3,2	5,7	9,8
		3	1,4	2,6	
		4	7	6,7	
Pollack	*Pollachius pollachius*	2			0
Queen scallop	*Aequipecten opercularis*	1	0,1		
		2	0,4	0,1	0,5
		3	0,3	0,1	
		4	0,2	0	
Roker	*Raja clavata*	1	3		
		2	28,9	0,1	
		3	6,5	0,2	
		4	7	0,1	
Blonde ray	*Raja brachyura*	1	0,8		
		2	0,4	0,2	
		3		0,1	
		4	0,9	1,1	
Spotted ray	*Raja montagui*	1	0,3		
		2	0,9		
		4	0	0	
Various sandlances	*Ammodytes*	4	0	0	
Red seabream	*Pagellus bogaraveo*	1	0		
Sea breams	*Sparidae*	1	0,1		
		2	0,2		
Common scallop	*Pecten maximus*	1	0		
		3	0		
		4		0	
Spinous spider crab	*Maja squinado*	1	0,3		
		2	0,1		
		4	0,2	0,6	
Starry smoothhound	*Mustelus asterias*	1	0,4		
		2	1,7	0,1	3,5
		4	0		
Various smoothhounds	*Mustelus*	1	0,9	3,5	
		2	5,5	8	0,3
		3		4,9	

		4	1,8	0,1	
Sardinella	*Sardinella*	4	0		
Raja rays nei	*Raja*	1	0		
Smoothhound	*Mustelus mustelus*	2		0,1	
		3		0	
Sole	*Solea solea*	1	0		
		3	0,2	0	
		4	0	0	
Sand sole	*Pegusa lascaris*	1	0		
		4	0		
Sprat	*Sprattus sprattus*	1	0		
		2			0,1
		4	0		
Common squids nei	*Loligo*	4	0		
Veined squid	*Loligo forbesii*	1	0		
		4	0		
Broadtail shortfin squid	*Illex coindetii*	1	0		
European squid	*Loligo vulgaris*	1	0,1		
		2	0,1	0	
		4	0	0	
Various squids nei	*Loliginidae*	1	0,1		
		4	0		
Starfish	*Asterias rubens*	1	0,9	0,7	
		2	1,7	0,3	0,3
		3	0,1	0,4	
		4	0,5	1,1	
Lesser spotted dogfish	*Scyliorhinus canicula*	1	4,6	12,3	
		2	8,9	21,2	0,5
		3	2,4	28,7	
		4	6,1	2	
Nursehound	*Scyliorhinus stellaris*	1	0,3		
		4	1,4		
Lesser flying squid	*Todaropsis eblanae*	1	0		
Lesser weever	*Echiichthys vipera*	2		0,1	
		3		0,1	
Twaite shad	*Alosa fallax*	1	0,3		
		3		0	
		4	0	0,1	
Turbot	*Scophthalmus maximus*	1	0		
		4	0		
European edible sea urchin	*Echinus esculentus*	2	0		
Ballan wrasse	*Labrus bergylta*	1	0		
Greater weever	*Trachinus draco*	1	0		
		3	0	0	
Blue whiting	*Micromesistius poutassou*	3	0		
Whelk	*Buccinum undatum*	1	1		
		2	0,1	0	0,1
		3	0	0	
		4	0,2	0	
Whiting	*Merlangius merlangus*	1	34,2	254,4	

	Quarter			
	2	15	78,3	229,1
	3	3,3	2,4	
	4	2,1	115,6	

Table 13: Average DPUE (in numbers per hour) per species, quarter and ICES subdivision (7d = eastern English Channel. 4c = southern North Sea and 4b = central North Sea). If DPUE = 0, discards totalled less than 0.5 individuals per hour.

			ICES Area		
Common name	**Scientific name**	**Quarter**	**7d**	**4c**	**4b**
Bernhard's hermit crab	*Pagurus bernhardus*	1	48	78	
		2	173	106	52
		3	82	60	
		4	105	43	
Black-bellied angler	*Lophius budegassa*	4	0		
Bib	*Trisopterus luscus*	1	120	369	
		2	66	128	30
		3	2	26	
		4	8	14	
Brill	*Scophthalmus rhombus*	1	0		
Black seabream	*Spondyliosoma cantharus*	1	13		
		2		1	1
		3	7	2	
		4	14	1	
Blackbelly rosefish	*Helicolenus dactylopterus*	2			0
		4	0		
Sea bass	*Dicentrarchus labrax*	1	9	13	
		2	9	7	
		3		3	
		4	3	5	
Cod	*Gadus morhua*	1	0	478	
		2	3	45	209
		3		0	
		4	0	1	
Conger	*Conger conger*	1	0		
		4	0		
Various congers	*Congridae*	4	0		
Cockles	*Cardiidae*	4	0		
Blue crab	*Callinectes sapidus*	2			2
		4	0		
Edible crab	*Cancer pagurus*	4	0	0	
Common cuttlefish	*Sepia officinalis*	1	3		
		2	3	0	
		4	11	1	
Streaked gurnard	*Chelidonichthys lastoviza*	1	3		
		2	2		
		3	8	1	
		4	3	0	
sea cucumbers	*Holothuroidea*	1	0		
		2	0	0	
		3	0		
		4	0		

Dab	*Limanda limanda*	1	565	1268	
		2	299	776	1669
		3	15	195	
		4	4	110	
Spurdog	*Squalus acanthias*	2			1
Horned octopus	*Eledone cirrhosa*	1	0		
		4	0		
Flounder	*Platichthys flesus*	1	1	31	
		2		0	
		3		1	
		4		1	
Tope	*Galeorhinus galeus*	3		1	
		4	0		
Grey gurnard	*Eutrigla gurnardus*	1	11	1	
		2	5	121	447
		3	2		
		4	1	83	
Red gurnard	*Chelidonichthys cuculus*	1	66	12	
		2	149	104	
		3	14	19	
		4	22	1	
Tub gurnard	*Chelidonichthys lucerna*	1	101	13	
		2	10	58	1
		3	17	23	
		4	105	137	
Haddock	*Melanogrammus aeglefinus*	1	0		
		2		0	284
		4	0		
Herring	*Clupea harengus*	1	6	4418	
		2	16	11	1
		3	2	5	
		4	380	59	
Horse mackerel	*Trachurus trachurus*	1	39	13	
		2	385	651	2
		3	505	342	
		4	68	54	
Stingray	*Dasyatis pastinaca*	4	0		
John Dory	*Zeus faber*	1	1		
		2		1	
		3	2		
		4	0	0	
Lemon sole	*Microstomus kitt*	1	1	3	
		2	0	4	6
		3		4	
		4	1	8	
Velvet swimcrab	*Necora puber*	1	0	0	
		2		6	2
		3	45	15	
		4	0	1	
Dragonet	*Callionymus lyra*	1	6		

		2	8	12	24
		3	92	7	
		4	4	3	
Mackerel	*Scomber scombrus*	1	17		
		2	3	214	2
		3	88	752	
		4	44	37	
Anglerfish	*Lophius piscatorius*	1	0		
		3	0		
		4	0		
Scaldfish	*Arnoglossus laterna*	1	0		
		4	0		
Striped red mullet	*Mullus surmuletus*	1	38	0	
		2	1	38	4
		3	0		
		4	365	102	
Common mussel	*Mytilus edulis*	1	0		
		2	0		
		3	0		
		4	0		
Norway pout	*Trisopterus esmarkii*	2			10
		4	1		
Horned and musky octopuses	*Eledone*	1	0		
European common squid	*Alloteuthis subulata*	2		1	
		3	0	0	
Cupped oysters nei	*Crassostrea*	4	0		
common oyster	*Ostrea edulis*	1	0		
		2		0	
		3	1	0	
Pandora	*Pagellus erythrinus*	1	0		
		2	6		
		4	0		
Pilchard	*Sardina pilchardus*	1	0		
		2	9	0	
		3		0	
		4	0	0	
Plaice	*Pleuronectes platessa*	1	137	17	
		2	31	59	103
		3	8	25	
		4	92	69	
Pollack	*Pollachius pollachius*	2			0
Queen scallop	*Aequipecten opercularis*	1	3		
		2	7	2	1
		3	2	2	
		4	6	0	
Roker	*Raja clavata*	1	6		
		2	35	1	
		3	9	0	
		4	9	0	
Blonde ray	*Raja brachyura*	1	1		

		2	1	0	
		3		1	
		4	1	2	
Spotted ray	*Raja montagui*	1	0		
		2	1		
		4	0	0	
Various sandlances	*Ammodytes*	4	1	0	
Red seabream	*Pagellus bogaraveo*	1	0		
Sea breams	*Sparidae*	1	0		
		2	2		
Common scallop	*Pecten maximus*	1	0		
		3	1		
		4		0	
Spinous spider crab	*Maja squinado*	1	0		
		2	0		
		4	0	1	
Starry smoothhound	*Mustelus asterias*	1	1		
		2	3	0	2
		4	0		
Various smoothhounds	*Mustelus*	1	4	31	
		2	13	16	0
		3		10	
		4	8	1	
Sardinella	*Sardinella*	4	0		
Raja rays nei	*Raja*	1	0		
Smoothhound	*Mustelus mustelus*	2		0	
		3		0	
Sole	*Solea solea*	1	0		
		3	2	0	
		4	0	0	
Sand sole	*Pegusa lascaris*	1	0		
		4	0		
Sprat	*Sprattus sprattus*	1	0		
		2			9
		4	0		
Common squids nei	*Loligo*	4	0		
Veined squid	*Loligo forbesii*	1	0		
		4	0		
Broadtail shortfin squid	*Illex coindetii*	1	0		
European squid	*Loligo vulgaris*	1	1		
		2	1	0	
		4	0	0	
Various squids nei	*Loliginidae*	1	0		
		4	0		
Starfish	*Asterias rubens*	1	14	29	
		2	45	9	6
		3	7	14	
		4	24	16	
Lesser spotted dogfish	*Scyliorhinus canicula*	1	10	58	
		2	15	57	1

		3	5	80	
		4	21	12	
Nursehound	*Scyliorhinus stellaris*	1	0		
		4	1		
Lesser flying squid	*Todaropsis eblanae*	1	0		
Lesser weever	*Echiichthys vipera*	2		3	
		3		2	
Twaite shad	*Alosa fallax*	1	0		
		3		0	
		4	0	0	
Turbot	*Scophthalmus maximus*	1	0		
		4	0		
European edible sea urchin	*Echinus esculentus*	2	1		
Ballan wrasse	*Labrus bergylta*	1	0		
Greater weever	*Trachinus draco*	1	0		
		3	0	0	
Blue whiting	*Micromesistius poutassou*	3	0		
Whelk	*Buccinum undatum*	1	3		
		2	1	1	1
		3	0	0	
		4	5	1	
Whiting	*Merlangius merlangus*	1	239	1819	
		2	124	738	1809
		3	25	22	
		4	12	617	

Wageningen Marine Research
T +31 (0)317 48 7000
E: marine-research@wur.nl
www.wur.eu/marine-research

Visitors' address

- Ankerpark 27 1781 AG Den Helder
- Korringaweg 7. 4401 NT Yerseke
- Haringkade 1. 1976 CP IJmuiden

With knowledge. independent scientific research and advice. **Wageningen Marine Research** substantially contributes to more sustainable and more careful management. use and protection of natural riches in marine. coastal and freshwater areas.

Wageningen Marine Research is part of Wageningen University & Research. Wageningen University & Research is the collaboration between Wageningen University and the Wageningen Research Foundation and its mission is: 'To explore the potential for improving the quality of life'