MARHAB

Improving marine habitat status by considering ecosystem dynamics

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Authors		
Name	Organization	E-mail
Mikael van Deurs*	DTU Aqua	mvd@aqua.dtu.dk
Amalie Broegaard-Iversen	DTU Aqua	amabr@aqua.dtu.dk

*Corresponding authors

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Executive Summary

This delivery report consists of two parts, each of which describes acquired data to be used together with data extracted from the systematic literature review (D3.1) to complete Deliverable D3.6 and subsequently support the development of the Policy Brief in D3.7.

1. Fish biodiversity and substrate data from a chain of sand banks in the northern North Sea surveys during the Danish sandeel dredge survey.
2. Commercial catch data of vulnerable megafauna species in Skagerrak and the North Sea, linked to gear type and substrate type.

Part 1: Fish Biodiversity on Sand Banks

This data will be used to study relationship between fish communities and biodiversity across sand banks that differ in depth and sediment composition.

- Nearly 200 samples have been analyzed, recording more than 35 species and over 10.000 individuals.
- Data will be made openly available on DTUdata.dk as part of deliverable D3.4 (and can be shared upon request before official release).
- Sandeel, a key prey species, is included in the fish community analysis. We will assess the relative importance of sandeel compared to other prey fish on these sand banks.
- Using sandeel predation data, we also aim to evaluate whether current fisheries reference points sufficiently account for ecosystem needs. In other words, we ask whether the ecosystem services provided by sand banks via the sandeel are adequately considered in

fisheries management.

Part 2: Commercial Catch Data of Vulnerable Top-Predators

This part explicitly links to other work packages focusing on the role of top predators in maintaining healthy ecosystems.

- Commercial catch data, often representing bycatch of large predatory species, provide valuable insights into where these species – that were once far more common in fisheries - are associated with specific substrate types.
- Because these data cover seasonal variation and include passive gear fishing on seabeds not surveyed by scientific trawls, they are expected to reveal more information than trawl surveys alone.
- We have acquired data for four species across 103,000 fishing trips since 2008, with spatial information included.
- EMODnet substrate categories were extracted using coordinates (e.g., for haul end or gear deployment location).
- An aggregated, GDPR-compliant version of these data will be published open access on DTUdata.dk at the time of publication.

Document history		
Version	**Date**	**Description**
V1	18.12.2025	First version

List of acronyms	
Acronym	**Meaning**

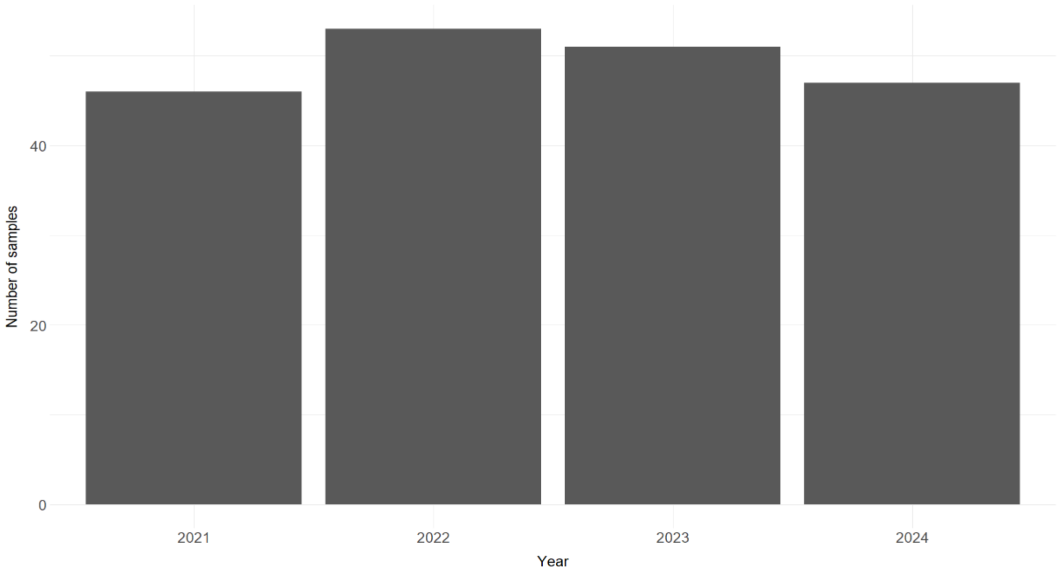
Part 1: Fish Biodiversity on Sand Banks

Technical data report – species and grain sizes

Species distribution

In the first part of this technical report, data was obtained from the sandeel dredge survey, where fish samples were collected, preserved, and stored for later analysis. Data on fish species were collected from 2021-2024. The number of samples taken each year and sample location can be seen in figure 1. The number of samples taken across all years are nearly stable. Despite this, the distribution of each fish species has varied considerably from year to year (Fig. 2). The years 2021 and 2022 were relatively stable, followed by 2023, which had an increase in the number of fish, followed by a very small decrease in 2024. The five most frequent fish species across all years are *Callionymus reticulatus* (Reticulated dragonet), *Buglossidium luteum* (Solenette), *Pomatoschistus minutus* (sand goby), *Pomatoschistus pictus* (painted goby) *and Arnoglossus laterna* (mediterranean scaldfish) (Fig. 2).

Before the samples of the surveys were analyzed *Callionymus reticulatus* and *Buglossidium luteum* were considered non-native in Danish waters. This is likely due to difficulties in identifying the species, suggesting that they have probably always been present in Danish waters. *Callionymus reticulatus* has been found over the four sampling years in a belt extending from northern Jutland westward into the North Sea (Fig. 3). Furthermore, it was found on the Westcoast of Jutland. Additionally, *Buglossidium luteum* was found along the coast of northern Jutland and the west coast of Jutland in a pattern similar to that of *Callionymus reticulatus* (Fig. 4).



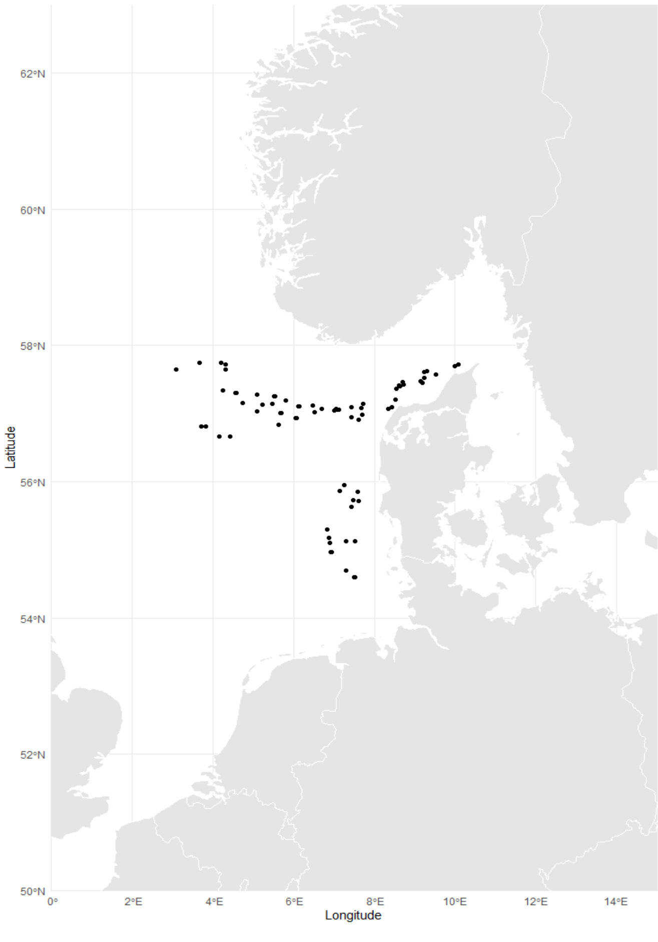
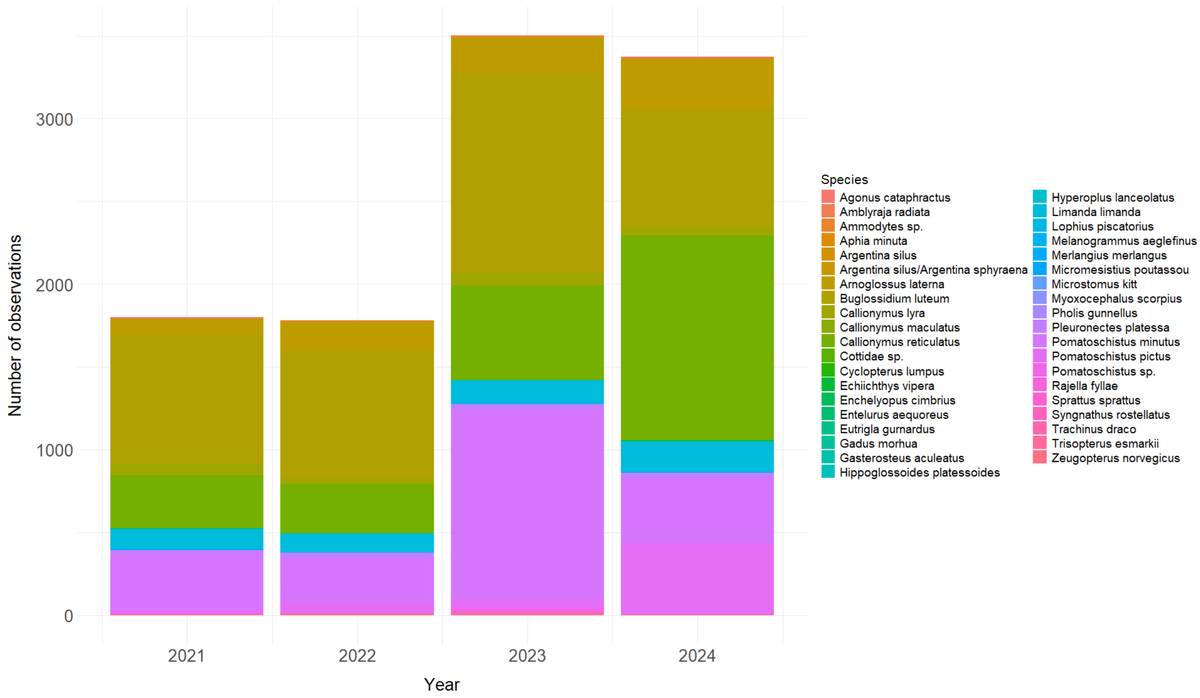


Figure 1: Top: Number of samples taken each year from 2021-2024. Bottom: Sample location.



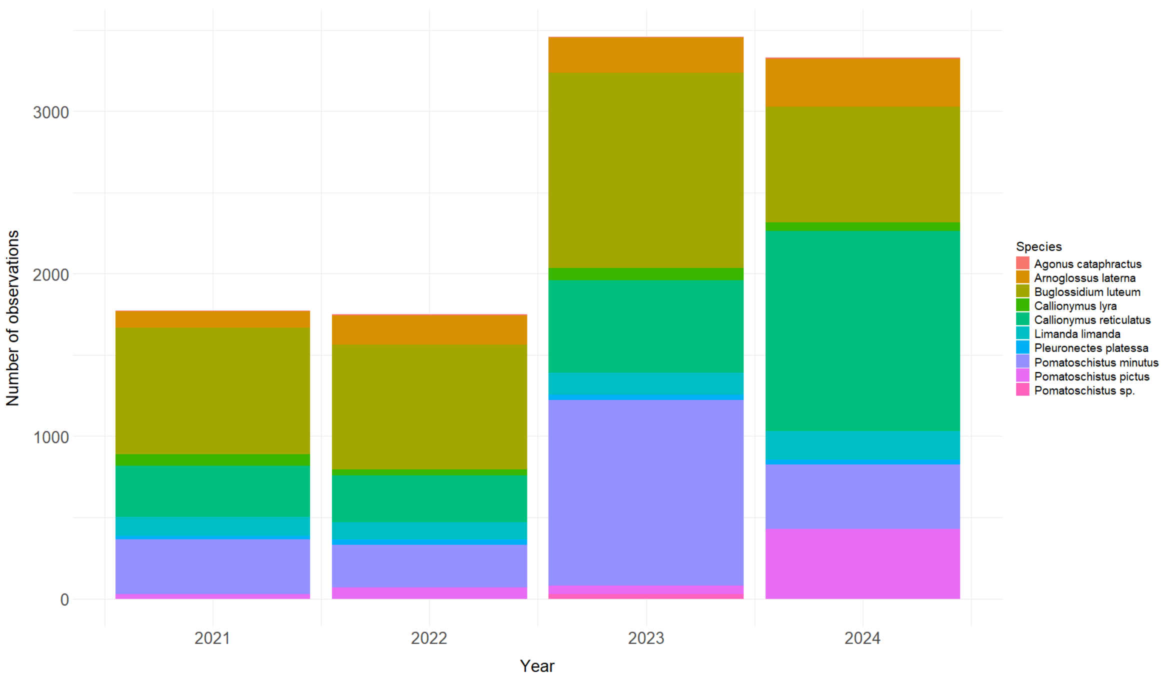


Figure 2: Top: The distribution of all fish species from 2021-2024. Bottom: The ten most frequent fish species from 2021-2024.

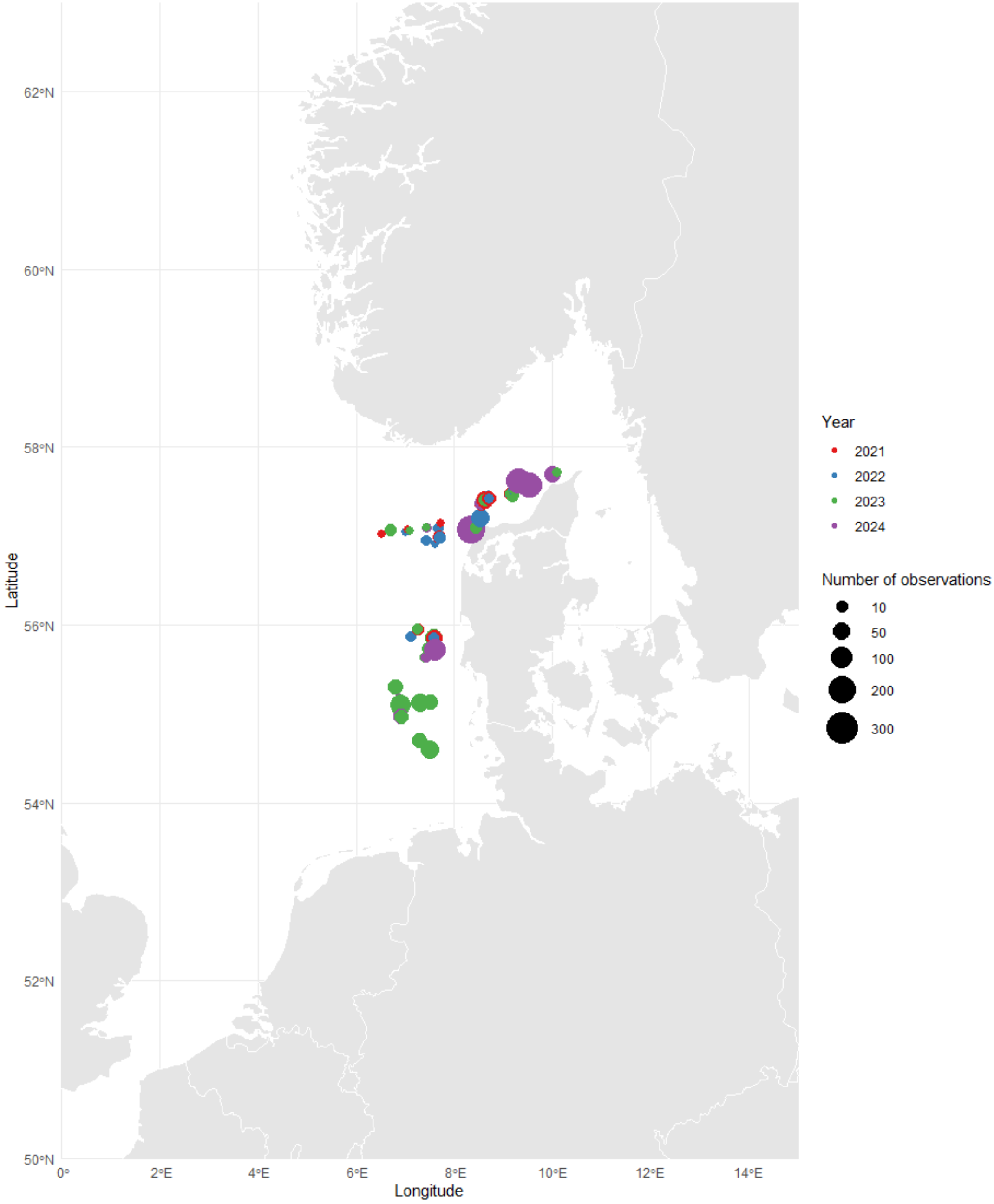


Figure 2: Sample locations where *Callionymus reticulatus* was found. Colours indicate sampling year.

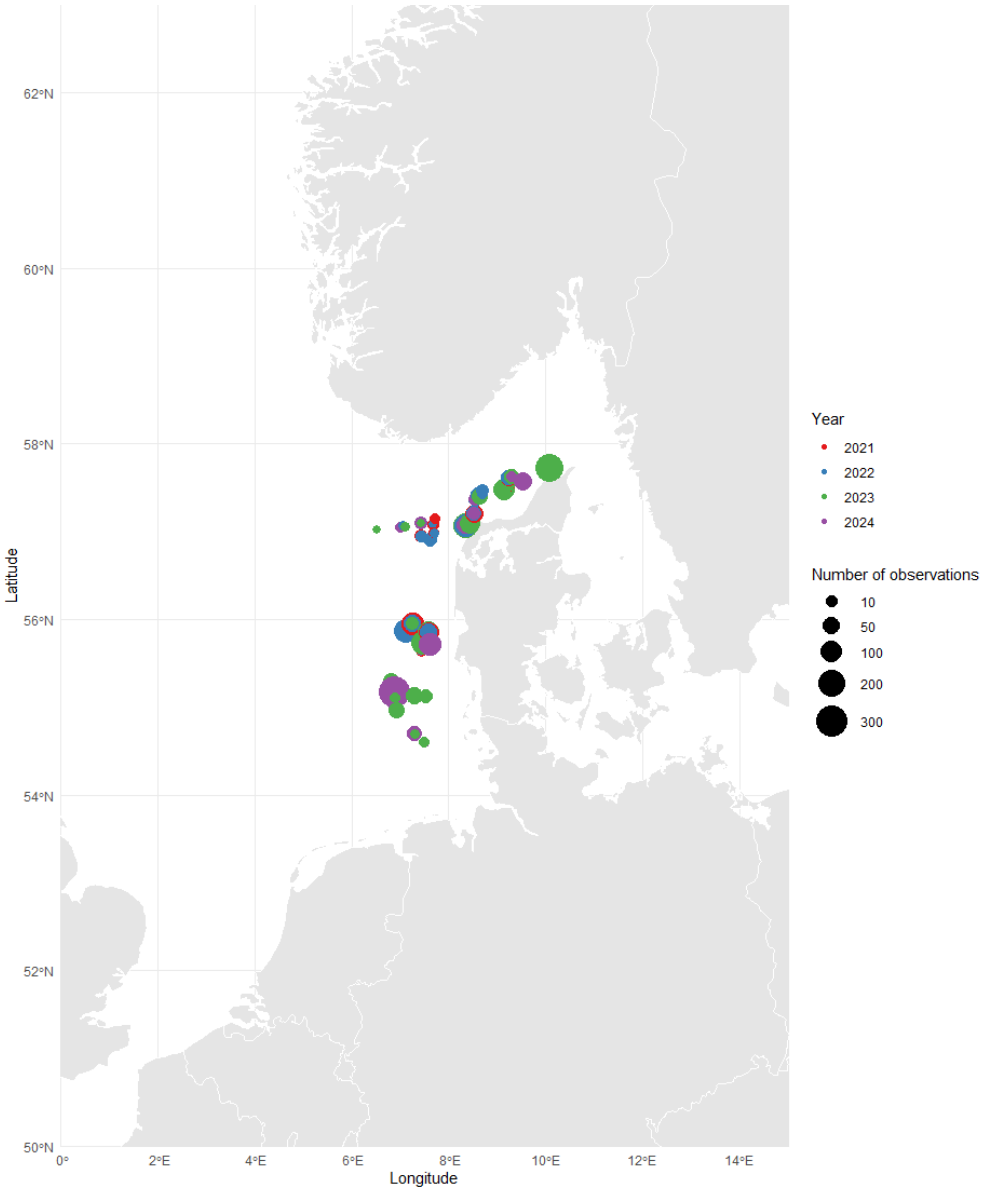


Figure 3: Sample locations where *Buglossidium luteum* was found. Colours indicate sampling year.

Grain size distribution

The sediment samples were taken during the sand eel surveys and contain data from 2012-2024 (sample locations in figure 5). The grain size distribution of each sediment sample was analyzed, and all samples went through sieves sizes of 8, 4, 2, 1, 0.5, 0.25, 0.125 and 0.063 mm. An example of a classical grain size distribution curve can be seen in figure 6, the curve was made based on one of the sediment samples from the survey. To obtain an overview of the distribution of different grain sizes, a weighted average was calculated across all sample replicates and years (Fig. 7). The two most common grain sizes are 0.25 mm and 0.125 mm (red and blue dots on figure 7).

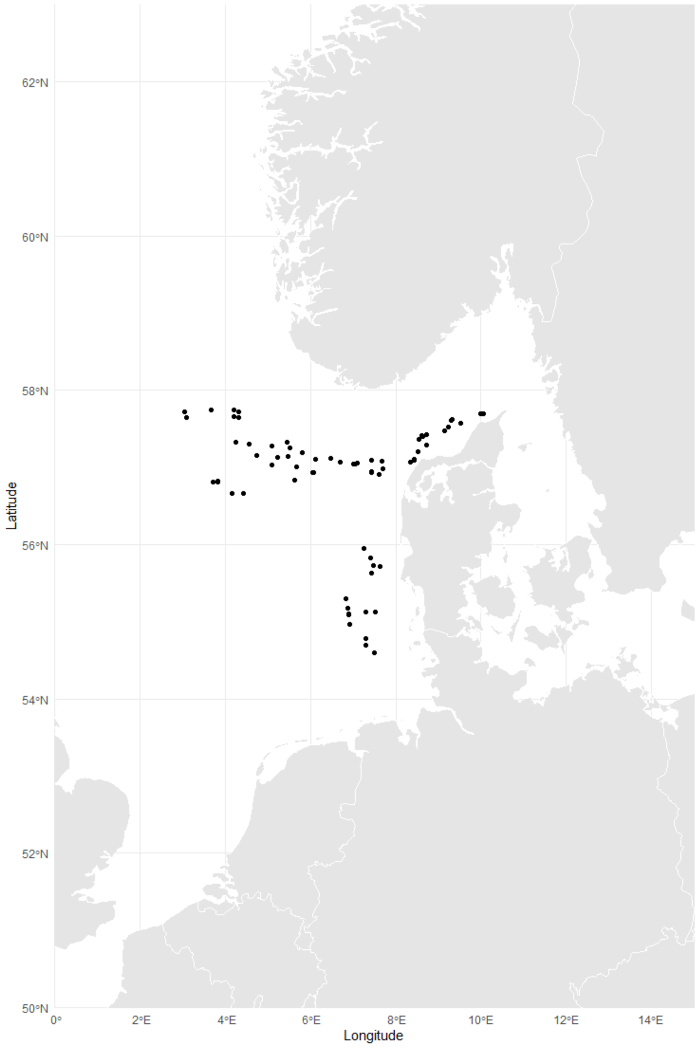


Figure 4: Sample location for the sediment samples from 2012-2019.

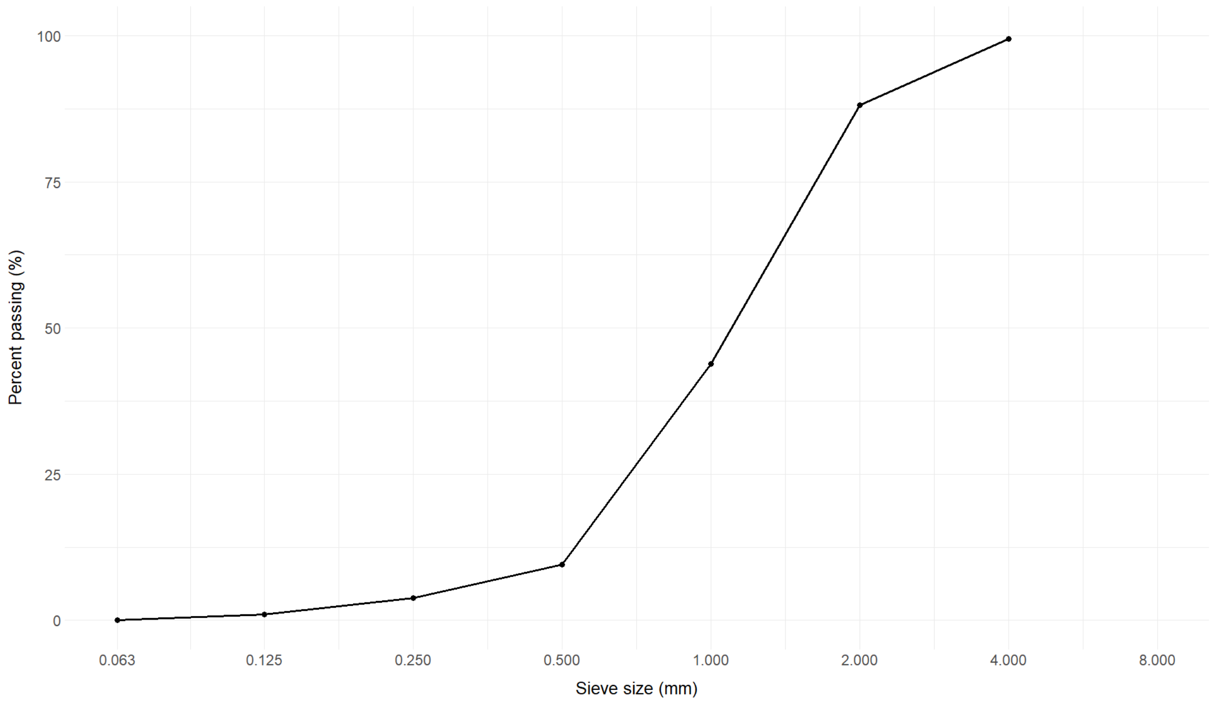


Figure 5: An example of a grain size distribution curve. The curve is made based on one of the sediment samples collected during the sand eel surveys.

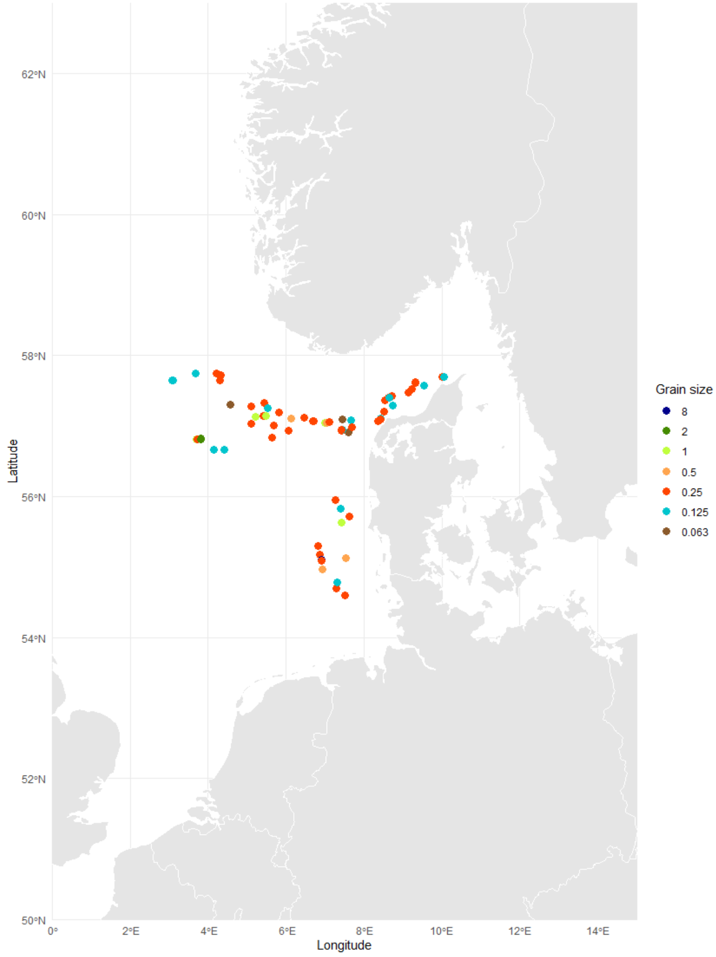


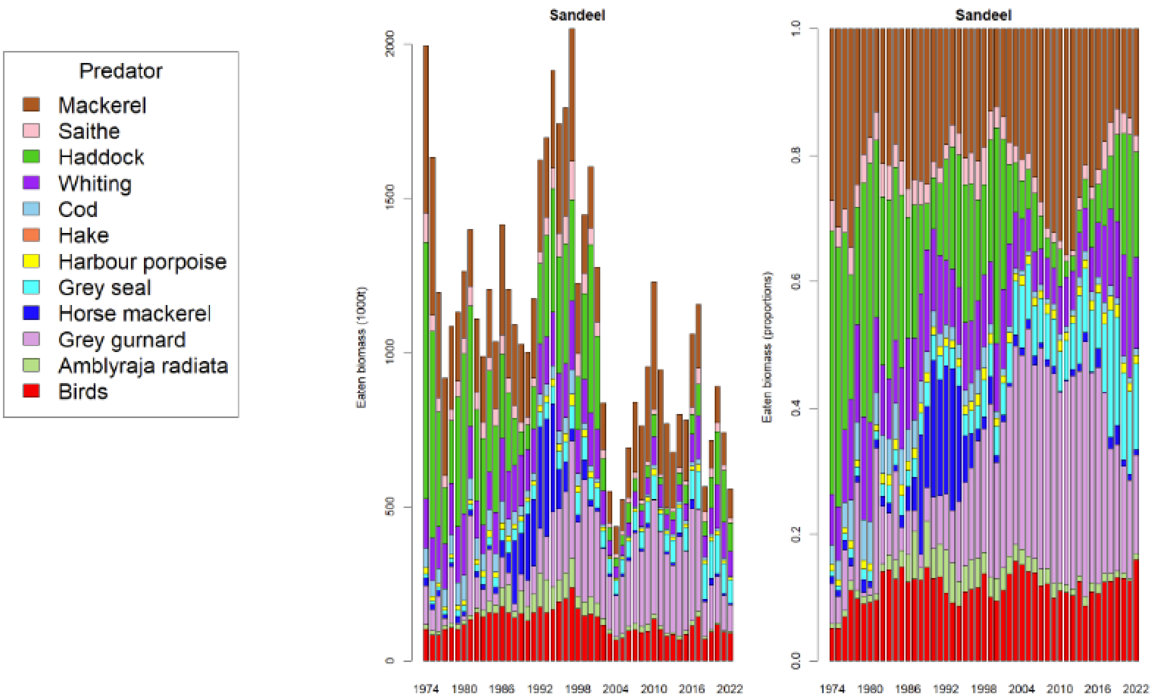
Figure 6: Average weighted grain sizes across all years and replicates and location.

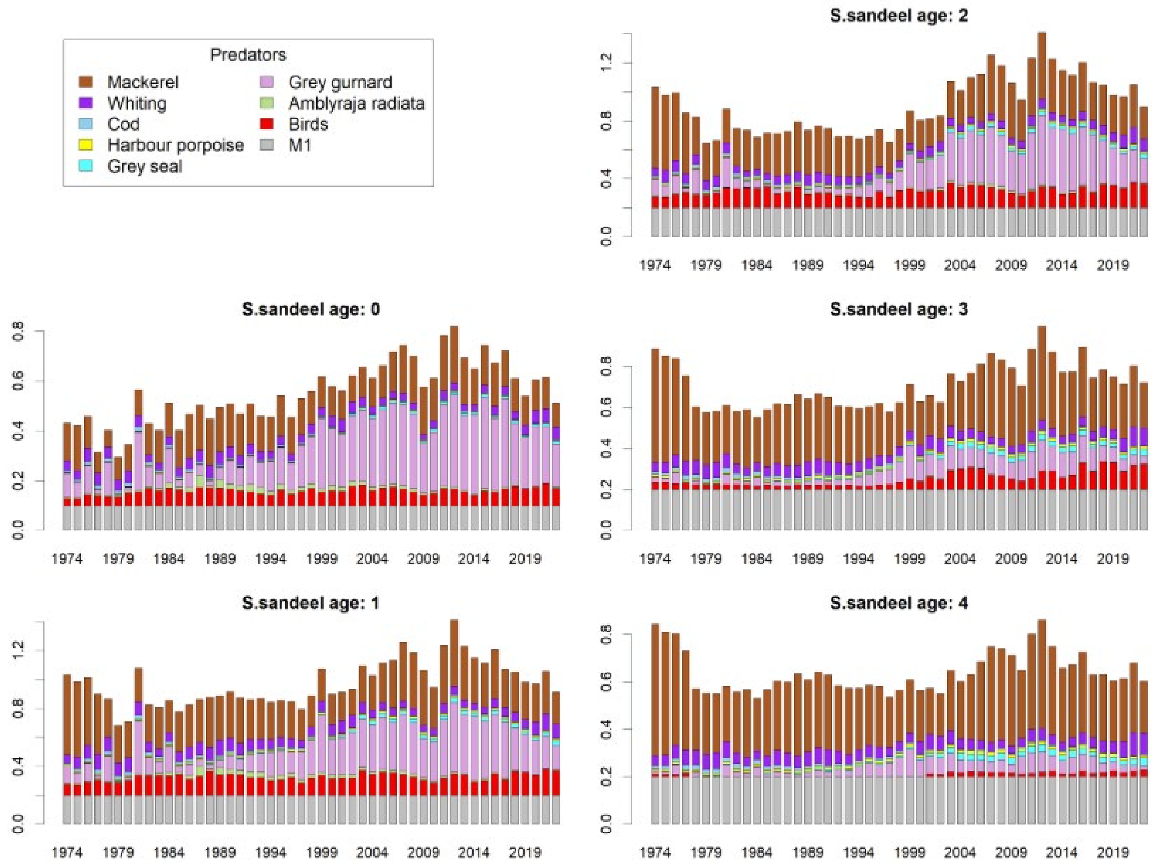
Sandeel and sandeel predation

Data on sandeel catch rates from the same dredge survey are routinely being published as open access by DTU Aqua:

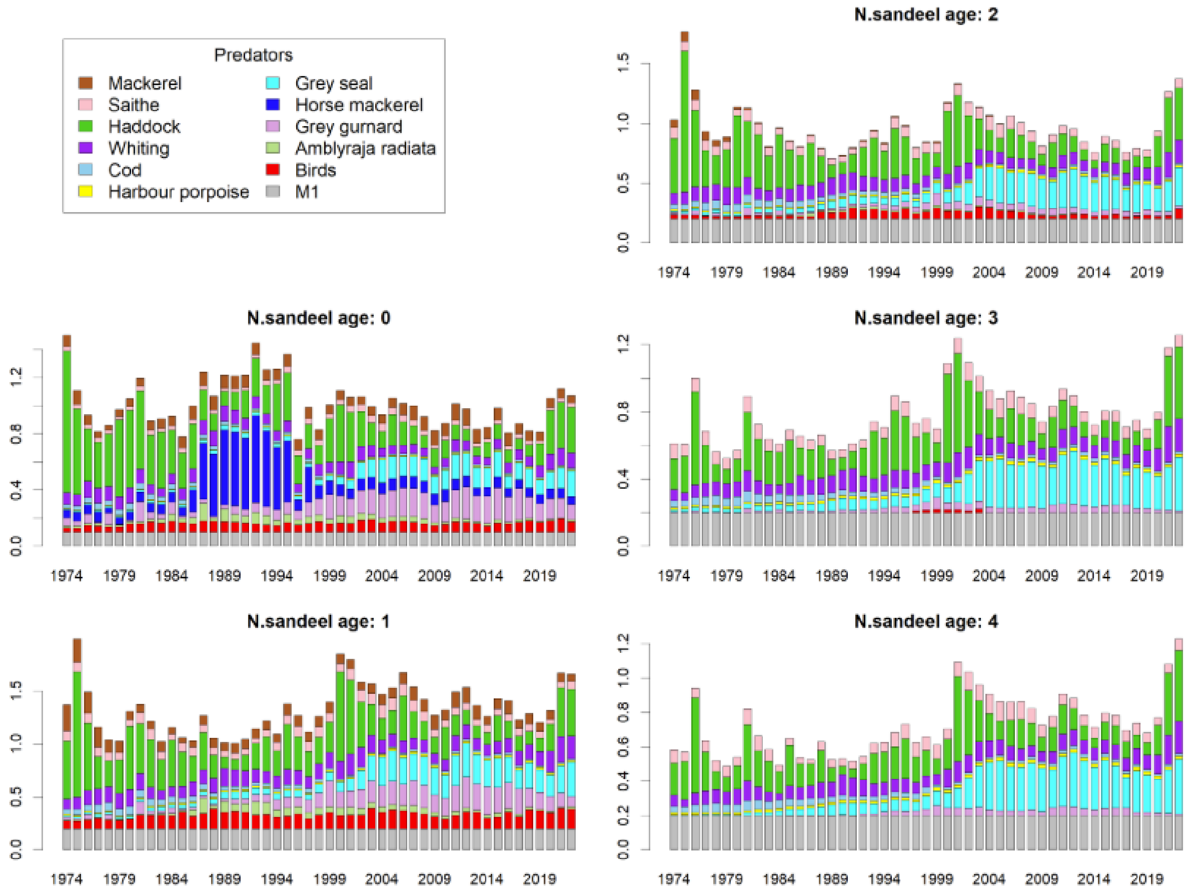
- Data, model and coding-script supporting analysis for Henriksen et al. (2024), Effects of sediment type and light availability on the burying behavior of small sandeel (Ammodytes tobianus)
- Sandeel survey 2020
- Sandeel survey 2019
- Sandeel Survey 2018
- Sandeel survey 2017

The estimated sandeel predation by fish, mammals and birds are provided by the ICES WGSAM working group. An overview of these estimates is provided below.





S.sandeel. Annual mortality (sum of quarterly M1+M2)



N.sandeel. Annual mortality (sum of quarterly M1+M2)

Part 2: Commercial Catch Data of Vulnerable Top-Predators

Technical data report - commercial fisheries data to inform habitat preference of four vulnerable top-predators

A general overview

The dataset covers the period from 2008 to 2024 and includes 487 vessels and a total of 103,078 trips. The number of active vessels increased from 2008 to 2015, followed by a slight decrease until 2024 (Fig 1, top). Since 2014, the number of trips has remained more or less stable, with a maximum of 8,523 trips in 2016 (Fig. 1, bottom). The distribution of active vessels and trips during the timeseries can be found in figure 1. Total hours spent at sea, defined as the time from departure to return to harbour, rose slightly from 2008 to 2019 and have been gradually declining since then (Fig. 2 top). The total number of fishing hours, defined as the portion of total time at sea during which fishing occurs increased from 2008 to 2016, and has since been slowly decreasing, remaining more or less stable from 2020 onward.

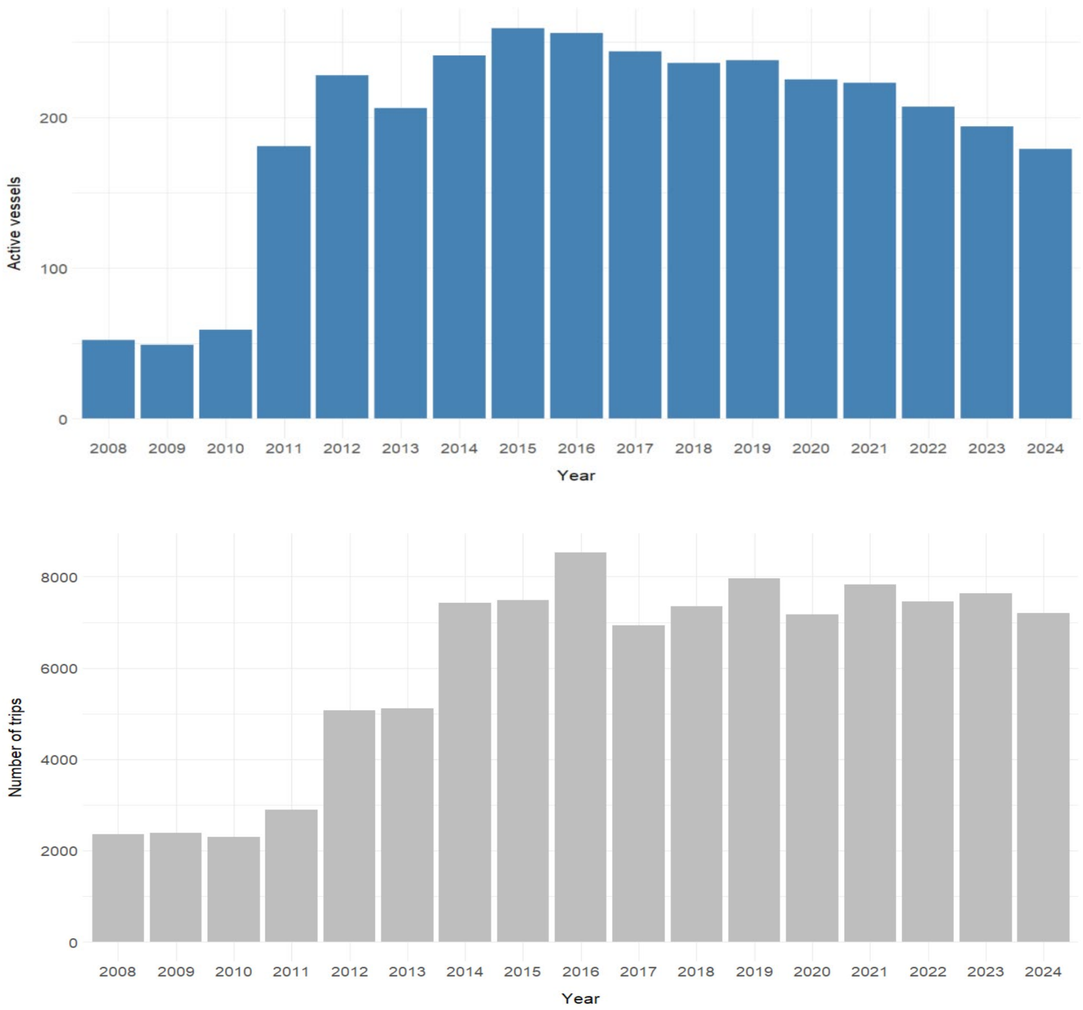
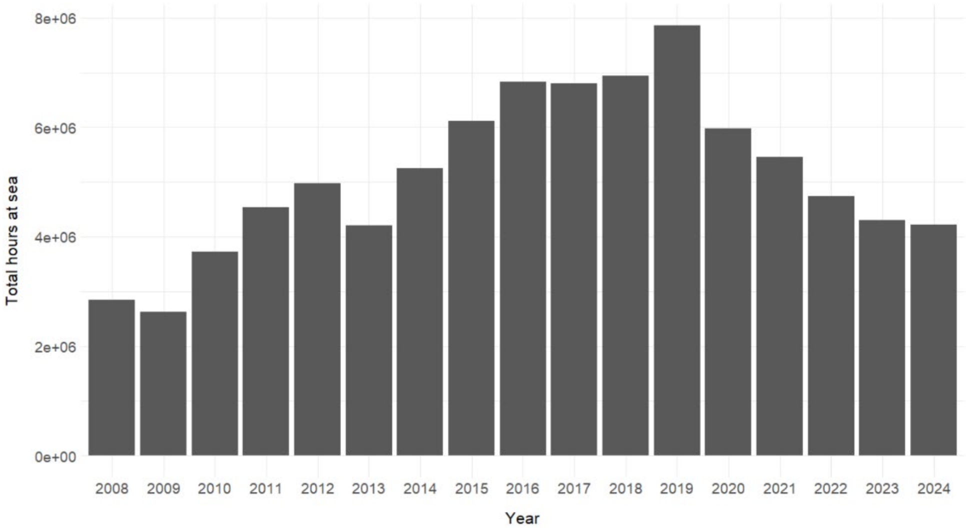


Figure 1: Top: The number of active fishing vessels for each year from 2008-2024. Bottom: The number of trips each year from 2008-2024.



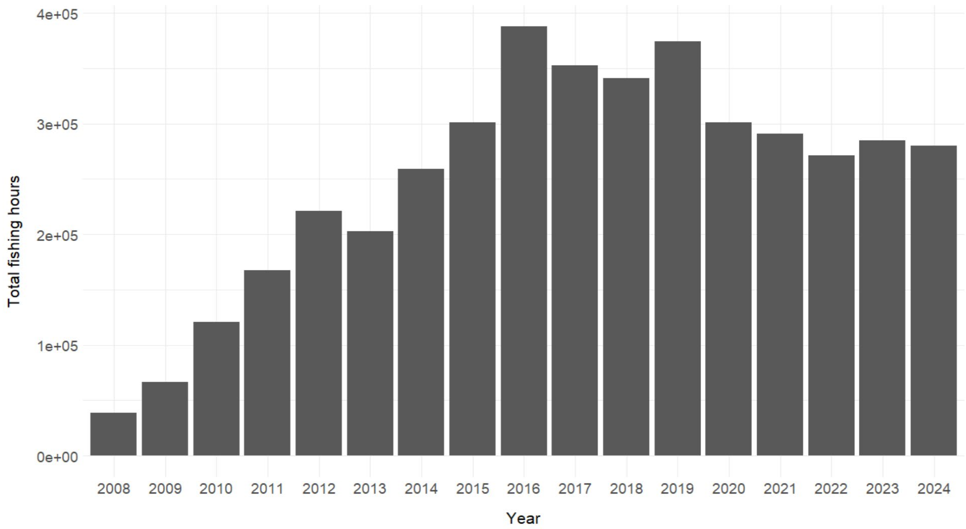


Figure 2: Top: Total hours at sea which is from when the vessel leaves harbour and come back. Bottom: Total amount of hours spent fishing.

Species distribution and sea bottom habitat

The dataset covers an area spanning from the Baltic Sea (with few observations) to the North Sea (with most observations) (Fig. 3). Five different fish species are present in the dataset, including Atlantic halibut (*Hippoglossus hippoglossus)*, ling (*Molva molva*), spiny dogfish (*Squalus acanthias)*, and wolffish (*Anarhichas lupus*) (Fig. 4). The largest landings in the time series are of ling. Landings of ling increased from 2016 to 2019, followed by a slight decrease. Wolffish is the second most landed fish species in the dataset and generally follows the same trend as ling. The lowest landings in the dataset are for piked dogfish, which remain almost stable throughout the entire time series, with an increase in landings from 2023 onward. The allocation of sea bottom substrates/habitats vary greatly across the entire (Fig. 5). The three most common sea bottom substrates in the study area are deep circalittoral sand, shallow circalittoral sand and deep circalittoral mud (Fig. 5)

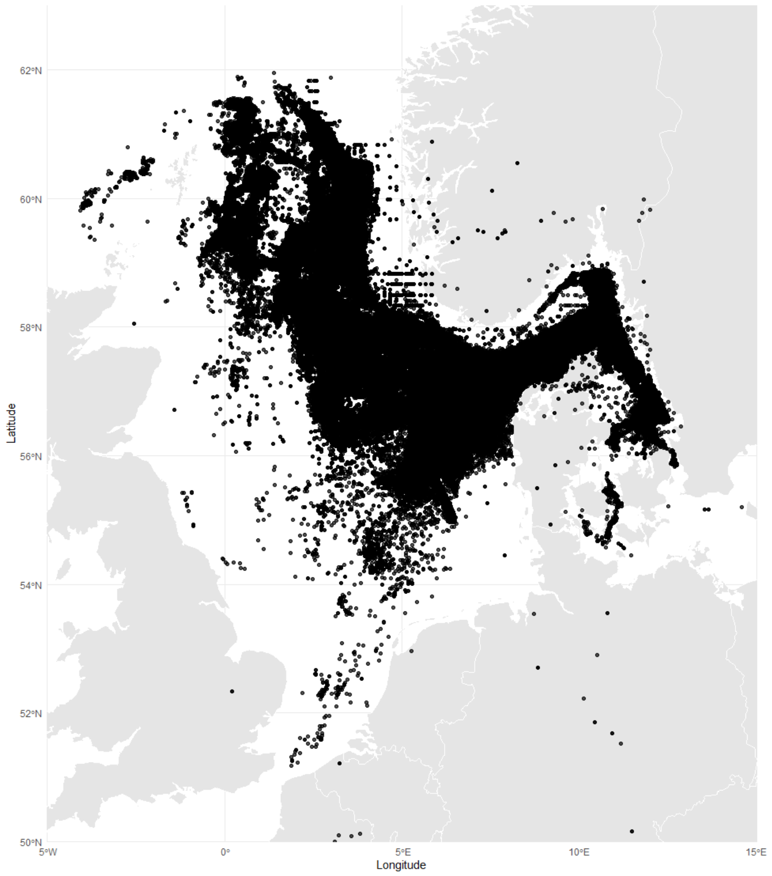


Figure 3: Each data point represents a fishing location.

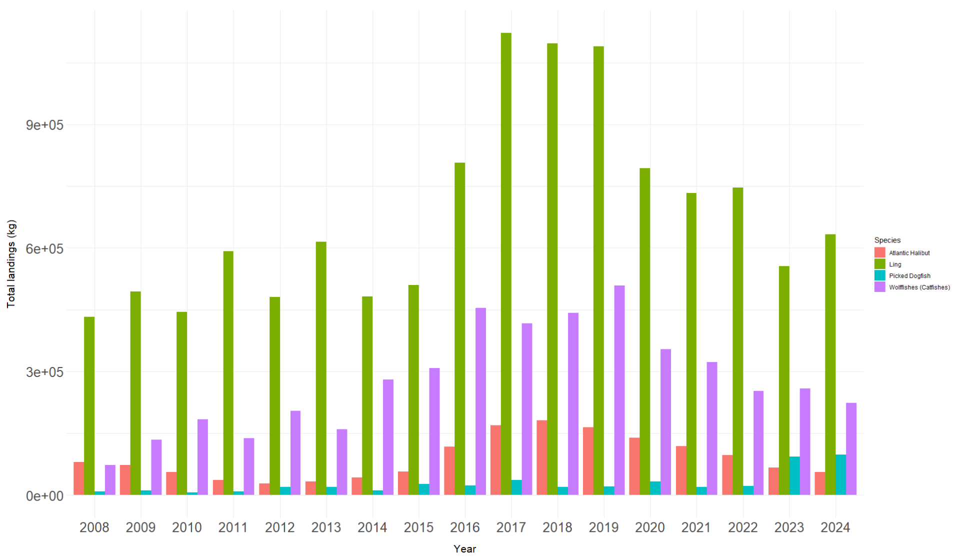


Figure 4: The species distribution (kg) of the five fish species; Atlantic halibut, ling, spiny dogfish, and wolffish from 2008 to 2024.

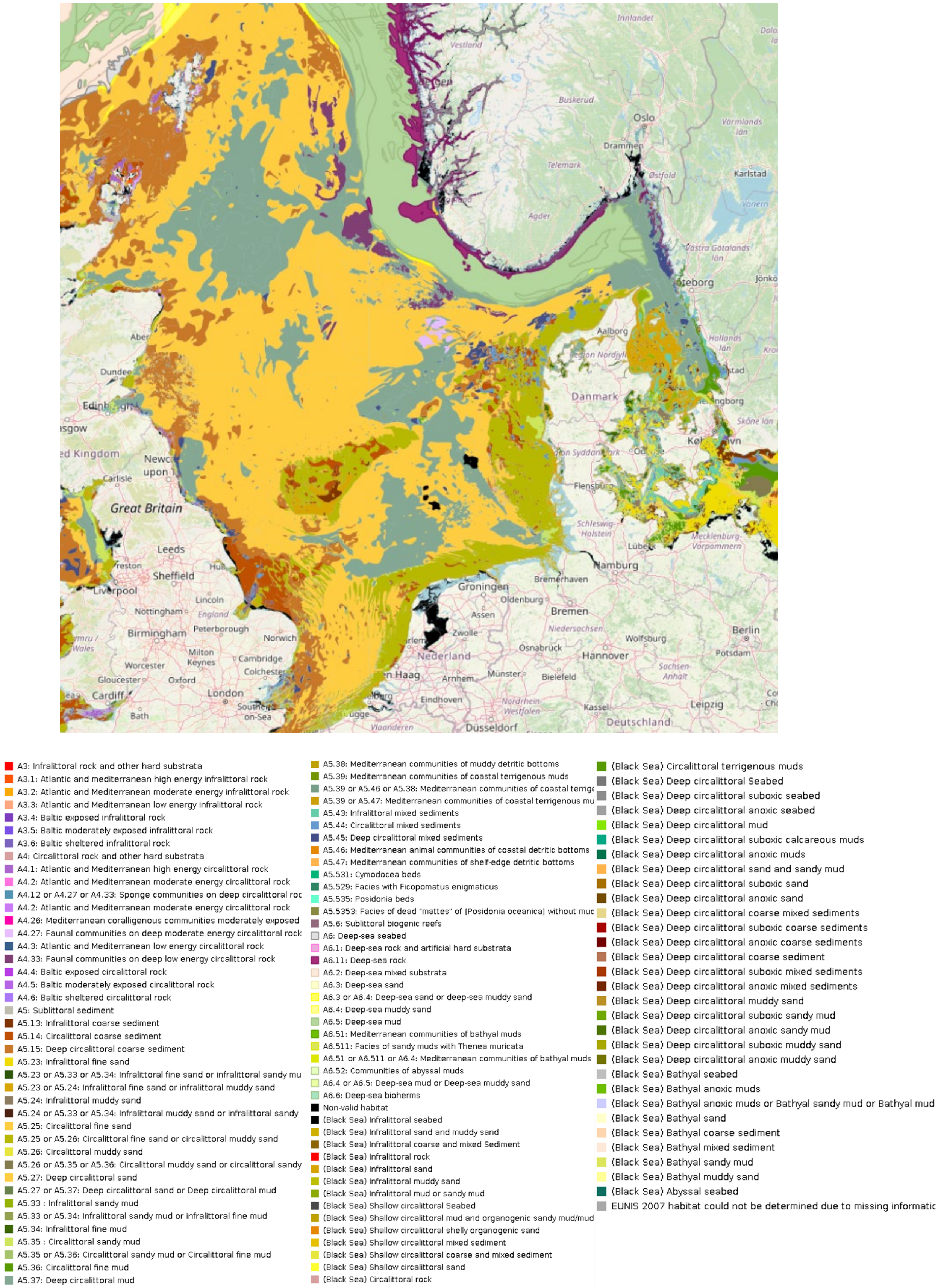


Figure 5: Sea bottom map showing the different types of sea bottom substrates *(Comission, 2025)*.

Fishing gear

The fishing gear used to catch the five fish species consist of 18 different gear types which have been divided into passive and active gear types.

Passive gears

The dataset contains nine different passive gear types (Table 1), with trammel nets, gillnets, and set gillnets being the most commonly used (Fig. 6). The largest proportion of the different passive gear types were used on offshore circalittoral sand, offshore circalittoral sediment and circalittoral sand (Fig. 6).

Table 1: The passive gear types used to catch the 5 fish species. The abbreviation and full name of gear is given in the table.

Passive fishing gear	
Abbreviation	Full name
GN	Gillnets
FPN	Fish pots/traps
GNS	Set gillnets
GTR	Trammel nets
LHP	Hook gears
LL	Longlines
LLS	Longlines
PTB	Pot/traps for bottom species
PTM	Pot/traps for midwater species

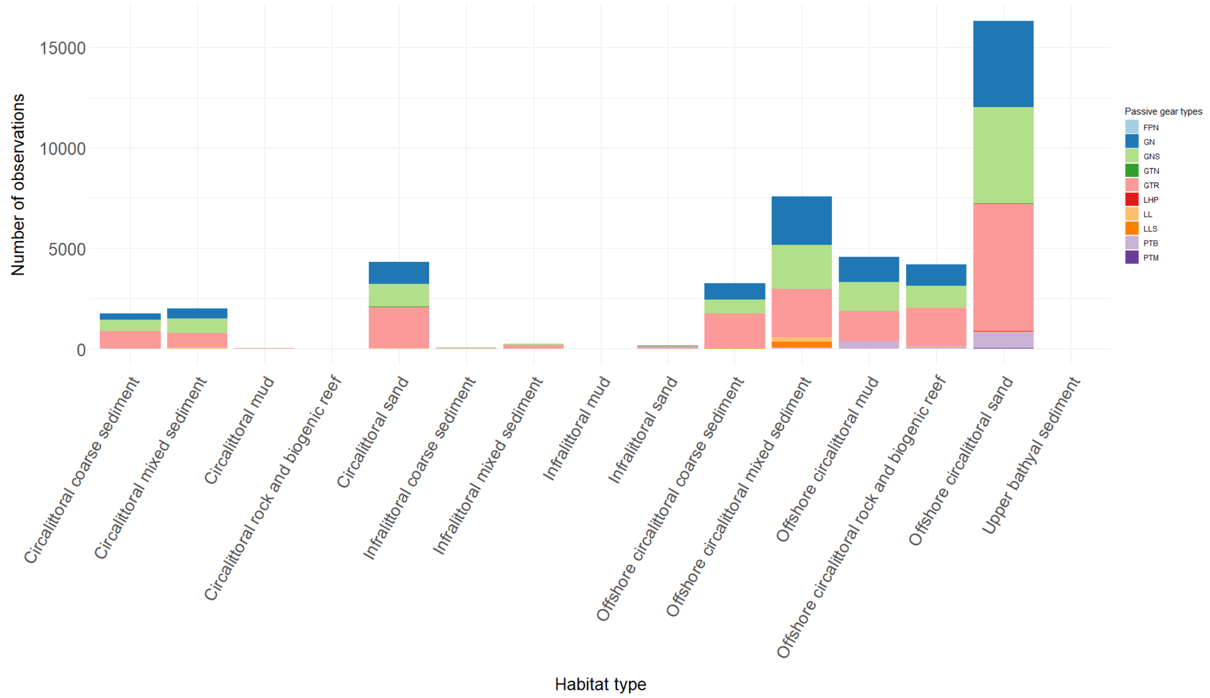


Figure 6: The number of observations of passive gear types used on the different sea bottom substrates in the study area.

Active gears

The dataset contains nine different active gear types (Table 2). Bottom otter trawl and Danish seine are the most used active fishing gears. The largest proportion of active gear types was used on offshore circalittoral mud and offshore circalittoral sand (Fig. 7). None of the active gear types are found on reef or stone substrates, which makes sense, as trawling is not possible on these seabed habitats.

Table 2: The active gear types used to catch the 5 fish species. The abbreviation and full name of gear is given in the table.

Active fishing gear	
Abbreviation	Full name
OTB	Bottom otter trawl
OTM	Midwater otter trawl
OTT	Pair trawl
PS	Purse seine
SDN	Danish seine
SSC	Scottish seine
TBB	Beam trawl
TBN	Beam trawl (flat fish)
TBS	Beam trawl (shrimp)

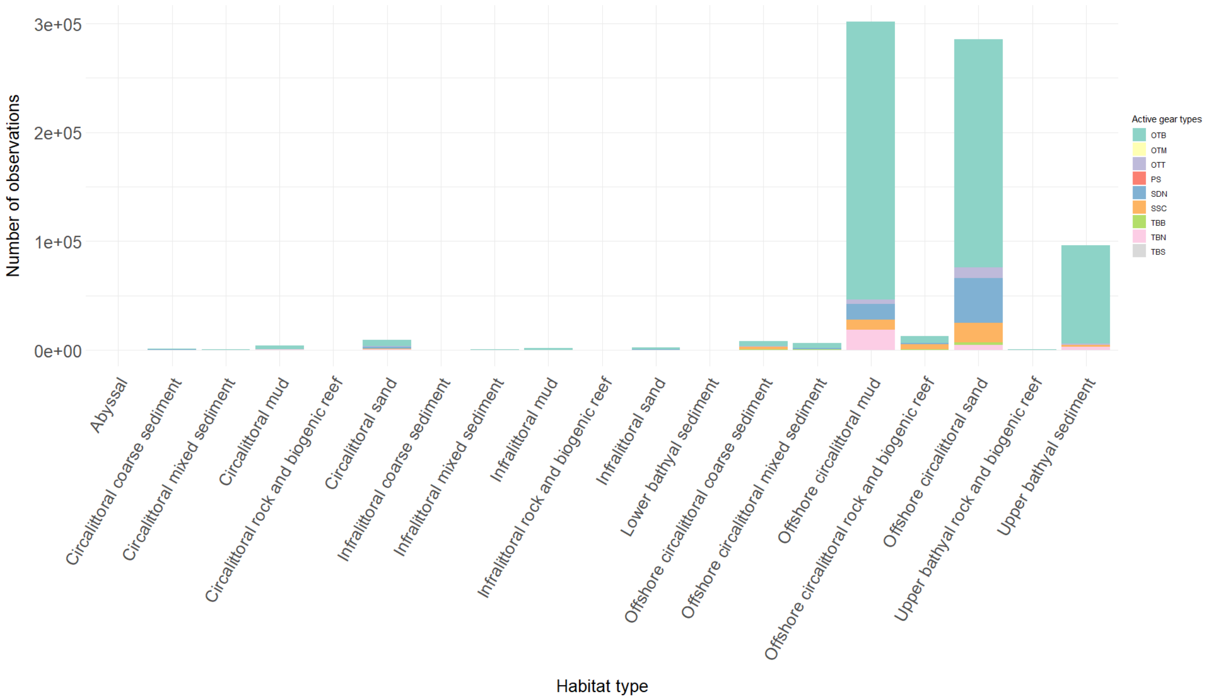


Figure 7: The number of observations of active gear types used on the different sea bottom substrates in the study area.

Species

For each of the five fish species in the dataset, a heatmap of total landings, aggregated into 5x5 km grid cells across all years, was created to visualize the areas where each species was caught. Furthermore, for each species, plots and maps were created showing where the fish were caught with passive and active gears, and on which seabed substrates they were caught with each gear type within the two categories.

Atlantic Halibut

Atlantic halibut is a demersal flatfish belonging to the family Pleuronectidae, distributed across the northern Atlantic from the Arctic waters of Labrador and Greenland to Iceland and the Barents Sea, extending south to the Bay of Biscay and Virginia (FishbaseA, 2025a). The spatial distribution of Atlantic halibut measured in total landings (kg) across all years can be found in figure 8. The largest proportion of Atlantic halibut which was caught with passive gear was caught on offshore circalittoral sand (Fig. 9, top). The most frequently used passive gears for catching Atlantic halibut were trammel nets (GTR), set gillnets (GNS), and gillnets (GN). The locations where the different passive gears were used to catch Atlantic halibut are shown in the bottom panel of Figure 9.

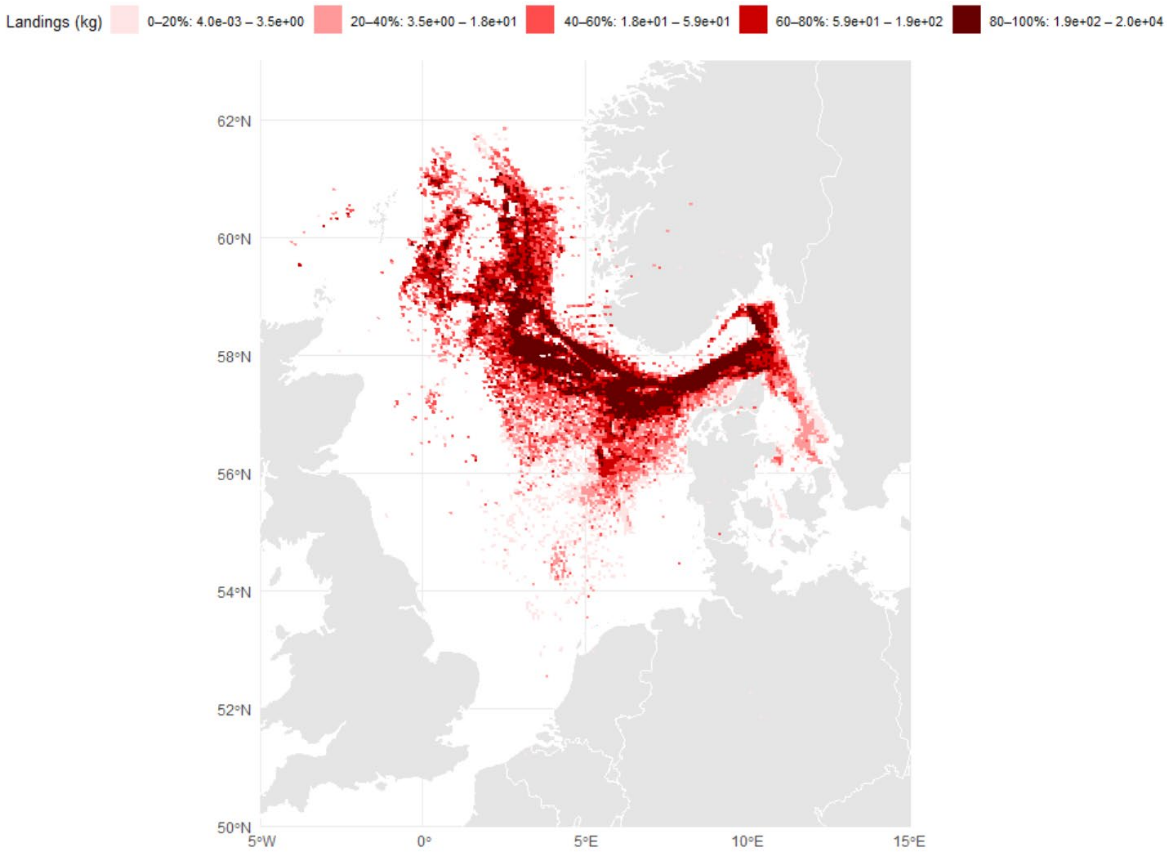


Figure 8: The spatial distribution of Atlantic halibut in total landings (kg) across all years.

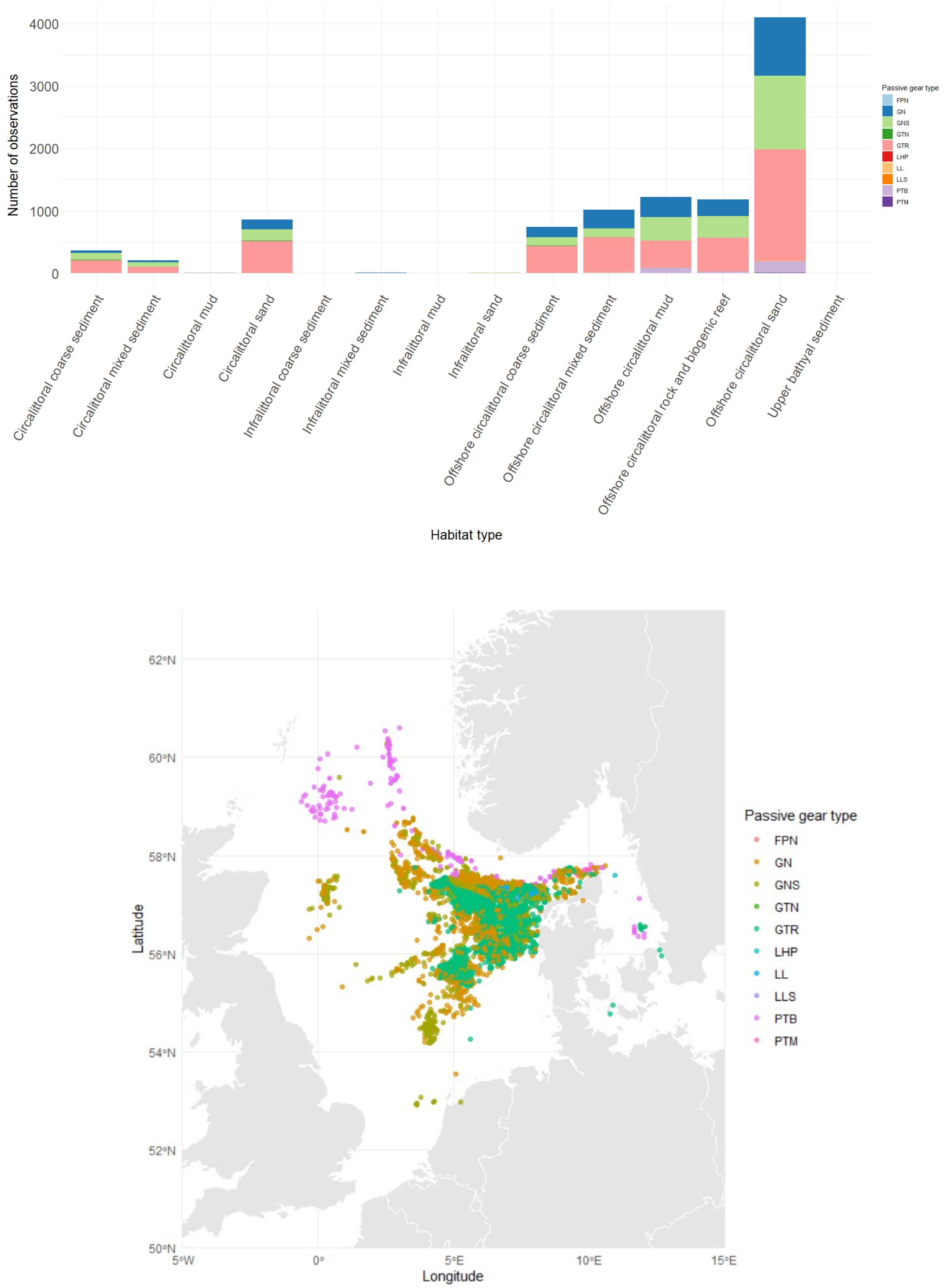


Figure 9: Top: Number of times an Atlantic halibut was caught by the different passive gear types on the different sea bottom substrates. Bottom: map showing the location of where Atlantic halibut was caught by the different passive gear types.

The largest proportion of Atlantic halibut caught with active gear was captured on offshore circalittoral sand, offshore circalittoral mud, and upper bathyal sediment (Fig. 10, top). When comparing the distribution of Atlantic halibut caught with active versus passive gears, three seabed substrate types dominate catches with active gears, whereas with passive gears, Atlantic halibut are caught more evenly across approximately 11 different habitat types. The two most used active gears were bottom otter trawl (OTB) and Danish seine (SDN). The locations where the different passive gears were used to catch Atlantic halibut are shown in the bottom panel of Figure 10.

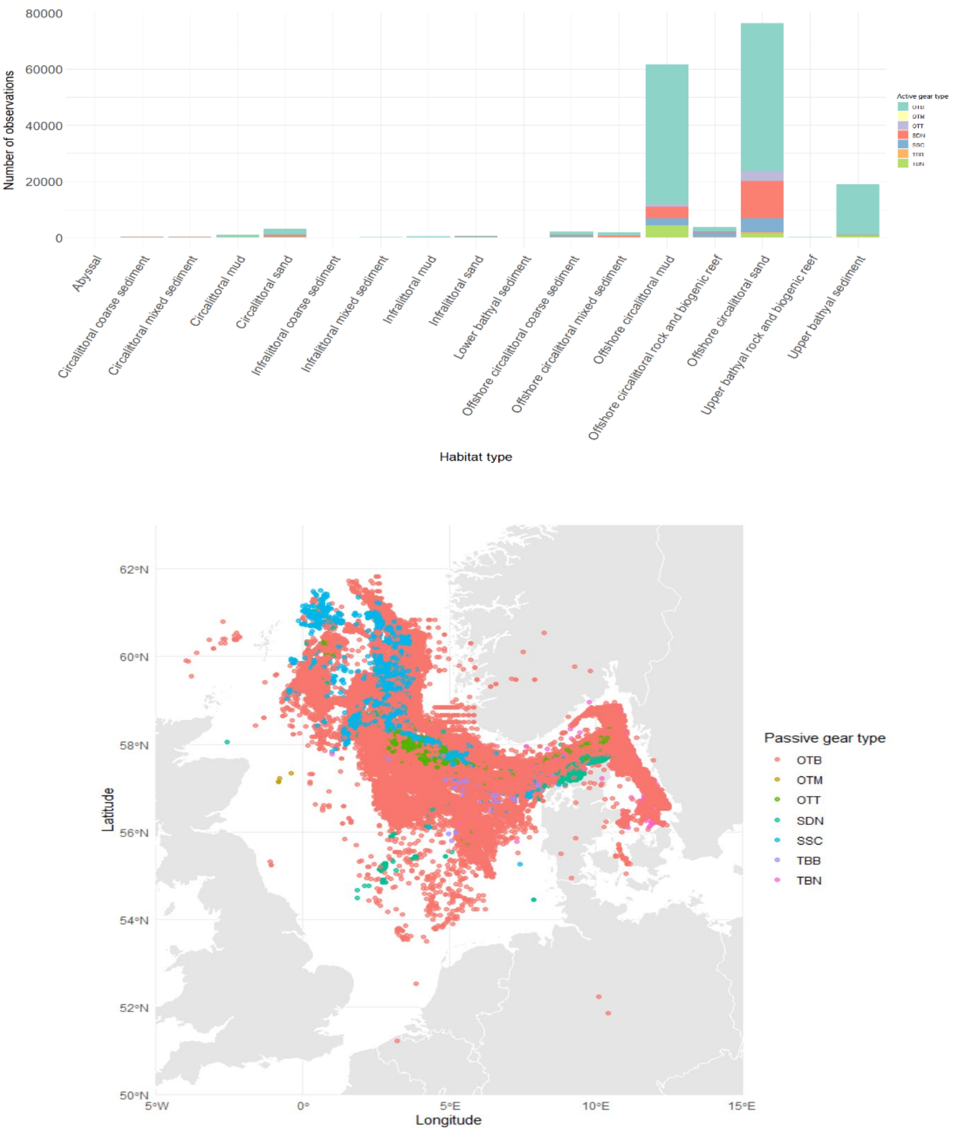


Figure 10:Top: Number of times an Atlantic halibut was caught by the different active gear types on the different sea bottom substrates. Bottom: map showing the location of where Atlantic halibut was caught by the different active gear types.

Ling

Ling is a cod like demersal fish species with belongs to the Lotidae family and is commonly found in the Northwest Atlantic off southern Greenland and Canada, in the Northeast Atlantic from the Barents Sea and Iceland to Morocco, and in the northwestern Mediterranean Sea (FishbaseB, 2025b). The largest proportion of ling was caught off the coast of Norway (Fig. 11). The largest proportion of ling caught with passive gear was found on offshore circalittoral sand, offshore circalittoral mixed sediment, and circalittoral sand (Fig. 12, top). The passive gears most frequently used to catch ling were trammel nets (GTR) and set gillnets (GNS). The bottom panel of Figure 12 shows the locations where the different passive gears were used to catch ling.

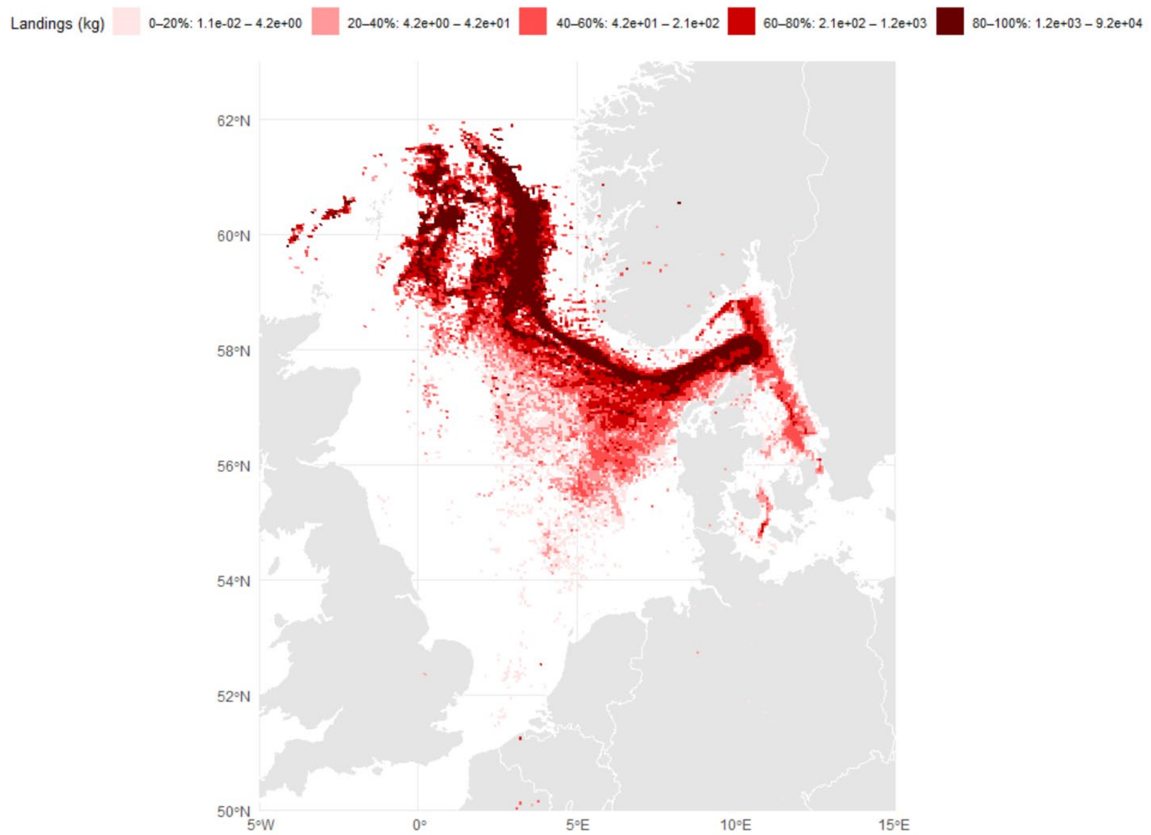
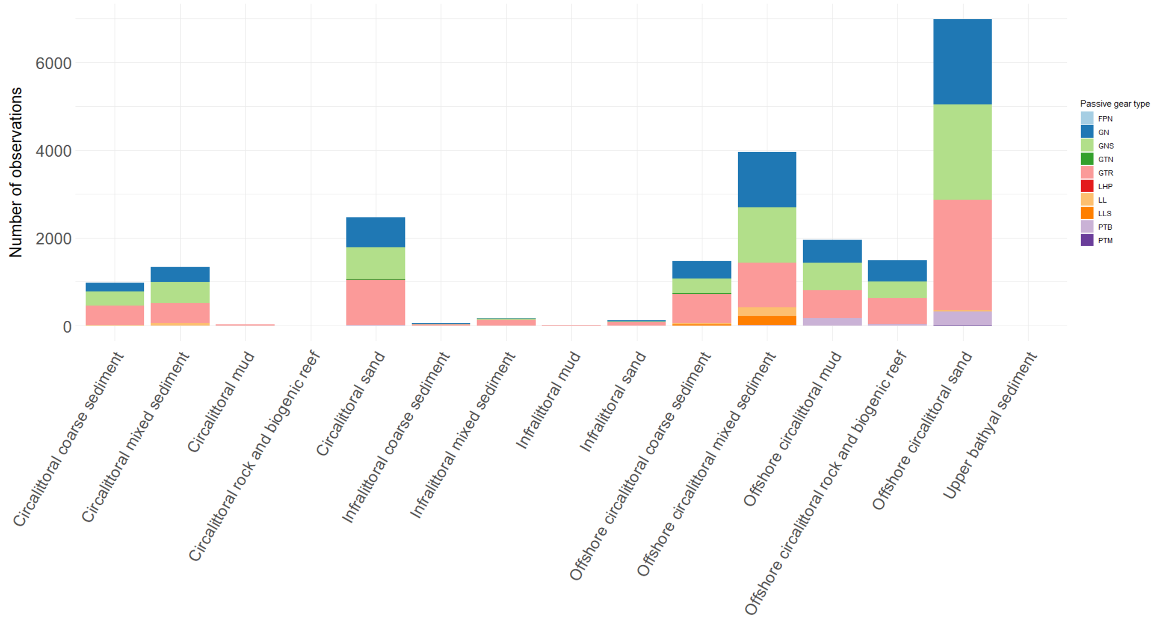


Figure 11: The spatial distribution of ling in total landings (kg) across all years.



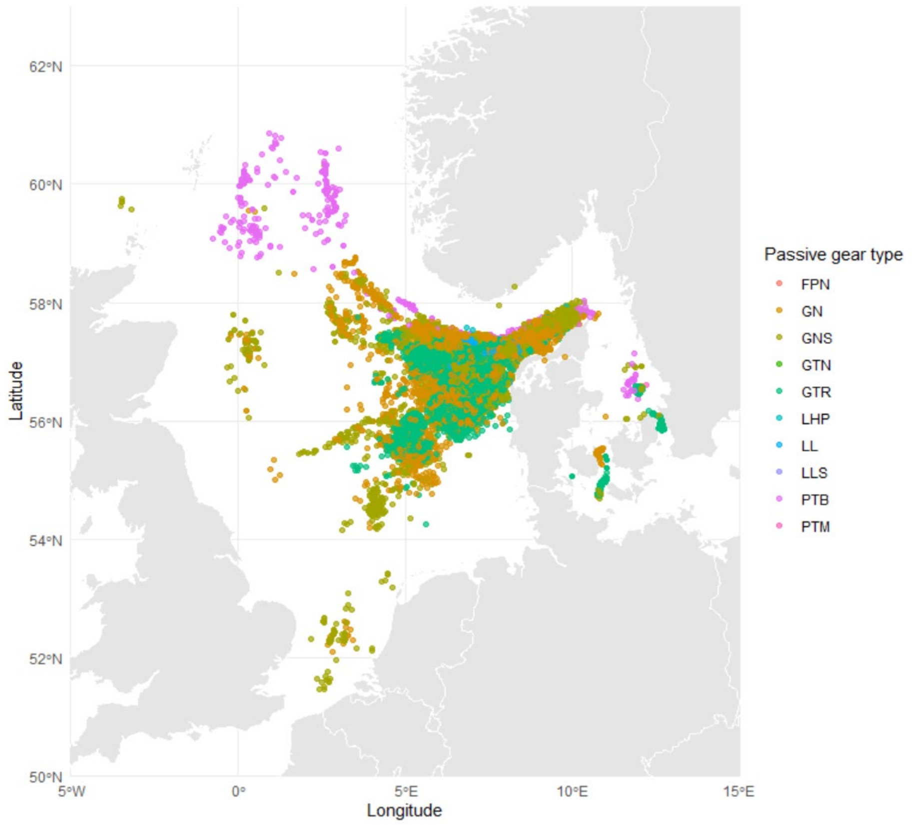


Figure 12: Top: Number of times a ling was caught by the different passive gear types on the different sea bottom substrates. Bottom: map showing the location of where ling was caught by the different passive gear types.

The largest proportion of ling caught with active gear was captured on offshore circalittoral mud, offshore circalittoral sand and upper bathyal sediment (Fig. 13, top) and the most frequent gear type used is bottom otter trawl. Danish seine is also frequently used, especially off the coast of Norway (Fig. 13, bottom).

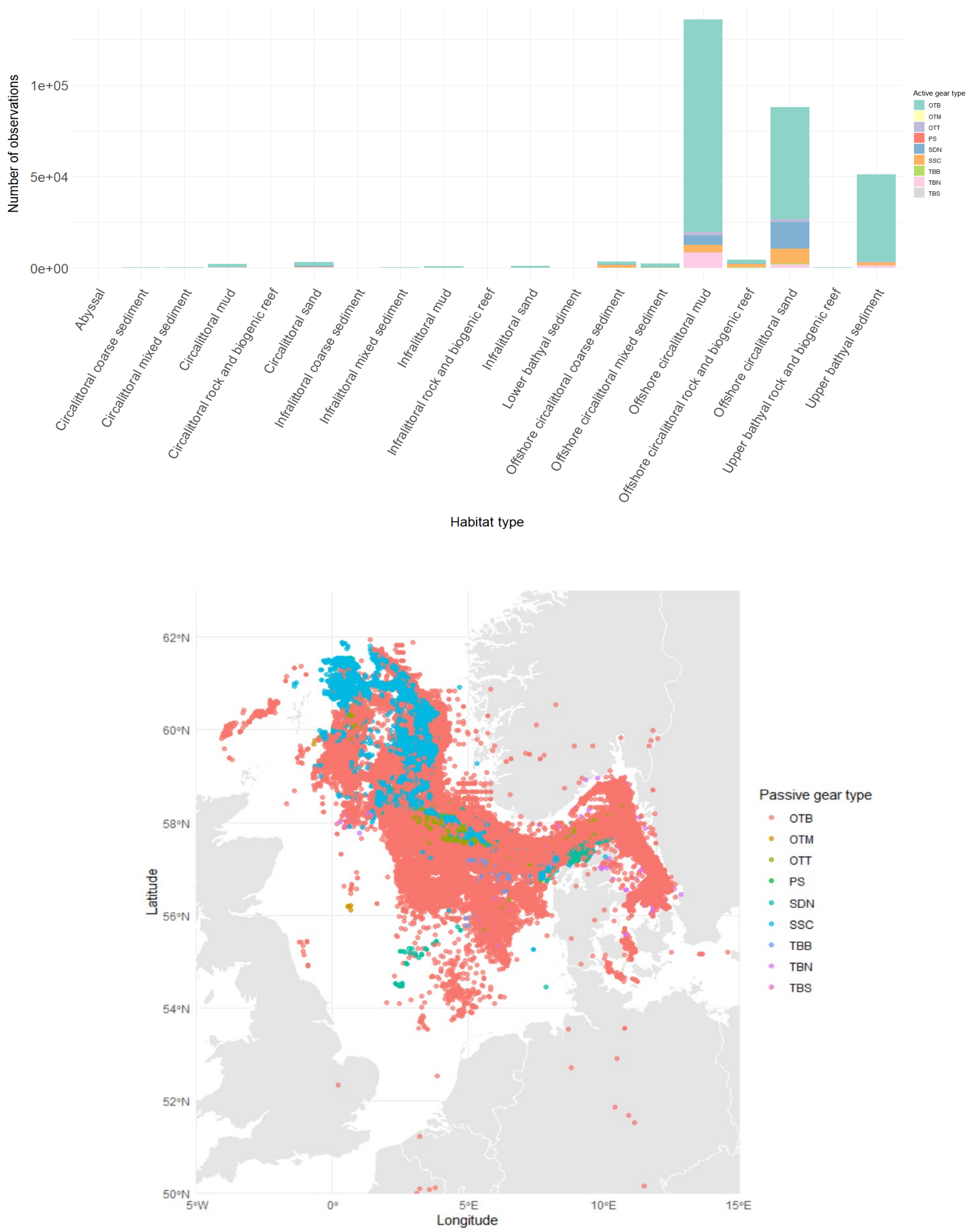


Figure 13:Top: Number of times a ling was caught by the different active gear types on the different sea bottom substrates. Bottom: map showing the location of where ling was caught by the different active gear types.

Spiny dogfish

The spiny dogfish belongs to the Squalidae family and can be found in both shallow coastal waters and offshore areas in most parts of the world, particularly in temperate regions (FishBaseD, 2025D). The piked dogfish is the least common fish species of the species in the dataset. The spatial distribution of spiny dogfish can be found in figure 14.

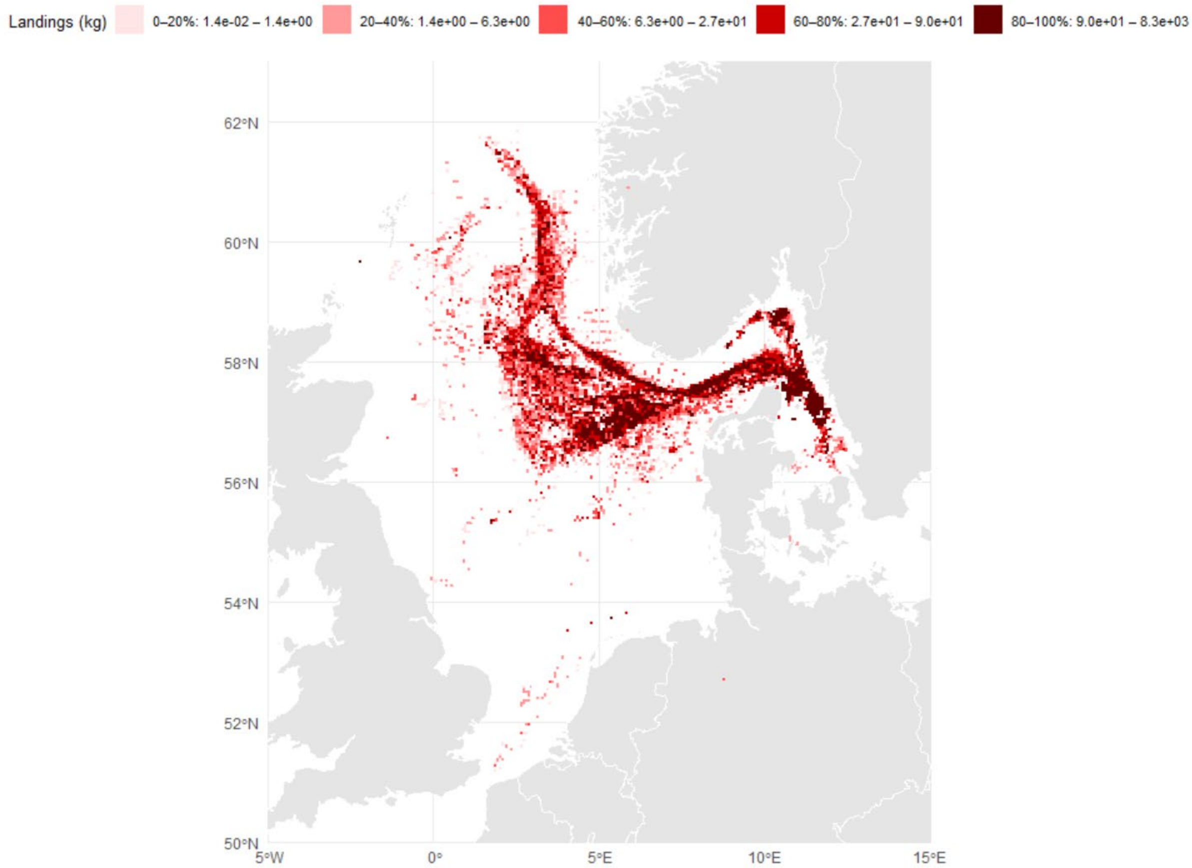
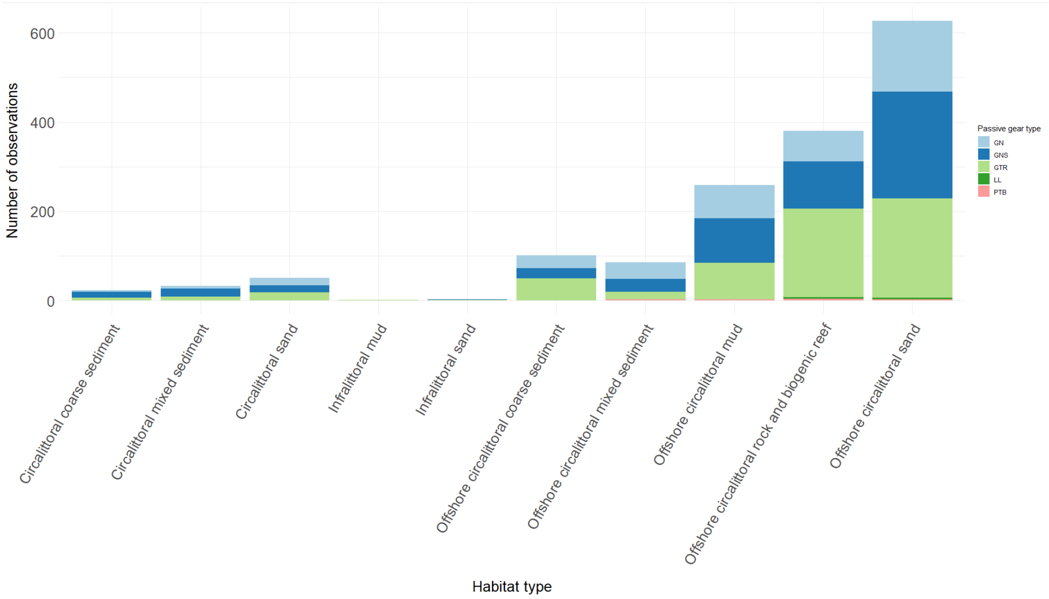


Figure 14: The spatial distribution of spiny dogfish in total landings (kg) across all years.

With passive gear the spiny dogfish is primarily caught on offshore circalittoral sand, offshore circalittoral rock and biogenic reef and offshore circalittoral mud and it mostly caught with trammel nets and set gill nets (Fig. 15, top). Spiny dogfish were primarily caught in the northern North Sea, with additional, though fewer, records from the southern North Sea off the coasts of the Netherlands and Belgium (Fig. 15, bottom).



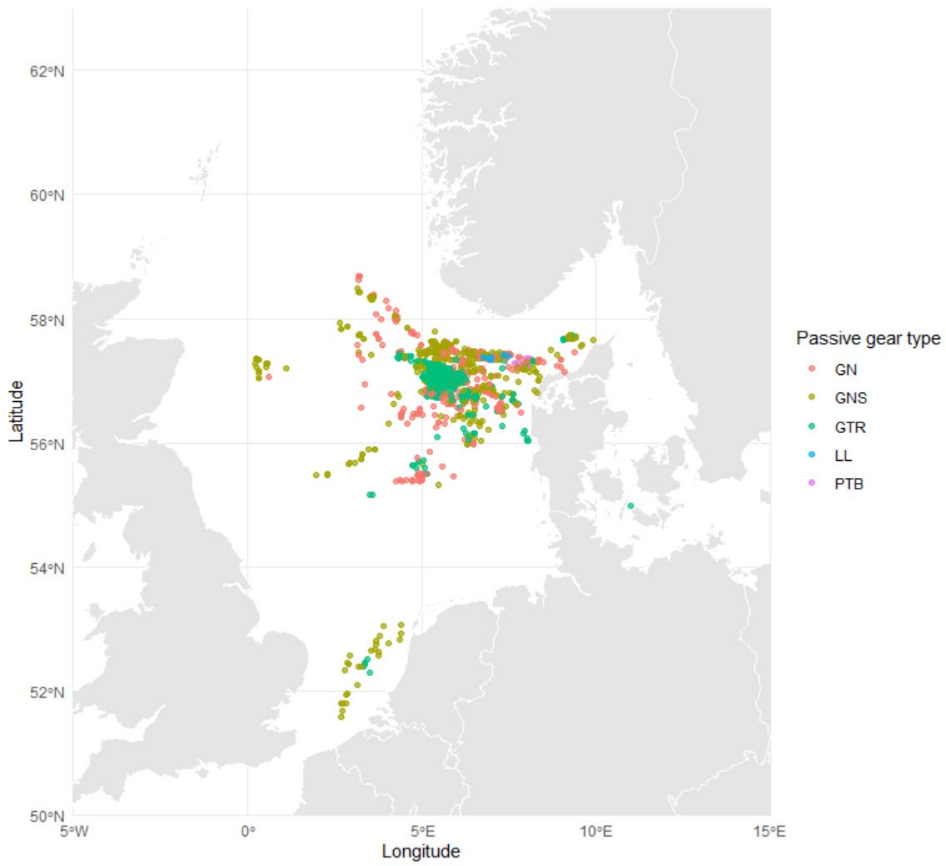


Figure 15: Top: Number of times a spiny dogfish was caught by the different passive gear types on the different sea bottom substrates. Bottom: map showing the location of where spiny dogfish was caught by the different passive gear types.

Spiny dogfish was with active gear types almost only caught on offshore circalittoral sand, offshore circalittoral mud and upper bathyal sediment (Fig. 16, top) and was mainly caught with bottom otter trawl (Fig. 16, top+bottom).

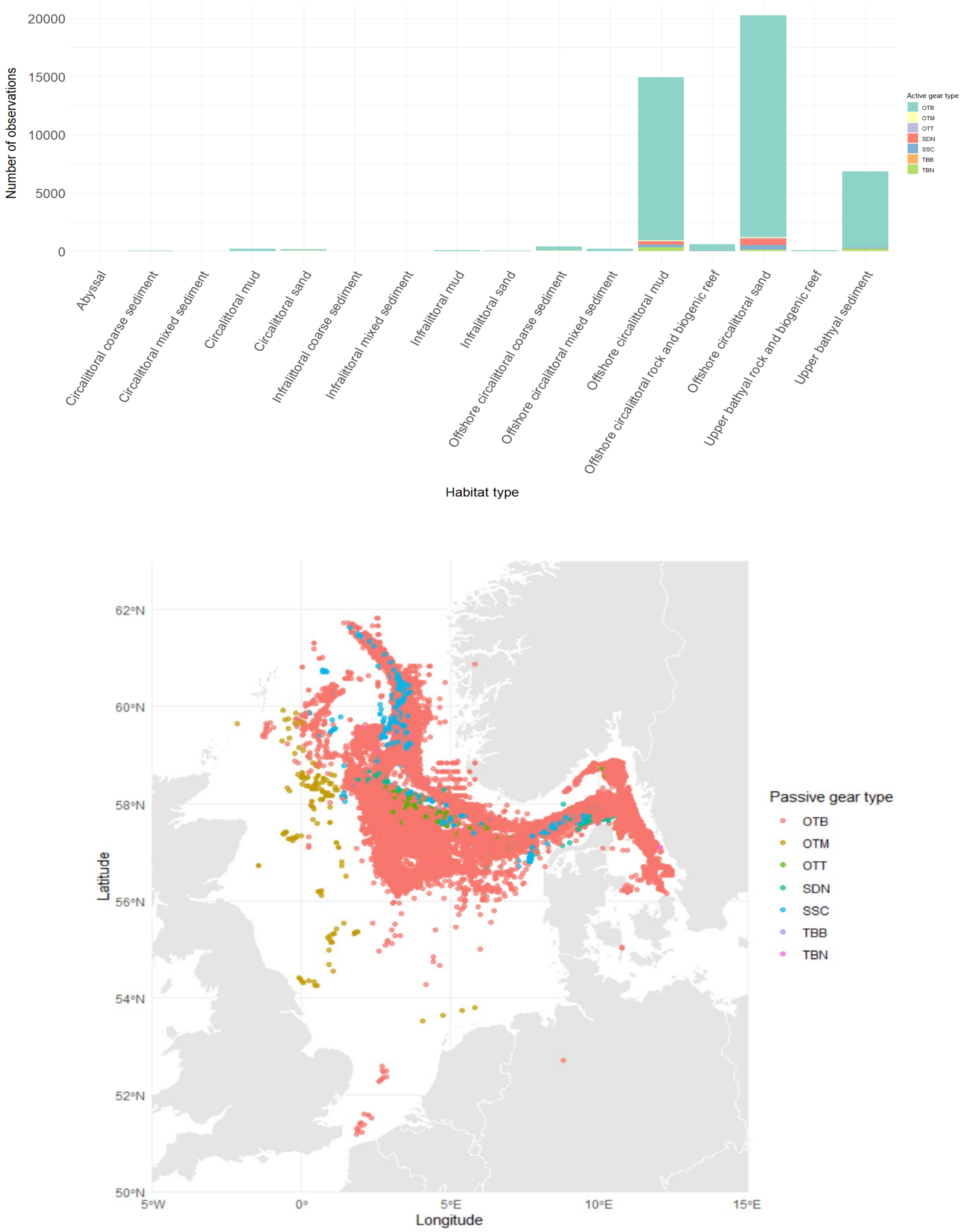


Figure 16: Number of times a spiny dogfish was caught by the different active gear types on the different sea bottom substrates. Bottom: map showing the location of where spiny dogfish was caught by the different active gear types.

Wolffish

Wolffish is a demersal fish species which is a part of the Anarhichadidae family. It can be found in the northeast Atlantic from Spitsbergen to the White Sea, long the Scandinavian coasts, the North Sea, and also around Iceland and the southeastern coast of Greenland (FishBaseC, 2025C). The spatial distribution of wolffish measured in total landings (kg) across all years can be found in figure 17. With passive gears, wolffish was mostly caught on offshore circalittoral sand and offshore circalittoral mixed sediment, using trammel nets, set gillnets, and gillnets.

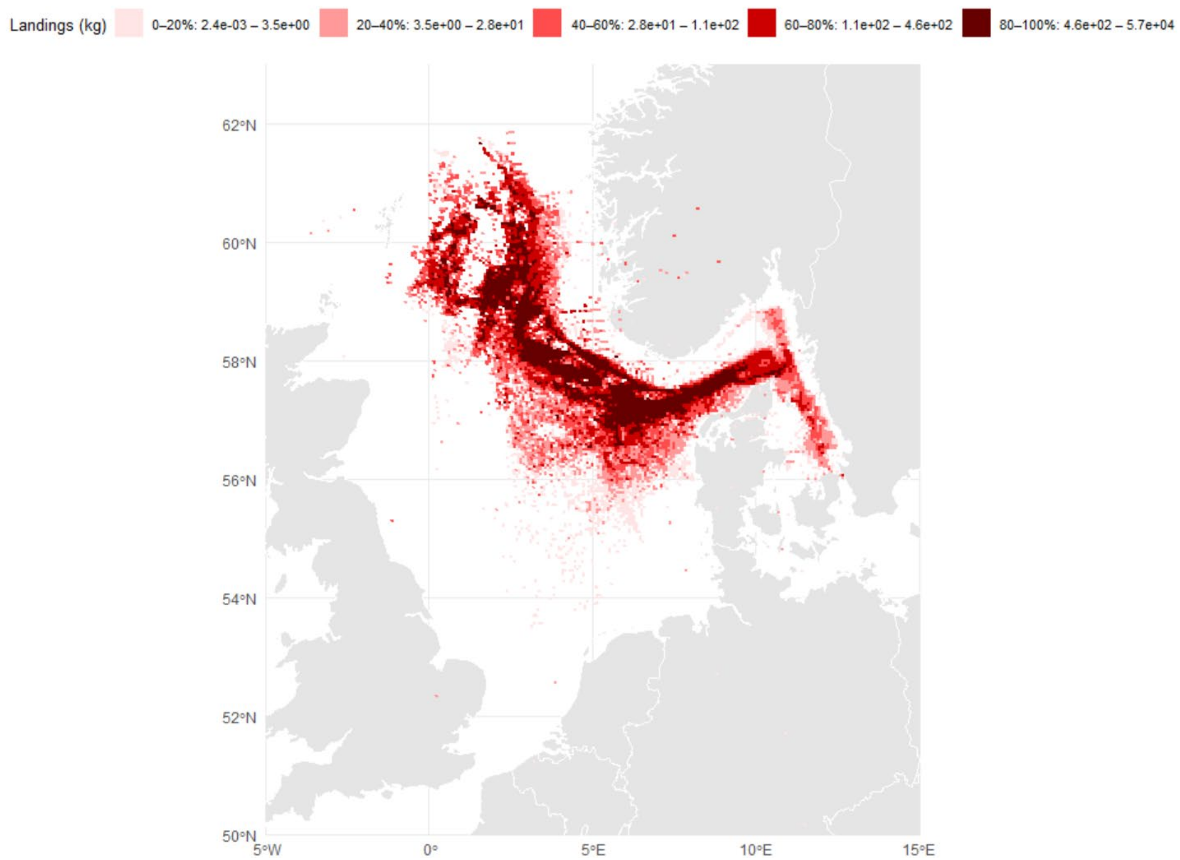
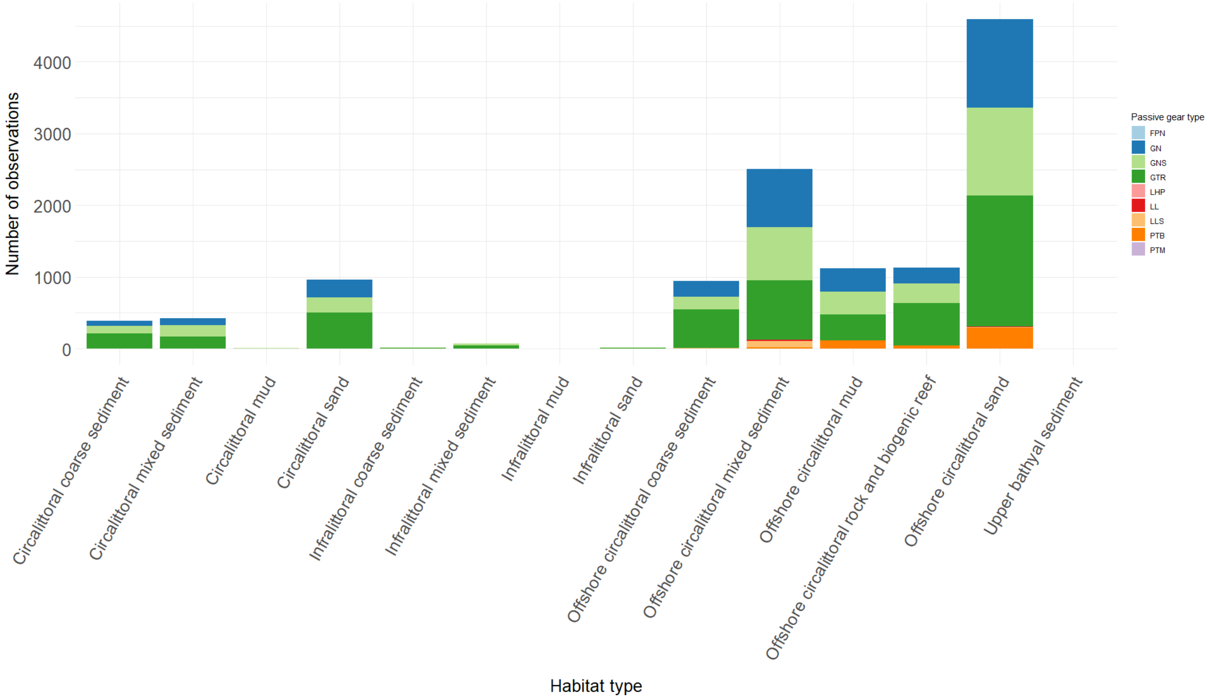


Figure 17: The spatial distribution of wolffish in total landings (kg) across all years.



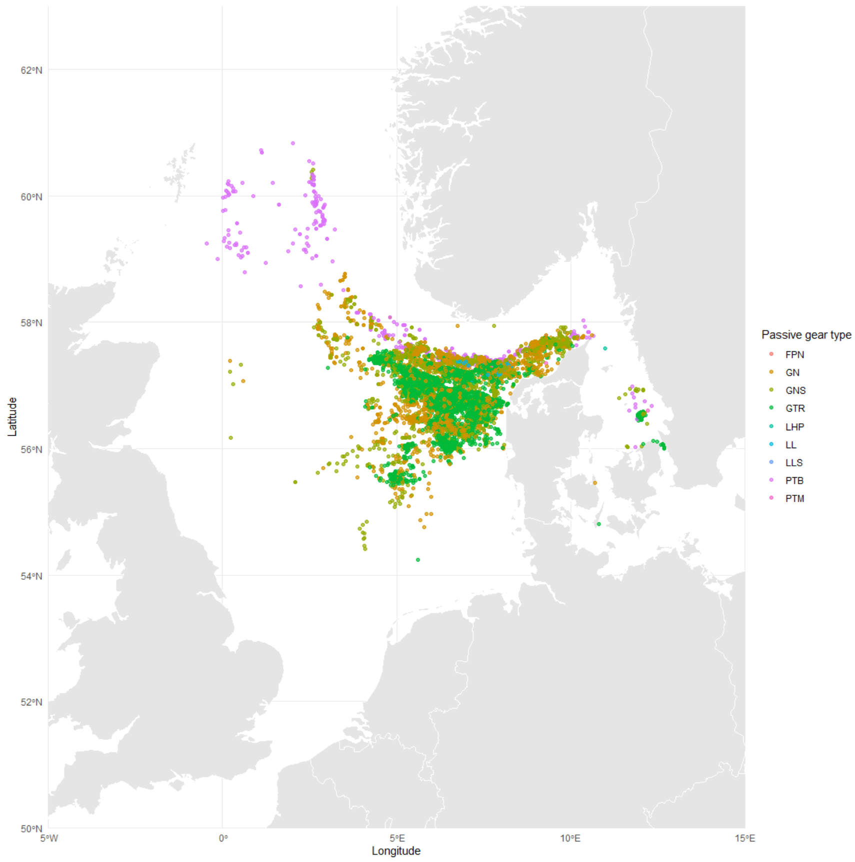


Figure 18: Top: Number of times a wolffish was caught by the different passive gear types on the different sea bottom substrates. Bottom: map showing the location of where wolffish was caught by the different passive gear types.

With active gears, wolffish was caught on offshore circalittoral sand and mud, primarily using bottom otter trawls (Fig. 19, top). Danish seine was used to catch wolffish near the Danish coast (Fig. 19, bottom).

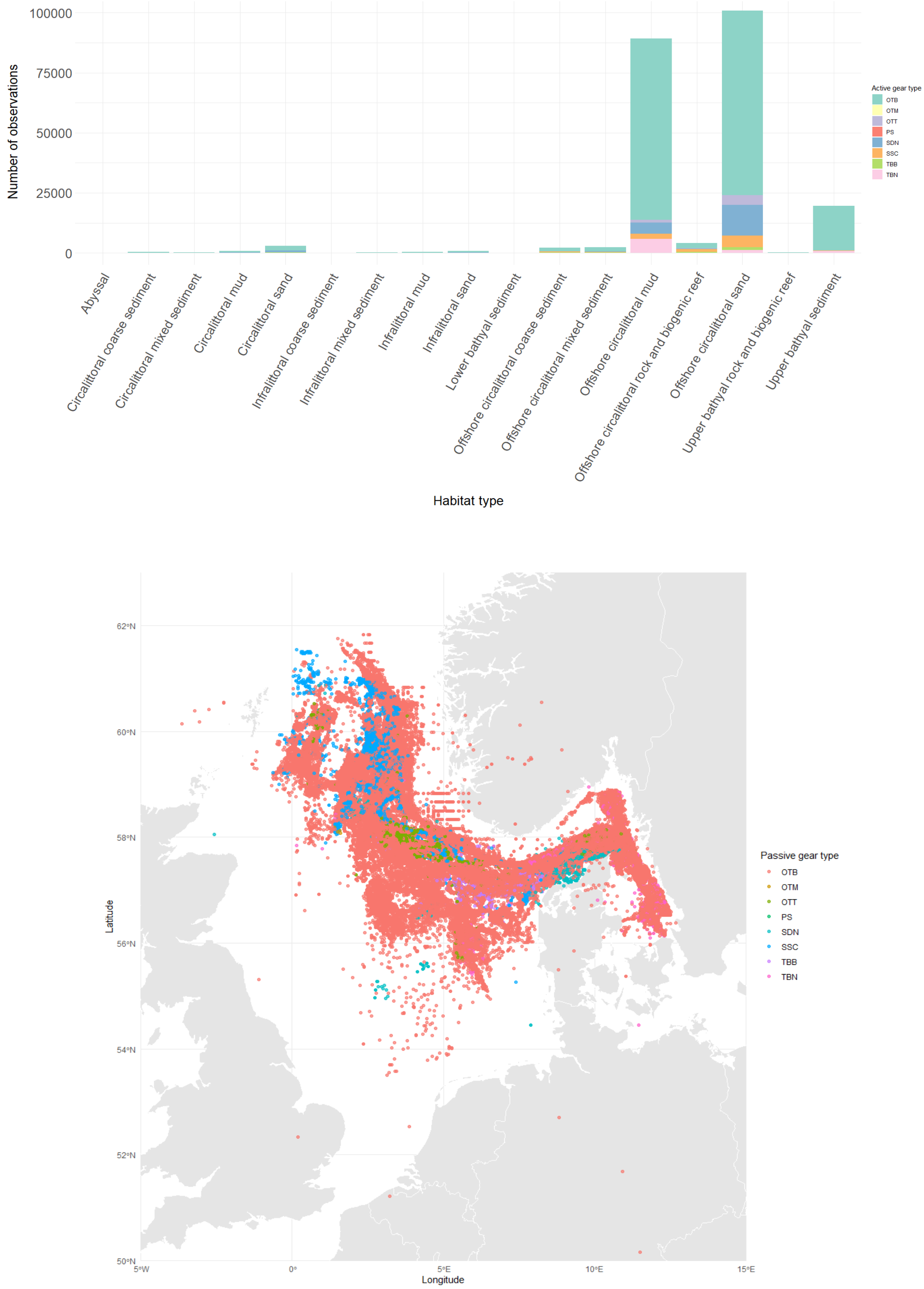


Figure 19: Number of times a wolffish was caught by the different active gear types on the different sea bottom substrates. Bottom: map showing the location of where wolffish was caught by the different active gear types.