THE COASTAL REFERENCE FLEET 2007-2019

Fleet composition, fishing effort and contributions to science

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RAPPORT FRA HAVFORSKNINGEN NR. 2021-52

Title (English and Norwegian):

The Coastal Reference Fleet 2007-2019

Kystreferanseflåten 2007-2019

Subtitle (English and Norwegian):

Fleet composition, fishing effort and contributions to science

Flåtesammensetning, innsats og bidrag til havforskningen

Report series:	**Year - No.:**	**Date:**
Rapport fra havforskningen	2021-52	16.12.2021
ISSN:1893-4536		

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Distribution:

Open

Project No.:

15561

Program:

Kystøkosystemer

Barentshavet og Polhavet

Research group(s):

Fiskeridynamikk

Number of pages:

61

Partners

UNIVERSITY OF BERGEN

Summary (English):

Catch quotas are used for the sustainable management of fish stocks and are based on official catch statistics and research surveysSustainable management of the Norwegian fisheries depends on quota advice that is based on stock assessments, using scientific data from research surveys and official landings statistics. The official landings statistics are given in metric tons, and for vessels less than 15 meters only include rough information on fishing effort. The research cruises, on the other hand, only take place in certain areas and at certain times of the year. However, these methods provide only partial information, as the official catch data at best include rough measures of effort, and the survey data are only collected at certain times of the year. In 2005, the Norwegian Coastal Reference Fleet (CRF) was established by the Institute of Marine Research (IMR) ,to obtain data at-sea on in order to register catches in numbers per species including size- and age composition, discards, and bycatch, as well as data on fishing , gear, and effort. The vessels in the CRF were selected along the entire coast using criteria to ensure that they as represent able for the Norwegian coastal fishing fleet as closely as possible. These historic data and the development of the CRF are evaluated have been ccomprehensively visualisedin , and this report, using descriptive methods and provides a description and visual displaysanalysis of the CRF data. Between 2007-2019, a total of 64 fishing vessels particip ated in the CRF along the Norwegian coast collecting data from a cumulated total number of 287 taxa, and from 29 137 individual fishing operations. The most common species was cod (*Gadus morhua*), which occurred in 60.9% of the fishing operations. Throughout the study period gillnet was the most common gear in all years, but there were small shifts in the gear composition over time of the CRF shifted, however gillnet was the most common gear in all years. Catch per unit effort (CPUE) from fisheries standardises catch data for comparisons in both space and time and is often used as a proxy indices of for fish abundance, assuming constant catchability (the probability from 0 to 1 of a fish being caught per unit effort) over time. When collecting fisheries dependent data, however, fishers actively try to maximise catchability of their target species or species composition, by e.g., using different gears to handle natural variations in catchability dependent on season, and area. Broad coverage in space and time may reduce this human bias as well as providing information on the behaviour of the fishers and the effect of technological advancements. This report includes CPUE timeseries for cod, haddock (*Melanogrammus aeglefinus*), and golden redfish (S*ebastes norvegicus*) north of 62°N.

Summary (Norwegian):

En bærekraftig forvaltning av de norske fiskeriene er avhengig av gode kvoteråd basert på vitenskapelige data. Disse dataene bygger ofte på fangststatistikk og data fra forskningstokt, men gir alene et ufullstendig bilde av situasjonen i havet. Den offisielle fangststatistikken gir kun grove anslag på innsats for fartøyer mindre enn 15 meter, og forskningstoktene foregår bare i gitte områder på begrensede tider av året. For å utvide datagrunnlaget startet Havforskningsinstituttet (HI) i 2005 en kystreferanseflåte (KRF) bestående av kystfiskere langs hele norskekysten som representerer det norske kystfiskeriet. Disse fiskerne leverer data på fangstsammensetning, individvekt, individlengde, aldersmedium (otolitter), utkast, bifangst, redskap og innsats. Disse dataene blir i denne rapporten visualisert i sin helhet for første gang, og rapporten inneholder en generell beskrivelse og visuell analyse av KRF-data. I perioden 2007-2019 deltok totalt 64 fiskefartøy i KRF, og det ble samlet inn data fra 287 arter og artsgrupper fra 29 137 individuelle fiskeoperasjoner. Den vanligste arten var torsk (*Gadus morhua*), som forekom i 60.9% av fiskeoperasjonene. Redskapssammensetningen i KRF endret seg gjennom studieperioden, men garn var det vanligste redskapet hvert år. Fangst-per-enhet-innsats (CPUE) standardiserer fangstdata slik at det er mulig med sammenligninger på tvers av tid og rom, og kan brukes som et relativt mål for en mengde i en populasjon gitt konstant fangbarhet i fiskeriet. Men, i fiskeriavhengig datainnsamling prøver fiskere aktivt å maksimere fangbarheten av sine målarter, ved blant annet å bruke ulike redskaper for å utnytte naturlige variasjoner i fangbarhet som følge av sesong og område. God dekning i tid og rom kan redusere disse variasjonene, og gir samtidig informasjon om atferden til fiskere og effekten av teknologiske framskritt. Denne rapporten inkluderer CPUE-tidsserier for torsk, hyse (*Melanogrammus aeglefinus*) og vanlig uer (*Sebastes norvegicus*) nord for 62°N.

Content

1 - Background

This report is a modified excerpt from the master thesis “A descriptive analysis of data from the Norwegian Coastal Reference Fleet and comparison with catch-per-unit-effort data from research surveys” by Hanne Hjelle Hatlebrekke, for the degree Master of Science in Fisheries Biology and Management at the University of Bergen in March 2021. The thesis was a collaboration between the University of Bergen and the Institute of Marine Research (IMR), research group Fisheries dynamics, and aimed to investigate the possibility of analysing data from the Norwegian Coastal Reference Fleet (CRF) using the statistical tool Pasgear II. In this report we present a general overview of the efforts and contributions from the CRF from the time period 2007-2019, and trends in CPUE for the species cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), and golden redfish (*Sebastes norvegicus*).

Fish is a renewable resource, providing long term food and income when managed sustainably. In Norway, this is mainly done by having quotas (Gullestad et al. 2014) along with species-specific minimum catch sizes and subsequent gear restrictions to prevent the catches of too-small individuals (Johnsen and Eliasen 2011; Gullestad et al. 2014; Gullestad et al. 2015). These quotas are set based on recommendations from the International Council for the Explorations of the Sea (ICES), where data from multiple data sources such as catch statistics and research surveys are analysed to predict future stock sizes (Nagelsen 2018). These surveys are time consuming and expensive to conduct, as well as only occurring at certain times of the year and often only for a few weeks. Although the methods used during the surveys are consistent in time and reproducible, the reduced temporal coverage may result in the data not being representative for all species due to seasonal variations in the distributions of a stock (Durant et al. 2008). In contrast to scientific surveys, the fisheries are active throughout the year. The Coastguard and the Directorate of Fisheries (DoF) collect biological and environmental samples from both landed catch and inspections at sea to use in assessments and research (Nedreaas et al. 2006; Ministry of Trade, Industry and Fisheries 2017). Similarly, IMRs “catch sampling lottery” receive catch samples from the pelagic fishery (www.hi.no/fangstprover), and their rented catch sampling vessel as well some stationary personnel collect biological samples from port landings. Data on the fishing effort used to obtain the catches, however, are not reported, limiting the usability of the catch data as direct indices of fish abundance.

Catch per unit effort (CPUE) has been extensively used to describe population dynamics, distributions in space and time, and catch rates (Petitgas et al. 2003; Verdoit et al. 2003). It is important that a CPUE series has a good enough spatial coverage to ensure comparison of the same populations over time (Hillborn and Walters 1992). To interpret CPUE data, knowledge and understanding of the distribution of both the fish and the fishing effort is important (Paloheimo and Dickie 1964) as landings in an area depend on the local population dynamics and the available quotas and restrictions (Jakobsen and Lindkvist 2003). For example, as a fishery develops, effort might increase to best take advantage of the resources, and CPUE will also be high. After some time, CPUE will in theory start to decrease as the stock abundance decreases (Jennings et al. 2001), however this has been shown to not always be the case (Harley et al. 2001). Nevertheless, CPUE timeseries may provide more information about a fishery than landing statistics alone.

2 - The Coastal Reference Fleet

2.1 – Aims of the program

To improve estimates on discards (the part of the catch that is returned to the sea (Alverson et al. 1994)) and bycatch (the incidental catch of non-target species (Alverson et al. 1994)), to supplement the data collected by the government and research institutions, and to collect continuous and consistent samples, several programmes involving fishers self-sampling their catches are being developed world-wide (Nedreaas et al. 2006; Bell et al. 2017; Van Overzee et al. 2019). In 2005, a Coastal Reference Fleet (CRF) was established in Norway (Clegg and Williams 2020), consisting of vessels ≤15 m (Williams and Gundersen 2020), and generally operating within 12 nautical miles from the shore (Fangel et al. 2015). The CRF has since grown to include vessels using a variety of gears and targeting different species (Pennington and Helle 2011), often varying gear and fishing location based on their current target species and time of year (Berg 2019). In this report we present results for the years 2007-2019 since we consider the two first years being training and introduction years.

While the need for more biological data and information about the fish caught by Norwegian fishers was the initial intention of establishing a reference fleet, it has become increasingly important to explore the possibility of using fishery dependent data as indices of fish abundance for data poor populations both in Norwegian waters and in areas where survey data are not available for stock assessment worldwide. An external review of the IMR' stock assessment processes recommended that analyses of commercial CPUE should be revisited to determine if useful timeseries can be generated, with appropriate adjustments for technology differences and research on the variations of catchability with time (IMR 2020).

The four main goals of the Norwegian Reference Fleet are to: (1) support fish stock assessments with biological data including length composition of catches (length and weight measurements for all species captured), age composition of catches (otoliths and scales collected), and quality control and facilitation of data for stock-assessment; (2) document the fishing effort and catch composition of total catches, including bycatch, discards and catches of non-commercial species, seabirds and sea mammals to provide data for the monitoring of biodiversity, fishing effort and catch per unit effort (CPUE) over time; (3) provide a platform for the collection of additional samples from fisheries, and (4) increase collaboration and strengthen dialogue between researchers and the fishing industry (Clegg and Williams 2020).

2.2 – Vessel selection

The CRF includes vessels using a variety of gears and targeting different species (Pennington and Helle 2011), often using different gears and fishing locations based on their current target species and time of year (Berg 2019). An overview of the fleet in 2016 can be found in Appendix 1. It provides biological and environmental data with a good statistical, spatial, and temporal coverage electronically, including species that might be hard to sample on scientific surveys such as deep-sea species, populations in shallower waters or closer to land, or generally rare species (Nedreaas et al. 2006). Furthermore, the data on discards reported by the CRF are the only consistent discards data in Norway (Berg 2019). As the vessels partaking in the CRF are also part of the entire Norwegian fishery, the data collected are assumed to be representable for the entire fleet and thus used as a proxy for the catch and effort in both research and for management purposes (ICES 2017).

By law, the bidding must be open for all vessels to apply, and the selection is based on the location of the home port (assuming this is where the majority of the fishing activity occurs) and the fishing pattern to ensure broad data coverage and representation (Fuglebakk et al. 2018; Clegg and Williams 2020; Williams and Gundersen 2020). The fishing pattern refers to how a fisher fishes with regards to gear, species, and effort, as well as the general composition of the CRF. The Norwegian coastline is divided into nine statistical areas (Figure 1) by the DoF to account for local differences in fish populations along the coast, and the IMR aims to have at least two vessels in the CRF from each area. The full names of these areas along with the shortened names used in this report are presented in Table 1. The contracts for the CRF last for four years (Clegg and Williams 2020; Williams and Gundersen 2020), however if the reported data is believed not to be representative of the catches, the contract may be terminated (Bjørge and Moan 2017). Thus, the data collected are assumed to be of good quality due to continuous training, with the scientists and the fishers having a trust-based partnership (Nedreaas et al. 2006).

The contracts for the CRF are generally made between the IMR and a specific vessel, however as quotas are per vessel, one boat may not have a large enough quota to operate throughout the year. Some skippers solve this by either having multiple vessels used in succession as the quotas are filled, or by cooperating with other fishers to catch the quotas for both vessels between them. Additionally, a fisher can borrow a vessel while they wait for their own to be repaired, for example. Provided that all vessels meet the same requirements as the original vessel in the contract, the skipper can register data from all boats used, although they cannot register data from multiple vessels fishing at the same time. In this study, the data are reported as being from the vessel holding the contract, as this most accurately represents the number of fishers participating in the CRF. This vessel is identified using an individual call sign, which is a permanent signature for a vessel.

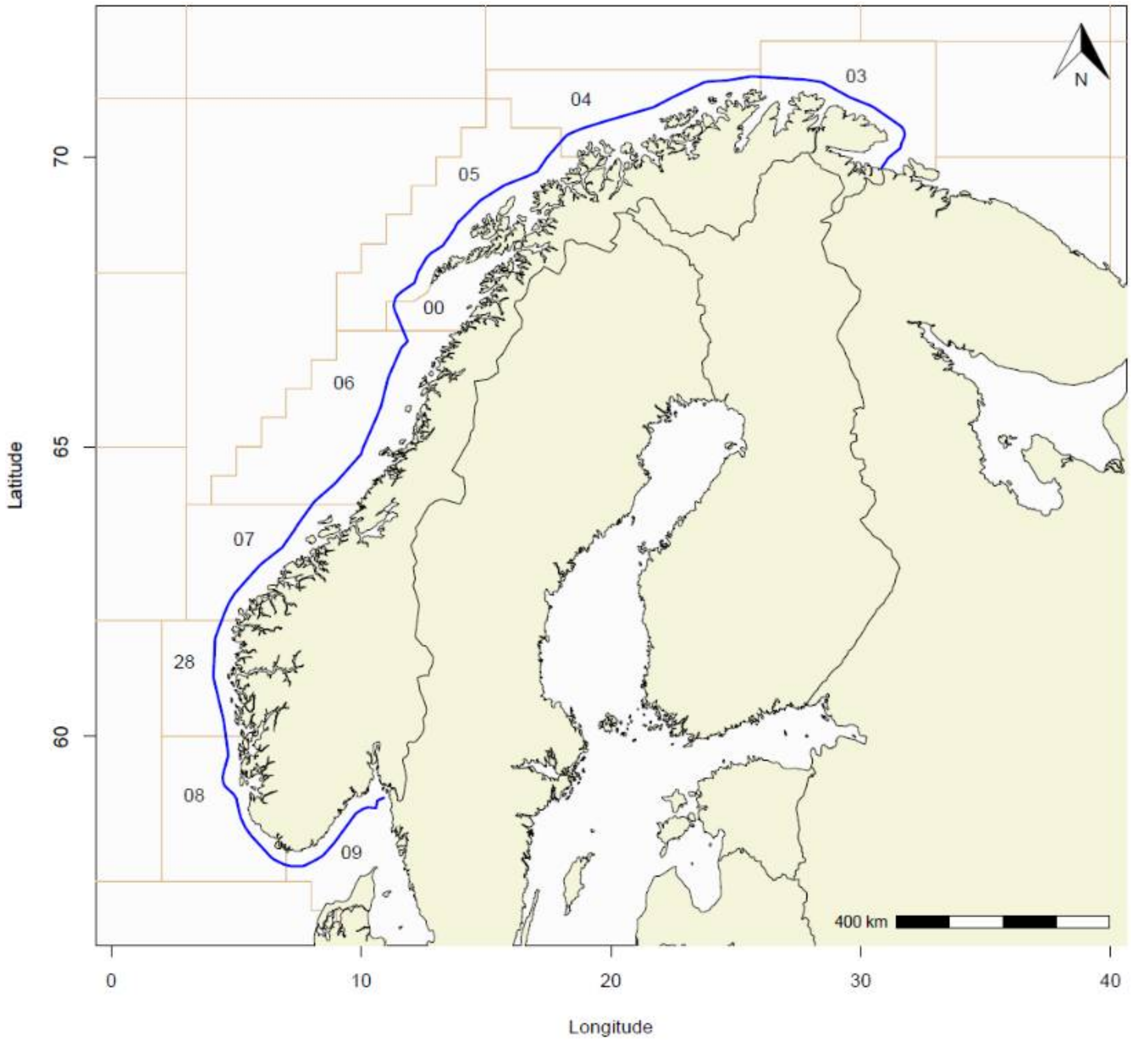

Figure 1. *The Directorate of Fisheries' statistical areas along the Norwegian coast. The blue line represents 12 NM from the coast, where the majority of the coastal fishery is conducted.*
Figur 1. Fiskeridirektoratets statistiske områder. Den blå linjen representerer 12 NM fra kysten, hvor hovedandelen av kystfisket finner sted.

Table 1. The Directorate of Fisheries' statistical areas along the Norwegian coast.

Tabell 1. Fiskeridirektoratets statistiske områder langs norskekysten.

Statistical area		Shortened name
03	East Finnmark	
04	North Troms – West Finnmark	Troms
05	Røst – South Troms (Vesterålen)	Vesterålen
00	Vestfjorden (Lofoten)	Vestfjorden
06	Helgeland	
07	Møre – Trøndelag	
28	Stad – Austevoll	
08	Austevoll – Lindesnes	
09	Skagerrak	

2.3 - Data collection

Contracted vessels are equipped with the appropriate measuring instruments, and the crews receive training in how to sample the catches consistently, including taking individual length and weight measurements and collecting otoliths for age determination (Nedreaas et al. 2006; Clegg and Williams 2020; Williams and Gundersen 2020). Sampling methods are the same as those used on research surveys conducted by the IMR, however the protocol is slightly different regarding e.g. the number of samples and how often they are to be taken (Table 2) (Nedreaas et al. 2006; Clegg and Williams 2020; Williams and Gundersen 2020). Consistent methods allow the studying of long-term trends in commercially important stocks, as well as monitoring fleet behaviour and how technical advancements and regulations influence fishing effort and efficiency in real-time (Nedreaas et al. 2006; Pennington and Helle 2011). The fishers are encouraged to record everything they catch, including what is discarded at sea, by receiving payment for the number of taxa caught per fishing operation with the promise that these data will not be used as grounds for inspections (Clegg and Williams 2020). Each vessel is allocated a contact person from the IMR who visits at least once a year, and the IMR provides training and updates the equipment as necessary (Nedreaas et al. 2006; Clegg and Williams 2020; Williams and Gundersen 2020).

Table 2. Protocol for registration and sampling in the CRF (Clegg and Williams 2020).

Tabell 2. Prøvetakningsinstruks for Kystreferanseflåten (Clegg and Williams 2020).

Gear type	Catch registration	Sampling
All gear types	Every day – the total catch is registered, including all bycatch species and discards of both commercial and bycatch species. Splitting the catch – if the day's catch is taken from multiple fishing operations from different depths, fishing area or different gear types, then the catch should be split and registered separately. For example, two gillnets used the same day with different mesh-sizes and set at different depths.	One catch per week – length and weight measurements are taken of up to 20 individuals for each species in the catch, both landed and from discards. Otolith samples are taken for important demersal species.
Shrimp trawl	Every day – from 2019 the registering of bycatch of corals and sponges is also included in the procedure.	

2.4 - Pasgear II

Pasgear II is a customised data processing program for storing and analysing fisheries data (Kolding and Skålevik

2009). It has been used in numerous studies, e.g. Dincer and Bahar (2008) and Prchalova et al. (2013). Raw, organised data from the CRF database were directly imported to Pasgear II where they were further processed, and all figures (except Figure 1 and Appendices 1 and 5) were made using this software.

2.5 - Catch per unit effort (CPUE)

The basic assumption in fisheries theory is that catch (*C*) and stock abundance, or standing biomass ($\acute{B}$), are related by

$$C = f \times q \times \acute{B}$$

where f is a measurement of the nominal fishing effort or intensity, and q is the catchability coefficient.

Rearranging to

$$C/f = q \times \acute{B} = U$$

where *U* is catch per unit effort (CPUE), which is the weight or number of a species caught per unit effort used to obtain the catch, and proportional to the biomass if q is constant (Sparre and Venema 1998 ; Jennings et al. 2001).

In Pasgear II, CPUE is calculated as

$$CPUE = \frac{1}{y} \sum_{i=1}^{n} W_i$$

where *y* is absolute effort, *n* is the number of samples, and W_i is the catch in weight or numbers.

The IMR frequently uses boat-days or gillnet-days as a measure of effort. The CRF registers data per fishing trip, which has a higher resolution than boat-days. In this report, CPUE is therefore defined as landed weight caught per fishing operation using gillnets, excluding gillnets targeting anglerfish (gear codes 4129 and 4149). A fishing operation is the deployment and subsequent hauling of a specific fishing gear, and the use of multiple mesh sizes equates to one fishing operation per mesh size. For CPUE to be calculated correctly, the effort term needs to include all efforts made to obtain a sample, not just the effort made when the species of interest occurred in the catch.

2.5.1 - Investigating CPUE from multiple geographical areas merged

The areas north of 62°N is a separate region of management for cod, haddock, and golden redfish, and will thus be a region of increased focus in this report. As the structure of the CRF is such that the vessels are signed on depending on which statistical area they are most active in, they are not evenly spread out along the Norwegian coastline. When looking at CPUE-values for multiple areas combined, the values were thus weighted based on the surface area of each statistical area. This was done by dividing each surface area with the largest surface area.

The cod stock is for management purposes considered divided at 67°N (ICES 2021). To compare the populations north and south of this latitude, the statistical areas East Finnmark (03), Troms (04), Vesterålen (05) and Vestfjorden (00) were combined to form the region north of 67°N, and Helgeland (06) and Møre-Trøndelag (07) were merged into one region between 62° and 67°N, also referred to as south of 67°N onwards. These regions were weighted separately, so the surface areas were divided by the largest surface area within each region.

2.6 - The Index of Relative Importance

Pasgear II includes a predefined analysis which calculates an Index of Relative Importance (IRI) (Kolding 1989) and provides an output with the total catch composition of the dataset provided raw data has been imported. This is a way of standardising the relative importance of a species in a catch based on the weight, the number of individuals, and the frequency of occurrence (the number of fishing operations where a taxon was registered) for each taxonomic group in the catches (Kolding 1989). The output can be given as a percentage of the total IRI, which is a measure of relative abundance of a taxon within the entire dataset and presents the most commonly observed species in order of importance, or as a rectangle (Kolding and Skålevik 2009).

In Pasgear II, %IRI is calculated as

$$\% IRI_i = \frac{(\% W_i + \% N_i) \times \% F_i}{\sum_{j=1}^{S} (\% W_j + \% N_j) \times \% F_j} \times 100$$

where $\%W_i$ and $\%N_i$ is the percentage weight and number of each taxon of the total catch, $\%F_i$ is the percentage frequency of occurrence of each taxon in the total number of fishing operations, and S is the total number of taxa.

3 - Fleet composition, Efforts and contributions to science

3.1 - Vessels

The number of vessels fluctuates from year to year due to e.g. project economy and vessels joining and leaving the program. The number of vessels has varied from 16 unique vessels in 2007 to 25 unique vessels in 2015, with an average of 21 vessels participating each year (Table 3).

Table 3. Number of unique vessels (N) contributing to the Norwegian Coastal Reference Fleet 2007-2019

Tabell 3. Antall unike fartøy (N) som deltok i Kystreferanseflåten 2007-2019

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
N	16	18	19	18	20	21	20	19	24	25	24	23	22

Although each contract with a CRF vessel only lasts for four years, it is common for skippers to apply for a renewal of their contract and continue their participation as illustrated in Figure 2. This indicates a positive experience of the cooperation with the IMR. Note that a few missing months may only mean the vessel was not active during this period, and not that the contract ended or was terminated by either party. In total, 64 different vessels, usually with 1-3 people on board, have participated in the CRF between 2007-2019. A breakdown of vessel activity within each statistical area can be found in Appendix 2.

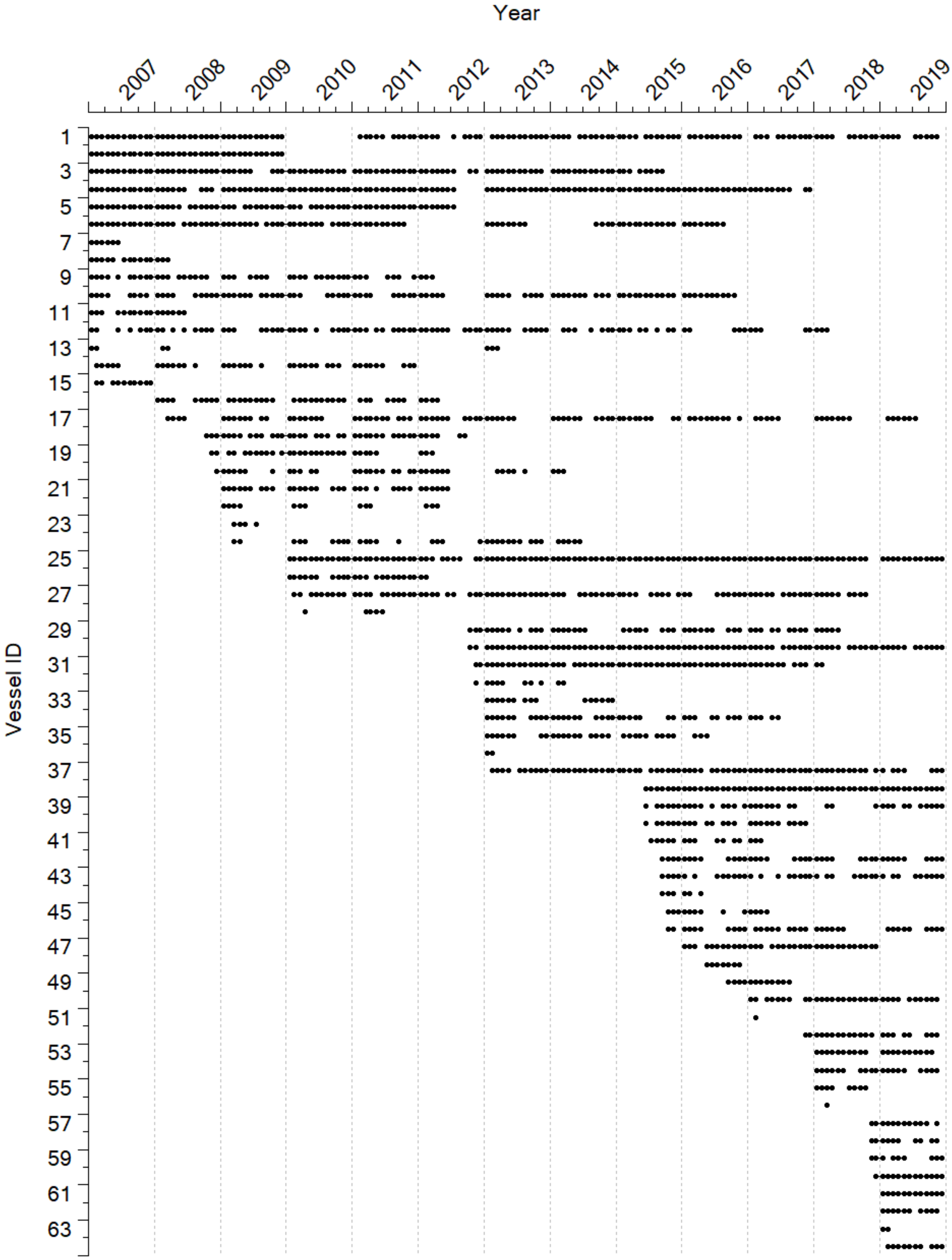

Figure 2. *The number of vessels contributing data to the Norwegian Coastal Reference Fleet. Each dot represents a month, and each line on the y-axis is a unique vessel. A total of 64 vessels delivered data in this time period. A table with vessel ID and the corresponding call sign can be found in Appendix 3.*

Figur 2. Antall fartøy som bidro med data til Kystreferanseflåten. Hver prikk representerer en måned, og hver linje på y-aksen er et unikt fartøy. Totalt deltok 64 fartøy i denne tidsperioden. En tabell med Vessel ID og tilhørende kallesignal er presentert i Vedlegg 3.

The number of vessels in the CRF fishing in each statistical area varied annually and between the areas (Figure 3). In general, there was an increase in the number of vessels in most areas until a peak in 2016, after which there was an overall decline (Figure 3A). Figure 3B shows the number of vessels with its homeport in each area, which is also the area where the majority of the fishing activity of a given vessel takes place; for example, there were no participating vessels with homeport in Vesterålen (05) in 2014 (Figure 3B), but several vessels with homeports elsewhere fished there that year (Figure 3A). Although the numbers in Figure 3B did not vary as much as in Figure 3A, the overall trends are similarly showing a general increase in the numbers of vessels with an additional rise in the movement between the areas towards the end of the study period.

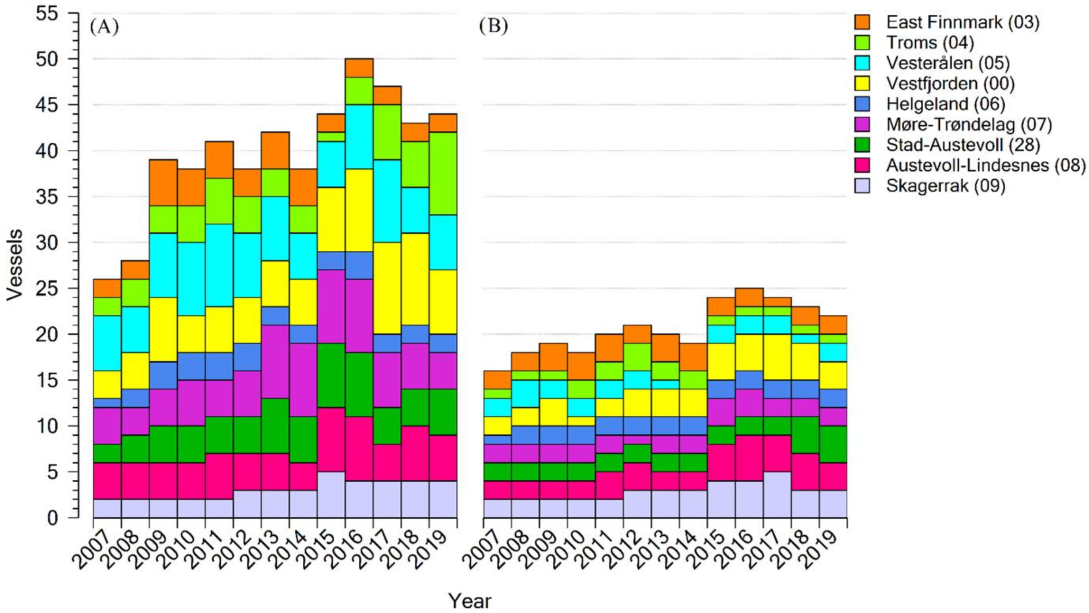

***Figure 3.** The number of unique vessels participating in the Norwegian Coastal Reference Fleet (A) operating in each statistical area, and (B) with its homeport in each statistical area.*
Figur 3. Antall unike fartøy som deltok i Kystreferanseflåten (A) som fisket i hvert statistiske område, og (B) som hadde hjemhavn i hvert statistiske område.

Furthermore, Conversely, the number of unique vessels fishing in each statistical area and hence, spatial coverage of CRF self-sampling, also showed large seasonal variations, with a marked decrease in sample sizes for May, June, and July (Figure 4). There were additional differences in the activity of the CRF in each area with season, with highest effort in East Finnmark (03) and Vestfjorden (00) being the most fished-in areas during the first quarter of the year, and Skagerrak (09) attracting more vessels after July.

In general, the number of fishing operations per year in the CRF increased throughout the study period, peaking in 2016 (Figure 5). The largest increase was seen in Vestfjorden (00), where the seasonal skrei-fishery is important and thus attracting vessels from other areas. There was also an observed increase in Stad-Austevoll (28).

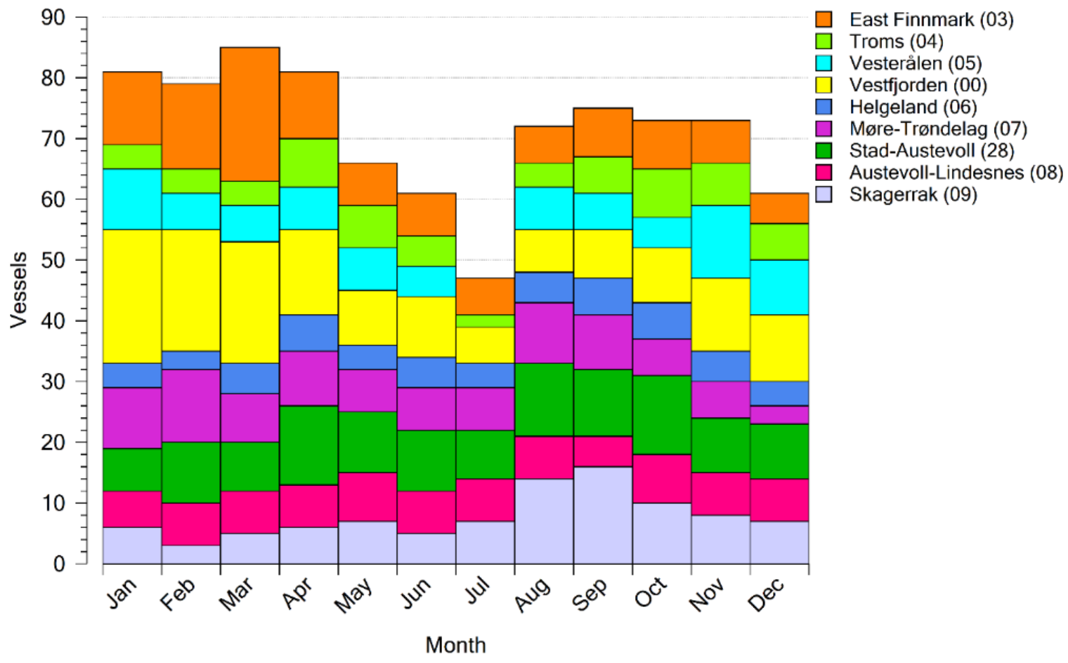

Figure 4. *The number of unique vessels in the Norwegian Coastal Reference Fleet operating in each statistical area per month between 2007 and 2019. Note that a vessel is only counted once within a statistical area, but may be registered in multiple areas during the same month.*
Figur 4. Antall unike fartøy i Kystreferanseflåten som fisket i hvert statiske område, fordelt på måned, fra 2007 til 2019. Merk at et fartøy kun er telt én gang innenfor et statistisk område, men at det samme fartøyet kan være registrert i flere statistiske område i samme måned.

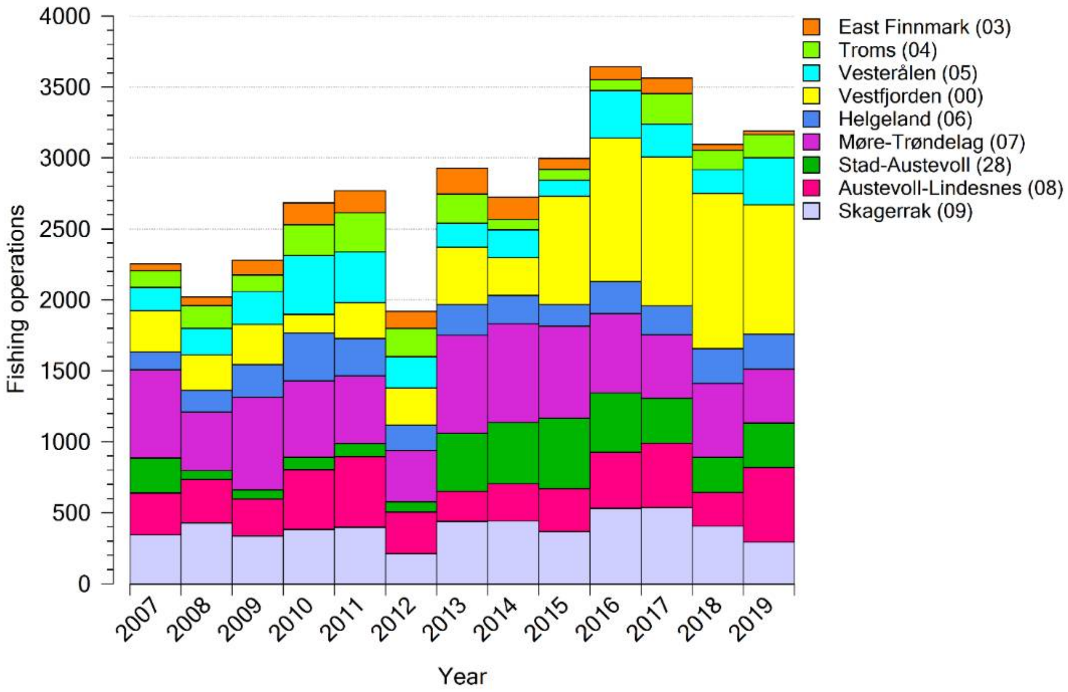

Figure 5*. The total number of fishing operations by the Norwegian Coastal Reference Fleet in each statistical area per year.*
Figur 5. Totalt antall fiskeoperasjoner utført av Kystreferanseflåten i hvert statistiske område per år.

3.2 - Composition of gears

In every year, more than 60% of all fishing operations carried out by the CRF were using gillnets (Figure 6). From 2013 there was a proportional increase in the use of traps, and from 2014 a larger portion of fishing operations used longlines and shrimp trawls, while the relative use of Danish seines and fyke nets decreased. Interestingly, the type of fishing gear varied greatly both between and within each area (Figure 7), showing that the fishing pattern was not constant. In East Finnmark (03), gillnets were used almost exclusively in 2007 then not at all in 2019, having been replaced by Danish seines, longlines, and traps. Similar decreasing trends were observed in Helgeland (06), Stad-Austevoll (28), and Skagerrak (09), where gears such as traps, fyke nets, and shrimp trawls have become more common. In fact, years with abrupt changes in the types of gears used were observed in all statistical areas, apart from Møre-Trøndelag (07), where gillnets were used almost exclusively. Unspecified trawl was only used by one fisher three times in Skagerrak (09) in 2015.

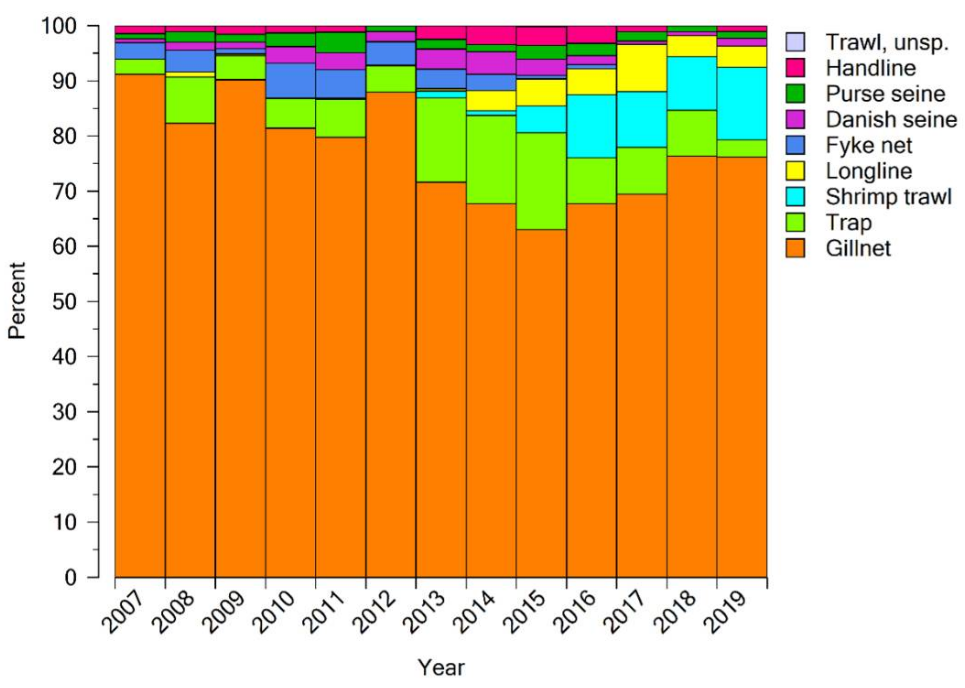

Figure 6. *The percent of fishing operations per gear category per year by the Norwegian Coastal Reference Fleet.*
Figur 6. Prosentvis fordeling av Kystreferanseflåtens redskapsbruk per år.

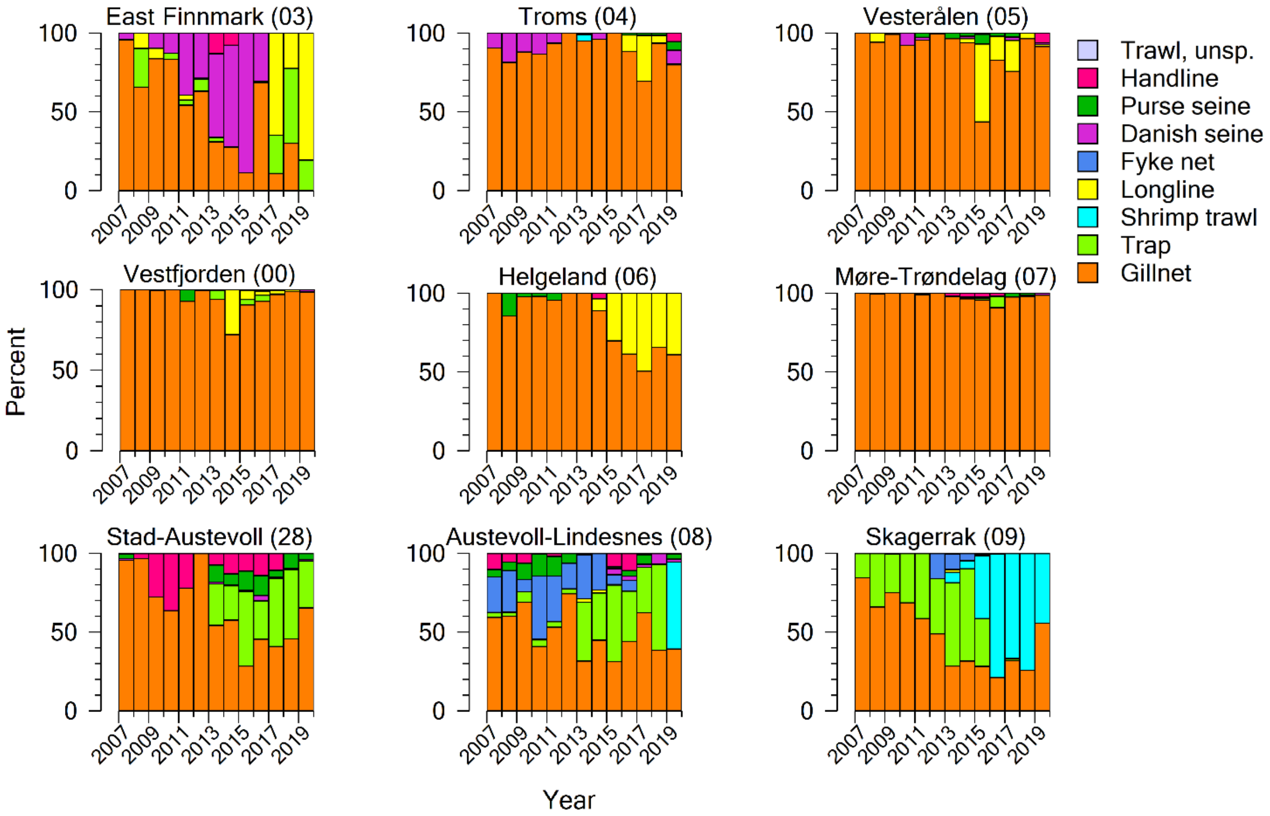

Figure 7. *The percent of fishing operations by the Norwegian Coastal Reference Fleet per gear category per year in each statistical area.*
Figur 7. Prosentvis fordeling av Kystreferanseflåtens redskapsbruk per år i hvert statistiske område.

3.2.1 - Gillnets

The proportional decrease in the use of gillnets seen in Figure 6 was also seen in the total number of gillnets used in each statistical area per year; Figure 8 shows a peak in numbers in 2010 and subsequent decrease towards 2015 followed by a somewhat higher and stable use. In some areas, such as Troms (04) and Møre-Trøndelag (07), the number was quite stable throughout the study period; in other areas such as Vesterålen (05) and south of Møre-Trøndelag, the numbers greatly varied.

The total soak time for gillnets did not show any clear trends over the study period (Figure 9); rather, it seems to have varied greatly within each area and between the years. In Vestfjorden (00) there has been a gradual increase in the accumulated hours, especially since 2014, whereas a decrease can be seen in Helgeland (06). Vesterålen (05) and Austevoll-Lindesnes (08) in particular had large variations in total soak time.

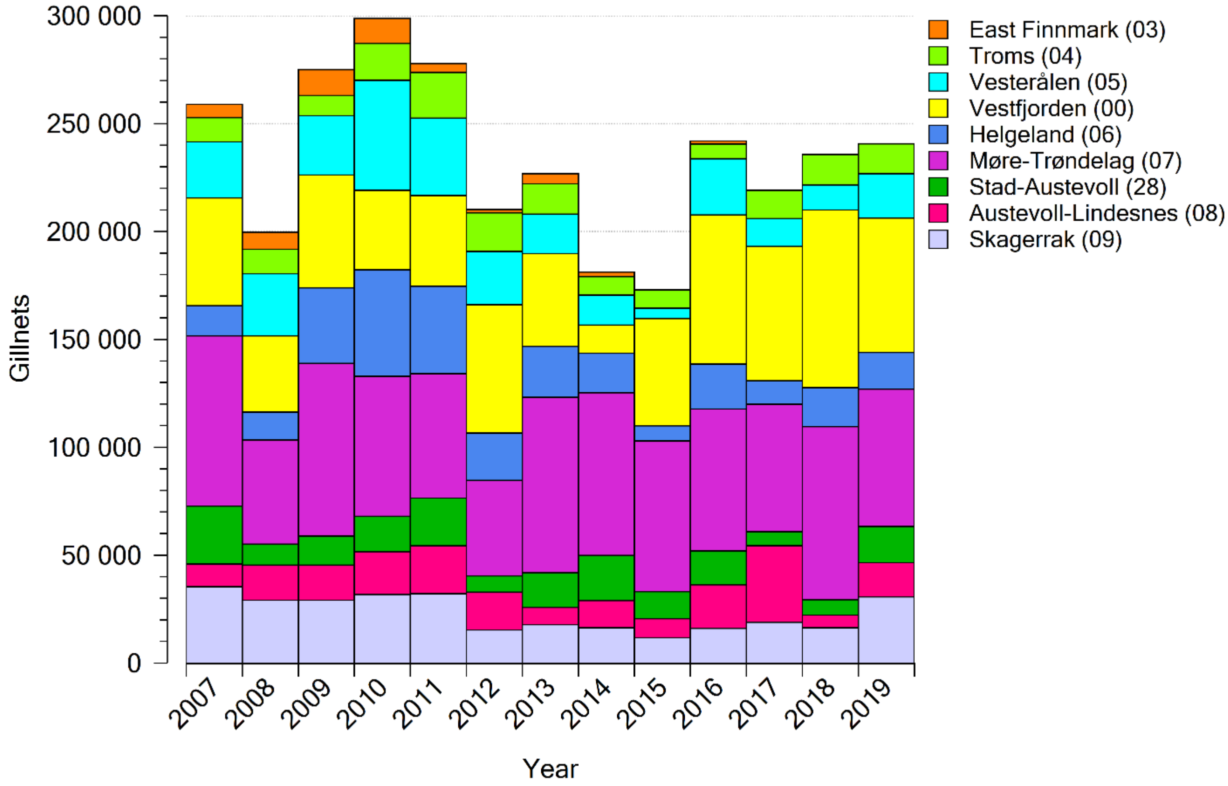

Figure 8. *The number of gillnets used by the Norwegian Coastal Reference Fleet in each statistical area per year.*
Figur 8. Totalt antall garn brukt av Kystreferanseflåten i hvert statistiske område.

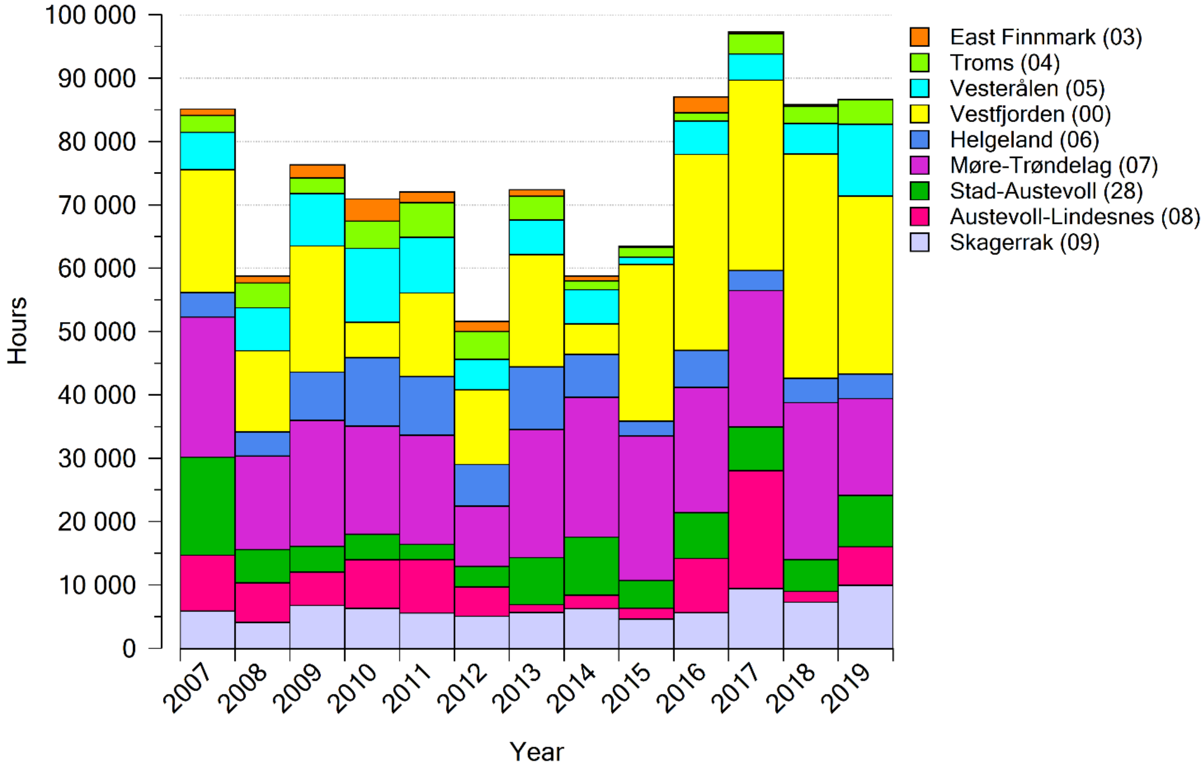

Figure 9. *The total soak time in hours for gillnets used by the Norwegian Coastal Reference Fleet in each statistical area per year.*
Figur 9. Total ståtid, i timer, for garn brukt av Kystreferanseflåten i hvert statistiske område per år.

Gillnet as a category of gears is not a homogenous group, but one where the fishers use a variety of mesh sizes to regulate selectivity when fishing. In this study, mesh size groups (measured in bar length) were used in addition to unknown mesh size. These groups can be seen in Figure 10, which also shows that the mesh sizes used by the CRF varied both within and between the areas, as well as between the years. This Figure also illustrates the development in the use of gillnets in general in each area over time by looking at the total number of fishing operations in each year. Note that the y-axes are free to highlight individual trends within each area. In all areas, the relative use of each mesh size group varied throughout the study period; in East Finnmark (03), Austevoll-Lindesnes (28) and Skagerrak (09) mesh sizes have generally increased with time, whereas in Helgeland (06), Møre-Trøndelag (07), and Stad-Austevoll (28) mesh sizes have decreased. Additionally, the fishers have overall become better at recording the mesh sizes used instead of using “Unknown”.

In all areas, the number of fishing operations using gillnets showed seasonal variations in the local fisheries (Figure 11). There were relatively low levels of activity in all statistical areas during the summer months compared to the first as last quarters of the year, aside from in Vesterålen (05) and Møre-Trøndelag (07) where activities did not increase in the autumn, and in Skagerrak (09) where the peak in fishing operations occurred in June followed by lower numbers August and September. Furthermore, in Vestfjorden (00), Helgeland (06), and Møre-Trøndelag (07) the mesh sizes increased throughout the year; in East Finnmark (03) and Troms (04) mesh sizes decreased. Note that in Figure 11, the y-axes are free to highlight individual trends within each area.

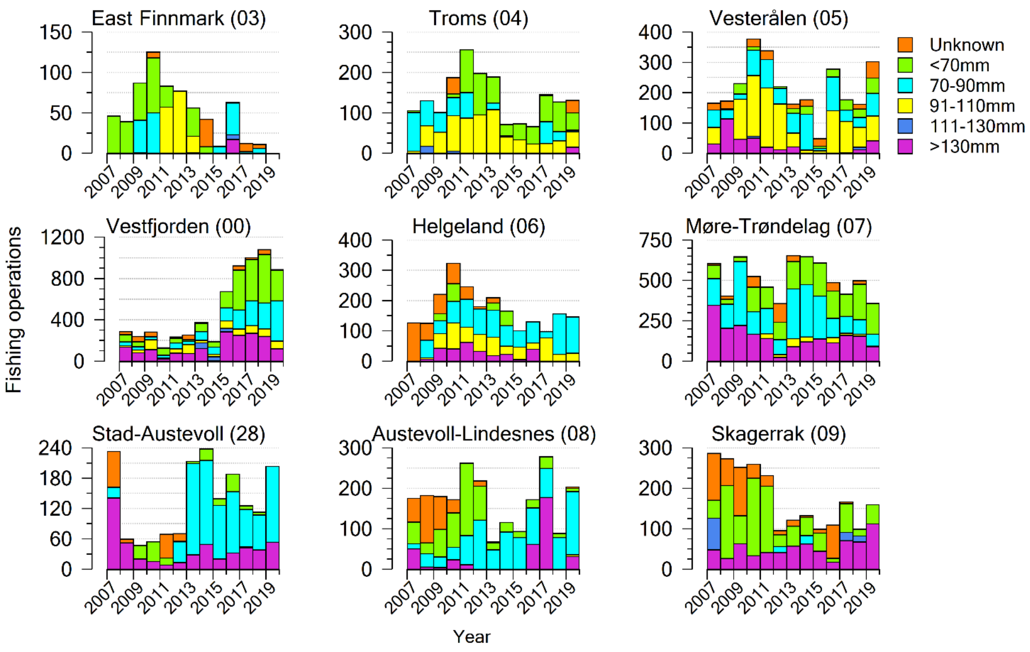

Figure 10. *The number of fishing operations by the Norwegian Coastal Reference Fleet per mesh size group per year using gillnets, with one panel per statistical area. Mesh size was defined as the bar length. Note that the y-axes are scaled individually as to highlight the individual trends within each area.*
Figur 10. Antall fiskeoperasjoner med garn, per maskestørrelse, registrert av Kystreferanseflåten fordelt på år og statistiske område. Maskestørrelse ble definert som stolpelengden. Merk at y-aksene varierer fra område til område.

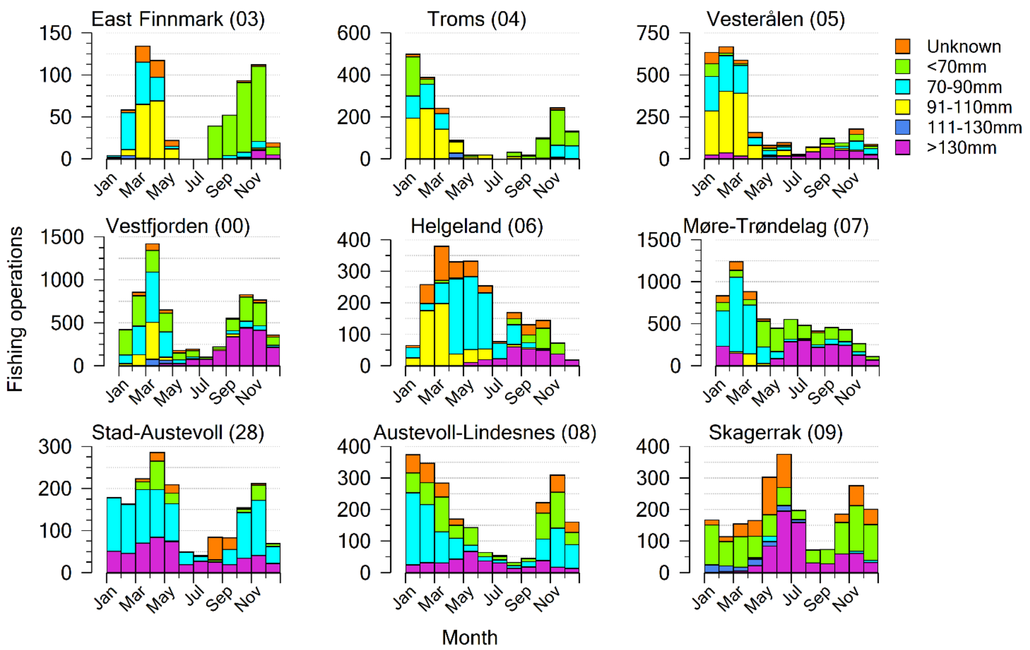

Figure 11. *The number of fishing operations by the Norwegian Coastal Reference Fleet per mesh size group per month between 2007 and 2019 using gillnets, with one panel per statistical area. Mesh size was defined as the bar length. Note that the y-axes are scaled individually as to highlight the individual trends within each area.*
Figur 11. Antall fiskerioperasjoner med garn, per maskestørrelse, registrert av Kystreferanseflåten fordelt på måned og statistiske område. Maskestørrelse ble definert som stolpelengden. Merk at y-aksene varierer fra område til område.

3.3 - Catch composition

287 taxa were registered by the CRF between 2007-2019 from 29 137 individual fishing operations. A comprehensive list including the total numbers of individuals, the weight, and the % IRI can be found in Appendix 4. The most important species overall were cod, which occurred in 61% of the fishing operations over the course of the study period and accounted for 45% of the total weight and about 5% of the counted specimens, and saithe (*Pollachius virens*, L.), occurring in 53% of the operations and accounting for 19% of the total weight and 4% of the counts (Figure 12). Figure 12 further illustrates the taxa with the highest IRI, which are presented along with the proportions of numbers and weight registered. The size of the bar is proportional to the IRI for each species. Throughout the study period, haddock was found in 42% of the catches, however in much lower quantities than cod when looking at both numbers and weight. Golden redfish (marked with an asterisk in Figure 12) was caught in 15% of the catches, and barely accounted for 1% of the total weight and less than 0.5% of all counted individuals.

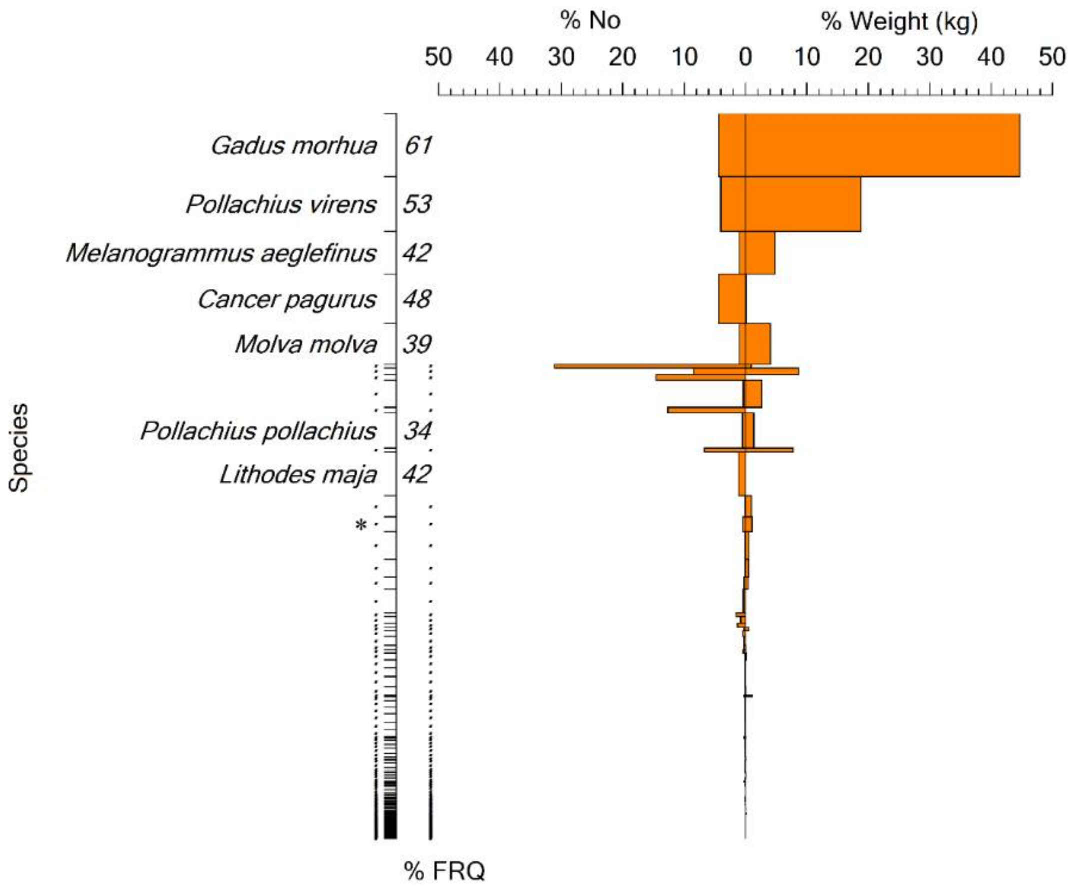

Figure 12. *The Index of Relative Importance (IRI) of the taxa caught by the Norwegian Coastal Reference Fleet between 2007 and 2019. The IRI standardises the catch composition based on the number, the weight, and the frequency of occurrence (FRQ) of a taxon. Here, % No is primarily discarded specimens and % Weight (kg) is primarily landed catch. An asterisk marks golden redfish (Sebastes norvegicus). The areas of the bars are proportional to the IRI for that taxon, and the y-axis is sorted by IRI-values.*
Figur 12. Indeks for relativ viktighet (IRI) for taksa fanget av Kystreferanseflåten mellom 2007 og 2019. IRI standardiserer fangstsammensetningen basert på antall, vekt og frekvensen av forekomst (FRQ) av et takson. Her er % No primært utkast, mens % Weight (kg) primært er beholdt fangst. Vanlig uer (Sebastes norvegicus) er markert med en stjerne. Søylene er proporsjonale for IRI for det taksonet, og Y-aksen er sortert på IRI-verdi.

Figure 13 shows the % IRI for the 15 species with the highest value overall between 2007-2019. These species accounted for 98.3% of the total IRI, 90.7% of the total number of individuals, and 95.7% of the total registered weight. Cod became increasingly important between 2007-2012, followed by a slight decline. The % IRI for haddock was quite stable, with somewhat higher values in 2014 and 2015. Although it is hard to discern from the Figure, golden redfish had the highest values in 2009-2011. Overall, the species composition of the CRF varied between the years, with species such as the brown crab (*Cancer pagurus*, L.) being less important after 2009 and northern shrimp (*Pandalus borealis*, K.) having a higher % IRI from 2016 onwards.

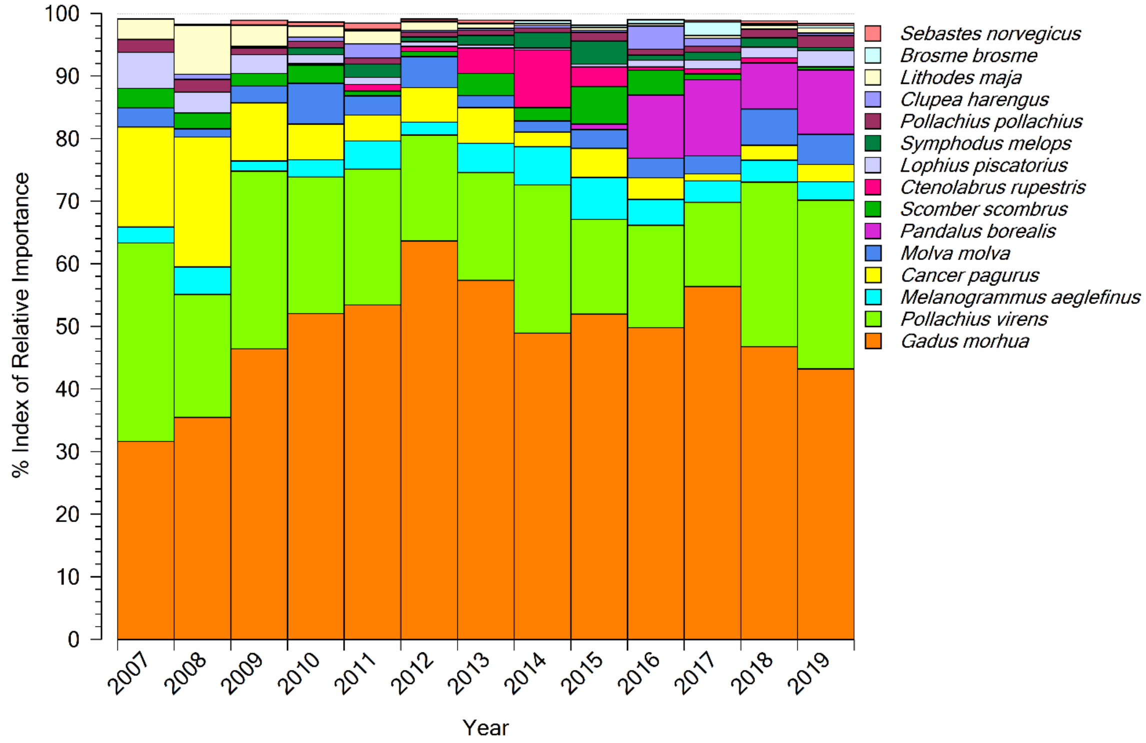

Figure 13. *The % Index of Relative Importance (IRI) for the 15 species with the highest % IRI for the entire study period caught by the Norwegian Coastal Reference Fleet. These accounted for 98.3% of the total IRI. IRI standardises the catch composition based on the number, the weight, and the frequency of occurrence of a taxon.*
Figur 13. Indeks for relative viktighet (IRI) for de 15 artene med de høyeste % IRI verdiene for hele studieperioden. Disse artene stod for 98.3% av den totale IRI. IRI standardiserer fangstsammensetningen basert på antall, vekt og forekomsten av et takson.

3.4 - Catch per unit effort infor the CRF

To investigate the temporal development of catch per unit effort (CPUE) in the CRF, landed catches were weighed and the unit effort was set to per fishing operation using gillnets (excluding gear codes 4129 and 4149). There was no obvious temporal trend in CPUE of all species throughout the study period between the statistical areas (Figure 14). However, there was a steep decline in CPUE in East Finnmark (03) after 2008 with subsequent peaks in 2013 and 2014, and an increase to a peak in 2014 followed by a decrease in Troms (04). Vesterålen (05), Vestfjorden (00), and Stad-Austevoll (28) showed similar trends but with earlier peaks, whereas the remaining areas had quite stable CPUE-values throughout the study period.

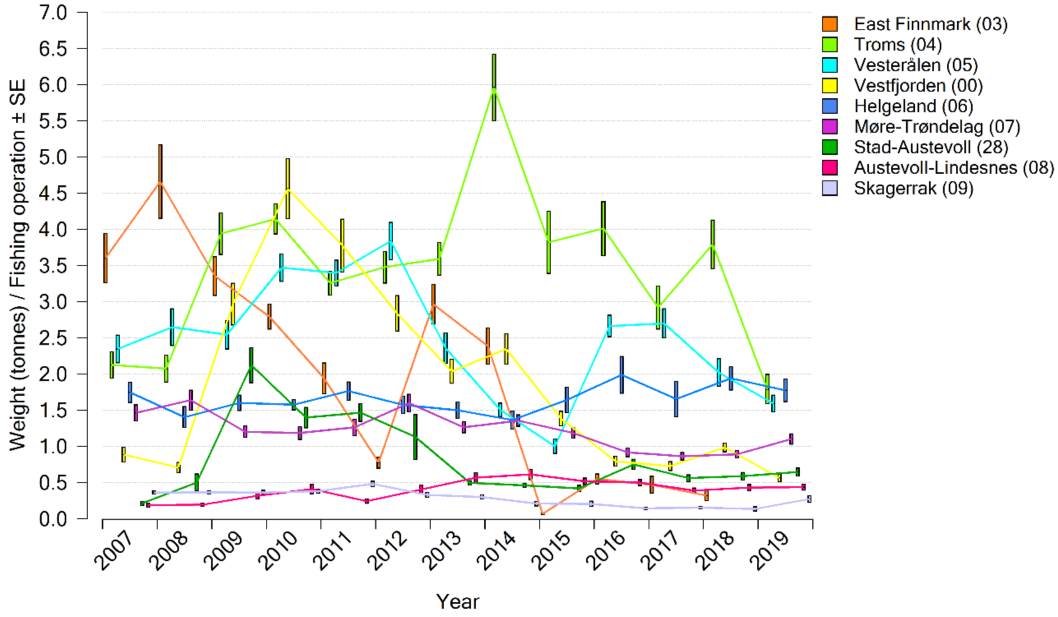

Figure 14. *Catch per unit effort from all catches using gillnets (excluding gear codes 4129 and 4149) by the Norwegian Coastal Reference Fleet in each statistical area, measured in tonnes per fishing operation ± standard error. Only landed catches were included.*
Figur 14. Fangst per enhet innsats fra alle fangstene med garn (utenom redskapskoder 4129 og 4149) til Kystreferanseflåten i hvert statistiske område, målt i tonn pr fiskeoperasjon ± standardfeil. Kun landet fangst.

CPUE of only landed cod showed similarities to that of all catches (Figure 15), especially in areas north of 62°N (Troms (04), Vesterålen (05), and Vestfjorden (00)) indicating that it is an important commercial species locally. At this scale, CPUE of cod was very low in the more southern areas of Stad-Austevoll (28), Austevoll-Lindesnes (08), and Skagerrak (09), and any trends are not discernible from the Figure. Landed haddock had high CPUE in Vestfjorden (00) and Møre-Trøndelag (07) at the start of the study period, and a peak in Troms (04) in 2016 (Figure 16). Overall, CPUE was quite variable in all areas. CPUE for golden redfish also showed variations, especially from 2007 to 2014, however a peak in Stad-Austevoll (28) in 2009 skews the y-axis making any trends hard to distinguish (Figure 17). This catch was from a vessel fishing both coastally and offshore and exceeding 20 m in length. This is larger than most coastal vessels, however it was included in the CRF to ensure coverage of this area and to reflect the diversity of the Norwegian fishing fleet. Also note the differences in the scaling of the y-axes in Figures 15, 16, and 17; as effort is the same for all species, it is evident that the catches of cod were much larger than those of haddock and golden redfish. After 2014, CPUE of golden redfish has been closer to zero.

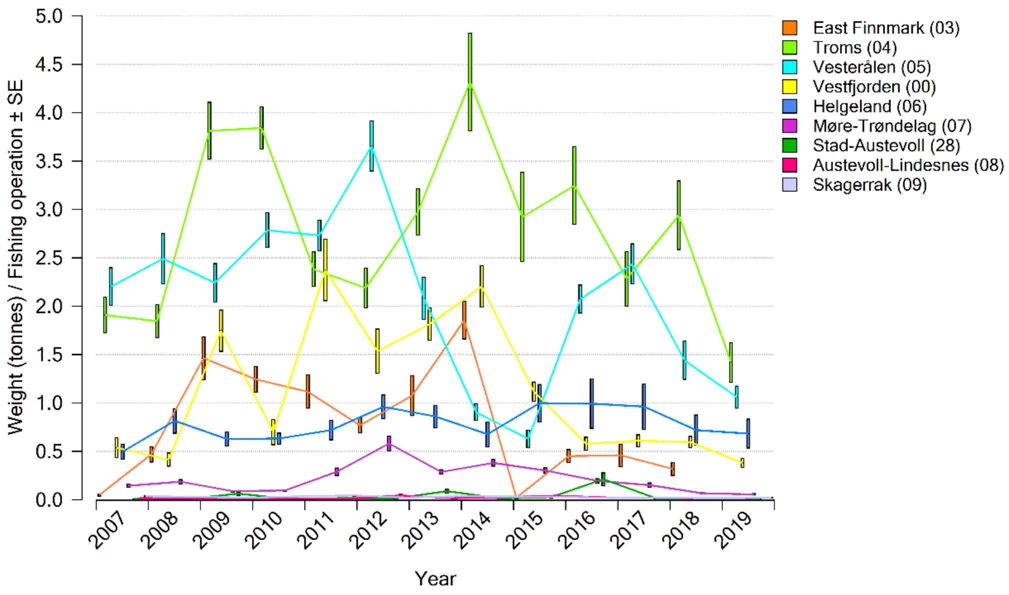

Figure 15. *Catch per unit effort of cod (Gadus morhua) landed from gillnets (excluding gear codes 4129 and 4149) by the Norwegian Coastal Reference Fleet in each statistical area, measured in tonnes per fishing operation ± standard error.*
Figur 15. Fangst per enhet innsats av torsk (Gadus morhua) landet fra garn (utenom redskapskoder 4129 og 4149) av Kystreferanseflåten i hvert statiske område, målt i tonn per fiskeoperasjon ± standardfeil.

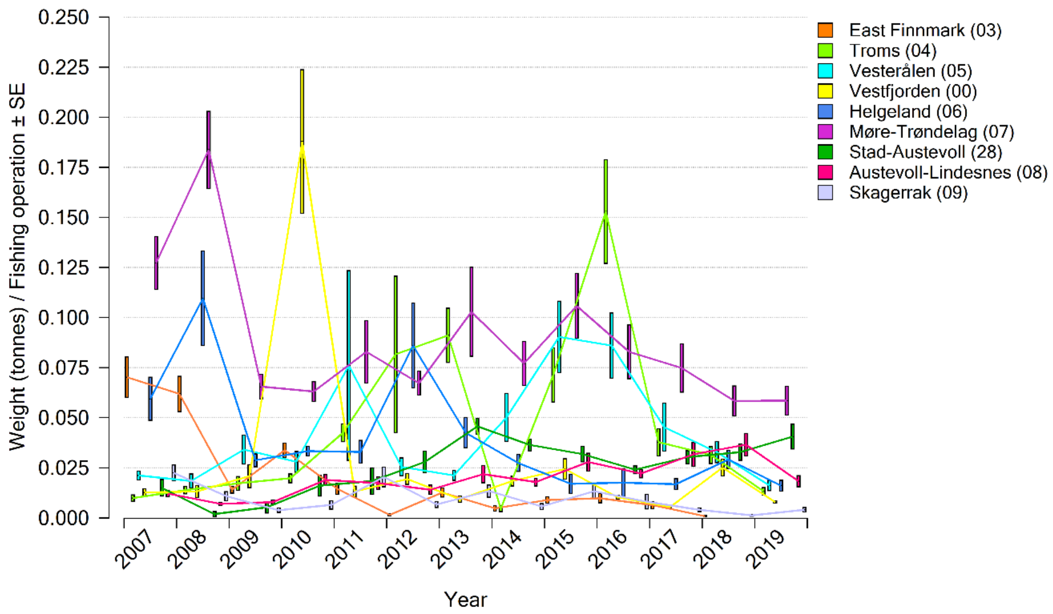

Figure 16. *Catch per unit effort of haddock (Melanogrammus aeglefinus) landed from gillnets (excluding gear codes 4129 and 4149) by the Norwegian Coastal Reference Fleet in each statistical area, measured in tonnes per fishing operation ± standard error.*
Figur 16. Fangst per enhet innsats av hyse (Melanogrammus aeglefinus) landet fra garn (utenom redskapskoder 4129 og 4149) av Kystreferanseflåten i hvert statiske område, målt i tonn per fiskeoperasjon ± standardfeil.

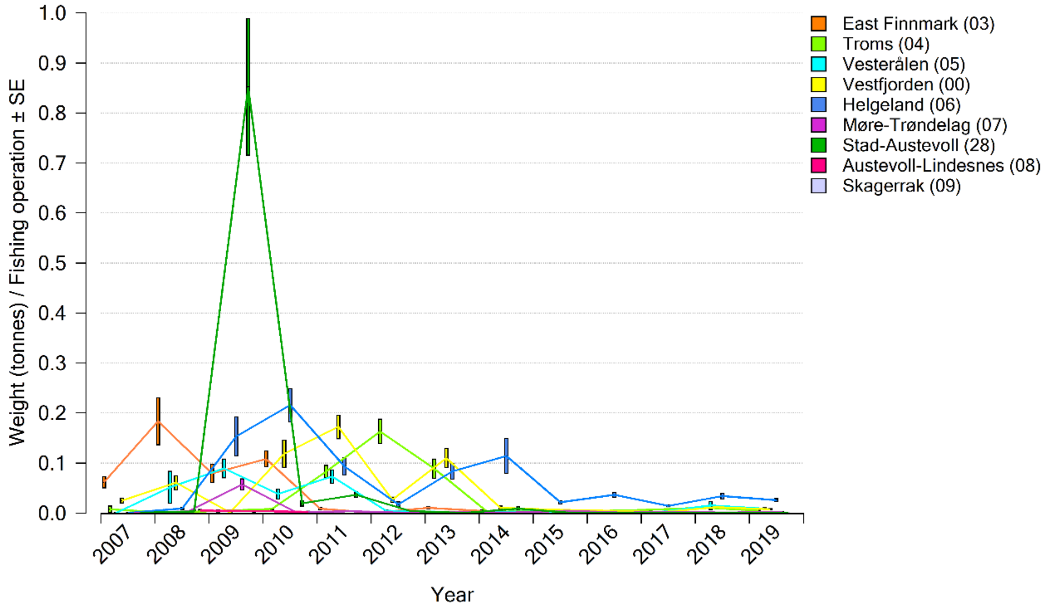

Figure 17. *Catch per unit effort of golden redfish (Sebastes norvegicus) landed from gillnets (excluding gear codes 4129 and 4149) by the Norwegian Coastal Reference Fleet in each statistical area, measured in tonnes per fishing operation ± standard error.*
Figur 17. Fangst per enhet innsats av vanlig uer (Sebastes norvegicus) landet fra garn (utenom redskapskoder 4129 og 4149) av Kystreferanseflåten i hvert statiske område, målt i tonn per fiskeoperasjon ± standardfeil.

3.4.1 - CPUE for cod, haddock, and golden redfish north of 62°N

The majority of the fishing on all three species occurs north of 62°N, so this region is managed separately from the areas further south. When comparing CPUE for cod, haddock, and golden redfish in this region, both cod and golden redfish showed increasing CPUE-values from the start of the study period until 2011, after which they both declined (Figure 18). Haddock had more variable values, but with an overall decline as well. Note that the species have separate y-axes.

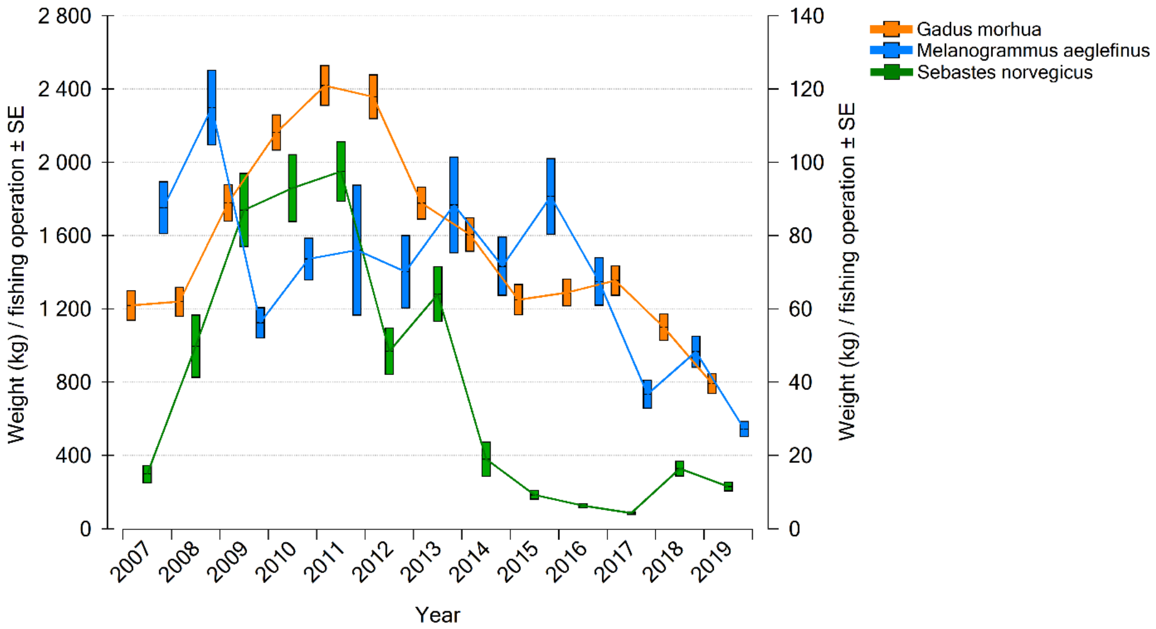

Figure 18. *Catch per unit effort (CPUE) of cod (Gadus morhua), haddock (Melanogrammus aeglefinus), and golden redfish (Sebastes norvegicus) landed from gillnets (excluding gear codes 4129 and 4149) by the Norwegian Coastal Reference Fleet north of 62°N, measured in kg per fishing operation ± standard error. The y-axis on the left is for cod, while the one on the right is for haddock and golden redfish. The CPUE-values have been standardised (weighted) by dividing the surface area of each statistical area by the surface area of the largest area.*

Figur 18 . Fangst per enhet innsats (CPUE) av torsk (Gadus morhua) , hyse (Melanogrammus aeglefinus) og vanlig uer (Sebastes norvegicus) landet fra garn (utenom redskapskoder 4129 og 4149) av Kystreferanseflåten nord for 62. breddegrad, målt i kg per fiskeoperasjon ± standardfeil. Y-aksen til venstre er for torsk, mens den til høyre er for hyse og vanlig uer. CPUE-verdiene er standardisert (vektet) ved å dele arealet på hvert statistiske område på arealet på det største området.

ICES has recently recommended to manage the cod stock north of 62˚N as two management units, i.e., north and south of 67˚N (ICES 2021). These regions were therefore inspected separately in Figure 19. Note that there are two y-axes, highlighting the differences in the amount of cod caught in each region. The curves show a similar trend with an initial increase followed by decreasing CPUE-values, although the peak in the southern region came later than the northern peak.

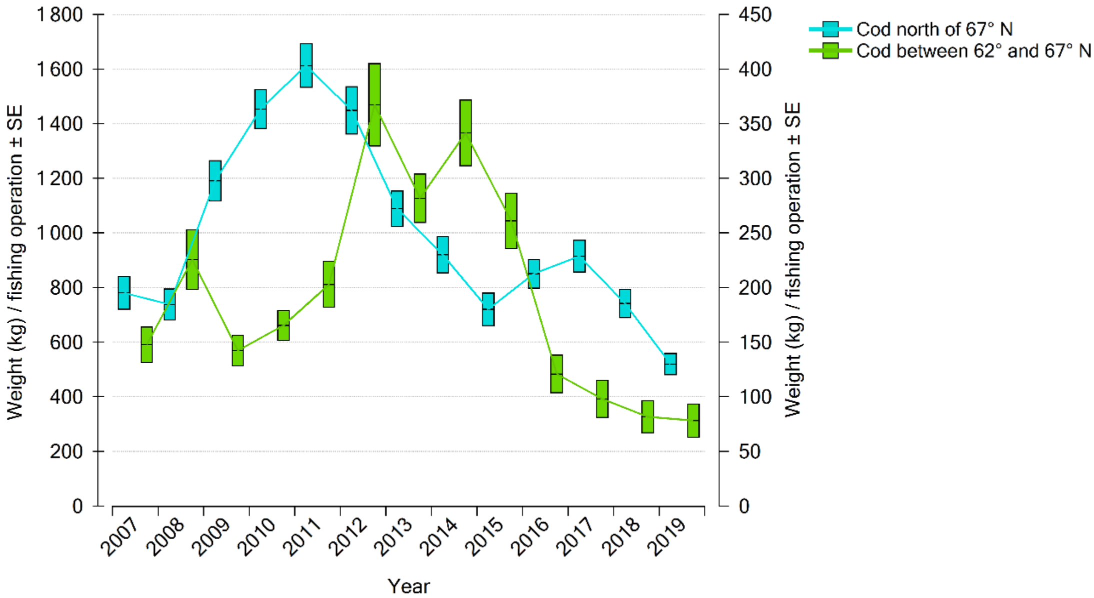

Figure 19. *Catch per unit effort (CPUE) of cod (Gadus morhua) landed from gillnets (excluding gear codes 4129 and 4149) by the Norwegian Coastal Reference Fleet north of 62°N, measured in kg per fishing operation ± standard error. The y-axis on the left is for cod caught north of 67 °N , while the one on the right is for cod caught between 62 ° and 67°N . The CPUE-values have been standardised (weighted) by dividing the surface area of each statistical area by the surface area of the largest area within each region. Figur 19 . Fangst per enhet innsats (CPUE) av torsk (Gadus morhua) landet fra garn (utenom redskapskodene 4129 og 4149) av Kystreferanseflåten nord for 62. breddegrad, målt i kg per fiskeoperasjon ± standardfeil. Y-aksen til venstre er for torsk fanget nord for 67. breddegrad, mens den til høyre er for torsk fanget mellom 62. og 67. breddegrad. CPUE-verdiene er standardisert (vektet) ved å dele arealet på hvert statistiske område på arealet på det største området innenfor hver region.*

3.4.2 - CPUE for cod, haddock, and golden redfish south of 62°N

As trends in CPUE for the statistical areas south of 62°N were not too obvious in Figures 14-17, these areas were inspected separately for each species. For cod, CPUE in Austevoll-Lindesnes (08) and Skagerrak (09) showed only slight variations with time, whereas there were three distinct peaks in CPUE in Stad-Austevoll (28) in 2009, 2013, and 2016 (Figure 20). For haddock, a general increase was observed in Stad-Austevoll (28) and Austevoll-Lindesnes (08), while CPUE in Skagerrak (09) decreased overall (Figure 21). The previously discussed peak in CPUE for golden redfish in 2009 is prominent in Figure 22 as well, however excluding Stad-Austevoll (28) only showed that the data for golden redfish was sparce before 2015, with almost no data after this (Figure 23).

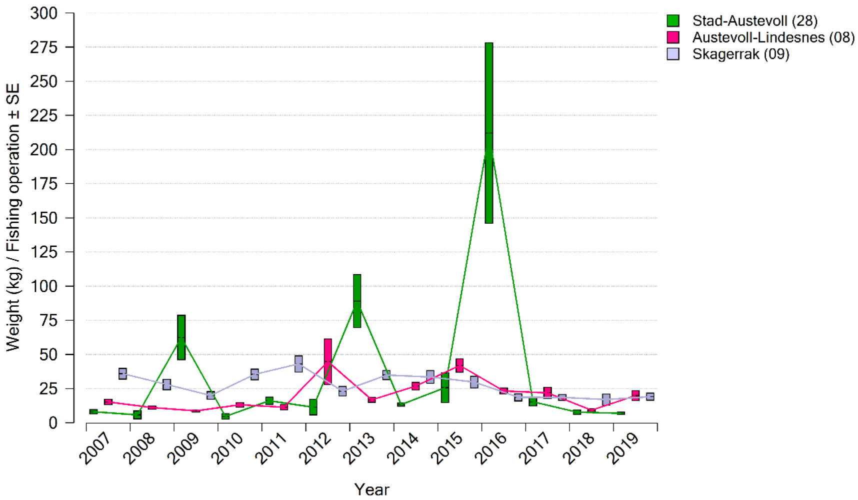

Figure 20. *Catch per unit effort of cod (Gadus morhua) landed from gillnets (excluding gear codes 4129 and 4149) by the Norwegian Coastal Reference Fleet south of 62°N , measured in kg per fishing operation ± standard error.*
Figur 20. Fangst per enhet innsats av torsk (Gadus morhua) landet fra garn (utenom redskapskodene 4129 og 4149) av Kystreferanseflåten sør for 62. breddegrad, målt i kg per fiskeoperasjon ± standardfeil.

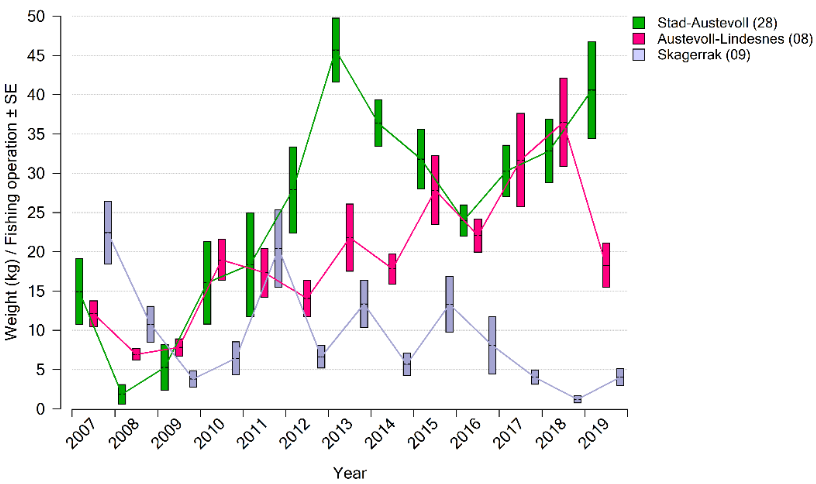

Figure 21. *Catch per unit effort of haddock (Melanogrammus aeglefinus) landed from gillnets (excluding gear codes 4129 and 4149) by the Norwegian Coastal Reference Fleet south of 62°N , measured in kg per fishing operation ± standard error.*
Figur 21. Fangst per enhet innsats av hyse (Melanogrammus aeglefinus) landet fra garn (utenom redskapskodene 4129 og 4149) av Kystreferanseflåten sør for 62. breddegrad, målt i kg per fiskeoperasjon ± standardfeil.

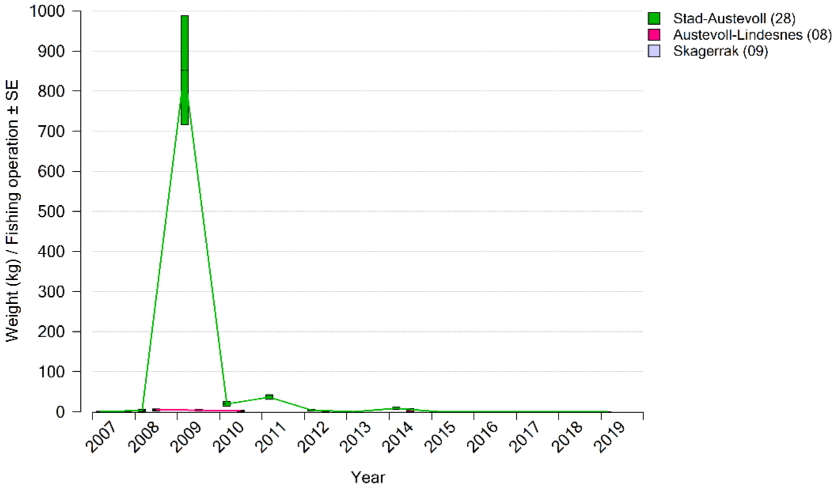

Figure 22. *Catch per unit effort of golden redfish (Sebastes norvegicus) landed from gillnets (excluding gear codes 4129 and 4149) by the Norwegian Coastal Reference Fleet south of 62°N , measured in kg per fishing operation ± standard error.*
Figur 22. Fangst per enhet innsats av vanlig uer (Sebastes norvegicus) landet fra garn (utenom redskapskodene 4129 og 4149) av Kystreferanseflåten sør for 62. breddegrad, målt i kg per fiskeoperasjon ± standardfeil.

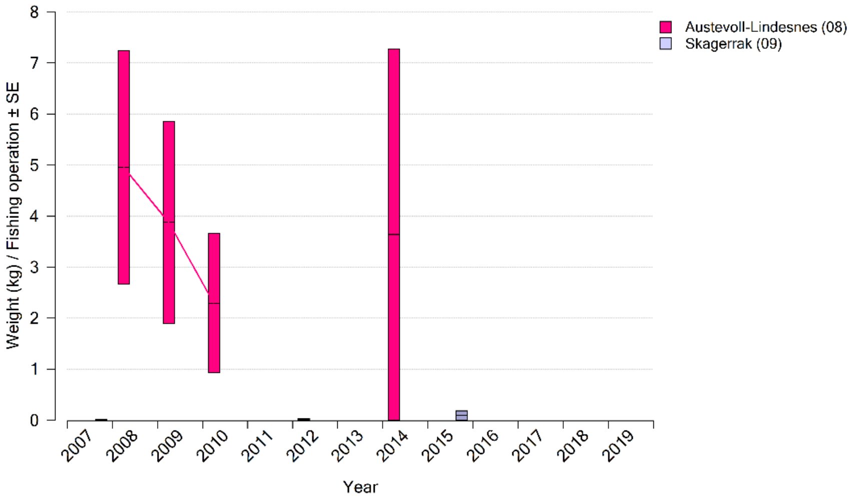

Figure 23. *Catch per unit effort of golden redfish (Sebastes norvegicus) landed from gillnets (excluding gear codes 4129 and 4149) by the Norwegian Coastal Reference Fleet from the statistical areas Austevoll-Lindesnes (28) and Skagerrak (09), measured in kg per fishing operation ± standard error.*
Figur 23. Fangst per enhet innsats av vanlig uer (Sebastes norvegicus) landet fra garn (utenom redskapskodene 4129 og 4149) av Kystreferanseflåten i de statistiske områdene Austevoll-Lindesnes (08) og Skagerrak (09), målt i kg per fiskeoperasjon ± standardfeil.

4 - Discussion

4.1 – The development of the CRF

The CRF program has developed and changed over the course of the study period. The number of vessels participating has increased, and with it the amount of data collected each year. Additionally, the fleet has become more mobile; at the start of the program the IMR did not encourage the participation in seasonal fisheries as this would decrease the data collected in a vessel's home area, however, the movement of vessels across statistical areas has become more frequent in the CRF over time. This has strengthened the data collected in areas such as Vestfjorden (00) and Vesterålen (05), where the skrei fishery takes place every spring and thus reflects the seasonality of the general fishery and the economically important seasonal fisheries in Norway (Huse and Bakketeig 2018; Statistics Norway 2020) .

Compared to the entire Norwegian coastal fleet, the CRF is not very large. As the aim of having at least two vessels per statistical area is not being met every year, caution is advised when extrapolating the data on smaller scales. For example, when looking at the gear composition for the entire study period in Figure 6, the variations in gear types seem gradual; when focusing on each statistical area in Figure 7, however, some areas had sudden shifts and complete replacements of gear as seen in e.g. East Finnmark (03). With few vessels in each area, the signing of a vessel using different gears will affect the composition of data collected here considerably. This could be unintentional by the IMR in order to simply secure coverage of the area, or intentional like in Skagerrak (09) where a shrimp trawler was signed on to reflect this locally important fishery (Ziegler et al. 2016) . Such sudden changes within an area have not been observed in the general fishery (Appendix 5), thus the changes in gear representation in the CRF does not always directly reflect or represent the overall fleet. Furthermore, in areas with seemingly little gear development over time, such as Møre-Trøndelag (07) where the vessels in the CRF mostly use gillnets, this does not match with the costal fleet overall as traps have become more common here over the course of the study period. These differences in the fishing pattern between the CRF and the entire coastal fishery will result in divergences in the overall catch compositions and the CPUEs, which could be further examined by comparing the catch composition of the CRF with sales notes from the coastal fisheries.

At the beginning of the study period, several catches were recorded using "Unknown" mesh size. This occurred when a fisher using different mesh sizes during the same fishing trip would record it as just one catch without including the mesh size. However, in most areas the frequency of these recordings has decreased over time. The detailed recording of each fishing operation, e.g. individual mesh sizes, number of nets used, and soak time, is a great strength of the CRF, as well as the amount and coverage of data in both space and time. Additionally, being the only reliable source of fishery dependent data on discards, the CRF data could increase the accuracy of assessments while being more cost-effective than collecting information using research vessels (Pennington and Helle 2011) . Lastly, close cooperation between fishers and scientists appears to increase mutual understanding of the stocks, improving overall fisheries management (Nedreaas et al. 2006) .

The species composition of the catches by the CRF showed variations across the study period. In all years, cod had the highest % IRI, which was expected as the cod fishery is the most valuable fishery in Norway (Statistics Norway 2020), however in 2007 saithe was almost equally as important. At the start of the study period, brown crab had quite high % IRI. This species is a common bycatch species in demersal gillnets and is thus often discarded at sea (Savina et al. 2017) . The lower % IRI after 2009 does not necessarily mean lower catches of brown crab but that other species became more important in the catches. For example, the increased importance of northern shrimp from 2016 coincides with the larger proportion of fishing operations using shrimp trawls in Skagerrak (09) (Figures 6 and 7).

4.2 - Biological factors affecting catchability

CPUE is frequently used as an index of abundance, however it is commonly known that the assumptions this is based on may not always hold true (Beverton and Holt 1957; Harley et al. 2001). For CPUE to be proportional to the size of a population, catchability would have to be constant (Jennings et al. 2001). Unfortunately, catches are influenced by a multitude of factors (Crespin et al. 2008; Maunder et al. 2006), some of which can neither be measured nor controlled for. These factors can be grouped into biological and technological elements which interact with and influence each other.

Biological factors influencing catchability are difficult to control for, and are further affected by season, the age of the fish, the environment, and interspecies interactions (Crespin et al. 2008) . For a fish to appear in a catch, it must be present and available on the fishing ground. For example, due to the low stock levels of golden redfish, the probability of catching this species will be lower than that of catching cod. Furthermore, the chances of catching cod in Vestfjorden (00) and Vesterålen (05) will be elevated in the spring due to the seasonal migration this species undergoes to spawn. This spawning time and location partially overlap with that for haddock, and large spawning aggregations will temporarily increase catchability (Bakketeig et al. 2017). In a fishery, the fishers will have experience and knowledge of the local conditions and seasonal abundances of the stocks, andstocks and will typically fish more where they anticipate higher catches of their target species.

The behaviour of a species, in both its environment and towards a given fishing gear, will directly affect its catchability (Crespin et al. 2008) . Demersal species, such as cod and haddock, are often targeted using a bottom trawl (Huse et al. 2000; Eide et al. 2003) , but might react to noise from the vessel towing the trawl and thus avoid it (Huse et al. 2000) . This behaviour could change depending on the vessels as the noise levels of the engines vary. Additionally, although species dependant, fish that are similar are likely to cluster together. Consequently, fish caught in the same fishing operation are likely to be more similar to each other than to the remainder of the population, known as intra-cluster correlation (Cochran 1977). A day’s catch from a vessel in the CRF is therefore considered a cluster of fish, and not a random selection of individuals from the total catch, or a population of fish (Nedreaas et al. 2006; Pennington and Helle 2011) . Thus, further v ariations in catches of e.g. golden redfish might be due to observed shoaling behaviour close to the seafloor during the day that disperses into the water column at night (Gauthier and Rose 2002). This change in activity and habitat preference would change the catchability of the species depending on the time of day. However, w hen calculating mean CPUE over an entire year, and looking at trends over long time scales, factors such as seasonality and individual fish behaviour will be evened out.

The size and morphology of a fish will affect their likelihood of getting caught depending on the specific gear used (Hamley 1975; Næsje et al. 2007). For example, the mesh size of a gillnet will determine if a fish will be able to swim right through, get caught, or make contact but not get entangled if the meshes are too small. However, the morphology of a species may increase the probability of entanglement (Hamley 1975; Næsje et al. 2007), e.g. the spikes on the dorsal fins of golden redfish might get tangled in the net even though the size of the individual is not targeted by the mesh sizes used. The catch of non-target species will decrease the available net area in which target species may get caught, reducing the efficiency of the net.

4.3 - Technological factors affecting catchability

Technological factors can largely be controlled for when planning a study or fishing operation, however they are also affected by seasonal and biological changes. Ideally, for abundance estimates, technological factors should be kept as standardised as possible to keep catchability constant, as each gear type has a different catchability coefficient. This is further influenced by the design, the size, the colour, and the material of each gear (Hamley 1975). For example, using a thinner twine in gillnets will increase the chance of entanglement if a fish comes in contract with the net, but if the twine is a colour which stands out from the background (such as red), the fish might see it and avoid the net altogether (Hamley 1975).

As fishery independent surveys data aim to provide a more accurate estimates of fish population characteristics and abundance indices to track stock size over time, the vessels, sampling design, and gears are mostly standardized consistent during scientific surveys. In the CRF, however, the composition of the fleet is constantly changing, and the vessels participating in 2019 were largely not the same ones as in 2007. This was also apparent when looking at the fishing patterns in the form of gear composition in each statistical area, which showed local changes with time, likely due to the exchange of vessels in the CRF. Thus, regarding standardised sampling for abundance, the variability of the CRF may not seem ideal; however, one of the aims of the CRF is to adequately represent the entire Norwegian coastal fishery. To fulfil this aim, a more varied fleet is desirable as the coastal fleet itself is very diverse, if the data collected from the CRF are to be representative of the whole coastal fishery along the Norwegian coast. Thus, several objectives must be balanced against each other when designing the composition of the CRF.

Focussing on gillnets, the total number of gillnets used showed some annual variations within each area (Figure 8), variations which were expected with the changes in the use of gillnets relative to other gear types (Figure 6). Although the number of gillnets deployed was recorded, the individual net length is not recorded by the CRF but is usually assumed to be 27.5 m. Gillnets that are longer or shorter than this will have different catchability coefficients due to the differences in surface area, however this would not be apparent from the data recorded by the CRF at present. Both the number of gillnets and the frequency of the different mesh size groups varied within each statistical area and between the areas over time. Gillnets are highly selective by e.g. adjusting the hanging ratio or mesh size to target different species and sizes (Hamley 1975; Næsje et al. 2007), however catch rates of any fish will depend on location, fishing depth, and soak time. In 2014, vessels in the costal fleet north of 62°N with a registered length of <11 metres were given an unlimited quota for cod by the DoF (DoF 2014). This could explain the increase in gillnets with mesh sizes of 80 to 110 mm, as these are often used to target cod (Berg 2019). There were also large seasonal differences in the mesh sizes used, for example the fishery targeting the angler takes place during the autumn, primarily using gillnets with mesh sizes >130 mm (Regulations on the practice of fishing in the sea 2005, § 34). These nets only need to be hauled every three days, as opposed to nets targeting cod and haddock, which have to be hauled every day according to regulations (Regulations on the practice of fishing in the sea 2005, § 28).

During a fishing operation, how the equipment is used further affects the probability of a certain catch. For passive gear, increased soak times will initially increase the number of specimens caught, however after some time the quality of the catch might decrease, and the remaining number of hooks on a longline or space in a gillnet will not be sufficient to secure a larger catch (Hamley 1975). Furthermore, the position of a gear could affect the size of the catch, by e.g. placing a gillnet perpendicular to the movement of a stock instead of along it or leaving it to soak overnight to catch nocturnally active species (Hamley 1975).

4.4 - Fishers' effect on catchability

Some of the temporal changes in CPUE may be an effect of the changing vessel composition of the CRF. CPUE for cod in East Finnmark (03) showed a drop in 2015 (Figure 15), likely due to one vessel leaving the program and another one entering. These fishers might have different target species, fish during different parts of the year, or fish in locations that are far apart while still being within the same statistical area. Size of the boat and engine power will also influence CPUE (Bishop 2006). Additionally, a s fishing is an intentional activity based on years of individual experience, when and where it occurs is not random (Hamley 1975). Thus, catchability is rarely a constant, as each fisher may improve with time both from experience and by technological advancements. As previously noted, the marine environment is a dynamic habitat where certain conditions might result in aggregations of fish. With experience, fishers target these fishing grounds to take advantage of these naturally high densities (Harvey et al. 2001; Petitgas et al. 2003) and might obtain large catches even though the overall abundance of a species is low . Good communication between fishers and scientists and knowledge about the individual vessels in a fleet and how they operate is therefore essential when interpreting the CPUE data (Maunder and Punt 2004; Maunder et al. 2006).

The objectives will also affect the catches, as a fisher tries to maximise catches of their target species while minimising any bycatch as this will be a waste of time and resources. An example of this is the regulations around the golden redfish fishery. Since 2014, this fishery has been closed with a bycatch limit of maximum 10% (Appendix 6). A fisher's catch composition is influenced by individual behaviour towards changes in regulations, e.g. aiming for the minimum or maximum allowable bycatch. Furthermore, fishers applying to partake in the CRF might be more interested in fisheries biology and conservation, and thus more likely to follow regulations to a stricter degree (Berg 2019). As seen in Figures 17, 22, and 23, golden redfish CPUE from the CRF has been low since this fishery closed in 2014, indicating that the fishers are trying to avoid catching it by using selectivity measures such as changing the fishing grounds and the mesh sizes of the gillnets. However, during surveys, the researchers are not trying to be selective, and comparisons with CPUE from survey data suggests that the stock levels of golden redfish were quite stable throughout the study perio d (Hatlebrekke 2021). For this species, survey data will therefore better reflect the status of the stock as it is assumed not as selective, while the fisheries behaviour suggest that they actively avoid catching golden redfish.

For the variety of reasons mentioned above, CPUE is not necessarily proportional to abundance. Oftentimes commercial CPUE remains high although abundance is declining (Harley et al. 2001), which is known as hyperstability (Hilborn and Walters 1992), and if not noticed thus may lead to biomass being overestimated while fishing mortality is underestimated (Crecco and Overholtz 1990). Within the CRF, different levels of sampling between the areas increases the variability and decreases the precision of the data, and as each vessel uses one primary gear or a small selection of gears, the data collected will be biased. However, when looking at comprehensive datasets over larger regions and longer time periods, this bias will be evened out and rather represent the diversity of the Norwegian coastal fisheries. To increase the resolution of the CRF data, the number of vessels would need to be increased as they are the primary sampling unit (Pennington and Helle 2011).

4.5 - Limitations

The CRF data base from 2007 to 2019 consisted of 295 372 individual catch records from 29 137 fishing operations. When working with such large datasets, there is an increased risk of human errors during recording, punching, and data handling. Similarly, misidentification of species or incorrect recording of data are likely to have occurred in the CRF. To prevent such mistakes, the IMR has organised workshops focussing on recognising and differentiating between e.g. different species of rays (Berg and Nedreaas 2021). These workshops might increase the taxonomic resolution of data collected afterwards. Moreover, previous studies have shown that data reporting from the vessels are not 100% consistent when compared with sales notes from landings. This could be due to not sampling all catches, or there being some technical error (Berg 2019). Additionally, as the data from the CRF are collected almost continuously, unexpected events such as illness or bad weather might prevent the hauling of gears. In addition to lowering the quality of the catch, the soak time recorded would be longer than usual. As the relationship between the IMR and the fishers is trust-based, these irregular data recordings are assumed to have been done with good reason. Furthermore, it is not possible to land all species at all locations along the coast. It is known that fishers might discard at sea what they know cannot be landed, instead of discarding it at port, as the fishers may end up having to pay to land unwanted species at the landing facilities. This could be prevented by increased local reception facilities, which would improve the data on species that are not commercially targeted (Berg and Nedreaas 2021).

Due to transitioning from the database Regfisk to Sea2Data at the IMR in 2014, some of the soak times for gillnets were incorrectly transferred. In Regfisk, a separate column was used when coding for durations longer than 99 hours, but unfortunately this column was lost in the conversion. Extensive effort has been made to rectify this in the CRF database, including during the present study, however it is likely that some errors remain undetected. Additionally, errors such as recording one hour as one minute have been detected and corrected by cross-referencing with individual length measurement forms by the IMR prior to this study.

5 - Conclusion

The Norwegian CRF is a dynamic fleet, and over the course of the study period the fishing pattern including gear types and mesh sizes changed in the CRF. This was partly due to the increased participation in seasonal fisheries. The most common species caught by the CRF was cod, and the most common gear used was gillnets. Large variations in CPUE for cod, haddock, and golden redfish were observed, and trends in CPUE varied between the statistical areas. Throughout the study period, regulations for golden redfish have been variable and increasingly restricted, explaining both the dissimilarities in the trends and CPUEs close to 0 for the CRF after 2014. Biological and technological factors affecting the catchability in commercial fisheries are evened out by calculating annual mean CPUE, although caution is advised when using CPUE from fisheries dependent catches to infer abundance of a stock. The technical variations offer, however, insight into the catch composition and fishing pattern of the coastal fisheries, and further analyses of the data collected by the CRF could increase the understanding of the species and the coastal fleet as a whole.

5.1 – CRF into the future

We believe that involving fishermen in scientific data collection will give the end users of scientific advice, i.e., also the fishers, an ownership to the data and hence create more trust in making “the scientific map match the terrain”. We think that an ecosystem and a resource will benefit from co-management and -monitoring and joint data collection of common resources. In this way the CRF provides a cheap way to collect data with a great spatial and temporal coverage, as long as the skipper behaviour is understood, and technology creep is monitored.

The DoF proposes to expand the obligatory data collection from the whole fishing fleet. The purpose is to collect better position and activity data from the smallest fishing fleet. The DoF believes that the data from the fleet below 15 meters will provide increased knowledge of stocks along the coast about which there is currently little data and provide better management of these stocks. This is especially true for the stationary stocks. Among other things, the knowledge will enable the administration to detect danger signals at an earlier stage. The position and effort data will be of great value to the marine land management and in the industry's own work to meet the requirements of various certification schemes. The requirements for tracking and reporting will be introduced step by step. Today, the fishing fleet over 15 meters is required to track via VMS (Vessel Monitoring System) and do catch reporting and to report on where to land the fish and time of landing via ERS (Electronic Reporting System). The new requirements for position and activity data are proposed to be introduced step by step and from 1 July 2022, the requirements for tracking and reporting will apply to the fishing fleet between 11 and 15 meters. For the smaller vessels between 10 and 10.99 meters, the requirements will apply from 1 March 2023 and from and including 1 January 2024 for all vessels under 10 meters.

The CRF will be important and helpful during the implementation progress of this obligatory data collection from the whole Norwegian fishing fleet less than 15 meter. The CRF may e.g., be used as a test fleet for quality assurance and comparisons, and for app development for efficient data handling at sea.

An obligatory electronic reporting of catch and effort from all vessels less than 15 meters will provide a huge dataset of CPUEs, and the main purpose of a CRF may hence slightly change towards more boats with competence and focus on biological self-sampling, and eventually a sampling lottery among these.

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7 - Appendices

7.1 - Appendix 1 – The Coastal Reference Fleet in 2016

Figure i. *The composition of the Norwegian Coastal Reference Fleet in 2016.*
Figur i. Sammensetningen av Kystreferanseflåten i 2016.

7.2 - Appendix 2 – Contributing vessels per statistical area

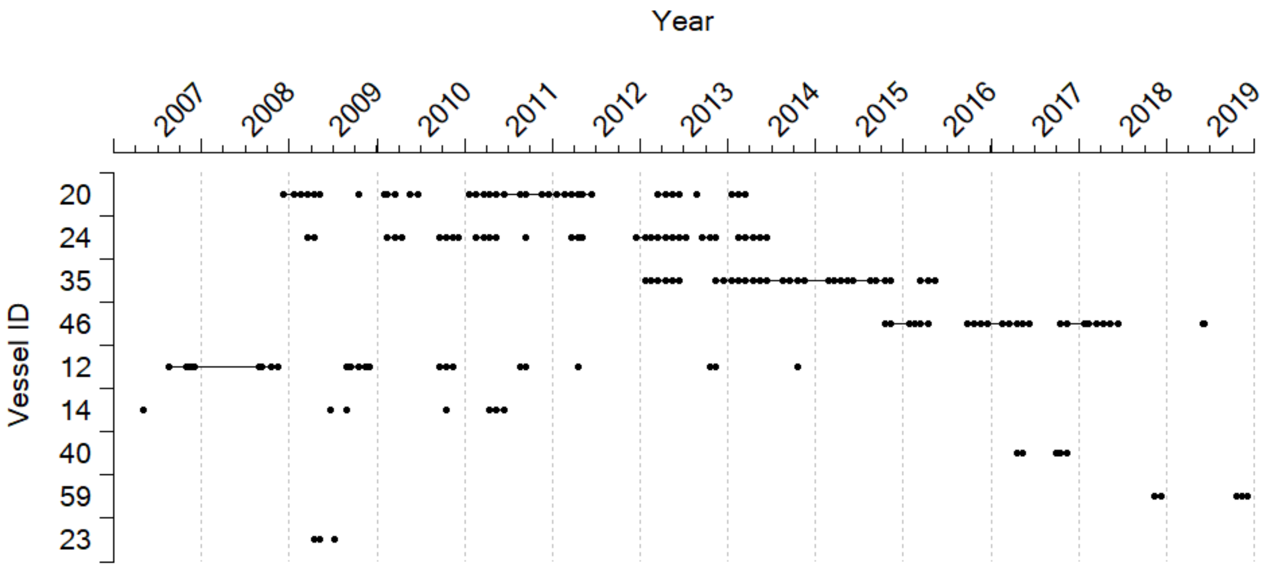

Figure ii. *The number of vessels contributing data to the Norwegian Coastal Reference Fleet in the statistical area East Finnmark (03). Each dot represents a month, and each line on the y-axis is a unique vessel. The vessels are sorted by how many months in which they registered data. A table with vessel ID and the corresponding call sign can be found in Appendix 3.*
Figur ii. Antall fartøy som samlet inn data i Kystreferanseflåten i det statistiske området Øst-Finnmark (03). Hver prikk representerer én måned, og hver linje på y-aksen er et unikt fartøy. Båtene er sortert basert på hvor mange måneder en båt har samlet inn data. En oversikt over vessel ID og korresponderende kallesignal er i Vedlegg 3.

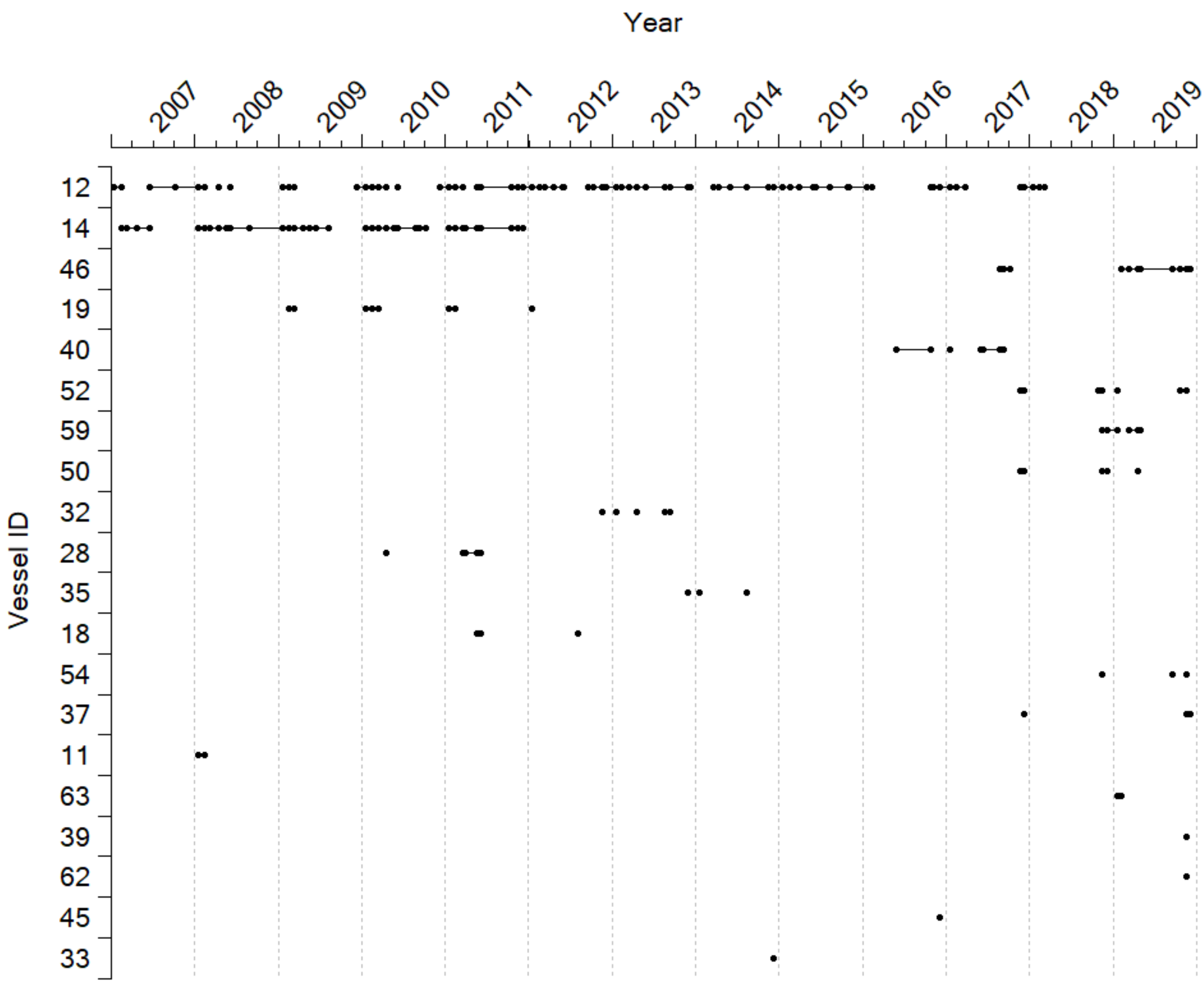

Figure iii. *The number of vessels contributing data to the Norwegian Coastal Reference Fleet in the statistical area Troms (04). Each dot represents a month, and each line on the y-axis is a unique vessel. The vessels are sorted by how many months in which they registered data. A table with vessel ID and the corresponding call sign can be found in Appendix 3.*
Figur iii. Antall fartøy som samlet inn data i Kystreferanseflåten i det statistiske området Troms (04). Hver prikk representerer én måned, og hver linje på y-aksen er et unikt fartøy. Båtene er sortert basert på hvor mange måneder en båt har samlet inn data. En oversikt over vessel ID og korresponderende kallesignal er i Vedlegg 3.

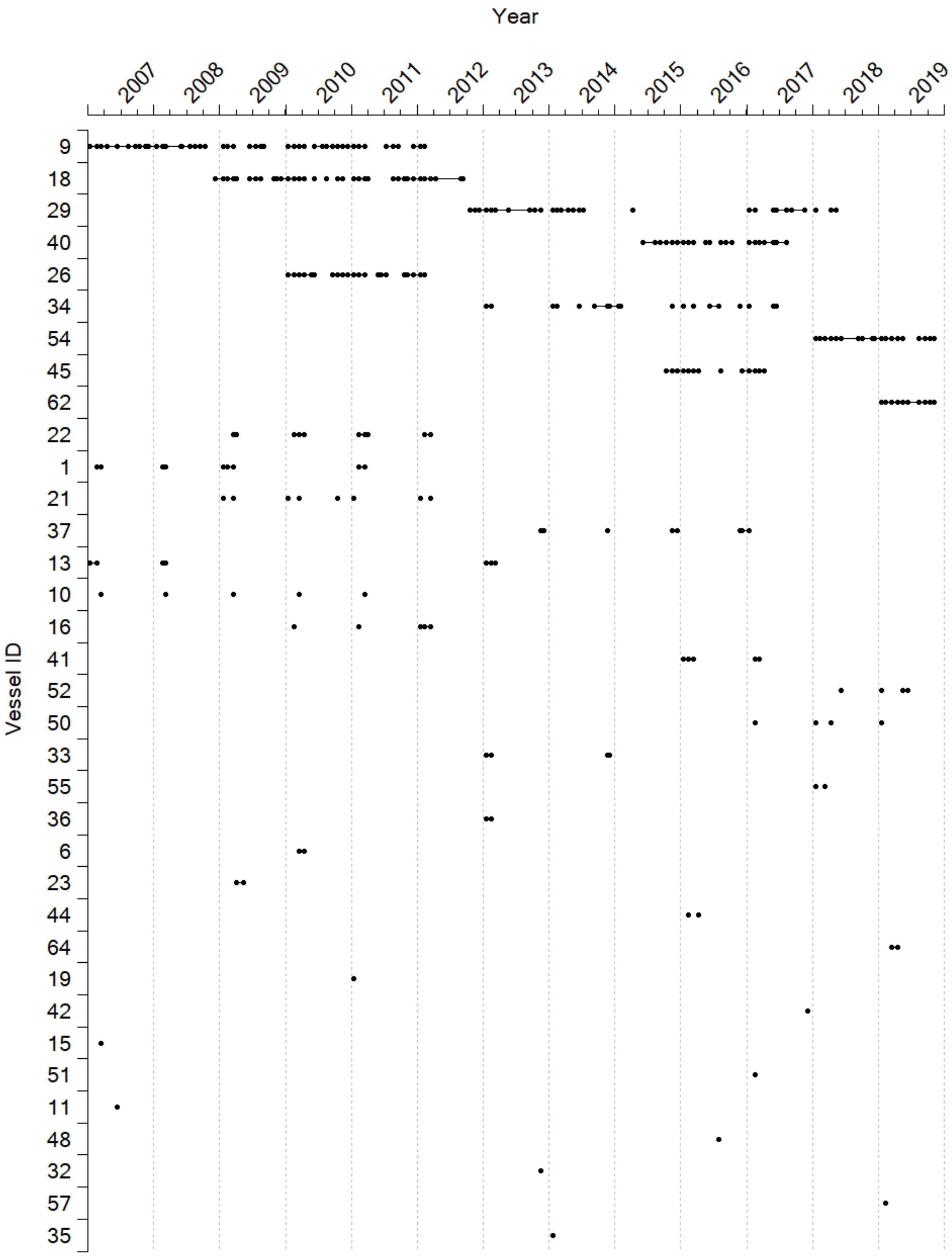

Figure iv. *The number of vessels contributing data to the Norwegian Coastal Reference Fleet in the statistical area Vesterålen (05). Each dot represents a month, and each line on the y-axis is a unique vessel. The vessels are sorted by how many months in which they registered data. A table with vessel ID and the corresponding call sign can be found in Appendix 3.*

Figur iv. Antall fartøy som samlet inn data i Kystreferanseflåten i det statistiske området Vesterålen (05). Hver prikk representerer én måned, og hver linje på y-aksen er et unikt fartøy. Båtene er sortert basert på hvor mange måneder en båt har samlet inn data. En oversikt over vessel ID og korresponderende kallesignal er i Vedlegg 3.

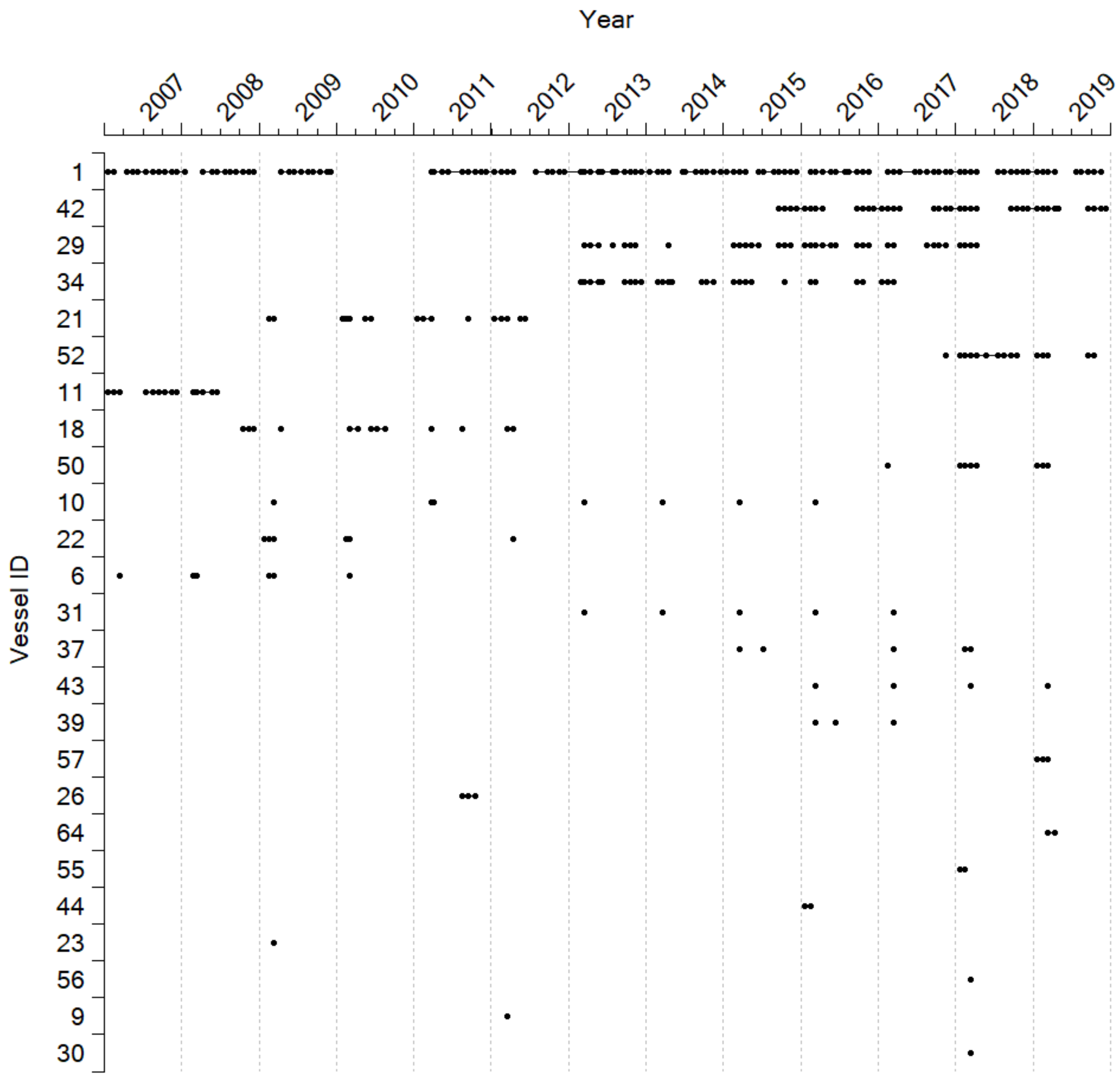

Figure v. *The number of vessels contributing data to the Norwegian Coastal Reference Fleet in the statistical area Vestfjorden (00). Each dot represents a month, and each line on the y-axis is a unique vessel. The vessels are sorted by how many months in which they registered data. A table with vessel ID and the corresponding call sign can be found in Appendix 3.*
Figur v. Antall fartøy som samlet inn data i Kystreferanseflåten i det statistiske området Vestfjorden (00). Hver prikk representerer én måned, og hver linje på y-aksen er et unikt fartøy. Båtene er sortert basert på hvor mange måneder en båt har samlet inn data. En oversikt over vessel ID og korresponderende kallesignal er i Vedlegg 3.

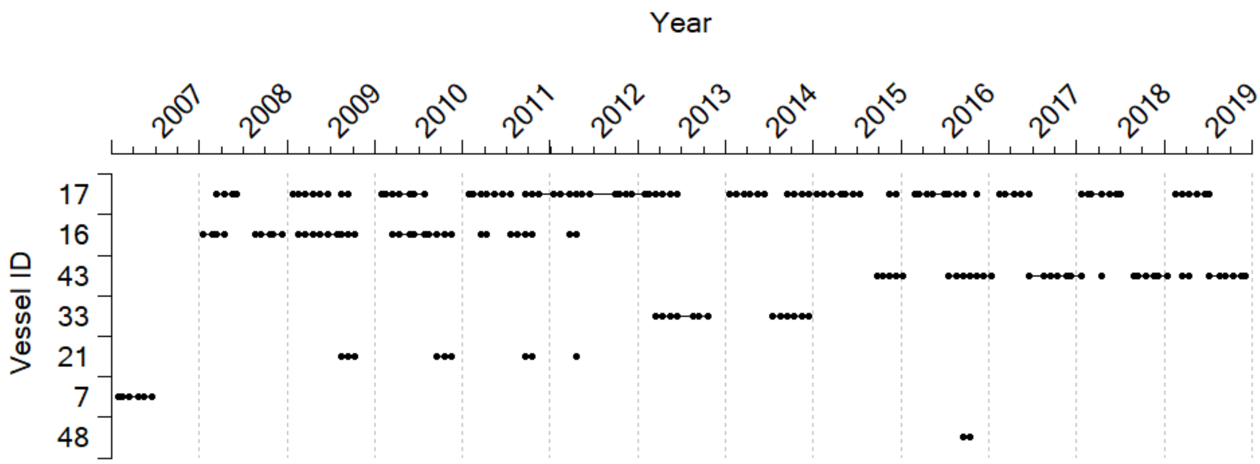

Figure vi. *The number of vessels contributing data to the Norwegian Coastal Reference Fleet in the statistical area Helgeland (06). Each dot represents a month, and each line on the y-axis is a unique vessel. The vessels are sorted by how many months in which they registered data. A table with vessel ID and the corresponding call sign can be found in Appendix 3.*
Figur vi. Antall fartøy som samlet inn data i Kystreferanseflåten i det statistiske området Helgeland (06). Hver prikk representerer én måned, og hver linje på y-aksen er et unikt fartøy. Båtene er sortert basert på hvor mange måneder en båt har samlet inn data. En oversikt over vessel ID og korresponderende kallesignal er i Vedlegg 3.

Figure vii. *The number of vessels contributing data to the Norwegian Coastal Reference Fleet in the statistical area Møre-Trøndelag (07). Each dot represents a month, and each line on the y-axis is a unique vessel. The vessels are sorted by how many months in which they registered data. A table with vessel ID and the corresponding call sign can be found in Appendix 3.*
Figur vii. Antall fartøy som samlet inn data i Kystreferanseflåten i det statistiske området Møre-Trøndelag (07). Hver prikk representerer én måned, og hver linje på y-aksen er et unikt fartøy. Båtene er sortert basert på hvor mange måneder en båt har samlet inn data. En oversikt over vessel ID og korresponderende kallesignal er i Vedlegg 3.

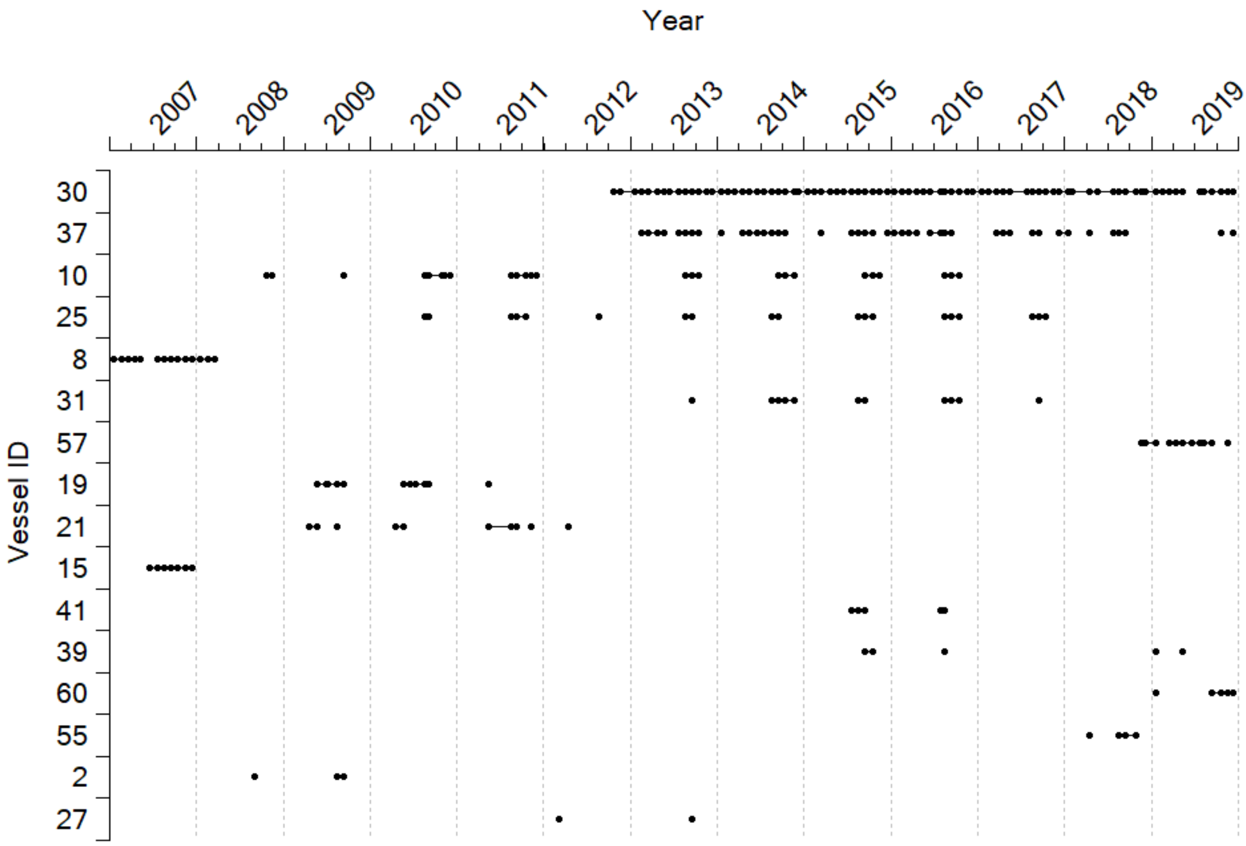

Figure viii. *The number of vessels contributing data to the Norwegian Coastal Reference Fleet in the statistical area Stad-Austevoll (28). Each dot represents a month, and each line on the y-axis is a unique vessel. The vessels are sorted by how many months in which they registered data. A table with vessel ID and the corresponding call sign can be found in Appendix 3.*
Figur viii. Antall fartøy som samlet inn data i Kystreferanseflåten i det statistiske området Stad-Austevoll (28). Hver prikk representerer én måned, og hver linje på y-aksen er et unikt fartøy. Båtene er sortert basert på hvor mange måneder en båt har samlet inn data. En oversikt over vessel ID og korresponderende kallesignal er i Vedlegg 3.

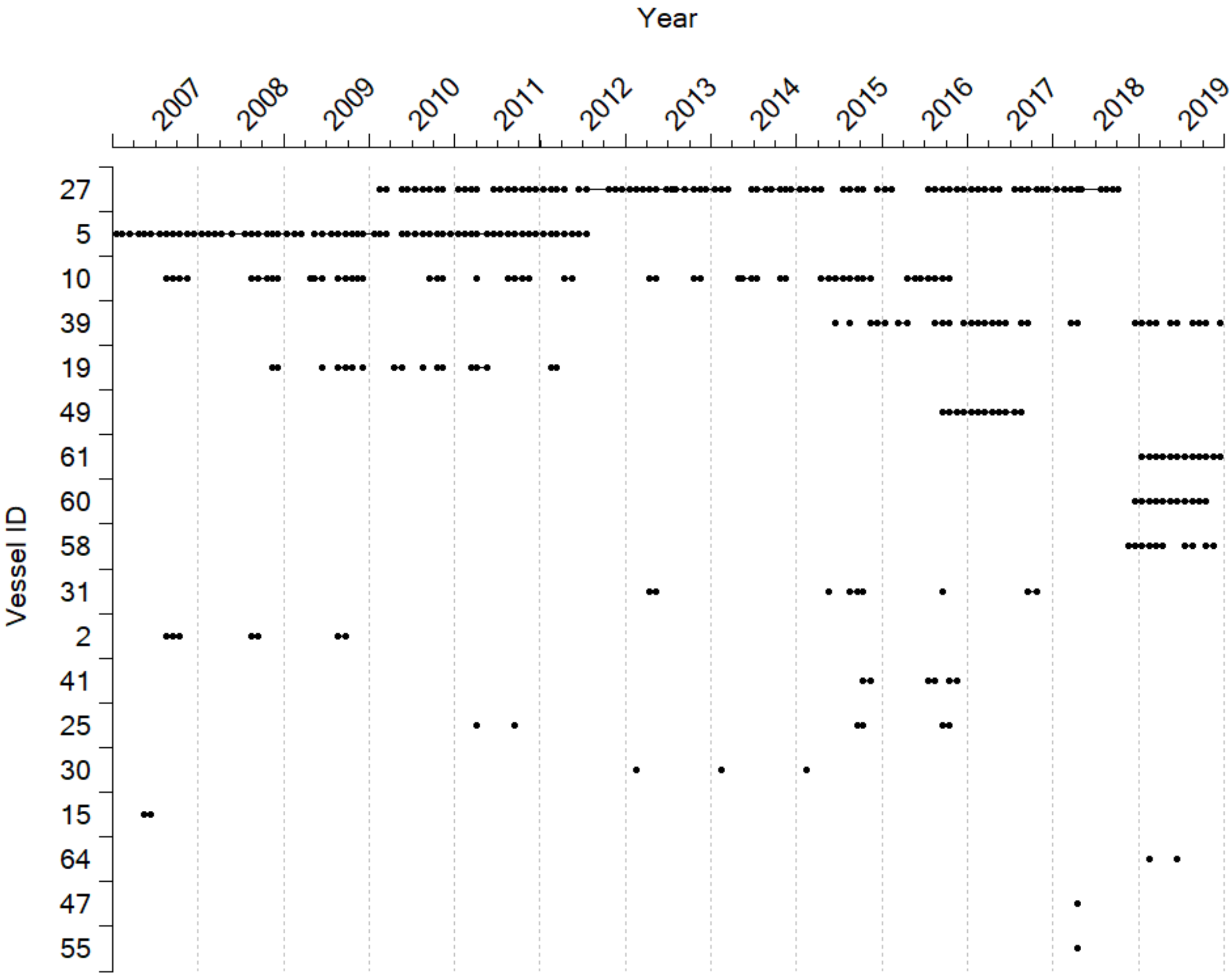

Figure ix. *The number of vessels contributing data to the Norwegian Coastal Reference Fleet in the statistical area Austevoll-Lindesnes (08). Each dot represents a month, and each line on the y-axis is a unique vessel. The vessels are sorted by how many months in which they registered data. A table with vessel ID and the corresponding call sign can be found in Appendix 3*
Figur ix. Antall fartøy som samlet inn data i Kystreferanseflåten i det statistiske området Austevoll-Lindesnes (08). Hver prikk representerer én måned, og hver linje på y-aksen er et unikt fartøy. Båtene er sortert basert på hvor mange måneder en båt har samlet inn data. En oversikt over vessel ID og korresponderende kallesignal er i Vedlegg 3.

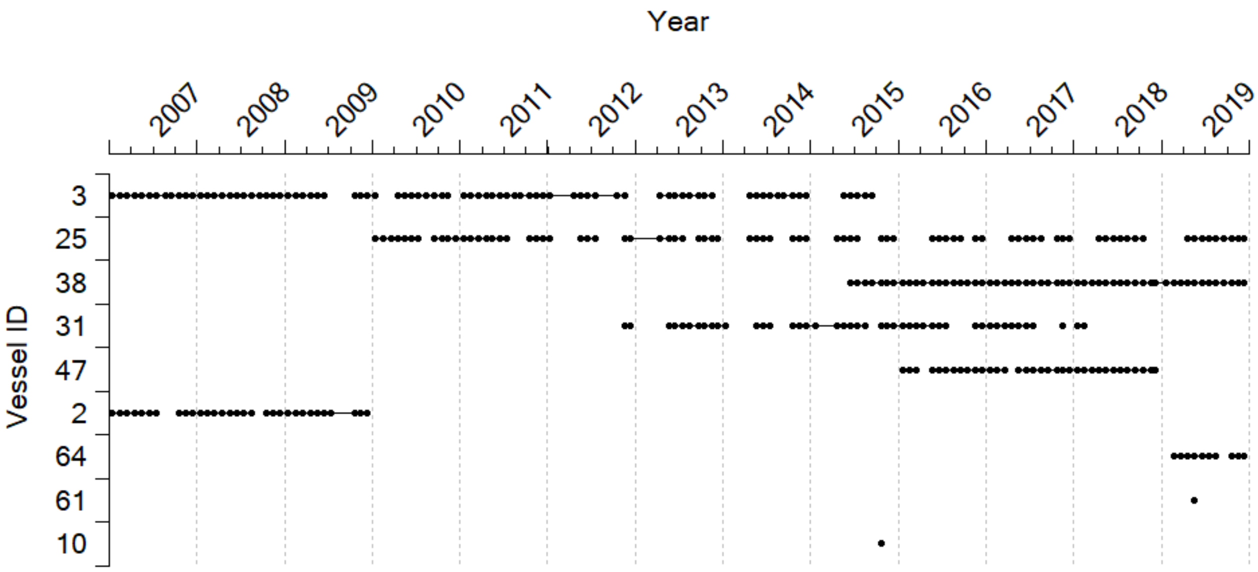

Figure x. *The number of vessels contributing data to the Norwegian Coastal Reference Fleet in the statistical area Skagerrak (09). Each dot represents a month, and each line on the y-axis is a unique vessel. The vessels are sorted by how many months in which they registered data. A table with vessel ID and the corresponding call sign can be found in Appendix 3.*
Figur x. Antall fartøy som samlet inn data i Kystreferanseflåten i det statistiske området Skagerrak (09). Hver prikk representerer én måned, og hver linje på y-aksen er et unikt fartøy. Båtene er sortert basert på hvor mange måneder en båt har samlet inn data. En oversikt over vessel ID og korresponderende kallesignal er i Vedlegg 3.

7.3 - Appendix 3 – Vessel ID

Table i. Vessel ID and the corresponding unique call sign.

Tabell i. *Vessel ID og korresponderende kallesignal.*

Vessel ID	Call sign	Vessel ID	Call sign
1	LK5016	33	LM9649
2	LK5874	34	LK5948
3	LM7915	35	LK3293
4	LK7141	36	LK2569
5	LK4399	37	LM5970
6	LM5498	38	LM3995
7	LK3175	39	LG7405
8	LM7949	40	LK5647
9	LK3988	41	LK9305
10	LK3270	42	LK6737
11	LM8020	43	LK5045
12	LM2864	44	LK5160
13	LK3697	45	LM8662
14	LK2234	46	LM2890
15	LK6828	47	LK5352
16	LK8734	48	LK2759
17	LK4789	49	LG9311
18	LK3041	50	LG4010
19	LK5711	51	LCFH
20	LK8820	52	LK5376
21	LK4154	53	LG3690
22	LK6977	54	LK3925
23	LK7126	55	LG3013
24	LK3860	56	LK7442
25	LK5485	57	LG4914
26	LK6598	58	LM8940
27	LK6606	59	LK7556
28	LG3457	60	LK6326
29	LM8308	61	LKZZ
30	LK6966	62	LM7459
31	LK7238	63	LG7408
32	LK6531	64	LH2820

7.4 - Appendix 4 – All taxa caught during the study period

Table ii. All taxa caught by the Norwegian Coastal Reference Fleet between 2007 and 2019 sorted by %IRI (Index of Relative Importance). % Number is primarily discarded specimens; % Weight (kg) is primarily landed catch.

Tabell ii. *Alle arter og taksonomiske grupper som ble fanget av Kystreferanseflåten mellom 2007 og 2019 sortert etter %IRI (i ndeks for relativ viktighet). % Number er primært utkast; % Weight (kg) er primært beholdt fangst.*

Species	No	% No	Weight (kg)	% Weight	% FRQ	% IRI
Gadus morhua	890844	4.4	21788450	44.7	60.9	53.4
Pollachius virens	815643	4	9182870	18.8	52.9	21.5
Melanogrammus aeglefinus	200208	1	2359578	4.8	41.6	4.3
Cancer pagurus	886224	4.3	57239	0.1	47.9	3.8
Molva molva	196434	1	1989090	4.1	39.3	3.5
Pandalus borealis	6346554	31.1	459248	0.9	3.8	2.1
Scomber scombrus	1730367	8.5	4195639	8.6	6.4	2
Ctenolabrus rupestris	2970548	14.6	46	0	5.4	1.4
Lophius piscatorius	70113	0.3	1290151	2.6	26.3	1.4
Symphodus melops	2580543	12.6	3343	0	5.4	1.2
Pollachius pollachius	100394	0.5	655623	1.3	33.8	1.1
Clupea harengus	1362984	6.7	3791967	7.8	3.9	1
Lithodes maja	227930	1.1	253	0	42.4	0.8
Brosme brosme	30817	0.2	461993	0.9	20.2	0.4
Sebastes norvegicus	75791	0.4	517931	1.1	14.5	0.4
Hippoglossus hippoglossus	30031	0.1	289079	0.6	26.7	0.4
Merluccius merluccius	32884	0.2	251311	0.5	17.4	0.2
Squalus acanthias	55669	0.3	214699	0.4	11.6	0.1
Chimaera monstrosa	64638	0.3	2591	0	22.8	0.1
Carcinus maenas	315309	1.5	0	0	3.5	0.1
Labrus bergylta	160192	0.8	647	0	6.8	0.1
Centrolabrus exoletus	266965	1.3	53	0	4	0.1
Trachurus trachurus	57473	0.3	293657	0.6	3	0
Labrus mixtus	83529	0.4	2	0	5.5	0
Etmopterus spinax	45763	0.2	1755	0	8.8	0

Table ii. Continued.

Tabell ii. *Fortsettelse tabell ii*

Species	No	% No	Weight (kg)	% Weight	% FRQ	% IRI
Trisopterus esmarkii	62699	0.3	25483	0.1	4.1	0
Nephrops norvegicus	72776	0.4	15818	0	3.3	0
Cyclopterus lumpus	23412	0.1	38848	0.1	6.5	0
Merlangius merlangus	24174	0.1	8191	0	7.6	0
Galeus melastomus	22890	0.1	1127	0	8.7	0
Sebastes viviparus	20269	0.1	321	0	9.6	0
Pleuronectes platessa	10170	0	22351	0	8.9	0
Reinhardtius hippoglossoides	49163	0.2	545375	1.1	0.6	0
Anguilla anguilla	31363	0.2	6247	0	4.3	0
Trisopterus minutus	21325	0.1	8	0	6.2	0
Glyptocephalus cynoglossus	19457	0.1	2844	0	6.2	0
Lepidorhombus whiffiagonis	15294	0.1	510	0	8	0
Microstomus kitt	12103	0.1	1016	0	7.5	0
Amblyraja radiata	9452	0	2387	0	6.8	0
Paralithodes camtschaticus	36500	0.2	33449	0.1	1.4	0
Cottidae	29280	0.1	15	0	2.3	0
Homarus gammarus	16197	0.1	594	0	3.9	0
Micromesistius poutassou	16675	0.1	4015	0	3.3	0
Eutrigla gurnardus	9079	0	290	0	5.3	0
Molva dypterygia	9634	0	10048	0	3.5	0
Rajidae	4738	0	30919	0.1	2.7	0
Argentina silus	12797	0.1	2898	0	3	0
Raja clavata	5526	0	7459	0	4.6	0
Lithodidae	12795	0.1	13	0	3.1	0
Gobius niger	20138	0.1	0	0	1.7	0
Dendrobranchiata	420	0	26443	0.1	2.5	0
Dipturus oxyrinchus	3658	0	16792	0	2.6	0
Hippoglossoides platessoides	7338	0	400	0	3.5	0
Labridae	61735	0.3	0	0	0.4	0
Munida	14055	0.1	79	0	1.3	0
Zoarces viviparus	9407	0	0	0	1.8	0
Myoxocephalus scorpius	13499	0.1	0	0	1.2	0
Phycis blennoides	4179	0	809	0	3.2	0
Anarhichas lupus	848	0	9280	0	2.9	0
Sebastes	1465	0	10191	0	2	0

Table ii. Continued.

Tabell ii. *Fortsettelse tabell ii*

Species	No	% No	Weight (kg)	% Weight	% FRQ	% IRI
Limanda limanda	4890	0	54	0	2.2	0
Ciliata mustela	9240	0	0	0	1.1	0
Lipophrys pholis	7292	0	0	0	1.3	0
Pholis gunnellus	5912	0	0	0	1.3	0
Gobiidae	12334	0.1	0	0	0.6	0
Raniceps raninus	3268	0	0	0	1.7	0
Pleuronectidae	2627	0	4488	0	1	0
Macrourus berglax	9474	0	2689	0	0.3	0
Dipturus linteus	1165	0	5389	0	1	0
Scophthalmus maximus	770	0	3096	0	1.5	0
Platichthys flesus	2321	0	44	0	1.3	0
Caridea	597	0	30892	0.1	0.2	0
Phocoena phocoena	1010	0	100	0	2.2	0
Gaidropsarus	3332	0	5	0	0.7	0
Taurulus bubalis	4215	0	0	0	0.5	0
Cephalopoda	2512	0	144	0	0.8	0
Rajiformes	812	0	4605	0	0.7	0
Sprattus sprattus	315	0	56671	0.1	0.1	0
Scyliorhinus canicula	1094	0	2	0	1.6	0
Gadiculus argenteus	3152	0	214	0	0.5	0
Anarhichas minor	49	0	5963	0	0.5	0
Ommastrephidae	1943	0	121	0	0.6	0
Holothuroidea	1296	0	3	0	0.9	0
Sebastes mentella	431	0	3871	0	0.6	0
Dipturus batis	202	0	5421	0	0.4	0
Coryphaenoides rupestris	1519	0	245	0	0.6	0
Salmo salar	552	0	2359	0	0.6	0
Asteroidea	1226	0	0	0	0.7	0
Brachyura	4239	0	6	0	0.2	0
Syngnathidae	1783	0	0	0	0.4	0
Myctophiformes	1508	0	204	0	0.5	0
Lamna nasus	139	0	3497	0	0.4	0
Argentina sphyraena	1869	0	124	0	0.3	0
Bathyraja spinicauda	443	0	2816	0	0.3	0
Chirolophis ascanii	906	0	0	0	0.5	0

Table ii. Continued.

Tabell ii. *Fortsettelse tabell ii*

Species	No	% No	Weight (kg)	% Weight	% FRQ	% IRI
Entelurus aequoreus	1629	0	0	0	0.3	0
Anomura	1189	0	8	0	0.3	0
Coleoidea	1251	0	0	0	0.3	0
Parastichopus tremulus	808	0	0	0	0.5	0
Hyas	852	0	0	0	0.4	0
Echinidea	753	0	0	0	0.4	0
Zeugopterus punctatus	485	0	0	0	0.6	0
Leucoraja circularis	824	0	47	0	0.4	0
Micrenophrys lilljeborgii	1634	0	0	0	0.1	0
Zeus faber	326	0	132	0	0.6	0
Fulmarus glacialis	442	0	0	0	0.5	0
Phoca vitulina	237	0	70	0	0.6	0
Geryonidae	485	0	0	0	0.3	0
Geryon trispinosus	381	0	0	0	0.3	0
Gaidropsarus vulgaris	337	0	0	0	0.3	0
Animalia	153	0	118	0	0.5	0
Somniosus microcephalus	137	0	780	0	0.2	0
Scorpaenidae	22	0	1555	0	0.1	0
Uria aalge	377	0	0	0	0.2	0
Portunidae	352	0	6	0	0.2	0
Syngnathus typhle	954	0	0	0	0.1	0
Anarhichadidae	131	0	247	0	0.3	0
Gobiusculus flavescens	491	0	0	0	0.1	0
Zoarcidae	495	0	0	0	0.1	0
Rajella fyllae	199	0	117	0	0.2	0
Pasiphaea	160	0	739	0	0.1	0
Solea solea	171	0	14	0	0.2	0
Crustacea	235	0	13	0	0.2	0
Lycodes gracilis	1142	0	0	0	0	0
Acantholabrus palloni	278	0	3	0	0.1	0
Lophius budegassa	73	0	315	0	0.2	0
Scophthalmus rhombus	124	0	101	0	0.2	0
Lycodes	224	0	1	0	0.1	0
Belone belone	205	0	30	0	0.1	0
Anarhichas denticulatus	209	0	69	0	0.1	0

Table ii. Continued.

Tabell ii. *Fortsettelse tabell ii*

Species	No	% No	Weight (kg)	% Weight	% FRQ	% IRI
Pasiphaea sivado	80	0	376	0	0.1	0
Helicolenus dactylopterus	121	0	19	0	0.2	0
Copepoda	347	0	9	0	0.1	0
Morus bassanus	115	0	0	0	0.2	0
Scorpaeniformes	346	0	490	0	0	0
Alca torda	109	0	0	0	0.2	0
Molva	33	0	718	0	0	0
Chlorophyta	2779	0	0	0	0	0
Chimaeriformes	189	0	0	0	0.1	0
Galeorhinus galeus	33	0	261	0	0.1	0
Enchelyopus cimbrius	105	0	3	0	0.1	0
Phalacrocorax	78	0	0	0	0.2	0
Pomatoschistus minutus	195	0	0	0	0.1	0
Trisopterus luscus	89	0	0	0	0.1	0
Rissa tridactyla	78	0	0	0	0.1	0
Lophiiformes	249	0	0	0	0	0
Larus marinus	87	0	0	0	0.1	0
Mullus surmuletus	63	0	0	0	0.1	0
Trachinus draco	71	0	0	0	0.1	0
Scomber colias	107	0	0	0	0.1	0
Ophiuroidea	123	0	0	0	0	0
Conger conger	63	0	18	0	0.1	0
Urophycis chuss	80	0	1	0	0.1	0
Paguridae	80	0	0	0	0.1	0
Buccinum undatum	60	0	0	0	0.1	0
Syngnathiformes	76	0	0	0	0.1	0
Larus argentatus	60	0	0	0	0.1	0
Actiniaria	63	0	3	0	0.1	0
Ammodytidae	81	0	9	0	0.1	0
Hyperoplus lanceolatus	93	0	0	0	0	0
Salmo trutta	31	0	33	0	0.1	0
Mallotus villosus	58	0	0	0	0.1	0
Pleuronectiformes	98	0	14	0	0	0
Echinidae	65	0	0	0	0	0
Searsia	0	0	2602	0	0	0

Table ii. Continued.

Tabell ii. *Fortsettelse tabell ii*

Species	No	% No	Weight (kg)	% Weight	% FRQ	% IRI
Boreogadus saida	46	0	25	0	0.1	0
Cepphus grylle	56	0	0	0	0.1	0
Leucoraja fullonica	78	0	0	0	0	0
Cetorhinus maximus	32	0	0	0	0.1	0
Zoarcoidei	94	0	0	0	0	0
Alosa fallax	83	0	0	0	0	0
Notoscopelus kroyeri	45	0	2	0	0.1	0
Octopoda	87	0	2	0	0	0
Myxine glutinosa	49	0	0	0	0	0
Paromola cuvieri	28	0	2	0	0.1	0
Macropipus	56	0	0	0	0	0
Amblyraja hyperborea	57	0	4	0	0	0
Trisopterus	31	0	0	0	0	0
Dipturus nidarosiensis	20	0	30	0	0	0
Dicentrarchus labrax	41	0	11	0	0	0
Halichoerus grypus	22	0	0	0	0.1	0
Carcharhiniformes	27	0	0	0	0	0
Larus	25	0	0	0	0	0
Somateria mollissima	34	0	0	0	0	0
Myctophidae	28	0	20	0	0	0
Gadiformes	49	0	46	0	0	0
Clupeidae	66	0	0	0	0	0
Triglidae	23	0	0	0	0	0
Lycodes esmarkii	52	0	0	0	0	0
Lagenorhynchus	20	0	0	0	0	0
Squaliformes	34	0	0	0	0	0
Fratercula arctica	36	0	0	0	0	0
Callionymus lyra	14	0	0	0	0	0
Maurolicus muelleri	50	0	1	0	0	0
Capros aper	13	0	0	0	0	0
Gonostomatidae	23	0	2	0	0	0
Chelidonichthys lucerna	14	0	0	0	0	0
Callionymoidei	14	0	0	0	0	0
Eumicrotremus derjugini	70	0	0	0	0	0
Gobioidei	19	0	0	0	0	0

Table ii. Continued.

Tabell ii. *Fortsettelse tabell ii*

Species	No	% No	Weight (kg)	% Weight	% FRQ	% IRI
Macropodia rostrata	22	0	0	0	0	0
Anarhichas	10	0	15	0	0	0
Lumpenus lampretaeformis	13	0	0	0	0	0
Porifera	50	0	2	0	0	0
Gaidropsarus mediterraneus	20	0	0	0	0	0
Anguilliformes	31	0	0	0	0	0
Centrolophus niger	13	0	0	0	0	0
Sarda sarda	20	0	24	0	0	0
Bathyraja brachyurops	11	0	0	0	0	0
Myctophum punctatum	11	0	0	0	0	0
Gastropoda	15	0	0	0	0	0
Blenniidae	23	0	0	0	0	0
Cyclopteridae	8	0	5	0	0	0
Argentina	3	0	40	0	0	0
Plantae	45	0	0	0	0	0
Benthosema glaciale	11	0	0	0	0	0
Elasmobranchii	10	0	0	0	0	0
Cancer bellianus	6	0	0	0	0	0
Raja	5	0	30	0	0	0
Raja montagui	3	0	30	0	0	0
Chionoecetes opilio	5	0	0	0	0	0
Phalacrocorax carbo	5	0	0	0	0	0
Petromyzontiformes	5	0	0	0	0	0
Brama brama	5	0	0	0	0	0
Colossendeis	6	0	0	0	0	0
Gadidae	12	0	0	0	0	0
Phrynorhombus norvegicus	5	0	0	0	0	0
Soleidae	4	0	1	0	0	0
Pectinidae	0	0	9	0	0	0
Pasiphaea affinis	14	0	0	0	0	0
Larus fuscus	4	0	0	0	0	0
Actiniidae	6	0	0	0	0	0
Anguillidae	11	0	0	0	0	0
Echeneidae	10	0	0	0	0	0
Adamsia palliata	5	0	0	0	0	0

Table ii. Continued.

Tabell ii. *Fortsettelse tabell ii*

Species	No	% No	Weight (kg)	% Weight	% FRQ	% IRI
Stichaeidae	10	0	0	0	0	0
Oncorhynchus mykiss	2	0	7	0	0	0
Pusa hispida	3	0	0	0	0	0
Ceramaster granularis	1	0	8	0	0	0
Mola mola	2	0	2	0	0	0
Squalidae	2	0	1	0	0	0
Mytilus edulis	5	0	0	0	0	0
Rhodichthys regina	5	0	0	0	0	0
Echinus esculentus	4	0	0	0	0	0
Aves	2	0	0	0	0	0
Mytilidae	2	0	0	0	0	0
Lagenorhynchus albirostris	2	0	0	0	0	0
Sclerocrangon	4	0	0	0	0	0
Pagophilus groenlandicus	2	0	0	0	0	0
Lutra lutra	2	0	0	0	0	0
Syngnathus acus	2	0	0	0	0	0
Beryx	2	0	0	0	0	0
Phocidae	2	0	0	0	0	0
Zeiformes	2	0	0	0	0	0
Agonus cataphractus	2	0	0	0	0	0
Protomyctophum arcticum	3	0	0	0	0	0
Lysiosquillidae	3	0	0	0	0	0
Aurelia	3	0	0	0	0	0
Lanice	3	0	0	0	0	0
Larus ridibundus	3	0	0	0	0	0
Todarodes sagittatus	1	0	3	0	0	0
Callionymus	2	0	0	0	0	0
Mullidae	2	0	0	0	0	0
Buccinidae	2	0	0	0	0	0
Spirobranchus triqueter	2	0	0	0	0	0
Syngnathus	2	0	0	0	0	0
Chaetognatha	1	0	0	0	0	0
Callionymidae	1	0	0	0	0	0
Arctozenus risso	1	0	0	0	0	0
Remora remora	1	0	0	0	0	0

Table ii. Continued.

Tabell ii. *Fortsettelse tabell ii*

Species	No	% No	Weight (kg)	% Weight	% FRQ	% IRI
Hyas coarctatus	1	0	0	0	0	0
Gorgonocephalus caputmedusae	1	0	0	0	0	0
Lycenchelys sarsii	1	0	0	0	0	0
Labroidei	1	0	0	0	0	0
Gaidropsarus argentatus	1	0	0	0	0	0
Mora moro	1	0	0	0	0	0
Lamnidae	1	0	0	0	0	0
Petromyzontidae	1	0	0	0	0	0
Lophius	1	0	0	0	0	0
Lycaeidae	1	0	0	0	0	0
Spinachia spinachia	1	0	0	0	0	0
Petromyzon marinus	1	0	0	0	0	0
Centroscymnus coelolepis	1	0	0	0	0	0
Globicephala melas	1	0	0	0	0	0
Prionace glauca	1	0	0	0	0	0
Cumacea	0	0	2	0	0	0
Pisces	0	0	2	0	0	0
Total	2E+07	100	48773695	100	-	100

7.5 - Appendix 5 - Sales notes from the entire Norwegian coastal fleet

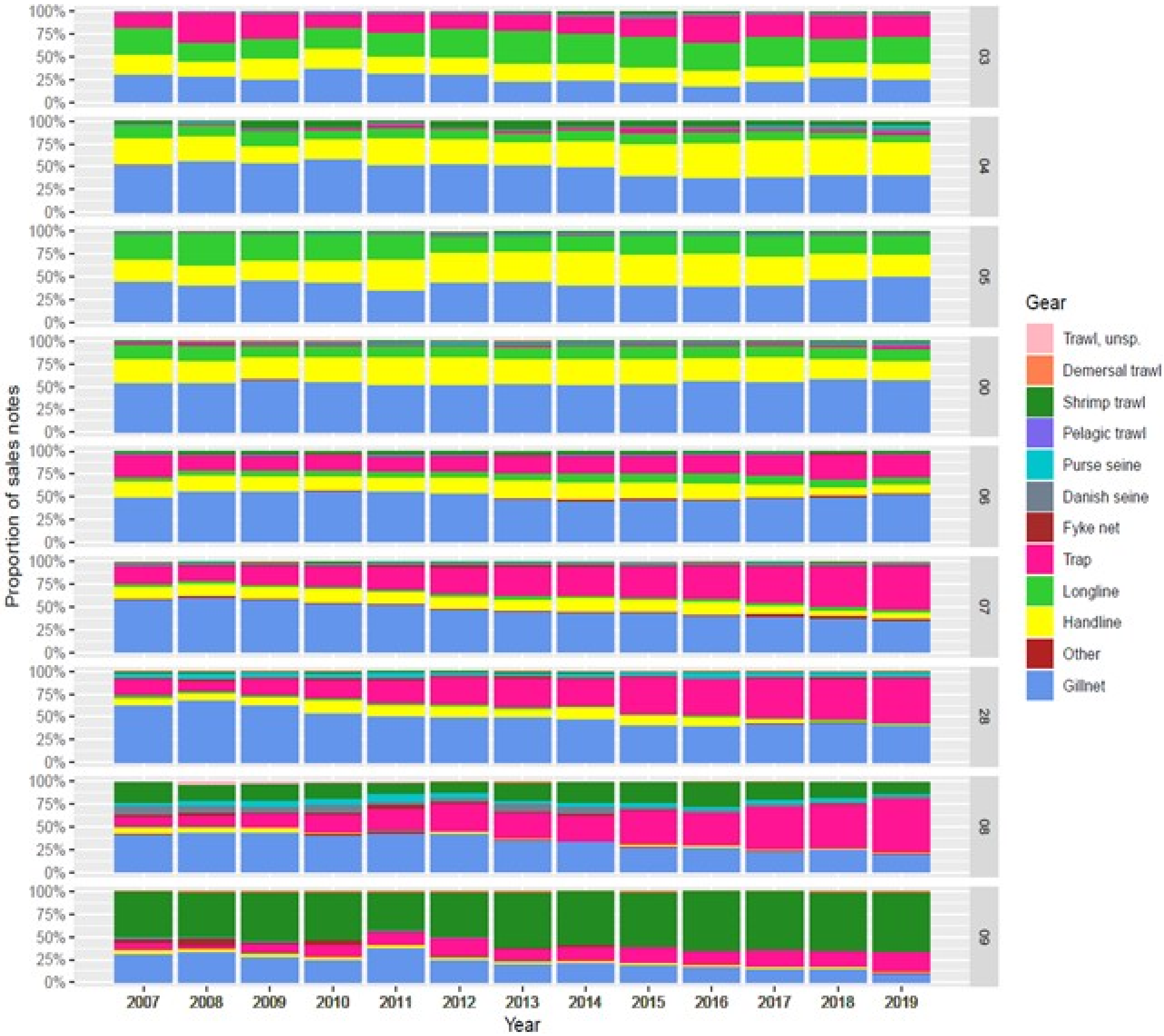

Figure xi. *The gear composition of vessels smaller than 15 m in the Norwegian coastal fleet, based on the number of sales notes per gear type*

Figur xi. Redskapsfordeling for fartøy mindre enn 15 m i den norske kystflåten basert på antall sluttsedler med oppgitt redskap

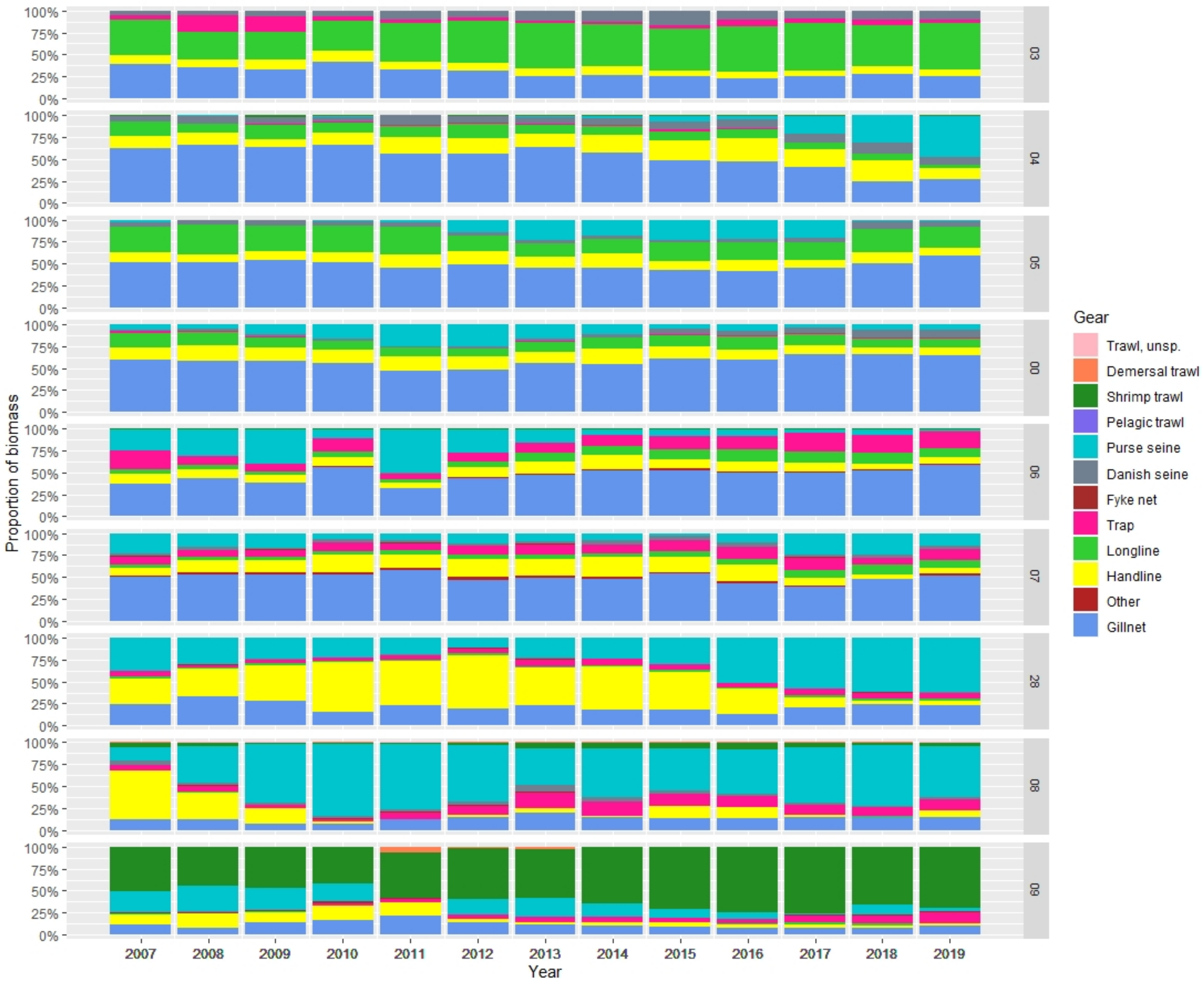

Figure xii. *The gear composition of vessels smaller than 15 m in the Norwegian coastal fleet based on the biomass reported in the sales notes per gear type*
Figur xii. Redskapsfordeling for fartøy mindre enn 15 m i den norske kystflåten fordelt i henhold til rapportert sluttseddel biomasse

7.6 - Appendix 6 - Golden redfish regulations

Table iii. The regulations regarding the golden redfish (*Sebastes norvegicus*) coastal gillnet fishery in Norwegian waters north of 62°N (Regulations on the practice of fishing in the sea 2005, § 34).
Tabell iii. Reguleringer på kystfisket etter vanlig uer (Sebastes norvegicus) *med garn i norske farvann nord for 62. breddegrad (Forskrift om utøvelse av fisket i sjøen 2005, § 34).*

Year	General bycatch	Seasonal bycatch	Closed season
2007	None	15% during the closed season	March-June and September
2008	None	20% during the closed season	March-June and September
2009	None	20% during the closed season	March-June and September
2010	None	20% during the closed season	March-June and September
2011	None	20% during the closed season	March-June and September
2012	None	25% during the closed season	20.12-31.7 and September
2013	None	25% during the closed season	20.12-31.7 and September
2014	25%	50% during 1-31.8 and 1.10-20.12	All year
2015	25%	50% during 1-31.8 and 1.10-20.12	All year
2016	10%	30% during 1.8-31.12	All year
2017	10%	30% during 1.8-31.12	All year
2018	10%	30% during 1.8-31.12	All year
2019	10%	30% during 1.8-31.12	All year

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