CHAPTER 4: Fishing in the Past: the spatial dynamics of the Belgian sea fisheries during the 20th century

CHAPTER 4. THE SPATIAL DYNAMICS OF THE BELGIAN SEA FISHERIES DURING THE 20TH CENTURY

ABSTRACT

Historically, fleet dynamics have received less attention than the aspects of population dynamics in fisheries research. However, to understand trends in the volume of landings and changes in the catch per unit of effort and in the economic returns by the fleet, spatio-temporally explicit information is needed. The integration of historical time series on the landings and value of landings of Belgian sea fisheries, by fishing area, allows for a spatial analysis of broad-scaled historical preference of different Belgian fisheries for specific fishing areas. It documents changes in the relative importance of fishing areas for the Belgian fisheries as well as changes in composition of landings from within fishing areas over 8 decades (1929-2009) and underlines the historical importance of the 'coastal waters' to the Belgian fisheries. Finally, qualitative and quantitative statements about the spatial dynamics of Belgian fisheries in published sources are validated and, where not supported by our data, challenged. Some of the cause-effect relations that may explain the spatial dynamics of Belgian sea fisheries, are explored.

Key words:

Fisheries, Belgium, sea use, spatial dynamics

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4.1. INTRODUCTION

In spite of being a relatively small fishing nation, Flemish fishers have exploited a diversity of fishing areas and travelled over long distances to increase their economic competitiveness and explore new opportunities. The cod fisheries to the Dogger Bank from the end of the 15^{th} century, to the Faroer and Iceland from the 17^{th} century, the fisheries in the Labrador and Barents Seas and in the waters of Portugal, Morocco and Spain in the early 20^{th} century (Cloquet 1842, De Zuttere 1909, Poppe 1977) are examples of the long distance fisheries by a small nation's fishing fleet.

It has been documented that fisheries and their investments shift towards more distant areas once the stocks in nearby areas start to show signs of decline. This is the concept of expansive behaviour in fisheries, as described by Pauly et al. (1998), where unsustainable forms of fisheries tend to deplete one stock or area and move to the next in consecutive stages. The relation between fishing effort and the status of fish stocks however is complex, and environmental variables have a demonstrated effect on the recruitment and biomass of fish stocks, in particular in conditions of low biomass (Planque and Fredou 1999, Brander 2005, Payne et. al. 2009)

Reconstructions of historical biomass of stocks of commercial species through stock assessments typically go back until the 1960s (ICES Stock assessments and Annual Advice). Studies covering a wider temporal range mostly focus on particular species e.g. Atlantic cod, herring or plaice (Gulland 1968, Daan et al. 1994, Hislop 1996, Pope and Macer 1996, Bannister 2004, Cardinale et al. 2009a and 2009b) and fishing areas of interest, e.g. the North Sea or the Baltic Sea (Pope 1996, Rijnsdorp et al. 1996, Bannister 2004, Poulsen et al. 2007, Eero et al. 2008, Cardinale et al. 2009a and 2009b).

Historically, fleet dynamics have received less attention than the aspects of population dynamics (Hilborn 1985, Poos 2010). However, to understand trends in the volume of landings, in the catch per unit of effort and in the economic returns by the fleet, spatio-temporal explicit data on the fleet dynamics and fishing effort are required. Ideally the landings and fishing effort are known at the smallest spatial scale, by seasonal/monthly basis, and by métier (i.e. type of fisheries, target species, fishing gear and vessel class). Fishers use the seasonal variability in patterns of the target species' abundance and distribution to adapt their strategies of fishing effort in space and time, at the larger-spatial scale (Poos 2010). In the fisheries of the countries that operate under the EU Common Fisheries Policy CFP, it is safe to say that the quota system is an important determining factor that affects the way fishing effort is allocated at the scale of subdivisions in fishing areas. The quota also affect the rates of discarding, since vessels need to optimize their annual net revenues by continuously adjusting strategies on where to fish and what part of the catch to retain (Poos 2010). However, before the onset of quota, decision making probably relied on less complex management constraints in which indexes of catch rates per unit of effort, broad economic incentives and traditions played a proportionally more important role.

The objective of the present chapter is to document changes in the relative importance of fishing areas for the Belgian fisheries over time, as well as changes in composition of landings from within fishing areas over 8 decades (1929-2009). Potential cause-effect relations that may explain the dynamics of the Belgian sea fisheries at broader spatial scale are explored.

4.2. Methodology

4.3.1. Data sources and data integration

For Belgian fisheries, data on composition and value of landings at the species level were standardized and integrated for the period 1929-present (Lescrauwaet et al. 2010a). Earlier quantitative information with a spatial reference (e.g., Bestuursmemorialen 1815-1875, Cloquet 1842, De Zuttere 1909) is generally fragmented and disperse, and at a higher level of taxonomic or spatial aggregation. The resulting database (HiFiDatabase) spans 80 years of data by 41 species and 15 aggregated taxa, by month, by port of landing in Belgium (4 ports) and in 'foreign ports', and by fishing area of origin (21 georeferenced fishing areas plus the reported category 'other areas'). Lescrauwaet et al. (2010b) provide a detailed account of the data management, the quality control and the resulting data products. The HiFiDatabase also contains data on fishing effort and corresponding landings by fishing rectangle and data by fisheries type and by vessel class, from 1947-1983. Unique historical economic data on income and average price by species and by fishing area of origin, as well as by fish auction/port of call, are also included in the database. The economic data were standardized in Euro (40.34 Belgian francs per Euro) and expressed as values 2010 to account for inflation by correcting the data with the annual index. This allows comparing gross income and gross average prices spanning a period of nearly one century and taking into account economic parameters when interpreting trends in spatial dynamics of the fleet and fishing effort. The HiFiDatabase is managed by Flanders Marine Institute VLIZ and the data are available in the public domain through the Marine Data Archive (MDA, VLIZ).

4.3.2. Collecting spatial information on the Belgian sea fisheries in the 19th and 20th century

The spatial information related to effort and landings collected in the 20th century was recorded on paper logbooks kept on board, similar to the (electronic) logbooks that currently keep track of the activities of fishing vessels. Fishermen were obliged by law (the Royal decree of 26/05/1937 for vessels operating outside territorial sea, extended to fishing activities in all waters by the regent's decision of 20/10/1945) to register the catch by species and the catch was assigned to ICES statistical rectangles at least from 1947 onwards (1° longitude x 0.5° latitude corresponding to 30nmx30nm, Figure 1). Fish was classified on board, by species and length category and assigned to the main fishing rectangle of origin. A representative of the local maritime police ('*waterschoutsambt*') recorded the dates and hours of departure and arrival of fishing vessels in the ports by their immatriculation number. In this manner, effort (expressed as number of days at sea) was collected per vessel. In the fish auction, municipal officers kept accounts of all sale transactions as well as of landings that were rejected or withdrawn from the market. In this manner, detailed statistics were produced of the fish landings by species and length class, by statistical rectangle of origin, number of days and hours at sea and actively fishing, engine power (horsepower), vessel class, and number of vessels (Gilis 1959).

For reporting purposes this detailed spatial and temporal information was then later aggregated by month and by year and by fishing area. Finally the aggregated data was reported to ICES by year and by ICES subdivision (e.g. North Sea South IVc). Therefore the rich spatial information was unfortunately lost forever in the aggregation process (pers. comm. 25/01/2011 personal interview with Mr. J. Depreeuw, statistical officer at the National Institute of Statistics between 1953 and 1980s, in charge of Sea Fisheries Office from 1967). However, the efforts to reconstruct historical time series on Belgian sea fisheries disclosed previously uncovered monthly reports by statistical rectangle in the repositories of the Sea Fisheries Service. These statistical tables are available from 1947 to 1983 in 2 different reporting formats: one referring to rectangle, effort, fishing gear or type of fisheries and overall landings, and a second one providing general data on effort but detailed data on landings by species, per month and – for the commercially most important species – by weight class.

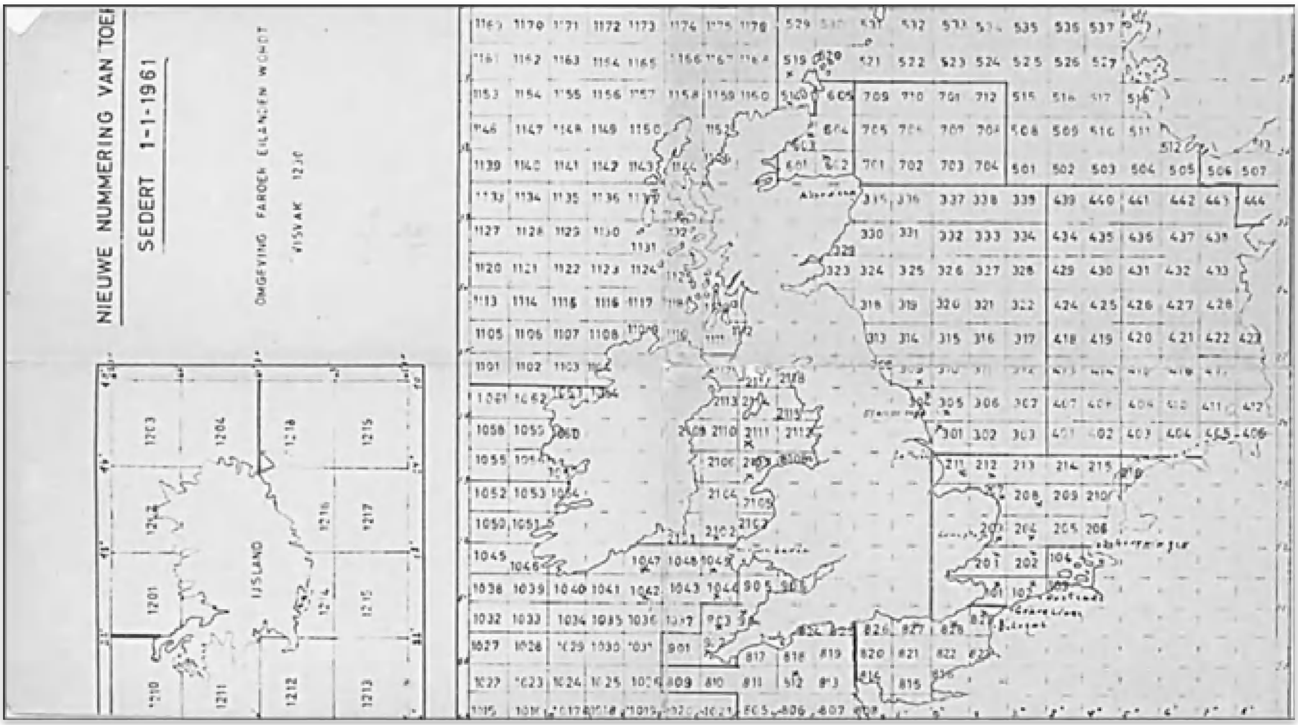


Figure 4.1.: Geography and boundaries of the statistical rectangles as reported in the national data uncovered and integrated in the HiFiDatabase (1947-1983).

4.3.3. THE GEOGRAPHY OF REPORTED SPATIAL DATA ON BELGIAN SEA FISHERIES IN THE 20TH CENTURY

Standardization of fishing areas and boundaries is a prerequisite for the integration of data at the spatial scale. However, in the historical reports on sea fisheries, the coordinates of the larger aggregated spatial units or 'fishing grounds' are not explicitly identified and fishing areas changed names over time or disappeared (temporarily) from the statistics. Maps and metadata issued for specific years were used as anchor points to reconstruct the boundaries of these spatial reporting units. After standardizing, 29 areas (including the non-spatially-explicit 'other areas') of the 41 different fishing areas that were reported in the period 1929-1999, remained. The geography of these fishing areas during the 20th century was reconstructed on the basis of formal reports and historical maps that explicitly refer to the sea fisheries context (Figure 4.2. and Table 4.1., see Manual for a summary http://www.vliz.be/imis/imis.php?module=ref&refid=141768). The fishing areas coincide largely with the ICES subdivisions. However, a number of important differences and advantages are noted:

The 'Coastal waters' (located in ICES subdivision IVc), the North Sea central-east and the North Sea central-west (located in ICES subdivision IVb), Moray-Firth and Fladen (located in ICES subdivision IVa) are not separate ICES spatial reporting units and they provide a unique level of spatial resolution in historical Belgian sea fisheries statistics. The boundaries of the fishing area 'Coastal waters' were delineated at 20-30 nautical miles (37 km) from the shoreline since they broadly coincide with two ICES statistical rectangles 102 and 103 (Figure 4.1.). These unique and additional spatial reporting units situated in the subdivisions IVc, IVb and IVa in the HiFiDatabase also represent the historically most important fishing areas as sources for fish products.

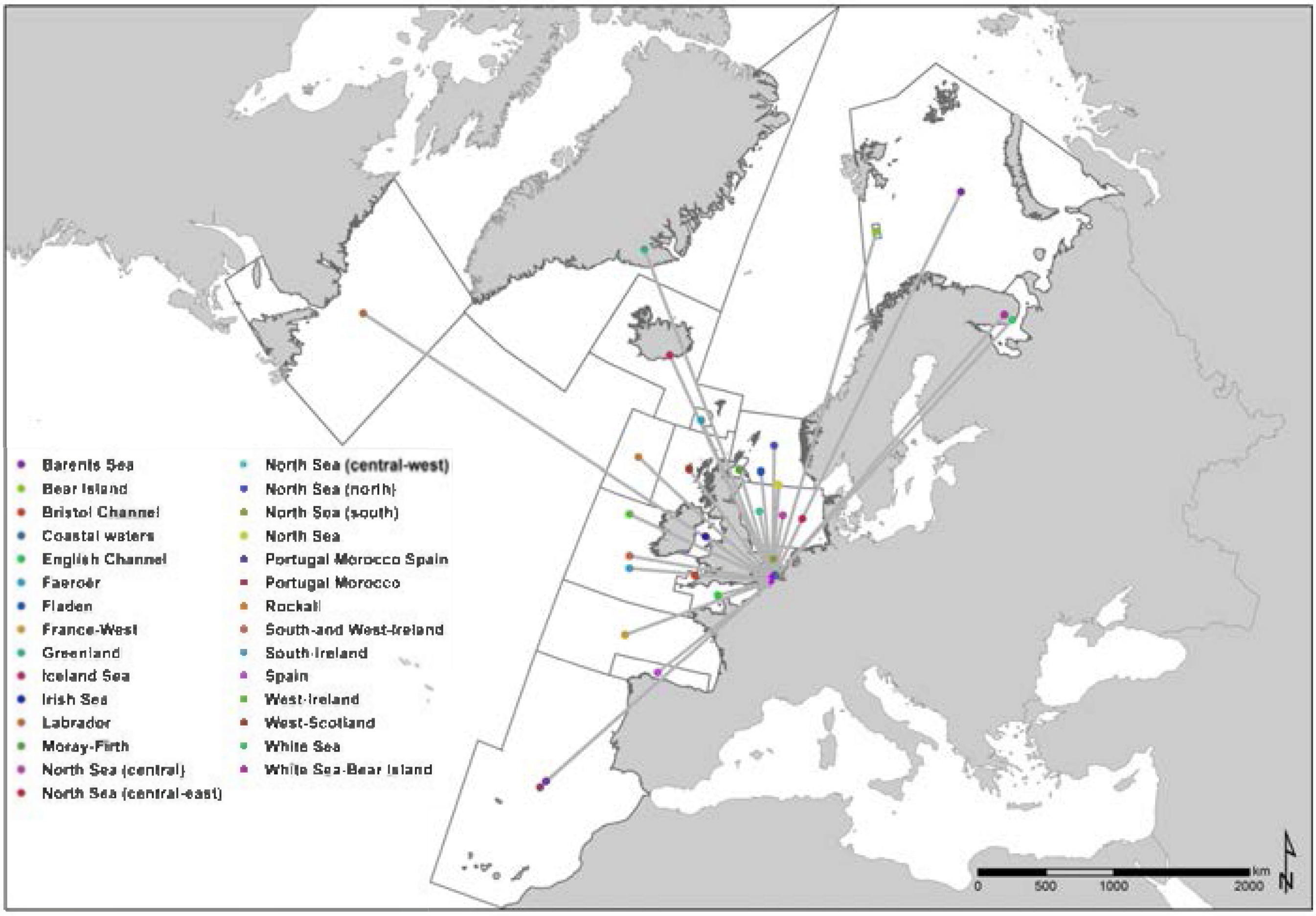


Figure 4.2.: Geography and boundaries of the 29 reported fishing areas of Belgian sea fisheries (1929-1999) with centroïds of the shapes. Note: in historical sources in the UK, Barents Sea and White Sea were used as synonyms to indicate the same fishing area.

To look at the evolution of 'distance from port', an indicative value of overall tonne-kilometres (tkm) was calculated as an indicator of 'sustainability' of the fishing activities (Figure 4.9.). For each year, the annual landings (t) from each fishing area (all species) were multiplied by the average distance (km) to the centre of the Belgian coast (Oostende). Distances are calculated as a straight line between the centroid of the fishing area (shape) and Oostende, probably inducing an underestimate for the tkm from distant waters.

The landings from the Belgian fleet sold in foreign ports are reported as an aggregated unit 'foreign ports' and can not be pinpointed to a particular 'foreign port'. Therefore, no distance to fishing area can be calculated for these landings and they were not included in the calculation. Landings in foreign ports make up for an average 10% of all landings by the Belgian fleet.

Table 4.1.: Overview of the 29 reported fishing areas (shapes), centroïds of the shapes and their coordinates, distances (km) from the centroïds to the centre of Belgian coastline (Oostende) and area (km^2). (*) Note: to view the areas in the VLIZ Marine Gazetteer VLIMAR, replace the ID number in the link of the Marine gazetteer in the example below (Coastal waters) http://www.vliz.be/vmdcdata/vlimar/vlimar.php?p=details&id=24504, by the ID number of the fishing areas as in the table.

Fishing areas, Standard Names	Latitude	Longitude	Distance (km)	Area (km^2)	Gazetteer link *
Bristol Channel/Kanaal van Bristol	50,81	-5,20	570	18726	24503
West-Ireland/West-Ierland	53,53	-13,78	1159	123641	24517
Irish Sea/Ierse Zee	53,46	-4,92	587	49937	24501
Portugal Morrocco Spain/Portugal Marokko Spanje	35,02	-13,82	2227	1803322	24514
West-Scotland/West-Schotland	57,49	-8,63	1020	235785	24518
Rockall	57,20	-15,00	1335	220423	24515
North Sea (north)/Noordzee (noord)	60,06	1,41	988	215673	24511
Fladen	58,28	0,17	805	35259	24498
Moray-Firth	58,17	-2,54	849	15837	24506
English Channel/Engels Kanaal	49,80	-2,47	412	89388	24496
Coastal waters/Kustzee	51,62	3,16	48	8411	24504
North Sea (south)/Noordzee (zuid)	52,66	2,84	160	55138	24512
North Sea (central-east)/Noordzee (midden-oost)	55,46	5,73	508	151456	24508
North Sea (central-west)/Noordzee (midden-west)	55,69	0,65	520	127090	24509
Faeröer / Faroe	60,77	-8,84	1285	20750	24497
Bear Island/Bereneiland	74,44	19,01	2678	5414	24495
White Sea/Witte Zee	66,20	39,08	2605	87362	24519
Barents Sea/Barentszzee	75,27	42,44	3180	2012754	24494
Labrador	53,99	-52,33	3592	1460267	24505
Spain/Spanje	43,97	-6,76	1081	92775	24516
Portugal Morrocco/Portugal Marokko	34,53	-14,16	2289	1710547	24513
Iceland Sea/IJslandzee	64,17	-16,21	1816	553305	24502
North Sea (central)/Noordzee (midden)	55,59	3,42	488	278546	24510
White Sea-Bear Island/Witte Zee – Bereneiland	66,73	38,30	2596	92776	24520
North Sea/Noordzee	57,60	2,44	710	494219	24507
South-Ireland/Zuid-Ierland	50,16	-11,97	1053	415734	24522
South-and West-Ireland/Zuid- en West-Ierland	50,94	-12,37	1065	539375	24521
France-West/Frankrijk-West	45,88	-10,58	1152	581938	24499
Greenland/Groenland	69,56	-28,78	2607	1322045	24500

Indices of biological diversity are used to measure and compare biological diversity between samples to compare e.g. areas or periods. Hill (1973) developed a suite of diversity indicators in which the importance of rare species declines as the order of the index increases. The index N_0, refers to the number of species irrespective of their relative abundance in the sample, whereas N_{infite} is the inverse (1/x) of the relative abundance (x) of the most abundant species, hence assigning no importance to less abundant or rare species. N_1 (exponent of Shannon-Wiener index) and N_2 (inverse of Simpson's index) provide intermediate measurements. Applied to landings by fishing area, the indices reflect fisheries preference behaviour rather than measuring a relative biological diversity of an area. The landings are to be considered as subsample of the true diversity and one which is 'biased,' i.a., by the fishing gear and the behaviour and decisions of the fisher.

Box plots were used to compare relative importance of fishing areas over the study period, or compare the relative importance of species within particular fishing areas, and to conduct an exploratory analysis of outliers, medians and quartiles. The TWINSPAN program was used to explore distinctive features or species diversity between fishing areas.

4.3. RESULTS: SPATIAL ANALYSIS OF THE BELGIAN FISHERIES IN THE 20TH CENTURY

4.3.1. THE RELATIVE IMPORTANCE OF FISHING AREAS AS SOURCE OF FOOD AND INCOME OVER THE YEARS

Fishing areas were exploited with different degrees of intensity (fishing effort, gear and technique) and over different time slots (annual and seasonal fluctuations). While larger areas were disaggregated in the reports as their commercial importance increased, others were merged or disappeared from the statistics as they became less important. The nearby fishing areas (Coastal waters, North Sea south, North Sea central-west, North Sea north) and the western waters (Bristol Channel and English Channel, South-and West-Ireland) appear almost continuously throughout the reporting period. The activities in the Iceland Sea, which dated from at least the 16^{th} century (De Zuttere 1909) ceased completely in 1995 (Lescrauwaet et al. 2013 under review). The Barents Sea and the waters off Rockall were reported for 6 years, whereas other areas did not appear in more than 5 annual reports, e.g. Greenland, Faroer, Labrador, West-France and White Sea - Bear Island. In historical sources in the UK, Barents Sea and White Sea were used as synonyms.
Besides the overall number of reported calendar years of exploitation since 1929, it is also interesting to look at the continuity in the fishing activity in a certain area, i.e. the number of periods of uninterrupted fishing in the area (Figure 4.3.).

While 5 areas were exploited for less than 5 years, 10 fishing areas were reported during more than 50 years. From these, 5 areas have provided fishing products continuously except during the Second World War (WWII, 1939-1945). When taking into account the WWII statistics (Lescrauwaet et al. 2013 under review) the 'Coastal waters' were the only continuous providers of demersal and pelagic fishes, molluscs and crustaceans. Although e.g. the Fladen and the Irish Sea both appeared in the statistics in 39 years, Fladen was discontinuously exploited while the Irish Sea was continuously exploited during 39 years from 1961 (Figure 4.3.).

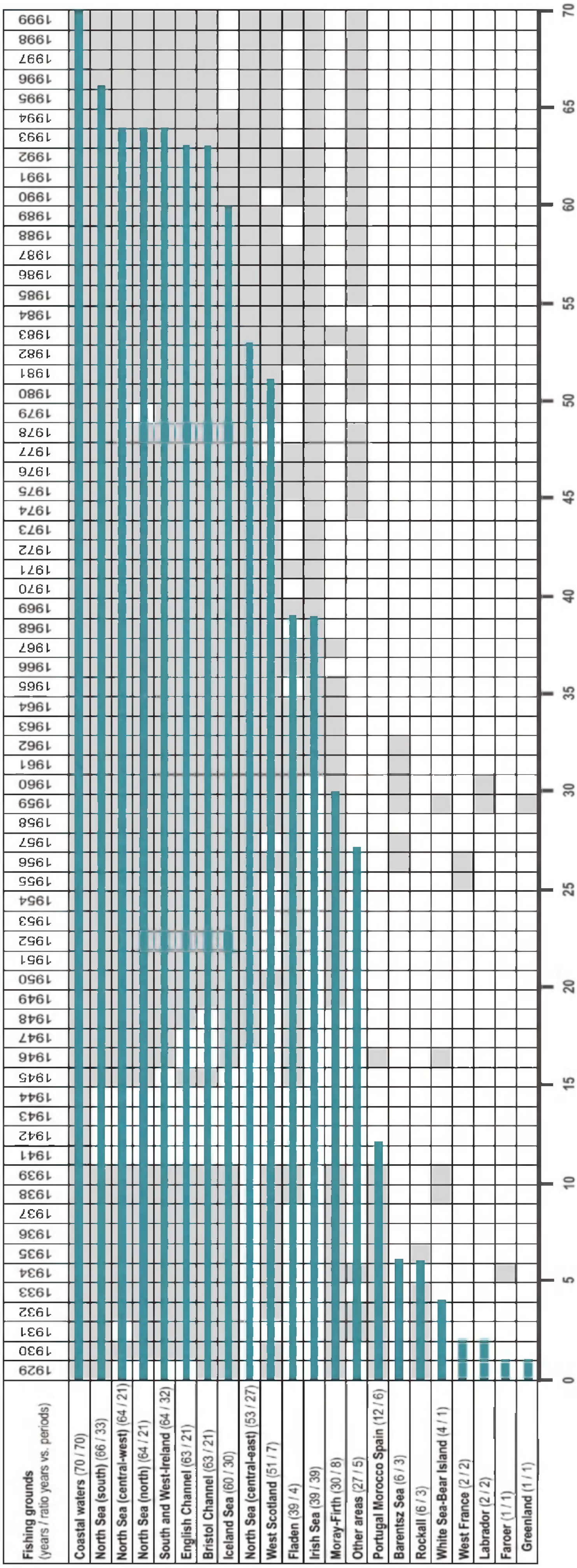


Figure 4.3.: Fishing areas as reported by year (black rectangles, by chronological order in upper x-axis, 1929-1999) in the official annual landing statistics and the total number of years in which landings were reported for a fishing area (white horizontal bars, bottom x-axis 1-70 years, see also the numbers between, brackets in the first column).

4.3.2. Observed trends in annual landings of the Belgian fishing fleet by area of origin (1904-2010)

In the reconstruction of the time series of landings of the Belgian sea fisheries by fishing area of origin for the period 1904-2010, data from 1904-1929 are incomplete and not standardized and therefore not integrated in the HiFiDatabase. However, for the purpose of visualization of the main trends, they are included (Figure 4.4.). From the beginning of the 20th century until the outbreak of the First World War (WWI, 1914-1918), reported landings originated mainly from the 'North Sea' (sic) and to a lesser extent from the 'southern coast of Ireland', the 'Iceland Sea', the 'Gulf of Biscay' and the 'English Channel'. Total annual landings in the pre-WWI times fluctuated between 10,000 and 15,000 t.

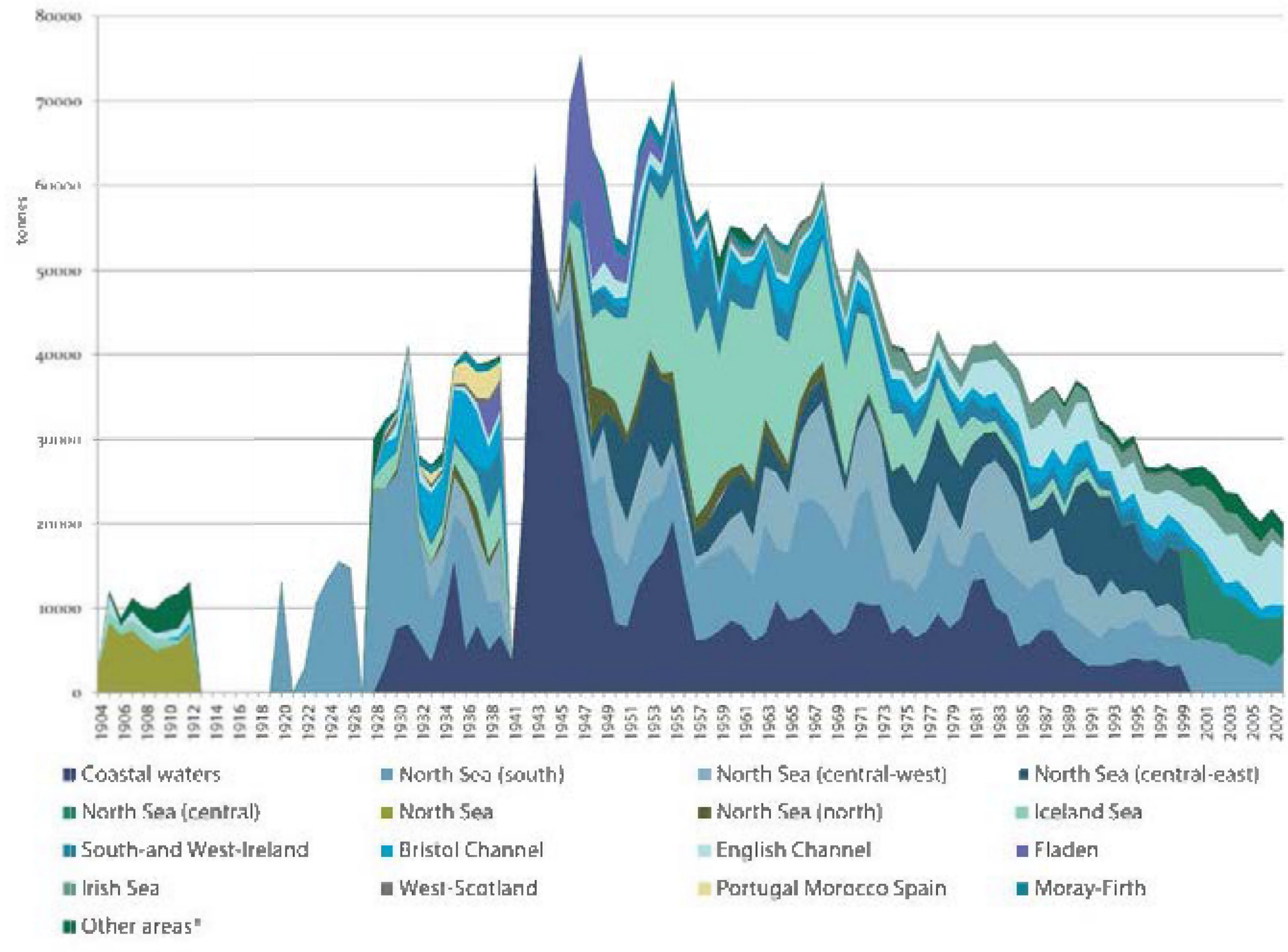


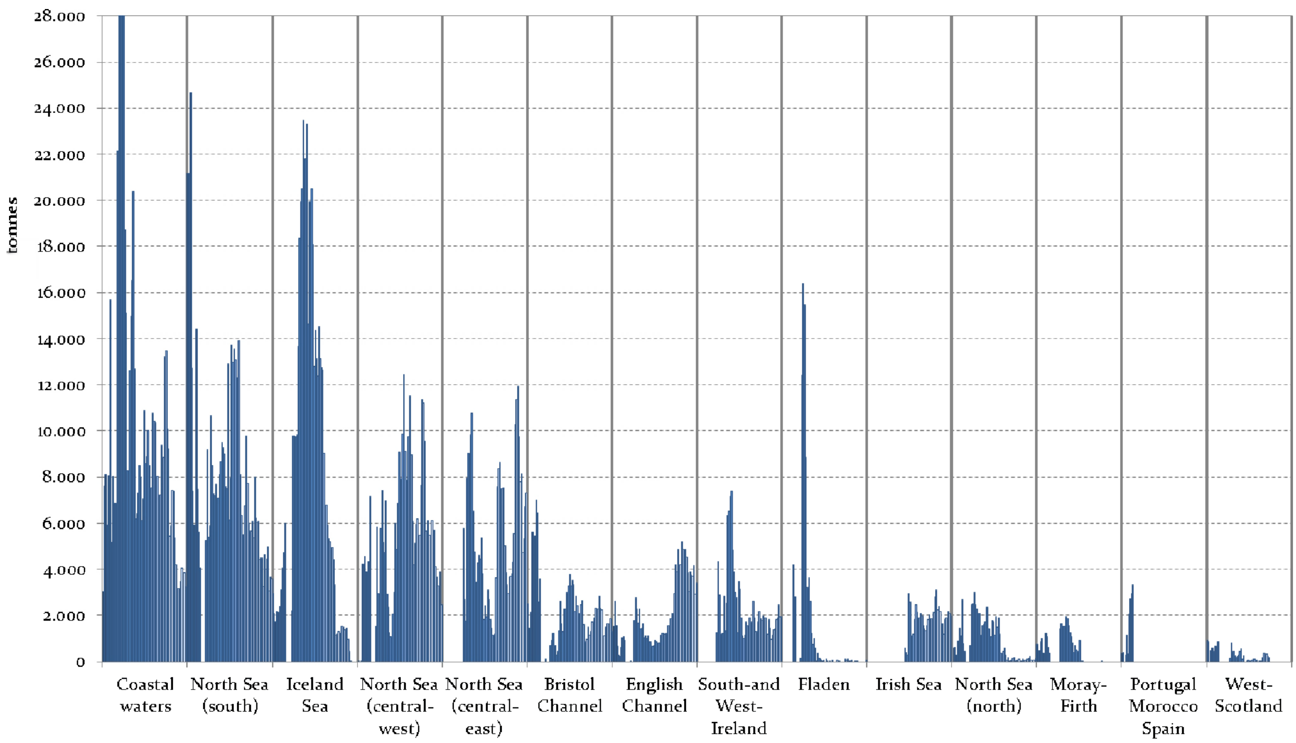
Figure 4.4.: Annual total landings (t) of Belgian sea fisheries in Belgian and foreign ports by fishing area of origin in the 21 fishing areas (+'other areas') in the period 1904-2010. Data 1929-1999 are provided by the HiFiDatabase (2009) and complemented with partial information for the period 1904-1913 (ICES Annual reports; De Zuttere 1909). Data for the period 1920-1928 are based on the surveys conducted by Gilson and reported to ICES. Flanders Fisheries Service (Dienst Zeevisserij) provided the recent data 2000-2010.

During the WWI, information on fishing activity is anecdotal: a witness reports that fishing in Belgian waters was practically impossible between October 15, 1914 and May 19, 1916 (Vermaut 1998). After WWI, landings quickly increased again to the pre-war levels of 12,000-15,000 t. Data for this period (1920-1926) are preliminary statistics limited to the port of Oostende only. However, in the first decade of the 20th century other data sources confirm that Oostende accounted for approximately 70% of all Belgian landings of fresh fish and 100% of salted cod (De Zuttere 1909). The 1920-1926 data confirm that landings were predominantly from the fishing grounds of the 'North Sea south', without distinction of the 'coastal waters' as separate reporting entity (Figure 4.4.). The scarce metadata suggest that before 1929, landings from coastal waters were not reported as such but either aggregated as 'North Sea' or 'North Sea (south)'.

From 1928 onwards the importance of the nearby fishing areas (North Sea south) gradually declined and fishing areas diversified to Iceland and the 'western waters' (West-Scotland, South-and West-Ireland, the Bristol Channel) between 1934 and 1939 (Figure 4.4.). With the outbreak of WWII, fishing was exclusively restricted to the 'Coastal waters' and yielded unprecedented quantities of herring, besides sprat, and to a lesser extent plaice, and brown shrimp. The WWII data were obtained from previously unknown government reports with detailed monthly statistics and are not available from ICES or other sources (Lescrauwaet et al. 2013 under review).
By the end of the WWII, 10% of the landings originated from the North Sea (south) and after WWII fishermen quickly turned to the 'western waters' again. Between 1950 and the mid 1970s, the most important observed trend was the increase of landings from the 'Iceland Sea'. The 'North Sea central-west', the 'North Sea central-east' and the western waters could not make up for the losses once fishing in the 'Iceland Sea' was restricted through the 'modern cod wars' and enforced by law after 1972 (Omey 1982). The instalment of fishing restrictions and quota through the EU Common Fisheries Policy CFP from 1983 onwards leaves less room for fluctuations in the relative importance of fishing areas.

The exploitation of the fishing areas follow different patterns. In terms of total landings for 1929-1999, the 'Coastal waters', 'Icelandic Sea' and 'North Sea-south' show bell-shaped curves. Note the gradual increase and decline in the 'Iceland Sea' and the outliers in the 'Coastal waters' and 'Fladen' (Figure 4.5., Upper panel). The patterns of fishing effort are expressed as 1000HP*Fishing Hours (Figure 4.5., Lower panel). They suggest the proportionally high fishing effort conducted in the southern North Sea compared to the landings obtained from it. Note the increase in fishing effort in the Irish Sea and the English Channel towards the mid 1980s

The evolution of the total landings by fishing area does not reflect the underlying trends at the species level. These trends are determined by a complex mechanism driven by market and fleet dynamics for each of the different fisheries and is flavoured by the fishermen's tradition, the state of the fish stocks and –especially after 1983 also by fisheries management and quota setting. These complex relationships are broadly explored in the current paper and the economical data that were integrated in the HiFiDatabase are made accessible for further research, from the website: http://www.vliz.be/cijfers_beleid/zeevisserij/list.php



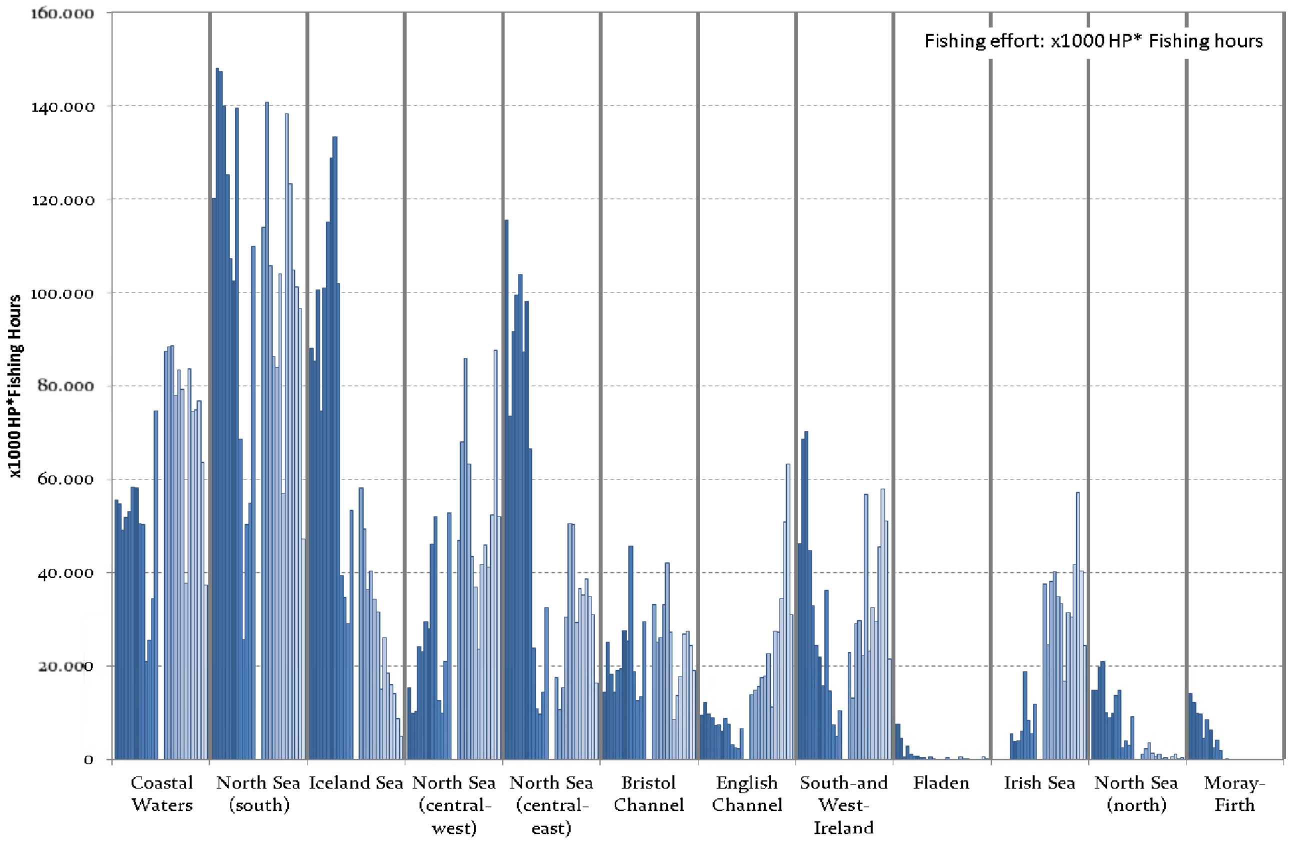


Figure 4.5.: Upper panel: Trends in total reported annual landings (t) for the 14 most important fishing areas, Belgian sea fisheries (1929-1999). Fishing areas are ordered according to decreased overall landings, x-axis denotes years, by fishing area. Note that the y-axis is cut off at 28,000t for improved visualisation of scale. Landings from Coastal waters peaked in 1943 with approximately 62,000t. **Lower panel**: Trends in fishing effort (x1000 HP*Fishing hours) from 1950 to 1983. Note the decrease in Icelandic waters and the increase in the English Channel and Irish Sea.

4.3.3. ECONOMIC IMPORTANCE OF FISHING AREAS

Gross value (Euro) of income

A fishing area may have acquired a relatively higher economic importance over time because of the absolute volume of landings it generated, because of the high proportion of high-valued species obtained from it, or a combination of both. Examples of the first are the Coastal waters or the North Sea south with important landings of herring and plaice while the Irish Sea and the English Channel are examples of the latter, with important catches of sole. The total nominal value of these landings (1929 until 2010) amounted to 3.1 million EUR which corrected for inflation (expressed as Euro values 2010) represented 6,9 million EUR. This excludes the value of income during World War II, a period for which no indexes are available to correct nominal values and calculate these in current values (Lescrauwaet et al. 2010). While the peak in landings (t) occurred in 1947, the annual gross income (expressed as Euro values 2010) generated by the Belgian fisheries steadily increased after 1950, peaked in 1987 and 1991 and declined afterwards (Figure 4.6.). In spite of the decline in landings, the gross value of income was compensated by the increase in market value for some species, and by increasingly targeting higher-priced species such as common sole (*S. solea*).

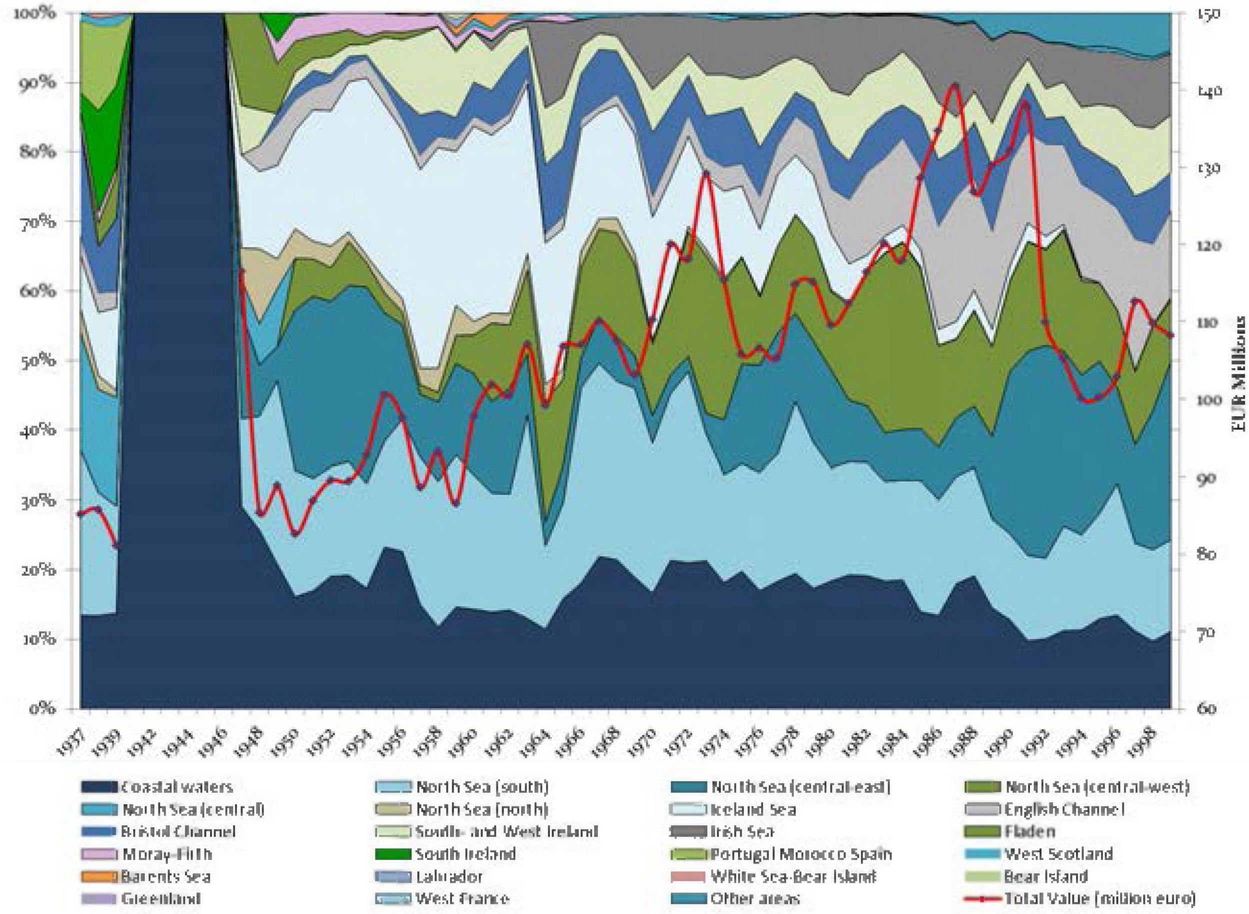


Figure 4.6.: relative economic importance (%) of fishing areas 1937-1999, based on the values of gross value of income (Euro values 2010), and trend in gross value of income (red line, Euro values 2010).

The 5 economically most important areas make up for 70% of the total income over the observed period: North Sea south (18%), Coastal waters (17%), North Sea central east (12%), Iceland Sea (11%) and North Sea central west (11%). The total generated gross value of income (x1,000 Euro values 2010) and total generated volume (t) by fishing area are placed in perspective by visualizing the proportion (%) of the total landing/value they represent over the entire period.

The summed absolute volumes (t, white bars) and values (grey bars) for the 14 most important fishing areas are compared (Figure 4.7.). In a relative perspective, the white squares indicate the proportion of the total landings that were obtained in each of the areas, while the triangles refer to % of total value (expressed as Euro values 2010).

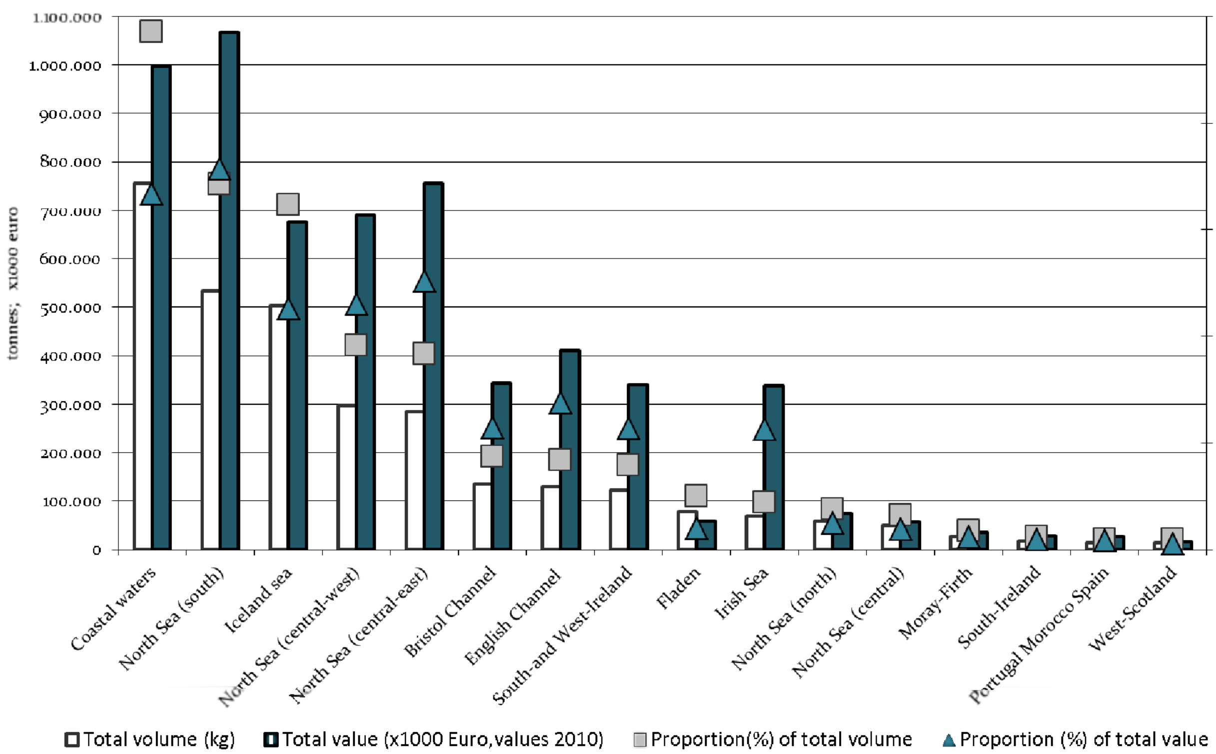


Figure 4.7.: Relative importance of the fishing areas in terms of landings (tonnes) (white bars, left axis) and gross values (x1.000Euro corrected for inflation, values 2010, blue bars, left axis). Gross values of income and landings are also shown as a proportion (%) (volumes as grey squares and values as blue triangles). Values for Coastal waters are underestimated because of their economic importance during WWII, a period for which no indexes are available to correct for inflation.

The graph suggests that some areas have generated relatively higher value by unit of volume. Fishing areas for which triangles are above boxes (e.g. Irish Sea), typically sustain fisheries on higher-values species such as sole, turbot.

4.3.4. MARKET VALUE (EURO/KG) AS A DRIVER FOR HAULING LONG DISTANCES

In terms of average market value of species, the Irish Sea (4.9€/kg), the English Channel (3.2€/kg), the Bristol Channel (2.5€/kg), South-West Ireland and the North Sea (central-east) (2.6€/kg) overall have generated higher-valued species (Figure 4.8., all species averaged, all years). The opposite is true for the Coastal waters (1.3€/kg), Fladen (0.8€/kg), North Sea north (1.3€/kg) and the Iceland Sea (1.3€/kg) where proportionally larger volumes were obtained from species that at that time had a proportionally lower value (herring, cod).

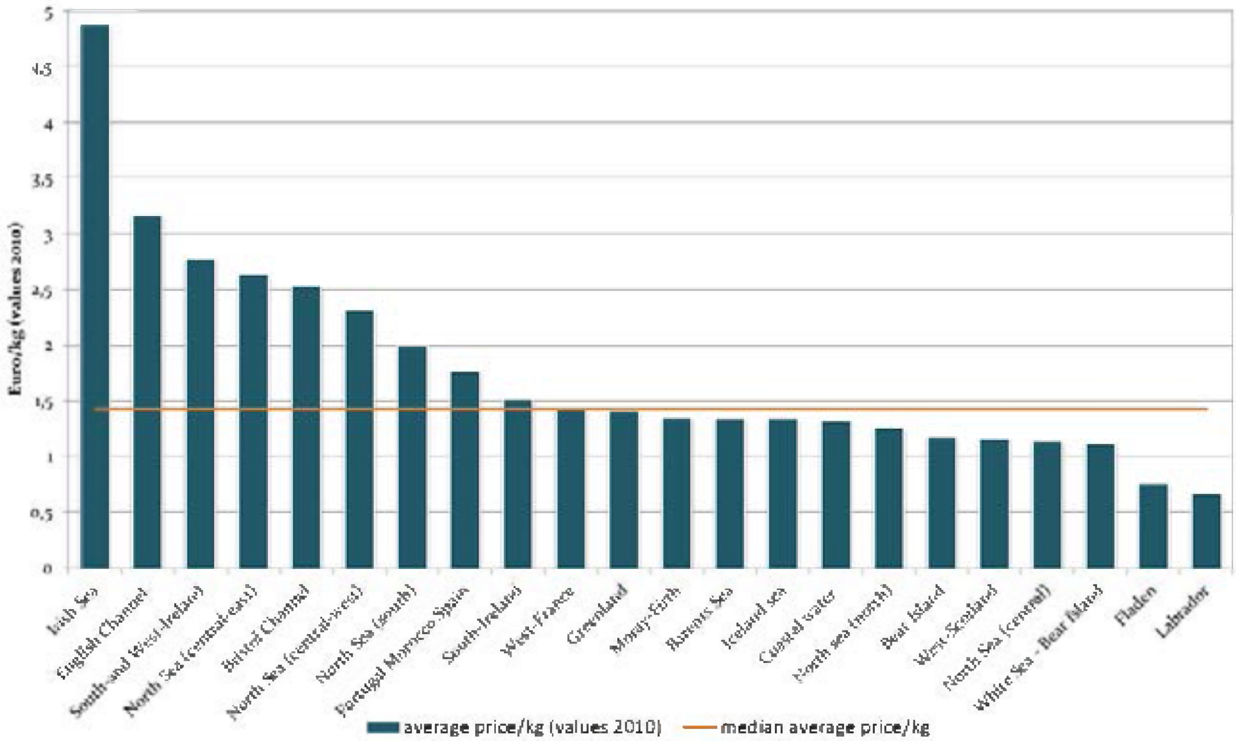


Figure 4.8.: Average value €/kg (prices 2010) of all species for all years (1929-1999) by fishing area.

As the cost of fishing increases with the distance to the harbour e.g. the cost of transit time and fuel (Sampson 1991) one would expect that at increasing distances successful fisheries either pursue a landings-maximization driven by higher catch rates per unit of effort, or a profit-maximization strategy driven by higher or increasing species market value (Hilborn and Walters 1987, Gillis et al. 1995). A graphical analysis of the trends of single species market values (€/kg) for the most important species (sole, plaice, cod, herring) in the HiFiDatabase over the observed period suggests that inter-annual differences in market values within specific fishing areas, exceed or at least compare with the differences between fishing areas within a specific year. Also there is no observed relation between years with higher market values (€/kg) for a particular fishing area and increases in landings from that area or vice versa. With the present spatio-temporal resolution, the data do not seem to indicate differential pricing mechanisms that could stimulate fisheries in a way to prefer a particular fishing area over another for a particular species. Therefore, at least at the spatio-temporal scale of the present analysis - and before the on-set of the EU quota system - market value does not seem to fully account for

observed spatial dynamics of fisheries. Future analyses of monthly statistics and statistics for differential pricing of length classes by species in the HiFiDatabase may shed more light on decision strategies in fishing.
There are particular cases however where the data quantitatively confirm sources that indicate an offer-demand mechanism (see Discussion). In general however, the dynamics of spatio-temporal allocation of fishing effort within a particular type of fishery is expected to be explained mostly by mechanisms related to optimizing indices of catch per unit of effort, in particular in the current conditions of stringent output control (Poos 2010, van Ginkel 2007).

4.3.5. Tonne-kilometres and tonnes per hectare: measures of sustainability and production

The cost of fishing in distant fishing areas is translated as additional costs of days at sea (staff cost, insurance, food, engine hours) and the increased cost of fossil fuels. Distance to fishing areas is therefore expected to be one of the important factors in the decision making of allocating fishing effort in space and time.

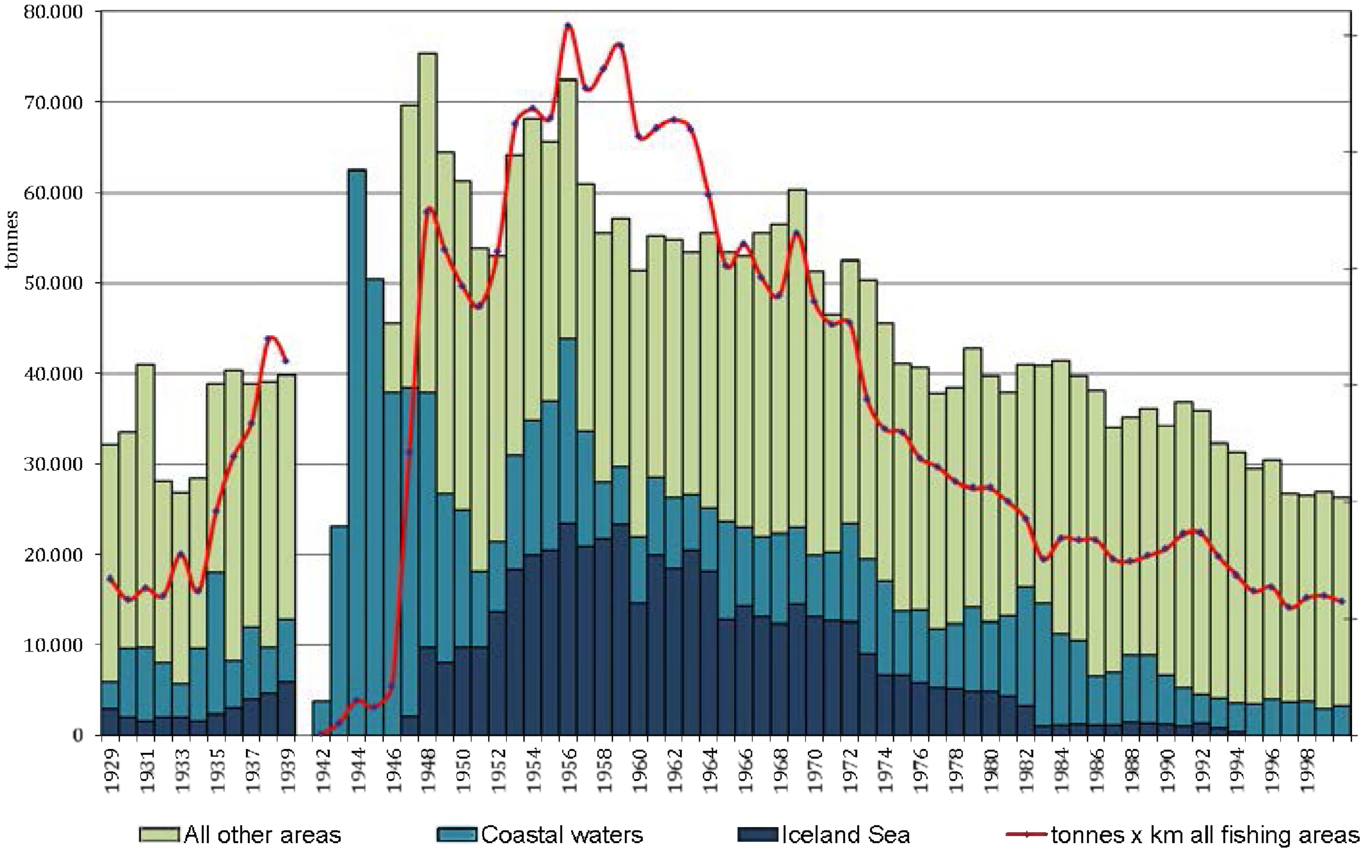


Figure 4.9.: The annual tonne-kilometres of the Belgian sea fisheries, red line (values in right-hand axis), calculated as the sum of the annual landings per fishing area *a* (tonnes) multiplied by the km distance to the centre of the fishing area *a*. The columns represent the overall annual landings per year (tonnes, left-hand axis)) for the distant 'Iceland Sea' (dark blue), the nearby 'Coastal waters' (median blue) and the remaining reported areas as 'all other areas' (light green).

The tonne-kilometre (tkm) is a unit of measure of goods transport which represents the transport of one tonne by road or overseas, over one kilometre (EUROSTAT definition). Although it is used as a measure of expenditure to transport, it is also used as an indicator in a context of moving towards sustainable development. Total tkm show a steep increase from an average 13 million up to 33 million tkm per year just before the outbreak of WWII, in a period in which overall landings remained stable, indicating seafood was increasingly being caught in distant waters (Figure 4.9.). In effect, up to 1933 most of the landings originated from the Coastal waters and the southern North Sea whereas other fishing grounds (e.g. Iceland Sea and the areas around Portugal Morocco and Spain) became more important from 1934 onwards. The importance of the nearby 'Coastal waters' during WWII generated a remarkably high amount of landings with an unprecedented low tkm (1-3 million tkm). Interestingly, the second peak in overall landings (1955, see Figure 4.4.) was generated by a proportionally much higher tkm (61 million tkm) than the similar first peak in landings in 1947 (45 million tkm). Whereas the first peak is still largely explained by the exploitation of nearby fisheries in the southern North Sea and coastal waters, the second peak is mainly explained by the increased landings from the Iceland Sea. After 1955, the proportional 'over-investment' of efforts in distant waters maintained the tkm at high levels while the overall landings already started an irreversible decline. The fisheries on distant grounds (e.g. 'Iceland Sea') however, remained important until the middle of the 1960s. From the end of the 1960s the overall tkm continuously declined and since the beginning of the 1980s, under the influence of the CFP, tkm are more closely correlated with the landings. By the end of the 20th century, and in spite of the considerable technological development in fleet and gear, the situation looked quite similar to that in the years after the First World War.

Fishing areas are also compared for their 'production', expressed as kg landings per unit of area (hectares). Smaller fishing areas such as the 'Coastal waters' (1.000kg/hectare), the 'North Sea 'south' and the 'Bristol Channel' (100kg/ha) have supported substantially more productive fishing as compared to other areas (Figure 4.10.). These values do not take into account the extent of years during which a fishing area was exploited, the dedicated fishing effort in, or the nearness of the fishing ground.

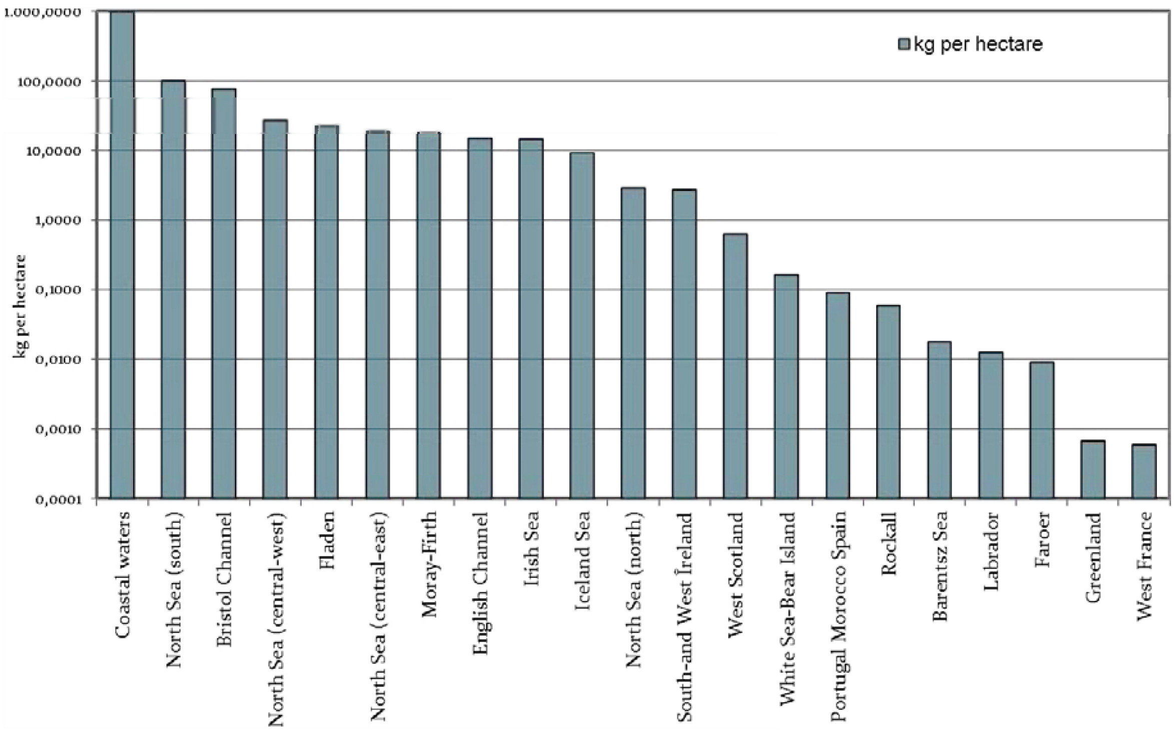


Figure 4.10.: An index of historical 'production' of fishing areas (expressed as the total amount of harvested kg per unit of hectare) (bars). Note the primary axis is in logarithmic scale.

4.3.6. Diversity of catch and landings from different fishing areas

Fishing areas were also compared by looking at the diversity and relative abundance of species in the landings originating from these areas, and the trends in this diversity over the years. While some regions may attract particular fisheries because of their characteristics as habitat for particular species or groups of species, others may be exploited because of commercial commodities (e.g. nearness of processing facilities and servicing). Still, provided the necessary cautionary approach in interpretation, the trends in the species diversity in the landings from specific fishing areas may indicate latitude/longitudinal shifts of species over time (Pinnegar et al. 2010, Kerby et al. 2013), as well as patterns of exploitation over time, e.g. an initial phase of highly selective fisheries may be followed by a diversification.

For 13 of the 22 fishing areas, overall species richness (N_0) in the landings is above 40 species out of a maximum 46 species. The areas that generated landings with significantly lower species richness N_0 (West-France, White Sea-Bear Island, Barents Sea, Faroer, Labrador and Greenland) were exploited for 6 years or less. Although the landings from the fishing areas 'Bristol Channel' and 'South- and West-Ireland' have similar number of species compared to other areas (e.g. North Sea south, North Sea central-east and central-west), they have higher N_1, N_2 and N_{inf} indices values and therefore the composition of landings was more diversified. This is also confirmed by the K-dominance plot (not included here). It is important to underline that the indices reflect fisheries preference behaviour rather than measuring a relative biological diversity of an area, as they are measuring the diversity of a subsample of the true diversity and one which is 'biased,' i.a., by the fishing gear and the behaviour and decisions of the fisher.

A similar comparison was conducted over 4 periods, the boundaries of which were chosen based on exploratory data analysis. Each period consists of 11 years: the 'pre WWII' (1929-1939), the 'post WWII' (1946-1956), the period marked by strong changes in technology of fleet and fishing gear and in particular the transition to beam trawlers (1965-1975) and finally the 'post-Common Fisheries Policy' (1985-1995) in which a more static approach is taken to fishing areas and catches through the establishment of quota.

The number of reported fishing areas decreased from 16 (pre-WWII) to 13 (post CFP). The median number of species in the landings increased over the first three periods from 37 to 41.5 but decreased again in the last period. The indices that take account of relative abundance suggest that, although in the 'post-WWII' a higher volume (t) was landed (see also Figure 4.4.) and more species were reported (N_0) than during the pre-WWII, it are a few 'dominant' species that provide proportionally higher volumes therefore making fishing less diverse. The third period is marked by a decrease both in reported areas and landings (t), however the number of reported species increased and the landings are less marked by dominant species. Finally, in the post CFP period, the total number of species reported and the volume of landings continued to decrease while the proportion of the most abundant species in the catch remained the same, therefore suggesting an increasing importance of 'dominant' species N_{inf}.

The results of a similar analysis of landings, detailed by fishing area, show that overall herring was the most important species both before (28% of all landings) and after WWII (29% of all landings) (Table 4.2.).

Before WWII, 'North Sea (south)' was the most important fishing area yielding 33% of all landings, and herring the most important species with 28% of all landings. While 'South-and West-Ireland' was the most diverse area (highest N_1) during this decade, Fladen was the less diverse with 83% of its landings composed of herring.

After WWII (1946-1956), the 'Coastal waters' accounted for 27% of all landings and were characterized by a 'dominance' of herring making up 61% of the production in 'Coastal waters'. 'Bristol Channel' was the most diverse while the 'Barents Sea' was the less diverse: 92% of its landings consisted of Atlantic cod.

Table 4.2: Overview of the most important fishing area and species in terms of volumes (t) and the most diverse and less diverse fishing areas based on N_1, for each of the 4 decades considered in this analysis. For the less diverse fishing area, the dominant species (in terms of % landed volumes) is indicated between brackets, with the proportion of landings of this dominant species landed from this area over the decade.

	Most important fishing area	***Most diverse fishing area***	***Less diverse fishing area (and dominant species)***	***Most important species***
Pre WW II 1929-1939	North Sea (south) (33%)	South- and West Ireland	Fladen (Herring 83%)	Herring (28%)
Post WW II 1946-1956	Coastal waters (27%)	Bristol Channel	Barents sea (Atlantic cod 92%)	Herring (29%)
Technology boom 1965 – 1975	Iceland Sea	South- and West Ireland	Moray-Firth (Atlantic cod 60%)	Atlantic cod (31%)
Post CFP	North Sea (central-east)	Bristol Channel	North Sea (central-east) (European plaice 65%)	European plaice (37%)

Atlantic cod (31% of all landed weight) and the Iceland Sea (22% of all landed weight) ruled the Belgian sea fisheries in the decade 1965-1975, a time marked by fast technological progress. But this position was completely taken over by the European plaice (37% of all landed weight) and the 'North Sea (central-east)' (21 % of all landed weight) once quota were established and the trade for fishing rights was installed. The Bristol Channel was the most diverse fishing area in the decade 1985-1995. European plaice can be considered as a 'dominant' species marking the period 1985-1995: this species did not only make up the most important volume of landings, it also made up 65% of all landed weight from the North Sea central-east (the less diverse fishing area).

In fact, the landings from the Central and southern North Sea over the entire period 1929-1999 show that in the colder period after the 1960s and before the mid 1980's, mainly Atlantic cod was obtained from these areas, whereas this changed to European plaice from the warmer mid 1980's (1983) onwards. This change also coincided with the fleet shifting from targeting roundfish to flatfish, a transition which was facilitated by subsidies to install the beam-trawl on existing vessels and later invest in purposely built medium-sized steel-hulled trawlers which were also equipped with beam-trawls. An EEC subsidy scheme implemented from 1980 onwards stimulated the construction of these new '*Eurocutters'* or vessels with engines <221kW and LOA < 23.99m..Also, after the gradual loss of access to the Icelandic waters, Belgian vessels shifted their activities again towards the central part of the North Sea (Omey 1982) and - to a lesser extent - towards the English Channel, Bristol Channel, South and West Ireland and the Irish Sea.

Overall, a gradual increase in N_1 is observed during the 2 decades from the early 1950s to the early 1970s, followed by a stagnation or downward trends. The southern North Sea was the most diverse of the four most important fishing areas with an average N_1 of 13 (Fig. 4.11.). While the landings from the coastal waters were initially least diverse due to the targeted sprat and herring fisheries (average $N_1 = 3$), the diversity of landings has gradually increased and from the 1970s even surpassed (average $N_1 = 8$) that of Icelandic waters and the North Sea central-east.

The diversity of species in the landings from the Icelandic waters and the North Sea central-east followed similar trends and fluctuated less over time, but with lower N_1 (Figure 4.11.). After 1995, fishing in Iceland comes to a complete halt; after 1999 the statistical information reports landings on the North Sea central –east and central-west in aggregated way.

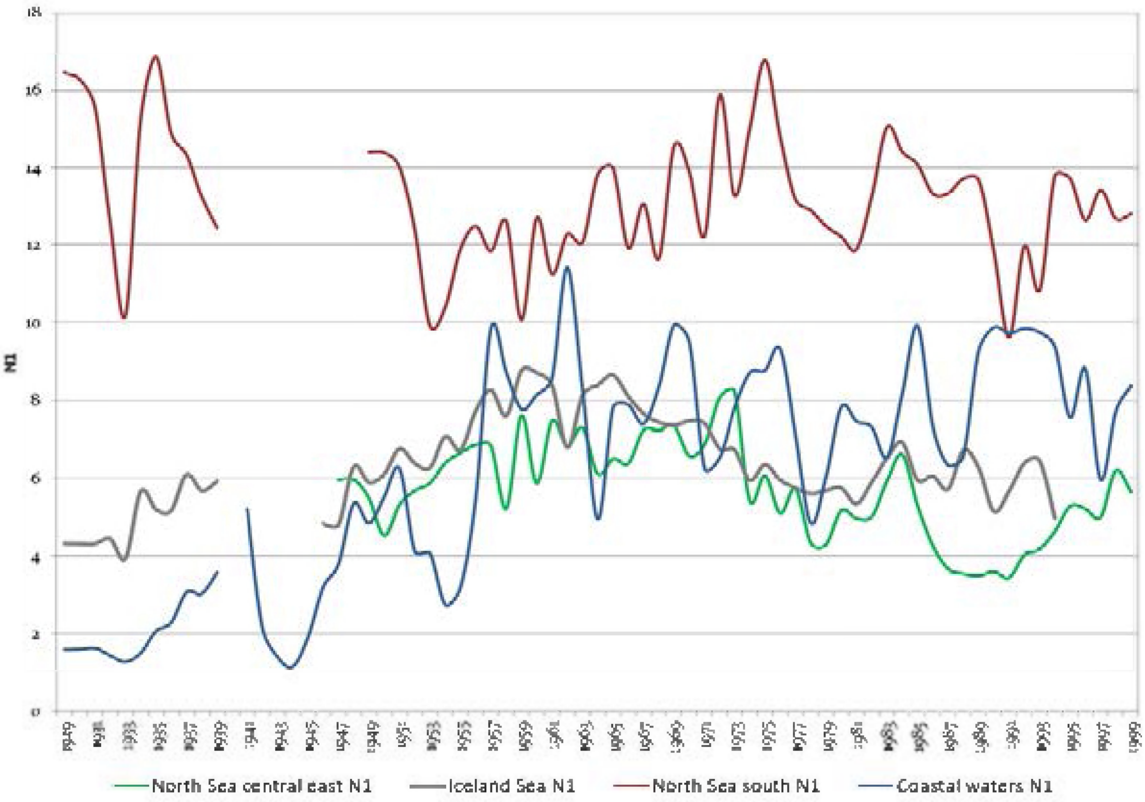


Figure 4.11.: diversity of species (N_1) in the composition of commercial landings from the 4 most important fishing areas, Belgian landings in Belgian ports 1929-1999.

4.3.7. RELATIVE IMPORTANCE OF THE COASTAL WATERS AS FISHING AREA FOR THE BELGIAN SEA FISHERIES (1929-1999)

The Belgian coast is 67 km long and the Belgian part of the North Sea or BNS is 3,457 km² (0.5% of the North Sea area; Figure 6.9.). The unique historical data reported for the 'Coastal waters' for 1929-2010 (HiFiDatabase) can serve as a proxy to quantify total landings and income from the commercial fisheries on the BNS, and the trends in species composition of the landings (Chapter 6). In terms of overall landings it is historically the most important fishing area for Belgian fisheries representing over 20% of the total Belgian landings, while these waters contributed nearly 60% of all landed pelagic species and 55% of all landed 'molluscs and crustaceans' (Lescrauwaet et al. 2010, Lescrauwaet et al. 2013). This suggests also that a variety of fishing gear is deployed in this fishing area compared to other areas.

The reported landings from the 'Coastal waters' amount to 0.8 million t (dead weight) and the trends in volume and composition of landings follow a similar pattern as that for the fisheries as a whole (Lescrauwaet et al. 2010a, see Figure 6.10.). The median of annual reported landings is 8100t with a peak value of 60,500t in 1943 and a minimum of 1900t in 2007 (Figure 4.12.). A first period (1929-1940) characterized by pelagic and shrimp fisheries, is followed by a peak in landings of pelagic species during and after WWII (1942-1964).

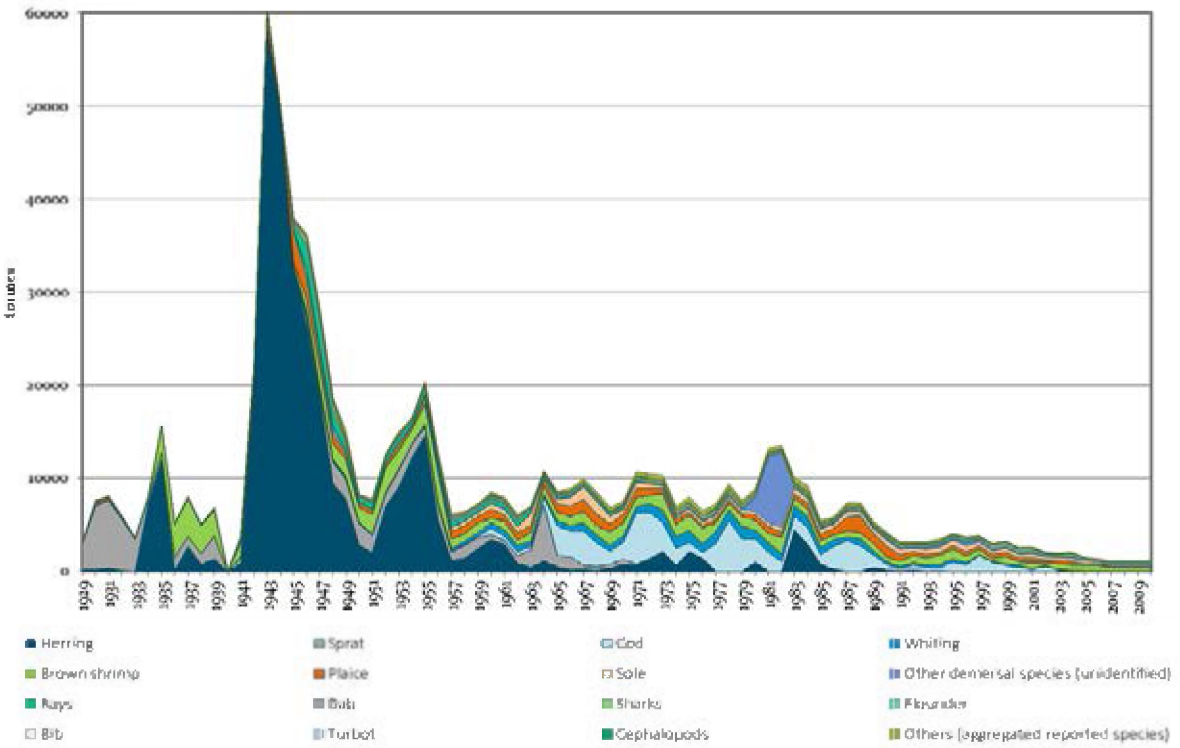


Figure 4.12.: Annual landings from the Coastal waters, by species. Based on annual landings in Belgian and in foreign ports

Cod is the dominant species in the reported landings from 1965-1980. After the mid 1980s the composition of the reported landings is less dominated by a single species although plaice and sole are the most important component. Herring and sprat (49%), brown shrimp (12%), cod (9%), plaice (6%), whiting (4%) and sole (3%) represent the most important species over the entire period. Commercial pelagic fisheries by Belgian fishermen have virtually completely disappeared from Coastal waters after the mid 80s. Interestingly, the five most important species landed from the Coastal waters, are from four different groups or fisheries: pelagic species (herring and sprat), flatfish (plaice), roundfish (cod), crustaceans (brown shrimp).
In spite of the numerous outliers, which in fact correspond to the exceptional 'herring years' during the WWII, the upper and lower quartiles for the data in the box plot for the Coastal Waters are relatively evenly distributed around the median, and the minimum and maximum values. If the outliers are excluded from analysis, the Coastal waters are considered not only by far as the most important fishing area in terms of overall landings and as source of food for local population, but also as the most stable provider of food.

4.5. Discussion

Historical sources sometimes refer to spatio-temporal information on fishing activities but these are generally qualitative and rarely based on quantitative evidence. Of the few historical references made about the geography of fishing, cited statements with temporal or spatially explicit information, were tested against the collected data and findings described (Results section 4.4.). A detailed overview of spatial dynamics of the fisheries by target species and fishing gear (brown shrimp fisheries, Norway lobster fisheries, roundfish and gadoid fisheries, flatfish fisheries, others) is available from Chapter 6.

Rapid expansion of the fleet after World War I stimulated long-distance destinations

According to Poppe (1977) many of the Belgian trawlers had fled to the UK with the outbreak of WWI, from where they turned towards the western waters (English Channel, Bristol Channel, St. George, south of Ireland and the coastal waters of Spain and Portugal). Although these areas were known to them from well before WWI, Belgian fishermen specialised in those regions during the WWI alongside their British fellows. Poppe (1977) explains that upon their return home after the WWI, Belgian trawlers continued fishing in these areas for a few decennia during the inter-war period. From the statistics however, the importance of 'the west' and the long-distance fishing grounds is not evidenced until after 1932. This may in part be due to the fact that expatriated fishermen did not return immediately in the years following the war and therefore these landings were not registered as 'Belgian landings'. Before 1950, there are no records of the landings by Belgian fishermen in foreign ports. However, we argue that it is possibly the instalment of credits to support the construction of new vessels (Royal Decision of July 1923) that was crucial for the fast expansion of the fleet after 1923 and until 1938 (Vanneste and Hovart 1959). As pointed out by Poppe (1977) when the engine made its appearance in the Belgian fishing sector, more fishermen shifted their activities and began travelling longer distances to the West and off the coast of Spain and Portugal. Also in other European countries – England, Scotland, Germany, the fishing fleet moved increasingly to distant waters in the 1930s (Ashcroft 2000, Robinson 2000).

Coastal fisheries achieve exceptional catches during WWII

The smaller vessels that stayed in Belgian ports during WWII, were to witness the most productive fishing (herring) seasons ever documented in Belgium and Flanders (Poppe 1977, Lescrauwaet et al. under review, Chapter 7). The presence of marine mines and other threats caused by imminent war had created a major decline in fishing in the North Sea already from autumn 1939. In the UK during WWII, the fleet moved to the safer, western waters (MAFF 1946). Some authors claim that the absence of the large-scale herring fisheries of the Doggerbank, Fladen and the east coast of England and the Channel (Gillis 1946) during the war, generated spectacular herring catches on the post-spawning areas on the Flemish Banks (De Mulder 1984, Lescrauwaet et al. under review). In spite of the severe damage the Belgian fleet suffered during the WWII, this success triggered an expansion of the coastal fishing fleet (Poppe 1977) and the post-WWII recovery was – again – quite fast. The reconstructed monthly statistics (HiFiDatabase) quantify these exceptional catches in 'Coastal waters' with up to 62,500 t in 1943 and demonstrate that these were in part explained by the absence of large-scale fishing during the war and influenced by two strong year-classes 1936 and 1938 (Lescrauwaet et al. 2013 under review). The coastal waters remained the most important provider of sea food until at least 1947, with 37% of annual landings (Figure 4.4.).

Western waters 'revisited'

The recovery of the North Sea fish stocks during WWII stimulated Belgian fishermen to shift their activities again to the North Sea - and Icelandic waters- after the war, until fisheries were hit by a crisis (in 1948) from which they would not recover until the end of the 1950s (Poppe 1977). According to this author, a combination of the effects of overfishing in the traditional North Sea fishing grounds and economic measures that failed to protect the internal market from foreign import, forced a large part of the fleet to head their activities again further northwards to the Iceland waters. Although the HiFiDatabase confirms and quantifies this increase in landings (t) from the Iceland Sea, it further expands on Poppe's hypothesis by showing that also the central-east part of the North Sea gained particular importance during the 1950s (mainly for plaice and sole), and this especially in monetary terms. Hovart (1994) probably refers to this trend when describing a second important shift during the 1950s, regarding the sole fisheries that were lured by the increased abundance of fish in the North Sea fishing grounds just after WWII, and in particular on the White Bank to the east of the central North Sea. After the decline in landings from the waters of the White Bank, according to Hovart (1994) the sole fisheries were forced to move again to the western fishing grounds from 1955 onwards. The HiFiData confirms this 'sole boom' in the North Sea (central-east) between 1949 and 1962, and shows a shy and gradual increase

in the sole landings from the Bristol Channel and South- and West-Ireland afterwards. It was however not until after 1964 that the western waters really became important fishing areas for Belgian sole fisheries. A similar 'westwards 'shift reported for the herring fisheries (Poppe 1977, Hovart 1994) needs to be put into perspective: during the second half of the 1950s, the herring fisheries already started the general decline which continued through the 1970s and 1990s (Lescrauwaet et al. under review, Chapter 7). Therefore, although areas like South-and West Ireland did gain some importance compared to traditional herring grounds e.g. Fladen and the Dogger Bank (Poppe 1977), these landings were quite limited in terms of weight (t).
In 1959 beam trawl fishing was introduced to increase profits in the shrimp fisheries and according to Hovart (1994) this system was also applied in the sole fisheries in the English Channel from the 1960s. Although an increase in the importance of sole fisheries (landings) from the English Channel is not visible from the HiFiDatabase until after 1970, Belgian trawlers were operating in the Bristol Channel (Horwood (1993).

The 1960s and the promise of growth through unprecedented technology
The sixties announced an era of structural changes in the fleet: while the last steam trawler (the O298 'Van Dyck') sailed out to England in January 1964, according to Poppe (1977) the fleet was already entirely renewed by motorized beam trawlers. A Royal decision (29 November 1961, nr.799) installed a system with governmental bounties for the demolition of larger old ships (>30 years) and the introduction of medium-sized steel trawlers (Poppe 1977). These trawlers moved to the Irish Sea, the fishing grounds around the Isle of Man and around the Smalls, 40-50nm off the southeast coast of Ireland - for the sole fisheries. New rich fishing grounds near Yorkshire caused a real 'codfish boom' (cfr. The 'gadoid outburst') in the second half of the 1960s and probably explain the increased landings from the North Sea (central-west) in the HiFiDatabase. Haddock off the central-east coast of England was sold at a higher price on the English markets (Grimsby, 1963-1964) and this is clearly quantifiable in the increased landing statistics from the North Sea (central-west) fishing area (1963-1964) in the HiFiDatabase.

There are particular cases where our data confirm sources that suggest an inverse offer-demand effect in the price of landings: e.g. the two-fold increase in sole landings in the peak year 1963 generated a 50% decrease in prices that year (witness interviews 'Yesterday's Sea' p. 191, validated by HiFiDatabase). Similarly, the sudden 'oversupply' of herring during the WWII caused the price on the formal market to exceed that of the black market (Beke 1985).

In spite of the energy crisis (1973-1974) and the renewed interest in passive fishing methods like fixed nets, long liners and twin-rig trawling (Hovart 1994) the effects of overfishing became more evident and quota were established for herring and later also for sole and plaice. As a result of Iceland's extended territorial sea and exclusive jurisdiction on fisheries up to 200 nm, Belgian fisheries in Iceland declined and shifted to nearby areas in the North Sea (Omey 1982). According to these authors, in 1980 the coastal waters and the southern part of the North Sea again became important fishing areas for the Belgian fisheries. A similar patter, for UK fisheries, is described by Kerby et al. (2012).

The HiFiDatabase confirms this statement and also expands it to include the fishing areas in the North Sea central east and west. Although Belgian vessels fished smaller amounts from the English Channel, Bristol Channel, South and West Ireland and the Irish Sea, these fishing grounds yielded high-valued fish products. This coincided with the introduction of an (EEC) temporary measure for subsidies to improve the structure of the shrimp fishing fleet and the coastal fleet. With the subsidies, new Euro-cutters were built, that were more efficient than the vessels they were replacing (De Wilde 1998). Although the subsidies were conceived to improve the segment of the coastal fleet fishing for brown shrimp, cod and whiting, the vessels targeted flatfish at least part of the year. A peak is observed in the total landings from the coastal waters from the early 1980s until the mid 1980s, however, a closer look at the composition of these landings from coastal waters shows that – although the landings of plaice and sole gradually increased from the beginning of the 1980s - the peak in landings of flatfish occurred around 1995.

Finally, in 1983 the Common Fisheries Policy (CFP) was put in place and with it the EU practice of setting annual TAC's established by Article 3 of the EU Regulation 170/83. Since then national fisheries are somehow 'fixed' according to this international context of quota by fishing area within which spatio-temporal dynamics of fishing is mostly explained by a profit-maximization strategy (Gillis et al. 1995).

4.7. CONCLUSION AND RECOMMENDATIONS FOR FURTHER WORK

The spatial dynamics of Belgian fisheries in the 20th century were marked by distinct periods. After 'stable' volumes of mostly herring from nearby fishing areas (coastal waters and the southern North Sea) before WWII, a rapid expansion followed, stimulated by the unprecedented local productivity during the war. Fisheries and their investments shifted towards more distant areas once the stocks in nearby areas started to show signs of decline, and with the development of larger, motorized fishing vessels. Investments, fishing efforts and spatial expansion of the fisheries continued well after Belgian fisheries had reached their historical peaks in landings in 1947 and 1955. The gradual loss of cod yields from the Iceland Sea was partly compensated by production from fishing areas in the western part of the North Sea.

The instalment of restrictive quota and the shift to targeted sole and plaice fisheries both in the eastern part of the North Sea and more recently in the western waters, coincided with a period characterised by warming temperatures through the beginning of the 1980s in the (southern) North Sea. This is in line with the hypothesis that the ecology of the North Sea has shifted between two different ecological states with the coincident decline of cod and the increase in sea surface temperature (SST) in the mid 1980s as the tipping point (Frid et al. 2000, Brander 2005, Callaway et al. 2007, Kirby et al. 2009). These authors claim that following the decline of North Sea cod, the abrupt ecosystem shift and onset of warmer temperatures resulted in a series of changes in trophodynamics of the plankton and benthos. The HiFiDatabase shows a change in the North Sea landings dominated by Atlantic cod between the 60's until the mid '80s, to predominantly plaice from 1983 onwards. This trend was also strongly related to the transition to beam-trawling (Poppe 1977, Hovart 1994). However, the landings data need to be correlated to fishing effort and LPUE of the commercial fleet in order to further test this hypothesis.

Fishermen use the general patterns in seasonal variability of target species to select spatio-temporal strategies of fishing effort at the larger-spatial scale. However, as Poos (2010) demonstrated for sole and plaice fisheries in the North Sea, local aggregations of limited persistence in time are superimposed on these large-scale patterns. Fishermen use empirical knowledge about these small scale concentrations of fish within the selected fishing areas to optimize landings and/or profit. As Poos stated, restrictive TAC's affect the effort allocation and the discard rates at the national fleet level, since vessels need to optimize their annual net revenues by continuously adjusting strategies on where to fish and what part of the catch to retain. Before the onset of quota and other management constraints in fisheries however, these strategies probably relied on less complex decision making in which indices of catch rates per unit of effort, broad economic incentives and traditions played a proportionally higher role.

The integration of historical time series (Lescrauwaet et al. 2010) increased the accessibility of quality-controlled data on the landings and value of landings of Belgian sea fisheries and particularly allows a quantitative dimensioning of the spatial dynamics of the Belgian fisheries in the 20th century. The present paper brings the outlines on the spatial information covered by this database. It provides quantitative evidence to support or challenge some of the statements from historical literature, underlines the historical importance of the 'coastal waters' to the Belgian fisheries and provides a picture of decades of diversity changes in fish species and fishing grounds, before the onset of the CFP. Finally, it provides a potential source to test hypotheses in ecosystem ecology and fisheries biology. Moreover, it allows contrasting the history of Belgian fisheries with that of other European countries that share the same fishing grounds.

ACKNOWLEDGMENTS

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