

**CHAPTER 2: Historical marine fisheries data for Belgium: Data sources, data management and data integration related to the reconstruction of historical time-series of marine fisheries landings for Belgium.**

## CHAPTER 2. DATA SOURCES, DATA MANAGEMENT AND DATA INTEGRATION RELATED TO THE RECONSTRUCTION OF HISTORICAL TIME-SERIES OF MARINE FISHERIES LANDINGS FOR BELGIUM

*In spite of the €1 billion of public money spent each year in Europe on monitoring and measuring the seas (COM/2010/0461), users are still confronted with restrictions on data access. When accessible, the quality of the data may be unknown or different standards and formats may apply which make data assembling from different sources a challenging and often specialists' task. This situation seriously hampers the opportunities to develop innovative products and services, including the use of data in advanced scientific research. This is particularly true for long-term time-series. The current chapter covers the process of reconstructing time-series for different parameters that describe the sea fisheries in Belgium: landings, value of landings, species, species length classes, fishing areas, and their seasonal and annual variability. The process from source to product is explained and the main outcomes and data products of the reconstruction of historical time-series on Belgian sea fisheries are commented.*

Chapter 2 modified from the publication:

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The current chapter contains updates on datasets included for the analysis of the Belgian fleet dynamics.

## 2.1 INTRODUCTION: COLLECTIVE (DIGITAL) MEMORY DISORDER

Assuming that the Internet is a first step for the exploration and discovery of information from a general users' perspective, availability of (meta)data on sea fisheries in Belgium, was assessed on the worldwide web. The Internet was searched for references using the Dutch keywords for 'landings', 'fisheries' and 'trends' on Belgian web pages, with 692 returns ([www.google.be/search?hl=nl&q=evolutie%2Baanvoer%2Bzeevisserij&btnG=Zoeken&meta=cr%3DcountryBE](http://www.google.be/search?hl=nl&q=evolutie%2Baanvoer%2Bzeevisserij&btnG=Zoeken&meta=cr%3DcountryBE), consulted on 07/Jan/2009). Of the first 100 references we screened on content, only 20% contained numerical values on the landings by Belgian fisheries. Nearly half of these references compare the current fish landings with those of the previous year or provide one overall figure for the total landings of Belgian fisheries for the year in review. Ten references contain annual time-series on the evolution of total landings, starting in 1990 (4 references), or 1984 (1 reference) at the earliest. A similar literature search was conducted in Google scholar ([scholar.google.com/advanced\\_scholar\\_search](http://scholar.google.com/advanced_scholar_search)) and the Web of Knowledge ([www.isiknowledge.com/](http://www.isiknowledge.com/)): there were no returns that contain references to the amount (t, tonnes), composition and/or value (Belgian francs or Euros) of Belgian marine fisheries. The annual reports titled 'Aanvoer en Besomming' (Landings and value of landings) are published by the 'Dienst Zeevisserij' (Sea Fisheries Service, Flemish Government) since 1973 (on paper), and since 2000 also as electronic copies. The reports summarize the evolution of landings from 1950 onwards in a Table with one general value for total landings every 5 years between 1950 and 1975 and annual values from 1975 to date. Since 2002, the Sea Fisheries Service also publishes the annual 'Uitkomsten van de Zeevisserij' (Economic output of Belgian Sea Fisheries) on the fleet and economic parameters. These documents represent the formal fisheries statistics reports of Flanders (Belgium) and are available via the Internet: <http://lv.vlaanderen.be/nlapps/docs/default.asp?id=218>.

The *Integrated Marine Information System* IMIS is a specialized marine information system of Flanders Marine Institute - VLIZ. A search effort on 12/Jan/2009, based on the Dutch keywords for 'landings' and 'fisheries' yielded 27 returns. Of these, 7 are the formal annual government reports on 'Landings and value of landings' (see above); another 4 refer to total landings in 2004; 1990; 1997; 1990 and one paper on marine archaeology refers to landings of herring and cod in the 18th century. A PhD thesis on shrimp fisheries (Polet 2004) reports total annual landings of the Belgian sea fisheries from 1970 onwards. Although the IMIS collection is not exhaustive in all disciplines, it contains the largest collection of publications and documents on marine and coastal sciences in Flanders and Belgium.

We reviewed available policy documents on sea fisheries from the Fisheries authority (Agriculture and Fisheries department of the Flemish Government) and a review study on the socio-economic analysis of Belgian sea fisheries in North Sea waters (Maes 2003). The longest available time-series in the latter depict the trend in the total production of Belgian fisheries, at 5-year intervals starting in 1960. In addition, graphs with annual landings covering the time period 1990-2000 are included for the four commercially important species cod (*Gadus morhua*), plaice (*Pleuronectes platessa*), sole (*Solea solea*) and brown shrimp (*Crangon crangon*). The historical context for landings covered in recent policy documents (e.g., National Operational Programme) to underpin strategies for (sustainable) marine fisheries in Belgium surprisingly only goes back to 1990 (ILVO 2008, Anon. 2008). From this directed search for sources on the Internet, we concluded that our current collective memory (*sensu 'publicly available digital data and information'*) related to quantitative information on sea fisheries in Belgium does not surpass 30 years. We could think of at least two possible reasons to explain the absence or incompleteness of data on marine fisheries before 1980:

- Data were not collected/never existed or are not available (anymore) in the public domain;

- Reliable data exist and are publicly available, but data policy restrictions apply;
- Freely accessible data are not available in the appropriate format for redistribution

In the following paragraphs, these questions are addressed following the logical steps of the data production process: data inventory, data digitization and quality control, standardization, integration.

## 2.2 INVENTORIES AND INVENTORYING

Starting points for inventorying potential sources of data and quantitative information on Belgian/Flemish sea fisheries were well-structured databases that allowed advanced querying on the basis of specific search terms. These databases were screened for publications, documents (including grey literature) and data on fisheries in Flanders/Belgium. Search terms included 'fishery', 'fisheries', 'fishing', 'landings' and 'fleet'. Where search options allowed, wildcards were used (e.g. 'fish\*'). The search was conducted between October 2007 and February 2008.

- a) **Specialized libraries and databases with digitally accessible collections (on-line index/query possibilities):**
  - The Integrated Marine Information System IMIS (Flanders Marine Institute - VLIZ; [www.vliz.be/imis](http://www.vliz.be/imis))
  - and its 'Open Marine Archive' - OMA ([www.vliz.be/OMA](http://www.vliz.be/OMA)) with full-text digital documents: screened for data and information (modules 'Publications' and 'Datasets');
  - The Belgian Marine Data Centre BMDC of the Management Unit for the Mathematical Model of the North Sea MUMM (<http://www.mumm.ac.be>);
  - The Food and Agricultural Organization of the United Nations (FAO) and the International Council for the Exploration of the Sea (ICES);
  - Fishbase ([www.fishbase.org/](http://www.fishbase.org/)) and the *Sea Around Us* Project ([www.seaaroundus.org/](http://www.seaaroundus.org/)).
- b) **Specialized libraries: physical collections:**
  - The library of the Flanders Marine Institute (VLIZ) (*Oostende*, Belgium);
  - The library of the Sea Fisheries Service (*Oostende*, Belgium); recent documents (after 1980) on marine fisheries are generally kept at the Sea Fisheries Service (DVZ). Older documents (>100years) were transferred to the State Archives (*Rijksarchieven-RA*), according to Belgian Law on State Archives. The responsibility for marine fisheries has changed between ministries since the creation of the Kingdom of Belgium in 1830 (e.g. the 'Ministry of Mobility and Infrastructure', 'Ministry of Mobility, Post, Telegraphy and Telephones', the 'Ministry of Labour and Industry', and the Ministries responsible for Agriculture). With the regionalization of Belgium in 1980, the Flemish government was created in 1980. The *Lambermont agreements* (2002) finally transferred responsibility for Sea fisheries from the federal level to the domain of agriculture of the Flemish Government.
  - The library and archives of the Institute of Agriculture and Fisheries Research – ILVO (*Oostende*, Belgium), which are stored in the archives of VLIZ to be disclosed, documented and partly digitized. (e.g. 'Fishery atlases' and 'Stock assessments for herring').
- c) **Catalogues, literature databases and internet 'harvesters':**
  - JSTOR, Web of Knowledge, Aquatic Sciences and Fisheries Abstracts, Google Scholar, Avano, Antilope and CCB (for completing reference titles).

The image shows two documents. On the left is the cover of a report titled 'Veertiende Jaarverslag over de ZEEVISSCHERIJ 1930' (14th Annual Report on the Fisheries, 1930) from the 'Ministerie van Verkeerswezen' (Ministry of Transport). On the right is a page from the report, 'Tableau I', which is a table titled 'ESPECES DE POISSON' (Species of Fish). The table lists various fish species and their quantities and values. The table is organized into columns for 'Quantité et valeur de chaque' (Quantity and value of each) and 'OSTENDE' (Ostend). The species listed include 'I. Poisson de fond' (Bottom fish), 'Lotte' (Eel), 'Vive' (Scallop), 'Gronde rouge' (Red mullet), 'Barbot' (Bass), 'Piscan' (Herring), 'Socle' (Sole), 'Cabillaud' (Cod), 'Nobaste' (Nobaste), 'Gronde' (Gronde), 'Colin' (Colin), 'Lingue' (Lingcod), 'Bromme' (Bromme), 'Merlu' (Merlu), 'Pue' (Pue), 'Scaurel' (Scaurel), 'Rais' (Rais), 'Rais raline' (Rais raline), 'Rouget' (Rouget), 'Limande' (Limande), 'Piette' (Piette), and 'Egelen' (Egelen). The table includes sub-rows for 'grande' (large), 'moyenne' (medium), and 'petite' (small) fish, and a 'Total' row for each category. The values are given in 'Kil.' (Kilograms) and 'Fr.' (Francs).

**Figure 2.1.:** Image of the original Tables and fisheries reports in the Series 'Jaarverslag over de zeevisscherij', Dienst voor Zeevisscherij/ Bestuur van het Zeewezen, 1930. Source: A century of Sea Fisheries in Belgium (VLIZ 2009) Scanned images available from [http://www.vliz.be/EN/Figures\\_Policy/Figures\\_Policy\\_Belgian\\_Sea\\_Fisheries](http://www.vliz.be/EN/Figures_Policy/Figures_Policy_Belgian_Sea_Fisheries).

- d) **Historical collections:** an additional search effort was conducted in the physical collections of historical archives and documentation centres in Belgium:
- Archives of the National Institute of Statistics, Belgium (NIS), kept in the collections of the State Archives (*Rijksarchieef*) of Belgium in Brussels;
  - State Archives (*Rijksarchieef*) of Belgium in Brussels and Bruges: contain physical collections and inventories of historical documents of the archives of the Province of West-Flanders (1795-1814, 1830-1875), the Chambers of Commerce of *Oostende* and *Brugge*, Municipal archives of *Nieuwpoort*, *Blankenberge*, *Brugge*, and *Heist*. The collection includes 'Bestuursmemorialen' and 'Rapport sur l'état de l'administration de la province de Flandre Occidentale' (Annual reports on the state of the provincial administrations) as well as 'Placcaeten van Vlaanderen' (De Wulf 1766), which collects ancient laws and prescriptions from the local governments from the 14<sup>th</sup>-18<sup>th</sup> centuries;
  - Provincial Archives in Bruges, which contain the inventories and physical collection of the archives of the Province of West-Flanders (1815-1830, 1875-present);
  - City Archives of Antwerp (*Erfgoedbibliotheek Hendrik Conscience, Antwerpen*) which contain one of the most complete series of 'Landbouwstatistieken' (Agriculture and Fisheries statistics of Belgium), Royal decrees and Ministerial decisions, official historical legislative documents.

Sources describing the history and development of early statistics in Belgium were studied and the list of official

statistical publications in Belgium from 1830 to 1914 was screened for older publications and data sources. Julin (1918) and de Reiffenberg (1932) provide a review of the history of the early statistics in Belgium and the development of census and data collecting systems to underpin state policies, in particular for marine fisheries. The need to standardize the collection of fisheries data was underlined much earlier by De Zuttere (1909) and in the early volumes of the series '*Jaarverslag der commissie voor zeevisscherij*', Provincie West-Vlaanderen (see further).

DATES d'Arrivée & d'Expédition.	ARMATEURS.	STURMAN.	Tonnes Merue d'Island.	Etland & Nord.		Tonnes Merue du Doggers- bank.	Expéditions en	
				Tonnes Hareng.	Tonnes Merue.		Tonnes Hareng.	Tonnes d'Island.
aout 14	J. De Lenois	M. Monteni	<del>121</del>	121	1			56
	J. De Bidan	J. Van Troon		123				81
	G. De Boe	J. Van Veneke		127				91
	L. Deghelasse	J. Van Meppen		131	4 1/2			27
	G. B. Deestram	J. Van Minnefel		226	1 1/2			30
				728	7			285

mod. et tel. par  
Brouwer  
Loyen

**Figure 2.2.:** Picture from the archives of the ancient regime of *Nieuwpoort* (INV 80 4184): fish landings register from August 25<sup>th</sup>, 1786 in the fishing port of *Nieuwpoort*. Source: A century of Sea Fisheries in Belgium (VLIZ 2009).

The methodology applied for screening and searching depended on the type and nature of the document or the series. As a general approach, the archivist was contacted previously and assisted in the search. Most promising inventories were screened based on titles (geographic and thematic).

The findings of the inventory on historical data on sea fisheries in Belgium were broadly divided into three categories or time intervals for the purpose of this paper (Table 2.1.): 1) recent history (1900-2000); 2) the Dutch (1815-1830), early Belgian (1830-1900) and Austrian and French periods (1700-1815); and 3) the Middle Ages. Each data source was archived and described in detail in a standardised way so as to create a searchable metadata inventory, facilitating data discovery and sharing. These metadata include information needed to decide on the relevance of a dataset in a particular context (e.g. where, when and how the data was collected, where they are stored and in what format, and under which conditions they are made available). All metadata descriptions are publicly available through the VLIZ website (IMIS).



### 2.3 OVERVIEW OF DATA SOURCES AND FORMATS

The need for systematically collected data on marine fisheries has long been recognized, e.g. by the government commission in charge of studying the effects of state subsidies in this sector (Du Bus and Van Beneden 1866). The work of De Zuttere (1909) and of Gilson (1859°-1944†, director of the Marine Research Institute, *Zeewetenschappelijk Instituut - ZWI*) and Gilis (fisheries technician at ZWI) both participants for Belgium in the 'Statistical Committee' of the International Council for the Exploration of the Sea ICES in the early 20<sup>th</sup> century, was also crucial in consolidating structural reporting on fisheries statistics. Their efforts were hampered by the First World War (1914-1918) and fraught with financial problems. Finally, the achievement of standardized and structural reporting at the beginning of the 20<sup>th</sup> century was the work of many contributors.

The current inventory in local or foreign archives did not uncover references or data sources on sea fisheries in Flanders from the 20 years of the first French Republic (1795-1804), the French Empire (1804-1815), or from the 15 years of the United Kingdom of the Netherlands (1815-1830) (Table 2.1.). During the Dutch administration, official statistics were coordinated by the 'Bureau of Statistics' (later 'Royal Commission for Statistics'), which was established in 1826 by the Ministry of Interior Affairs in The Hague. The founder of Belgian statistics, Adolph Quetelet (1796-1874) was a member of one of the provincial commissions. In their overviews of early official statistical publications (including the period of the first French Republic) Heuschling (1843) and Julin (1918) commented briefly on the difficulties encountered for marine fisheries statistics. Although the State Archives hold documents of correspondence with the fisheries administration in The Hague dating from the Dutch period, no fisheries statistics or reference to the existence thereof were found. Further efforts are required to expand this search effort to foreign archives and working groups that focus on historical fishery statistics abroad.

A large portion of the original and prime data sources, such as logbooks and monthly statistics that were once recorded by the authorities may have been lost or destroyed during World War I (1914 - 1918) and World War II (1939 - 1945) and are now mainly available in aggregated form through secondary references (e.g. Cloquet 1842, Vlietinck 1975 (reprint from publication in 1897), De Zuttere 1909). The inventory also demonstrated that the administrative support and control associated with granting state subsidies acted as an important driver for the collection of the early fisheries statistics, as was the case for the period 1842-1868.

Finally, the beginning of this structural reporting on fisheries and landings in Belgium coincided with the period where most states in Europe developed a statistical approach to underpin policy development (de Reiffenberg 1932a, 1932b, Julin 1918, Leti 2000, François and Bracke 2006) and was triggered by the efforts of the 'Statistical Committee' of the International Council for the Exploration of the Sea ICES to standardize fisheries statistics reporting format at the international level.

Formal sources that contain data on composition and economic value of landings by Belgian fishers in Belgian and foreign ports and data on fleet parameters were inventoried from 1700 to 2010 (Table 2.1.). The Table includes an indication of the temporal resolution (period and frequency of data sampling), taxonomic resolution (level of aggregation) and spatial resolution (by area of origin or port of landing). The political-administrative situation is indicated, as well as reference to some noteworthy events in fisheries at that time.

**Table 2.1.:** Sources containing historical time-series (>5 consecutive years) on landings by Belgian fisheries from 1700 to 2012 with an indication of temporal, taxonomic and spatial resolution.

	Interval	Marking events of for the period	Source	Period	Frequency	Taxonomic resolution	Spatial resolution	Physical location	Digitally available in VLIZ: Data set (D) Full text (F)
1	MODERN TIMES	EU Common Fishery Policy  1972 and 1975: 'Cod Wars' in Iceland waters	Series 'De Belgische zeevisserij. Aanvoer en besomming'. Dienst Zeevisserij.*	1973 - 2012	Annual	By species, subtotals, general total	By port and by fishing area	DVZ	Available in paper format: 1973-1997 D: 1998-2006
2			Series 'De Belgische zeevisserij'. <i>Landbouwstatistiek</i> . Nationaal Instituut voor de Statistiek.	1969 - 1999	Annual	By species, subtotals, general total	By port and by fishing area	HC-Antwerp	D
3			Collection 'Monthly landings'. Archief van dr. Frank Redant, ILVO.	1967 - 1980	Annual	By species, subtotals, general total	By port	ILVO and VLIZ libraries	Available in paper format
4		1958: first 'Cod war', Iceland	Series 'Statistiek van de zeevisserij' <i>Statistisch tijdschrift</i> . Nationaal Instituut voor de Statistiek.	1957 - 1968	Annual	By species, subtotals, general total	By port and by fishing area	HC-Antwerp	D
5		World War II (1940-1945)	Series 'Statistiek van de zeevisserij' <i>Statistisch bulletin</i> . Nationaal Instituut voor de Statistiek.	1934 - 1956	Annual, no data in 1941, no data by fishing area in WWII	By species, subtotals, general total	By port and by fishing area	Heritage Library Hendrik Conscience Antwerp	D
6			Series 'Bestuurlijk Jaarverslag over de Zeevisserij'.	1934 - 1939	Annual, no publication in 1941	By species, subtotals, general total	By port	VLIZ, DVZ	Available in paper format (1934-1936) F (1937-1939)



			Bestuur van het Zeewezen.						
7			Officiële lijst der Belgisch vissersvaartuigen	1929-2012	Annual and semestral	By vessel	By port	VLIZ, Shipping Control offices	paper format (1929–2012) F (1929–2012)
8			Series 'Jaarverslag over de zeevisscherij', Dienst voor Zeevisscherij/ Bestuur van het Zeewezen.	1927 – 1933	Annual	By species (from 1929), subtotals, general total	By port and by fishing area (from 1929)	VLIZ library, library Province West-Flanders,	F (1927–1931) paper format (1932–1933)
9		<b>1914-1918:</b> World War I <b>1914:</b> natural ice replaced by artificial ice to conserve	Series 'Jaarverslag der commissie voor zeevisscherij', Provincie West-Vlaanderen.	1912 – 1926	Annual; no publication in WWI (1914-1918)	Subtotals, general total	By port	VLIZ library, library Province West-Flanders,	F
10		<b>1909:</b> the end of 'salted cod' fisheries in Belgium	De Zuttere (1909). Enquête sur la pêche maritime en Belgique.	1836 - 1907	Annual+ summer/ winter landings for cod	Salted cod, herring and 'fresh caught fish'	By port	Archives and VLIZ library	F
11		<b>1862:</b> end of state subsidies in herring fisheries, Belgium  <b>1866:</b> survey on sea fisheries sector, Belgium	Rapport sur l'état de l'administration dans la Flandre occidentale fait par la Députation permanente au Conseil provincial	1836 - 1869	Annual	Cod, herring and 'fresh caught fish'	By port	State and Provincial archives	D
12	<b>BELGIUM</b> early decades (from 1830)	<b>1884:</b> arrival of the first steam trawler in Belgium (Oostende)	Memoriael Administratif der Provincie West-Vlaanderen. Bestuursmemoriaal van de provincie West-Vlaanderen-Section 'Pêche maritime'	1837-1875	Annual (not all volumes contain landing statistics)	Cod, herring and 'fresh caught fish'	By port	State archives	D

13	UNITED KINGDOM THE NETHERLANDS	1815-1830	Gazette van Gend	1814-1829	Annual and monthly	Fishing vessel movement and landings Salted cod and herring	Port of Oostende	Library of Ghent University	
14	French Republic	French Republic 1795-1804 And French Empire 1804-1815	Gazette van Gend				Port of Oostende	Library of Ghent University	
15	'Austrian Netherlands'	Oostende Compagnie (1723-1731) for stimulating Flemish trade and fisheries	Cloquet (1842). Études sur l'industrie, le commerce, la marine et la pêche nationale	1767-1780, 1783-1789		'Salted cod' and herring		UA Bibliotheek Stads-campus	F
16	'Spanish Netherlands (1549-1713)	<b>Ca. 1475:</b> start of Flanders 'Doggevaert' or cod fisheries on the Doggerbank in the North sea <b>1547:</b> Flemish fleet consists of 200 vessels	Vlietinck, (1975). Het oude Oostende en zijne driejarige belegering (1601-1604)	1492-1580				VLIZ library	Available in paper format
17	'Burgundian Netherlands	<b>1396:</b> Technique for conservation of herring: 'kaken' is applied in Flanders	Degryse & Mus (1966-1967). De laat-middeleeuwse haringvisserij	1398-1427				VLIZ library	Available in paper format

### 2.3.1 RECENT HISTORY: 1900-2000

Detailed digital sources for annual data on landings and their values were available as from 1998 onwards. This series of annual official reporting was available in paper format since 1973. However, predecessors of this series have been published since the early 20<sup>th</sup> century (1912). Fragmented parts of these series are kept in paper; in a few disperse province and city archives throughout Flanders.

An overview of the situation of sea fisheries in Belgium in 1909-1910 (von Schoen 1912) provided interesting information on the number of vessels and fishermen, their production and fishing areas, ports and auctions, and import and export, at that time. However, it does not refer to or contain data series on landings.

Our literature screening for time-series on landings and the economic value of these landings indicated that structurally embedded reporting in Flanders/Belgium started in 1929 with an acceptable degree of consistency and continuity ever since then, except during the war period (World War II: 1940-1945, and in particular 1941). The reports have been subject to a number of changes (e.g. responsible authority and editor, title and format of the

publication). They were either published as an independent report on fisheries, or as insert chapter in agriculture statistics reporting.

### 2.3.2 AUSTRIAN, FRENCH AND DUTCH PERIOD, AND THE EARLY DECADES OF THE KINGDOM OF BELGIUM: 1700-1900

Data on fisheries in Flanders were reported much earlier. Cloquet (1842) and De Zuttere (1909) reported on landings of herring and cod in the ports of Oostende and Nieuwpoort from 1767-1780 during the 'Austrian Habsburgs' (1713-1794) and French period (1794-1815). The data on 18th century landings reported by Cloquet (1842) were largely based on detailed records (the remainders of which were checked in State Archives) which were presumably still intact at that time. De Zuttere reported on landings for the period 1836-1907 for herring, salted cod and for 'fresh fish' (aggregate of unidentified species). Although the author probably consulted a wider range of original documents directly obtained from fish auction authorities or Chambers of Commerce, presumably lost at present, he referred to the annual state of administration of the province of West-Flanders (Rapport sur l'état de l'administration dans la Flandre occidentale fait par la Députation permanente au Conseil provincial) and the cantons (Rapports faits par messieurs les commissaires d'arrondissement). These sources were checked, and found to coincide with the data in De Zuttere (1909) except for some minor errors which were probably due to transcription. Some of the data and Tables reported by De Zuttere (1909) were also found as draft documents while screening for historical sources (with no metadata or identification whatsoever of author and context) in the State Archives at Brussels (inventory of Vleeshouwers 1979).

In spite of the level of detail provided by Cloquet (1842) for the time periods 1767-1780 and 1783-1789, and by De Zuttere (1909) for the same intervals and for 1836-1907, neither of the authors included data or references for the 45 year time period 1790-1835. This period largely coincides with the 20 years of the first French Republic (1795-1804) and the French Empire (1804-1815), and with the 15 years of the Kingdom of the Netherlands (1815-1830). During the Dutch administration, official statistics were coordinated by the 'Bureau of Statistics' (later the 'Royal Commission for Statistics'), established in 1826 by Interior Affairs in The Hague. The founder of Belgian statistics, Adolph Quetelet (1796-1874) was a member of one of the provincial commissions. In their overviews of early official statistical publications (including the French period), Heuschling (1843) and Julin (1918) commented briefly on the difficulties with marine fisheries statistics. The absence of references and data during the French and Dutch period may be due to the fact that these were non-existent or simply not disclosed in foreign archives or brought into the public domain. During our search in the State Archives, documents of correspondence with the fisheries administration in The Hague dating from the Dutch period were encountered, but no fisheries statistics or reference to the existence thereof were found. Promising sources for this period include the newspaper of the City of Ghent '*Gazette van Gend*' (edited between 1666 and 1940), which published in-and outgoing fishing vessels in the port of Oostende (1814-1829), the volume of landings of salted cod and herring (in unit of barrels), and the fishing area of origin. Further efforts are under way to expand this search effort to foreign archives and working groups that focus on historical fishery statistics both in Belgium abroad.

The State Archives in Bruges keep original documents and records on landings of cod from the Company for trade and fishing to Iceland 'De Groote Nationale Compagnie voor zeevaart en vischvangst op IJsland (1727-1780)' (Inventory of the old regime of the City of Nieuwpoort - INV80 - 4184). In 1866, a government commission was charged with the investigation into the marine fisheries of Belgium. The report from this commission contains valuable information on marine fisheries drawn from a survey (Du Bus and Van Beneden 1866).

The landings data reported for this period were also collected and digitized in the context of this project. Although not consistently or systematically collected over the period, they provide a good idea of the fisheries during that era. Today, only fragments remain since the largest part of the archives was destroyed during World War I (1914 -

1918) and World War II (1940 - 1945). The data demonstrate the importance of subsidies in the observed trends, as was the case for the period 1842-1868. The rise and fall of cod fisheries in the 19<sup>th</sup> century could in part be explained by the existence of these subsidies. On the other hand, it was mainly the administrative support and control associated with granting subsidies that acted as the driver for the collection of the early fisheries statistics.

### 2.3.3 MIDDLE AGES TO 1700

Historical documents such as charters and local laws shed light on the importance of fisheries in Flanders during the Middle Ages and the Early Modern Period. The ports of Oostende and Nieuwpoort enjoyed periods of wealth and independent status for trade and fisheries. Detailed records were kept on landings, due to the tax levies on salt and particularly during years in which subsidies were granted to the herring and cod fisheries. Early documented evidence of the extent of fish trade in Flanders can be derived from taxes levied in coastal ports at the beginning of the 11<sup>th</sup> century (Degryse, 1944). Early published reports of landings in Flanders refer to herring in the port of Biervliet in 1398-1427 (Degryse and Mus 1966-1967) and to Oostende in 1492-1580 (Vlietinck 1975). The State Archives at Bruges contain valuable documents on the history of fisheries and associated trade in Nieuwpoort such as the 'Keure van Nieuwpoort' (city charter of Nieuwpoort) from 1163 which summarizes the species of fish caught, traded and taxed; a Charter of 1574 in which the king granted the city the right to exploit salt (Archive INV80 – 376); and the 'Placaetboeken van Vlaanderen' (De Wulf 1766) with reference to local laws and charters.

### 2.3.4 STATE ARCHIVES AND STATISTICS

Belgian Law on State Archives (Rijksarchieven-RA) stipulates that all governmental documents and administration archives older than 100 years need to be transferred to the State Archives. In practice, RA strives to collect archives as soon as they are freed from legal value (30 years and older). Recent documents (after 1980) on marine fisheries are generally kept at the Sea Fisheries Service (DVZ). Older documents were transferred from the respective fisheries authorities to the State Archives, and it was not clear in what conditions these transfers were conducted or how complete these archives are (M. Preneel, National Institute of Statistics, Belgium, pers. comm.). The responsibility for marine fisheries has changed between ministries since the creation of the Kingdom of Belgium in 1830, e.g., the 'Ministry of Mobility and Infrastructure' created in 1884, 'Ministry of Mobility, Post, Telegraphy and Telephones', the 'Ministry of Labour and Industry', and the Ministries responsible for Agriculture in the Belgian government. With the regionalization of Belgium, the Flemish government was created in 1980. The Lambermont agreements, signed in 2002, finally transferred Sea fisheries from the federal level to the domain of agriculture of the Flemish Government.

We also looked at the history and development of statistics in Belgium and checked the list of official statistical publications in Belgium from 1830 to 1914 to check for additional references to older publications and data sources. Julin (1918) and de Reiffenberg (1932) provide good overviews of the history of the early statistics in Belgium and the difficulties in setting up methodologically sound census and data collecting systems to underpin state policies, in particular for marine fisheries. The need to standardize the collection of fisheries data was already underlined much earlier by De Zuttere (1909) and in the early volumes of the series 'Jaarverslag der commissie voor zeevisscherij', Provincie West-Vlaanderen (Table 2.1.).

The data sources, published and unpublished references and manuscripts listed in Table 2.1. can be organized in 3 categories: data on landing statistics (volume, composition and economic value), data describing the fleet and fishing effort, data related to biological parameters of species. The data sources for these 3 categories are further described in the sections below.

### 2.3.5 LANDING STATISTICS

Early published reports of landings in Flanders refer to herring in the port of *Biervliet* in 1398-1427 (Degryse and Mus 1966-1967, Table 2.1.) and to *Oostende* in 1492-1580 (Vlietinck 1975)( Table 2.1.). Time-series on landings of marine fisheries in Flanders are reported as early as 1767 (1767- 1780; 1836-1906, Table 2.1.) for herring, salted cod and for 'fresh fish' (aggregate of unidentified species).

From 1836 until 1869 annual landings were reported for herring and for salted cod, in the Provincial Reports 'Mémorial administratif' and 'Rapport sur l'état de l'administration de la Flandre Occidentale fait par la Députation permanente au Conseil provinciale'. The reports also contain total economic value of landed 'freshly caught fish' (all species aggregated). In 1866, a government commission was charged with the investigation into the marine fisheries of Belgium. The report from this commission contains valuable landings statistics data information on marine fisheries drawn from a survey (Du Bus and Van Beneden 1866). Although not consistently or systematically collected over the period, they provide a good idea of the fisheries during that era. Reporting ceased when state subsidies were abolished in 1869.

De Zuttere's socio-economic survey (Table 2.1.) served as a historic baseline for the statistical data collection programme that was under scrutiny for early internationally agreed standards and formats. The programme set off in 1912 and, after an interruption during WWI, took its final format in 1929 with detailed reporting at the species level. The systematic fisheries statistics were put in place in Belgium thanks to the efforts of G. Gilson and co-worker Ch. Gilis who represented Belgium in ICES. Since then, the composition and economic value of landings is reported annually in 'Jaarverslag over de zeevisserij' and its successors. However, it must be underlined that these reports often contain highly aggregated statistics, and that most of the detailed statistics with best taxonomic, spatial and temporal resolution (original handwritten reporting sheets) were obtained by searching the storage and repository of the Sea Fisheries Service in Oostende. These original handwritten reporting sheets were organized in 'Table series' containing mostly data on composition, volume and value of landings identified by roman numbers (I-IX). The most important and complete series are: data by port of landing; data by type of fishery (e.g., shrimp fishery, demersal trawl fishery, ...); data by fishing area (fishing area 1 to 21, see also Chapter 4 on spatial dynamics of Belgian sea fisheries). Particular 'Table series' also contain annual and monthly data on fishing effort as related to the landings that resulted from this effort. These Tables are organized by type of fishery (e.g. 'shrimp fishery', 'herring drift net fishery', '(beam trawl) flatfish fishery',...) by vessel class, by year and by month. The latter are documented in the context of particular research questions (Chapters 6 to 8).

#### Scope of the landing statistics included in the HiFiDatabase

The HiFiDatabase is based on publicly reported statistics on landings from the commercial fleet and therefore does not cover total removals of fish and shellfish by the Belgian fleet. Publicly reported statistics on fisheries refer to commercial landings which are only a part of the catch and hence of the total removals. The difference between publicly reported versus total anthropogenic removals includes several components. Besides the unreported and misreported commercial landings (Zeller et al. 2006, Zeller et al. 2007), part of the catch is discarded at sea by fishers (Kelleher 2005), suffers unaccounted underwater mortality in the fishing gear (Collie et al. 2000, Rahikainen et al. 2004, Kaiser et al. 2006, Depestele et al. 2008) or is removed by recreational/artisanal fishing (Coleman et al. 2004, Zeller et al. 2008). There is no quantitative or qualitative assessment of the small-scale fisheries (<12m) within 12 nm or territorial sea of Belgium. Discards of the commercial fleet, landings and discards of the recreational fleet, and artisanal and land-based fishing activities are not covered in systematic reporting. Together these components are often referred to as Illegal, Unreported and Unregulated catches (IUU). Chapter 6 provides a first estimate of these components for the Belgian sea fisheries and in particular for the BNS.

The HiFiDatabase contains data on the landings (tonnes) by the Belgian fleet in the Belgian and foreign fish auctions, and on the value (Euro) of these landings at first sale, in the Belgian and foreign fish auctions. It explicitly includes landings by the Belgian fleet, both in the Belgian ports and in foreign ports. Landings from foreign fleets in the Belgian ports are reported in some of the original sources. The data rescue for the latter was covered only in terms of global annual totals and subtotals by species. For the time being – and according to priority setting – these landings from the foreign fleet were not standardized and integrated and not considered for the purpose of data analysis.

Detailed monthly landings by statistical rectangles are available for a number of species (sole, whiting, haddock, cod, plaice) and for limited years (1954-1962 and 1969-1981), and also published as ‘Belgische zeevisserijatlas’ (Belgian sea fisheries atlas) by the Institute of Agriculture and Fisheries Research (ILVO and its predecessors). Unfortunately, most of the recent publications (1969-1981) report values as ranges instead of absolute values (1954-1962). Exceptionally, data on fisheries practiced from the beach (‘strandvisserij’) were collected during WWII; these were included in the data rescue and integration.

Historical data sources on landings before 1998 were only available in hard copy. None of the data were available electronically in the public domain, except for an electronic file (spreadsheet) with landings by (the most important) species by fishing area of origin 1996-recent year provided by the Sea Fisheries Service upon personal request of researchers. In other words, landings data was available on spreadsheets for 1996 onwards. The collection of original data sources was scanned, electronically stored as PDF format, described, and data were digitized from the earliest year of consistent time-series (1929).

All data and data sources are now public and no restriction other than the acknowledgement of sources is required. A detailed list and description of digitized sources of data on the composition and economic value of landings is available from: [http://www.vliz.be/cijfers\\_beleid/zeevisserij/pub\\_bijdrage.php](http://www.vliz.be/cijfers_beleid/zeevisserij/pub_bijdrage.php).

### 2.3.6 FLEET STATISTICS

Since 1929 the Belgian Ministry of Transport (federal government of Belgium) publishes the annual ‘Official list of the Belgian fishing vessels (OLBFV)’ on the state of the national fleet, with separate lists for the fishing fleet. The OLBFV describes characteristics of individual vessels by port of registration, identifying their immatriculation number, total length (TL), capacity as gross tonnage (GT) and net tonnage (NT), engine power (Kilowatt-kW or Dutch Horsepower-HP), owner (name, address), year of construction, ship wharf, construction material (wood, steel...), fishing gear, and - however in less complete records- presence of some of the communication and technical equipment on board (VHF, sonar,...).

**Table 2.2.:** Overview of sources containing historical time-series (> 5 consecutive years) on landings and fleet parameters by the Belgian fishing fleet between 1830 and 2010 with an indication of temporal, taxonomic and spatial resolution.

Period	Fleet parameters	Source
1830-1841	Number of ships for the port of Oostende; total gross tonnage of ships for the port of Oostende (in register-ton);	Rapport de la Commission chargée de faire une enquête sur la situation de la pêche maritime en Belgique. Séance du 17 mai 1866. Chambre des Représentants: Bruxelles. XLII, 75 pp.
1832, 1836, 1839	Number of ships for the ports of Nieuwpoort, Blankenberge, Heist, De Panne/Adinkerke, Koksijde/Oostduinkerke.	Rapport de la Commission, 1866.

1842-1864	Number of ships by port (Oostende, Nieuwpoort, De Panne/Adinkerke, Koksijde/Oostduinkerke, Blankenberge, Heist); total gross tonnage of ships by port (all ports)	Rapport de la Commission, 1866
1865-1871	No data	No sources
1872, 1877, 1882, 1887, 1892-1903	Number of ships by port, including number of steam trawlers ; total gross tonnage of ships by port; open and half-open vessels for 1892-1911 estimated based on punctual reported numbers for 1892 and 1905	Hoek, P.P.C.; Kyle, H.M. (1905). Appendix J: Statistics of the North Sea fisheries. Part I: The fisheries of the various countries. Belgium <i>Rapp. et Proc.-Verb. Cons. Int. Explor. Mer</i> 3: 82-91 1905.
1905	Number of ships by port, including number of steam trawlers; Total gross tonnage of ships by port, including tonnage of steam trawlers.	De Zuttere, C. (1909). Enquête sur la pêche maritime en Belgique: introduction, recensement de la pêche maritime. Lebègue & cie: Bruxelles. 634 pp.
1910	Number of ships by port, including number of steam trawlers; total gross tonnage of ships by port, including tonnage of steam trawlers.	Von Schoen, F. (1912). La pêche maritime de la Belgique <i>Bulletin de la navigation et des pêches maritimes</i> 14: 185-205
1911-1931	Number of ships by port, including indication of number of steam trawlers; total gross tonnage of ships by port, including indication of tonnage of steam trawlers.	Provincie West-Vlaanderen. Commissie voor Zeevisserij Jaarverslag der Commissie voor Zeevisserij. Druk. Verbeke-Loys: Brugge: 1912, 1913, 1919-1931.
1929-2008	Number of ships by port; GT, HP, KW, total length, total width, ownership and other ship-by-ship information	Officieele lijst der visschersvaartuigen. Ministerie van Landbouw. Dienst voor Zeevisserij: Oostende (and continued series): 1929-2010;
2008-2010	Number of ships by port; total gross tonnage of ships by port, in metric tonnes	Tessens, E.; Velghe, M. (2008). De Belgische zeevisserij: aanvoer en besomming 2008. Vlaamse Overheid. Departement Landbouw en Visserij. Afdeling Landbouw- en Visserijbeleid. Zeevisserij: Brussel. 103 pp. Tessens, E.; Velghe, M. (2010). De Belgische zeevisserij: aanvoer en besomming 2009. Vlaamse Overheid. Departement Landbouw en Visserij. Afdeling Landbouw- en Visserijbeleid. Zeevisserij: Oostende. 109 pp.

A second time-series consists of statistical Tables on characteristics of the fishing fleet and the fishermen, published as the 'statistical Tables V and VI' in the 'Landbouwstatistieken' (Agriculture statistics) from 1944 onwards. These tables contain aggregated data on number and capacity of vessels (by port, class of gross tonnage and category of engine power) and overall fishing effort (days at sea and days fishing) for steam-powered and for motor engines. Before 1929, data were obtained from disperse and fragmented sources (Table 2.2.) e.g., the report of the government's commission of 1866 and the survey conducted by De Zuttere (1909) (Table 2.1.). In spite of previously existing analyses (Polet et al. 1998, Depestele et al. 2008) where size (1905-2008) and engine power (1935-2008) of the fleet were reported with 15-year intervals (no references to sources), none of the data or time-series used in this report were available in electronic spreadsheet format or available for overviews or research analysis.

Much like the findings on historical landings, none of the data contained in the pre-1998 sources were available in electronic format or available for overviews or research analysis, with the exception of the annual reports on Belgian sea fisheries landings that are electronic formats (PDF or html) from 1998 onwards. Data on fleet parameters (number of vessels by vessel class, engine power KW) have been collected previously (e.g. IMPACT I



and IMPACT II projects) starting from 1905 with time intervals of 15 years. Unfortunately these datasets seem to have been lost.

The data on fleet size, engine power, capacity and technology to reconstruct the history of fishing power and catch effort for the Belgian sea fisheries fleet was largely based on 'ship-by-ship' information. The data from the original paper copies were digitised, standardised and integrated in the 'Belgian fleet' database as part of the HiFiDatabase (Lescrauwaet et al. 2010b). Integration efforts focused on the reconstruction of the 'lifeline' of individual ships (section 2.5.2.), while standardization was mainly centered on units of power, tonnage, and of proper names.

### 2.3.7 BIOLOGICAL DATA AND PARAMETERS ON FISH STOCKS

Currently fish stock assessments are based on the data and information generated in the context of the International Council for the Exploration of the Sea (ICES) and data is generated according to well-agreed international sampling and survey procedures, standards (see Chapter 1). Stock assessments are used to formally assess the status of fish stocks for management purposes in the EU Common Fisheries Policy, e.g. the annual ICES advice to define Total Allowable Catches TAC and quotas. Stock assessment models are based on three primary categories of data and information:

- 'Catch' data: the biomass removed from a stock by fishing: this is often referred to as 'catch', however in practice the data used are 'commercial landings', where possible corrected by discard data and removals from recreational and artisanal/subsistence fishing
- Abundance data: a measure of the number of individuals in the stock, or their weight. This is usually based on systematic sampling conducted in fishery-independent surveys
- Biology data: information e.g. on age, size, growth rates, reproductive rates, and natural mortality

The major part of the historical reconstruction included here refers to the species composition, volume, economic value and fishing area of origin of the commercial sea fisheries, and dynamics of the fishing fleet. However, an interesting number of historical studies were identified, which provide data on population structure and biological parameters (length, weight, sexual maturity, fat contents, stomach content, number of vertebrae). Gilson, and in particular Gilis in later years, conducted biological studies on shrimp and shrimp fisheries, on demersal fishery in the North Sea, on sole, and long-term annual assessments of the seasonal 'spent herring' fisheries. Some of these studies were not published but stored as internal reports for the purposes of the research institute. These proved very valuable and unique sources of biological information from times that typically stem from before formal stock assessments were started in the 1960s (chapter 6).

## 2.4 DIGITIZATION PROCESS AND QUALITY CONTROL

The sources identified in Table 2.1. and 2.2. (inventory of data sources) were scanned, described and disclosed electronically through the content management system IMIS. However, most of the actual data from the Tables contained in these sources needed manual digitalization and transcription to spreadsheets in order to allow for posterior manipulation and integration. Integrating data from different sources into one database is a stepwise process, involving basic aspects of data management such as standardization and quality control (QC). Quality control, in all its dimensions, is an essential aspect in the recovery and integration of (historical) data. The different steps of converting and controlling the quality of the converting process as well as the data are summarized below.

#### **2.4.1 CONVERSION OF SCANNED DATA TABLES (SCANS OF ORIGINAL PAPER COPIES) TO SPREADSHEETS**

Where quality of the scans permitted, the data from scanned sources were extracted by means of image/pdf reading software (ABBYY FineReader v.9.0) and converted to spreadsheets. The Table(s) were then copied and pasted in spreadsheets. Anomalies (dots, spots, etc in the printing and/or artifacts due to paper quality, storage and handling of the documents over the years) and misinterpretations of numbers or separators needed a first control during the conversion process. Still, approximately 30%-50% of the data sources needed manual conversion.

#### **2.4.2 QUALITY CONTROL OF THE DATA CONTAINED IN THE CREATED SPREADSHEETS**

A second QC focused on the quality of the data. The annual data tables are matrices which list species names in the first column and names of ports or fishing grounds in the first row, for any given year 'x'. Each data field in the table for year 'x' therefore corresponds with the landings of a given species in a given port or from a given fishing ground for that year. Row subtotals should represent the sum of all landings for a given species for all ports or fishing grounds in year 'x'. Column subtotals should sum landings of all species by the categories of (1) demersal species, (2) pelagic species and (3) molluscs and crustaceans, by port (or by fishing ground) for year 'x'. Finally, subtotals add up to 'Global totals' in the last row. These annual row and column subtotals and totals were presumably tabulated on a monthly basis and calculated in the original files by the staff of the fisheries authority, after the data was collected on a daily and monthly basis in the fish auctions. The reported calculated (sub) totals were also copied in the conversion process. Row and column (sub)totals were calculated independently in the spreadsheets, and crosschecked with the reported (sub)totals in the original document. Two main types of errors were detected in the original files:

- Errors that occurred when numbers were mistakenly copied from the draft to the final version of the reported tables, by the staff
- Errors that occurred when (sub)totals in rows or columns were mistakenly calculated by the staff in the reported tables (error in the original summation);

In these two cases, the error could be located by checking the rows or columns in the original and in the copied document. The consecutive steps of the conversion of scanned tables, the quality control on the conversion process and the first data quality control on each of these 'original' set of spreadsheets with the set of converted tables, resulted in a number of 'corrected files' or spreadsheets: each file representing a report for a given year. Detectable errors in copying and/or calculations were amended in these corrected files. Each of these errors was amended and documented in the 'metadata' sheets of the 'corrected files'.

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QUANTITÉ ET VALEUR DU POISSON DÉBARQUÉ DANS LES DIFFÉRENTS PORTS DE PÊCHE DE BELGIQUE  
HOEVEELHEID EN WAARDE ELKER SOORT VISCH GELOST IN DE VERSCHILLENDE VISSCHERIJHAVENS VAN BELGIË

(Source : Administration de la Marine) (Bron : Bureau van het Zeevaar)

ESPÈCES DE POISSONS	PORTS — HAVENS								TOTAL - TOTAAL		VISCHESOORTEN
	OOSTENDE OSTENDE		BLANKENBERGHE		ZEEBRUGGE		NIEUWPOORT NIEUPOORT		Quantité Hoeveelh.	Valeur Waarde	
	Kg.	Fr.	Kg.	Fr.	Kg.	Fr.	Kg.	Fr.			
A. — PÊCHE BELGE. — BELGISCHE VANGST											
I. Poissons de fond.											I. Diepzeewinnende visch
Lette . . . . .	301.536	1.941.883	—	—	—	—	60	658	301.596	1.942.541	Aalruip
Vive . . . . .	22.918	236.032	5.507	41.883	94.631	761.802	3.027	29.808	126.083	1.069.525	Arend
Grondin rouge . . . . .	287.625	505.700	—	—	—	—	—	—	287.625	505.700	Engelische aalruip
Bardoue . . . . .	352.469	2.427.787	8.388	62.759	24.277	236.985	8.710	78.486	393.844	2.806.017	Griet
Latoru . . . . .	18.652	55.434	—	—	—	—	—	—	18.652	55.434	Haringbaai
Elibot . . . . .	19.064	216.910	—	—	—	—	—	—	19.064	216.910	Heilbot
Beger . . . . .	4.063	60.358	—	—	—	—	—	—	4.063	60.358	Herder
Cabillaud . . . . .	3.106.305	9.437.053	6.817	13.744	7.880	29.323	22.613	47.275	3.143.615	9.527.395	Kabeljou
Silaste . . . . .	298.785	626.307	—	—	—	—	—	—	298.785	626.307	Kluisvich
Grondin . . . . .	715.890	667.860	2.924	4.218	55.347	60.745	12.832	23.040	716.963	755.863	Knorbaan
Surmelet . . . . .	18.848	51.257	—	—	—	—	—	—	18.848	51.257	Kontingvich
Colin . . . . .	964.677	1.507.936	—	—	—	275	350	10	964.962	1.508.309	Kroonvich
Lingue . . . . .	256.011	597.242	—	—	—	—	—	—	256.011	597.242	Lang
Bouma . . . . .	27.365	41.900	—	—	—	—	—	—	27.365	41.900	Lam
Merlu . . . . .	709.212	2.167.520	—	—	—	—	—	—	709.212	2.167.520	Motmeid
Pie . . . . .	2.346.714	6.160.253	97.381	333.504	555.968	2.354.354	258.649	724.238	3.258.712	9.572.349	Pladijs
Scareil . . . . .	37.070	30.813	4.270	2.276	—	—	2.103	2.491	43.443	35.580	Pour
Rois . . . . .	2.548.303	6.244.198	30.523	106.280	343.543	778.534	89.841	267.386	3.012.215	7.396.398	Rog
Rois radie . . . . .	552.964	1.706.141	15	54	—	—	—	—	552.979	1.706.195	Rog (Kou)
Rouget . . . . .	208.320	658.034	100	393	5.019	21.491	543	2.233	213.982	682.151	Roodbaard
Lisande . . . . .	129.667	437.225	16.291	71.038	65.097	294.150	40.555	194.440	251.610	996.853	Schaal
Flotte . . . . .	340.898	923.115	—	—	—	—	—	—	340.898	923.115	Schaal
Eglefin . . . . .	966.070	3.216.431	—	—	—	—	—	—	966.070	3.216.431	Scheldvich
Sole d'Ecosse . . . . .	665.294	2.196.681	—	—	—	—	—	—	665.294	2.196.681	Schal (Schotsche)
Sole l'emande . . . . .	255.434	1.259.048	35	74	29	228	4	38	255.502	1.259.388	Schal (Stem)
Tacaud . . . . .	324.760	537.589	325	246	850	2.260	4.177	4.662	330.112	544.757	Stroomot
Eutrogon . . . . .	4.502	75.648	—	—	—	—	—	—	4.502	75.648	Stour
Tarbot . . . . .	533.033	4.921.506	6.287	83.391	144.343	1.601.281	17.505	203.644	721.185	6.809.822	Tarbot
Sole . . . . .	1.608.859	23.526.084	30.375	409.942	379.170	5.622.587	58.078	804.252	2.076.482	30.362.865	Tong
Merlan jaune . . . . .	146.464	378.820	—	—	—	—	12	24	146.476	378.844	Flansitting
Merlan . . . . .	1.719.991	2.917.647	106.060	139.411	406.114	578.806	137.883	177.312	2.370.065	3.813.176	Witting
Bar . . . . .	63.620	69.794	—	—	—	—	—	—	63.620	69.794	Zaars
Squale pelierin . . . . .	433.376	370.109	210	286	54.240	46.566	627	612	488.453	417.573	Zeehaai
Petite rousette . . . . .	265.112	244.764	3.110	4.189	1.275	1.800	16.520	19.866	289.017	270.699	Zeehaai
Congre . . . . .	156.773	395.516	125	181	—	—	—	144	157.042	396.553	Zeeponing
Loup de mer . . . . .	37.780	74.673	—	—	—	—	—	—	37.780	74.673	Zeevif
Daïfè . . . . .	86.655	315.939	30	89	20	235	—	66	86.775	316.329	Zeevifvich
Autres espèces . . . . .	57.391	69.732	12.905	54.574	200	365	2.248	4.683	72.744	129.376	Andere soorten
Total I. . . . .	20.615.495	77.270.959	331.698	1.328.532	2.138.328	12.391.942	676.131	2.586.095	23.761.652	93.577.528	Total I
II. Poissons pélagiques.											II. Pelagische visch
Harom . . . . .	10.554.361	9.119.564	15	22	3.250	3.144	82.237	99.649	10.639.863	9.222.379	Haring
Maquereau . . . . .	702.315	1.123.014	—	—	—	—	—	—	702.315	1.123.014	Malvoet
Esport . . . . .	1.075.488	795.905	—	—	34.470	13.420	310.090	329.834	1.420.048	1.139.159	Sprot
Total II. . . . .	12.332.164	11.038.483	15	22	37.720	16.564	392.327	429.483	12.762.226	11.484.552	Total II
III. Crustacés et mollusq.											III. Schaal-en-weeckdieren
Seiche . . . . .	7.500	2.785	—	—	—	—	—	—	7.500	2.785	Inktvich
Buccins . . . . .	28.847	50.093	—	—	—	—	—	—	28.847	50.093	Kiebbarsen
Crabes . . . . .	43.565	17.813	—	—	15	306	666	1.155	44.186	19.274	Krabben
Homards . . . . .	4.065	69.569	99	3.172	155	2.301	816	16.310	5.135	91.352	Kreeften
Petits homards . . . . .	247.979	686.585	—	—	—	—	—	—	247.979	686.585	Kreeftjes
Grevettes et aut. esp.	1.115.766	4.350.762	114.332	550.745	2.000.123	8.412.912	286.197	999.670	5.516.418	14.314.089	Garnalen en and. soort
Total III. . . . .	1.447.722	5.177.607	114.431	553.917	2.000.293	8.415.519	287.619	1.017.135	3.859.065	15.164.178	Total III.
Total général (Pêche belge.)	34.395.381	95.487.049	446.144	1.882.471	4.176.341	20.824.025	1.356.077	4.032.713	40.373.943	126.256.256	Algemeen totaal (Belgische vangst)
B. — PÊCHE ÉTRANGÈRE. — VREEMDE VANGST											
Poissons de fond	5.927	24.997	—	—	—	—	—	—	5.927	24.997	Diepzeewinnende visch
Poissons pélagiques	525	520	—	—	—	—	—	—	525	520	Pelagische visch
Total . . . . .	6.452	25.517	—	—	—	—	—	—	6.452	25.517	Total
(1)											
C. — TOTAL : PÊCHE BELGE ET ÉTRANGÈRE. — TOTAAL : BELGISCHE EN VREEMDE VANGST.											
	34.401.833	95.512.566	446.144	1.882.471	4.176.341	20.824.025	1.356.077	4.032.713	40.380.395	126.281.773	
									(2)		

(1) Pays d'origine : France. (2) Land van herkomst : Frankrijk.

(2) Non compris 91,627 kg. de poisson de fond, d'une valeur de 302,037 fr., débarqué à Anvers.

(2) Niet inbegrepen 91,627 kg. diepzeewinnende visch ter waarde van 302,037 frank gelost te Antwerpen.

Figure 2.3.: Example of digitized original source (1936, from 'Statistisch Bulletin, 1937')

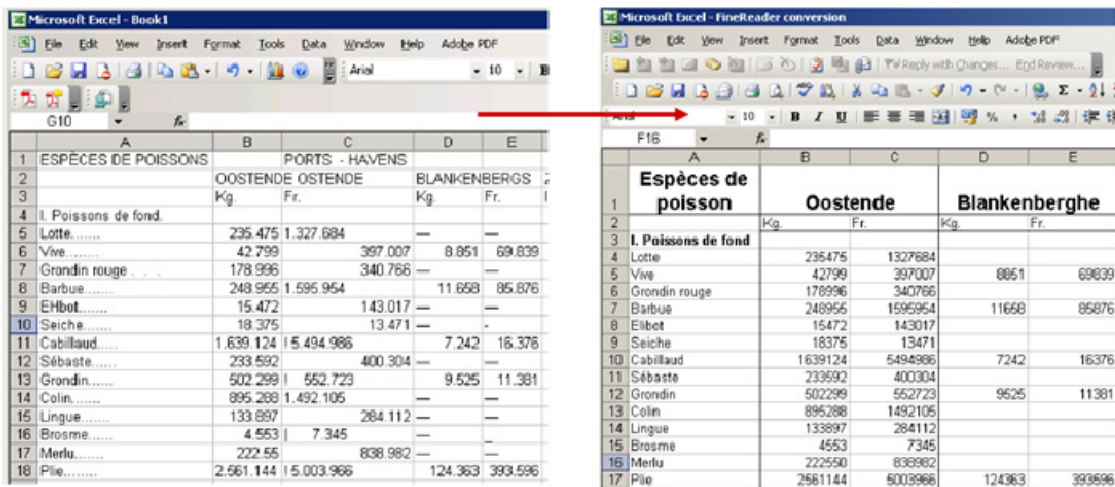


Figure 2.4.: Example of FineReader 9.0 stepwise conversion process.

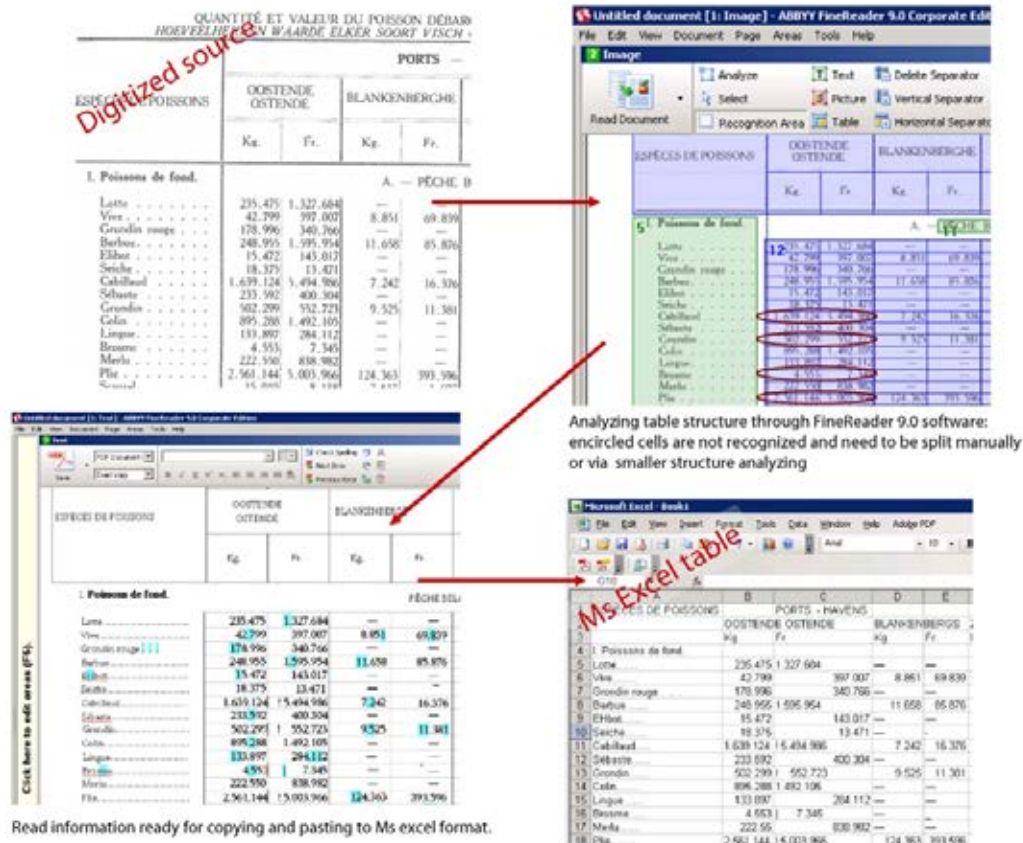


Figure 2.5.: Quality control of the FineReader conversion resulting in "clean" spreadsheet files.

Fish species	3. Zeebrugge		4. Nieuwpoort		Total		Excel total	
	Kg	F	Kg	F	Kg	F	Kg	F
John Dory	486	18760	297	6558	5368	104938	5368	104938
Sturgeon			80	4846	379	23783	379	23783
Shark	119235	649130	96046	186764	605839	3526308	666839	3526308
Dogfish (big & small)	31664	168420	106346	585078	544545	2978818	544545	2978818
Perceagle	383	2390	63	796	2003	63282	2003	63282
Other species	100	710	537	4124	17561	125121	17561	125121
Miscellaneous	98319	712850	31020	367117	1502729	9773044	1502729	9773044
Spwvn					201038	891735	201038	891735
<b>Subtotal</b>	<b>6175772</b>	<b>85850680</b>	<b>1981519</b>	<b>22419056</b>	<b>42932516</b>	<b>424797407</b>	<b>42932516</b>	<b>424797407</b>
<b>Excel subtotal</b>	<b>6175772</b>	<b>85850680</b>	<b>2041519</b>	<b>22419056</b>	<b>42992516</b>	<b>424797407</b>	<b>42992516</b>	<b>424797407</b>
<b>II. Pelagic fish</b>								
Horse mackerel			6755	10914	14440	22210	14440	22210
Herring			7463	65032	3051367	13372778	3051367	13372778
Mackerel					594505	2071717	594505	2071717
Sprat	17659	44345	99422	568932	901263	3306348	901263	3306348
Tuna					0	0	0	0
Other species			12	114	116312	379031	116312	379031
Miscellaneous					2577	9155	2577	9155
<b>Totaal</b>	<b>17659</b>	<b>44345</b>	<b>113652</b>	<b>632992</b>	<b>4680464</b>	<b>19161239</b>	<b>4680464</b>	<b>19161239</b>
<b>Excel Totaal</b>	<b>17659</b>	<b>44345</b>	<b>113652</b>	<b>632992</b>	<b>4680464</b>	<b>19161239</b>	<b>4680464</b>	<b>19161239</b>
<b>III. Mollusks and crustaceans</b>								
Shrimp	526942	20145906	133895	5327504	1004467	37170250	1004467	37170250
Langoustine	50021	893900			639289	9723800	639289	9723800
Cray	1375	8230	1796	8028	75303	144554	75303	144554
Limpet	68	6530	457	31192	3470	262777	3470	262777
Cephalopod			5773	10645	135857	544423	135857	544423
Whalk	1175	11530	3652	22622	85390	559554	85390	559554
Miscellaneous			323	2805	1063	4340	1063	4340
<b>Subtotal</b>	<b>579581</b>	<b>21066096</b>	<b>145896</b>	<b>5402796</b>	<b>1944839</b>	<b>48429698</b>	<b>1944839</b>	<b>48429698</b>
<b>Excel subtotal</b>	<b>579581</b>	<b>21066096</b>	<b>145896</b>	<b>5402796</b>	<b>1944839</b>	<b>48429698</b>	<b>1944839</b>	<b>48429698</b>
<b>Total</b>	<b>6773012</b>	<b>106961121</b>	<b>2241067</b>	<b>28454844</b>	<b>49557819</b>	<b>492388344</b>	<b>49557819</b>	<b>492388344</b>
<b>Excel total</b>	<b>6773012</b>	<b>106961121</b>	<b>2301067</b>	<b>28454844</b>	<b>49617819</b>	<b>492388344</b>	<b>49617819</b>	<b>492388344</b>

**Figure 2.6.:** Example of a case in which a figure for landings of 'shark' in Nieuwpoort was wrongly copied in the final source document: the error is reflected in the quality control calculated row and column subtotals. By replacing the '96046' by '90046' the original subtotals matched.

### 2.4.3 STANDARDIZATION: TAXONOMY, GEOGRAPHY, UNITS OF MEASUREMENT

One of the main difficulties in integrating and comparing different datasets from various data providers is the standardization of the data. Standardizing is a prerequisite for functional databases. Therefore an analysis was conducted of the different parameters included in the reported data sources. Single spreadsheets (one file per reported year) were integrated into one table per feature according to the defined database structure, in order to perform standardization. Standardization was performed for (1) taxonomy, (2) geography and spatial units, and (3) sampling methodology and reporting units.

- Reporting units of landed species:** most reporting units were at the species level (e.g., 'herring'), while others were aggregates (e.g. 'lobsters' or 'pelagic species not identified elsewhere') or because the species was locally known under a generic name (e.g., 'shells' probably refers to clams *Pecten maximus* and *Aequipecten opercularis*). Other aggregates refer to functional groups, e.g., 'total pelagic species' reported as the sum of all species reported as 'pelagic'. Some units were reported over the entire period (1929-1999) while others appeared only for a few years. Aggregations were applied in the data for those reporting units at the species level for which some doubts were raised on the accuracy of the taxonomic



identification, as species identification in the field is not always straightforward (e.g., ‘rays’ and ‘sharks’). The overall number of different reported taxonomic ‘units’ for all files over the reporting period was 113 (including different naming and spelling). After standardization this number was reduced to 56 (including all aggregates).

- **Taxonomic units:** most reporting units were at unique species level. Taxonomy was checked by means of the European Register of Marine Species (ERMS), which is the European component to the World Register of Marine Species (WoRMS, <http://www.marinespecies.org>) and (vernacular) names linked to officially acknowledged taxa (Aphia ID codes, see right column). This authoritative taxonomic register provides a list of species occurring in the European marine environment. Spelling mistakes were corrected, and the taxonomic name as recorded in the datasets was linked to the name as included as valid in the ERMS. More information on the ERMS (Cuvelier et al. 2006) is available from the MARBEF website ([www.marbef.org/data/erms](http://www.marbef.org/data/erms)). Additional sources were consulted (e.g., literature, Fishbase <http://www.fishbase.org>). In cases where taxonomic identification was uncertain, such as for sharks and rays, these taxa were aggregated in the final standardised database. The original naming was maintained in the original files. Finally after standardizing and aggregation, 41 units remained at the species level.
- **Assigning species names to aggregate groups:** species or reporting units may have been erroneously assigned to the wrong or different aggregate groups over a particular period, as was the case for ‘squid’ (classified as demersal instead of molluscs) and horse mackerel (classified as demersal instead of pelagic). A standardised approach was applied for the entire period 1929-1999.
- **Ports:** assigning landings as disembarked in a particular port. A total of 6 ports were reported in the overall period: *Nieuwpoort*, *Oostende*, *Zeebrugge* and *Blankenberge* (Belgium) while during World War II (1939-1945), landings were disembarked in France (*Gravelines* and *Dunkerque*). Landings in these French ports were not included as ‘Belgian ports’ in the time-series because this group of ports only refers to the four Belgian ports of *Nieuwpoort*, *Oostende*, *Blankenberge* and *Zeebrugge*. However, because of their particular importance during WWII, these data were included and ‘earmarked’ in the reporting unit ‘foreign ports’ in the database. An overview of the relative importance of each port and by species, is available from the website: [http://www.vliz.be/cijfers\\_beleid/zeevisserij/list.php](http://www.vliz.be/cijfers_beleid/zeevisserij/list.php) (Dutch and English version; select a species and click on ‘statistics’).
- **Fishing area:** the overall number of different fishing areas reported was 40 (including different spellings, Table 2.3.). Standardizing fishing area names and their boundaries is not an easy task in the absence of reliable geo-referenced data sources. A detailed description of the process of standardization is available from a readers’ guide and the list of fishing areas after standardization is included in the Appendix 1. To assign these standardised names, both the ICES map of fishing areas and the VLIZ Marine Gazetteer (<http://www.vliz.be/vmdcdata/vlimar>) database were consulted. The resulting map is included as Figure 2.7. (global) and Figure 2.8. (North Sea and ‘western’ fishing grounds). After standardizing, 31 standardised names of fishing grounds remained (Table 2.3.). More details on the quality control and standardization are available from the readers’ guides.
- **Units of measurement:** over the time frame covered in the present reconstructions, changes in units of measurement were recorded for different parameters. An example is the unit of volume or the tonnage of

a ship. In the past, the tonnage of a vessel in Belgium was expressed either in Moorsom ton or Gross Register ton GRT, or in Gross Tonnage (GT) (Chapter 5). The GT applies to new ships from 1982 although in practice, the first ships measured according to the GT system in Belgium were registered in the 1984 annual report. Before that, ships were reported as register ton GRT or in m<sup>3</sup>. From 1984 onwards these measurements were gradually replaced by GT as new ships entered the fleet or as older ships were gradually re-measured according to the GT system. From 1994, all ships measurements were expressed as GT. Other examples of standardization of units of measurement are the Dutch PK versus English horsepower HP and the Kilowatt kW. More details are provided in the context of the specific analysis in each of the Chapters and in the readers' guides in the reference list (Lescrauwaet et al. 2009, Lescrauwaet et al. 2010c, Lescrauwaet et al. 2011).

**Table 2.3.:** List of standardized reporting units (local names by alphabetical order in Dutch). Source: 'A century of Sea Fisheries in Belgium' (VLIZ 2009).

	English vernacular		Local name	Scientific name(s)	WoRMS ID
Demersal fish	Other species	Bodemvissen	Andere soorten		
	Flounder		Bot	<i>Platichthys flesus</i>	127141
	Red gurnard		Engelse poon	<i>Aspitrigla cuculus</i>	150662
	Grey gurnard		Grauwe poon	<i>Eutrigla gurnardus</i>	150637
	Brill		Griet	<i>Scophthalmus rhombus</i>	127150
	Greater weever		Grote Pieterman	<i>Trachinus draco</i>	127082
	Sharks ('dogfish')		Haaien	<i>Squalus acanthias</i> , <i>Scyliorhinus canicula</i> , <i>Lamna nasus</i>	105923,105841 105814
	Flathead mullet		Harder	<i>Mugil cephalus</i>	126983
	Hake		Heek	<i>Merluccius merluccius</i>	126484
	Halibut		Heilbot	<i>Hippoglossus hippoglossus</i>	127138
	Cod		Kabeljauw	<i>Gadus morhua</i>	126436
	Conger eel		Kongeraal	<i>Conger conger</i>	126285
	Coal fish		Koolvis	<i>Pollachius virens</i>	126441
	Spawn (fish roe)		Kuit		
	Ling		Leng	<i>Molva molva</i>	126461
	Cusk		Lom	<i>Brosme brosme</i>	126447
	Red mullet		Mul	<i>Mullus surmuletus</i>	126986
	Pollack		Pollak	<i>Pollachius pollachius</i>	126440
	Tub gurnard		Rode poon	<i>Chelidonichthys lucerna</i>	127262
	Rays		Roggen	<i>Bathyraja brachyurops</i> , <i>Raja montagui</i> , <i>Leucoraja circularis</i> , <i>Raja clavata</i> , <i>Amblyraja radiata</i> , <i>Dipturus batis</i> , <i>Leucoraja naevus</i>	271509,105887, 105873,105883, 105865,105869, 105876
Ocean perch/redfish	Roodbaars	<i>Sebastes spp (primarily S. norvegicus, S. mentella)</i>	127253		
Dab	Schar	<i>Limanda limanda</i>	127139		
Megrim	Scharretong	<i>Lepidorhombus whiffiagonis</i>	127146		
Haddock	Schelvis	<i>Melanogrammus aeglefinus</i>	126437		
Plaice	Schol	<i>Pleuronectes platessa</i>	127143		



	<b>Bib</b>		<b>Steenbolk</b>	<i>Trisopterus luscus</i>	126445
	<b>Sturgeon</b>		<b>Steur</b>	<i>Acipenser sturio</i>	126279
	<b>Turbot</b>		<b>Tarbot</b>	<i>Psetta maxima</i>	154473
	<b>Sole</b>		<b>Tong</b>	<i>Solea solea</i>	127160
	<b>Lemon sole</b>		<b>Tongschar</b>	<i>Microstomus kitt</i>	127140
	<b>Miscellaneous</b>		<b>Varia</b>		
	<b>Whiting</b>		<b>Wijting</b>	<i>Merlangius merlangus</i>	126438
	<b>Witch</b>		<b>Witje</b>	<i>Glyptocephalus cynoglossus</i>	127136
	<b>European sea bass</b>		<b>Zeebaars</b>	<i>Dicentrarchus labrax</i>	126975
	<b>Blackspot seabream</b>		<b>Zeebrasem</b>	<i>Pagellus bogaraveo</i>	127059
	<b>Angler</b>		<b>Zeeduivel</b>	<i>Lophius piscatorius</i>	126555
	<b>Wolf-fish</b>		<b>Zeewolf</b>	<i>Anarhichas lupus</i>	126758
	<b>John dory</b>		<b>Zonnevis</b>	<i>Zeus faber</i>	127427
	<b>Pelagic fish</b>		<b>Other species</b>	<b>Pelagische vis</b>	<b>Andere soorten</b>
<b>Herring</b>		<b>Haring</b>	<i>Clupea harengus harengus</i>		293567
<b>Horse mackerel</b>		<b>Horsmakreel</b>	<i>Trachurus trachurus</i>		126822
<b>Mackerel</b>		<b>Makreel</b>	<i>Scomber scombrus</i>		127023
<b>Sprat</b>		<b>Sprot</b>	<i>Sprattus sprattus sprattus</i>		236448
<b>(blue fin)Tuna</b>		<b>(blauwvin)Tonijn</b>	<i>Thunnus thynnus</i>		127029
<b>Miscellaneous</b>		<b>Varia</b>			
<b>Salmon</b>		<b>Zalm</b>	<i>Salmo salar</i>		127186
<b>Crustaceans &amp; molluscs</b>	<b>Other crustaceans</b>	<b>Schaal- en weekdieren</b>	<b>Andere schaaldieren</b>		
	<b>Other species</b>		<b>Andere soorten</b>		
	<b>Brown shrimp</b>		<b>Grijze garnaal</b>	<i>Crangon crangon</i>	107552
	<b>Brown shrimp (and other species)</b>		<b>Grijze garnaal (en andere soorten)</b>		
	<b>Cephalopods</b>		<b>Inktvis</b>	<i>Alloteuthis subulata, Loligo forbesi, Loligo vulgaris, Sepia officinalis(recent years)</i>	153131, 140270, 140271
	<b>Lobsters</b>		<b>Kreeften</b>	<i>Homarus gammarus, Nephrops norvegicus</i>	107253 107254
	<b>Edible crab</b>		<b>Noordzeekrab</b>	<i>Cancer pagurus</i>	107276
	<b>Shells</b>		<b>Schelpen</b>	<i>Schelpen (probably Pecten maximus)</i>	394429
	<b>Miscellaneous</b>		<b>Varia</b>		
	<b>Whelk</b>		<b>Wulk</b>	<i>Buccinum undatum</i>	138878

**Note:** the link to the species pages in the World Record of Marine Species is achieved by adding the ID code number (right column) in the URL address, e.g. the page for 'flounder' (code 127141) is:

<http://www.marinespecies.org/aphia.php?p=taxdetails&id=127141>

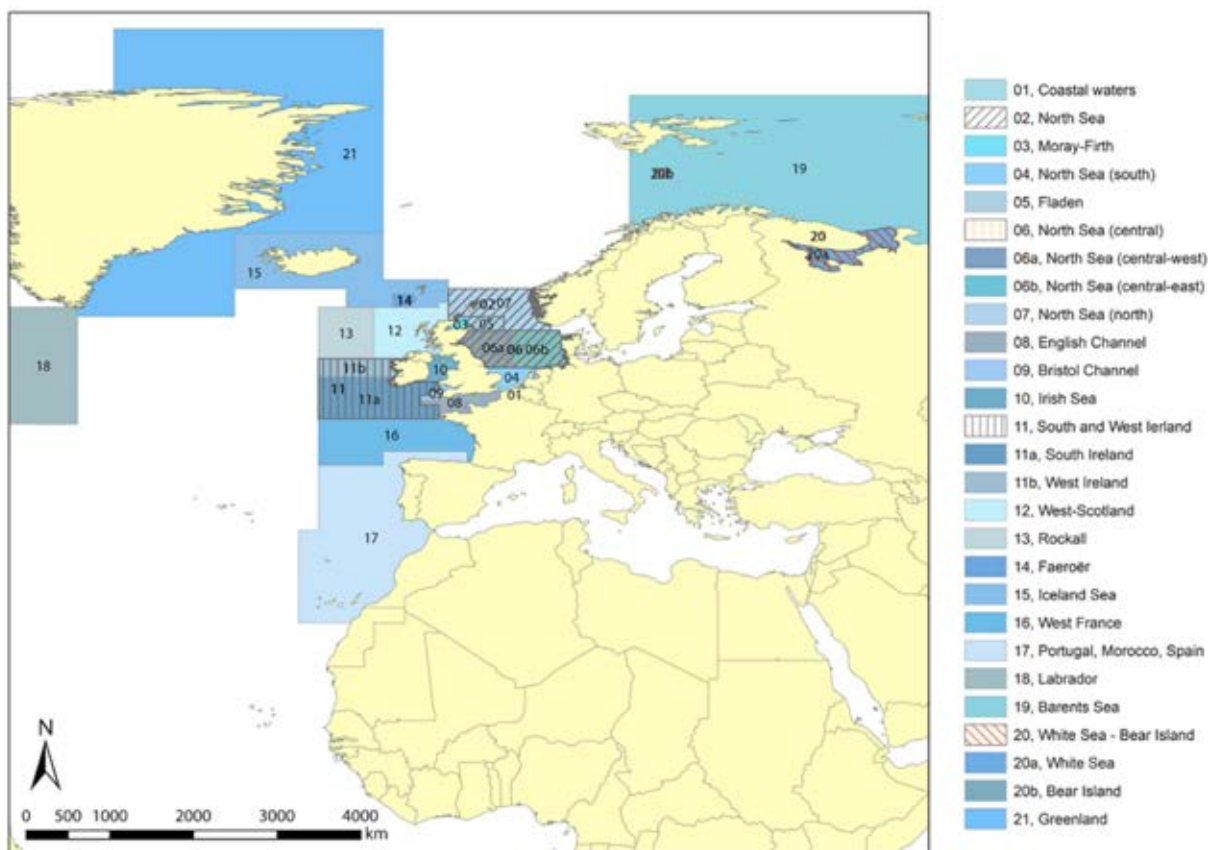
**Table 2.4.:** Original names of the fishing areas as reported in original statistical sources (second column), and names as assigned after standardization (right column) in the 'A century of Sea Fisheries in Belgium' (VLIZ 2009).

	Original name of fishing ground	Standardised name	English name
1	Kustzee	Kustzee	Coastal waters
2	Noordzee-Zuid	Noordzee (zuid)	North Sea (south)
3	Noordzee-Midden	Noordzee (midden)	North Sea (central)
4	Noordzee-Midden-Oost (Witte Bank)	Noordzee (midden-oost)	North Sea (central-east)
5	Noordzee-Midden-Oost	Noordzee (midden-oost)	North Sea (central-east)
6	Witte Bank	Noordzee (midden-oost)	North Sea (central-east)
7	Noordzee-Midden-West	Noordzee (midden-west)	North Sea (central-west)
8	Noordzee-Noord	Noordzee (noord)	North Sea (north)
9	Noordzee	Noordzee	North Sea
10	IJsland	IJslandzee	Iceland Sea
11	IJslandzee	IJslandzee	Iceland Sea
12	Faroe	Faeröer / Faroe	Faroes
13	West-Schotland	West-Schotland	West Scotland
14	Rockall	Rockall	Rockall
15	Moray-Firth	Moray-Firth	Moray-Firth
16	Noordzee - Moray Firth	Moray-Firth	Moray-Firth
17	Fladen	Fladen	Fladen
18	Noordzee - Fladen	Fladen	Fladen
19	Kanaal	Engels Kanaal	English Channel
20	Engels Kanaal	Engels Kanaal	English Channel
21	Bristol Kanaal	Kanaal van Bristol	Bristol Channel
22	Kanaal van Bristol	Kanaal van Bristol	Bristol Channel
23	Zuid-Ierland	Zuid-Ierland	South Ireland
24	West-Ierland	West-Ierland	West Ireland
25	Zuid- en West-Ierland	Zuid- en West-Ierland	South- and West Ireland
26	Zuid- en West-Ierland (Mine Head)	Zuid- en West-Ierland	South- and West Ireland
27	Mine-Head	Zuid- en West-Ierland	South- and West Ireland
28	Ierse Zee	Ierse Zee	Irish Sea
29	Portugal Marokko	Portugal Marokko	Portugal Morocco

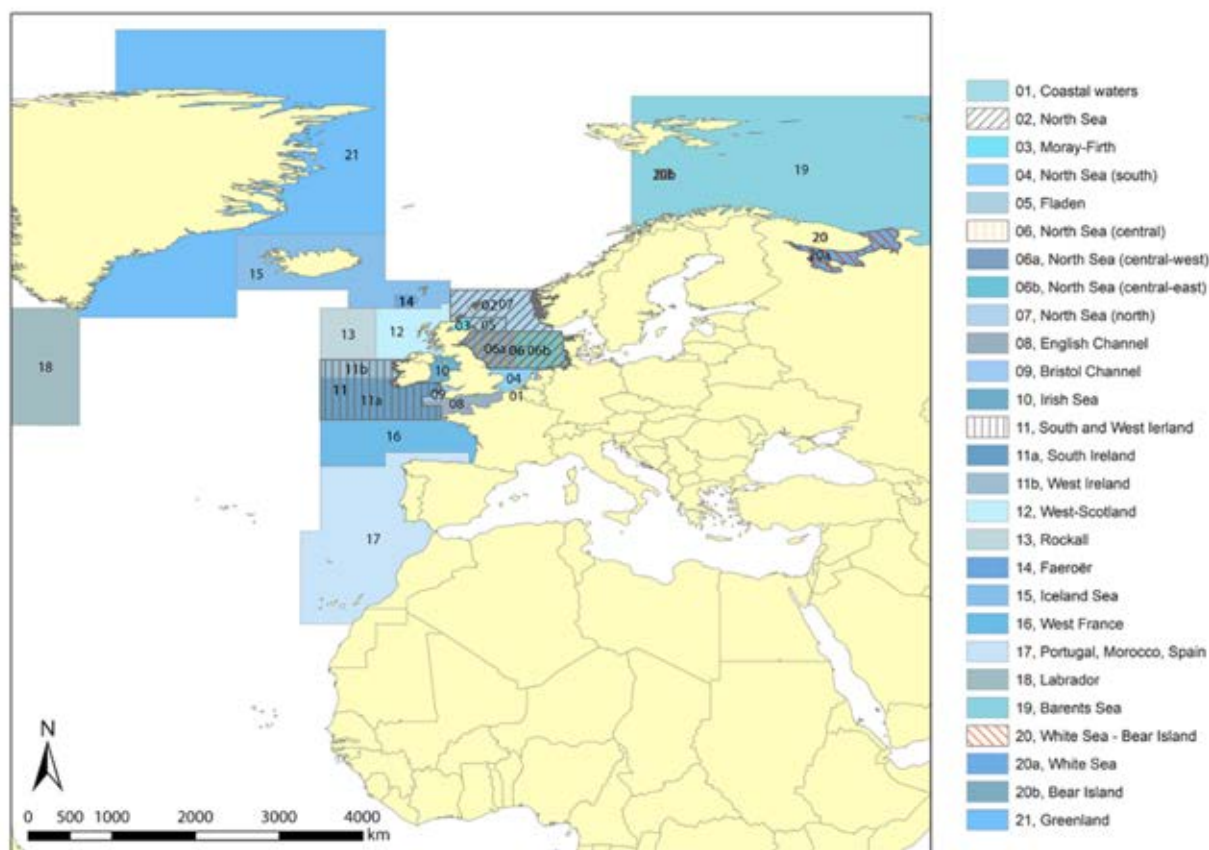
**Belgian part of the North Sea (BNS)**

In spite of the importance of fisheries data at the scale of national EEZs or marine waters, no historical time-series were available for the BNS so far. ICES data do not contain historical statistics with spatial reference to the BNS. Only from 1996 onwards, data are available for research purposes at a spatial scale that is of relevance to the BNS. This includes Vessel Monitoring System (VMS) data which are relevant to study distribution at a micro-scale. Landings data was originally collected with reference to the rectangles of origin, however this spatial data was lost after aggregation for reporting purposes (Chapter 4). Although one of the 3 reporting ICES statistical rectangles (31F2) that are relevant for the BNS has a significant proportion of its area within the BNS, unknown but likely significant landings from the areas of 2 other rectangles (31F3, 32F2) should be taken into account (Figure 6.9.). The HiFiDatabase contains data reported for the 'coastal waters' from 1929-2010. According to the maps of Vanneste and Hovart (1959), the 'coastal waters' correspond to an area 20-30 miles from the shoreline between the line 'Griz

Nez-South Foreland’ and the parallel of IJmuiden. For the purpose of quality control, the reported landings for the ‘coastal waters’ (1929-2010) were compared to the fragmented historical source documents that report at ICES statistical rectangle. The data for the combined rectangles 31F2 and 31F3 provide a fair match (<10% difference) with the historical time-series for the ‘coastal waters’. This was confirmed by the head of the fisheries statistics 1953-1975 (pers. com. Mr. J. Depreeuw). Considering the spatial scale of the BNS, this time-series is considered to provide an acceptable representation of the landings originating from the BNS. These unique historical data were therefore used in the present thesis to reconstruct and estimate landings and total removals at the scale of the BNS (Chapter 4 and Chapter 6).



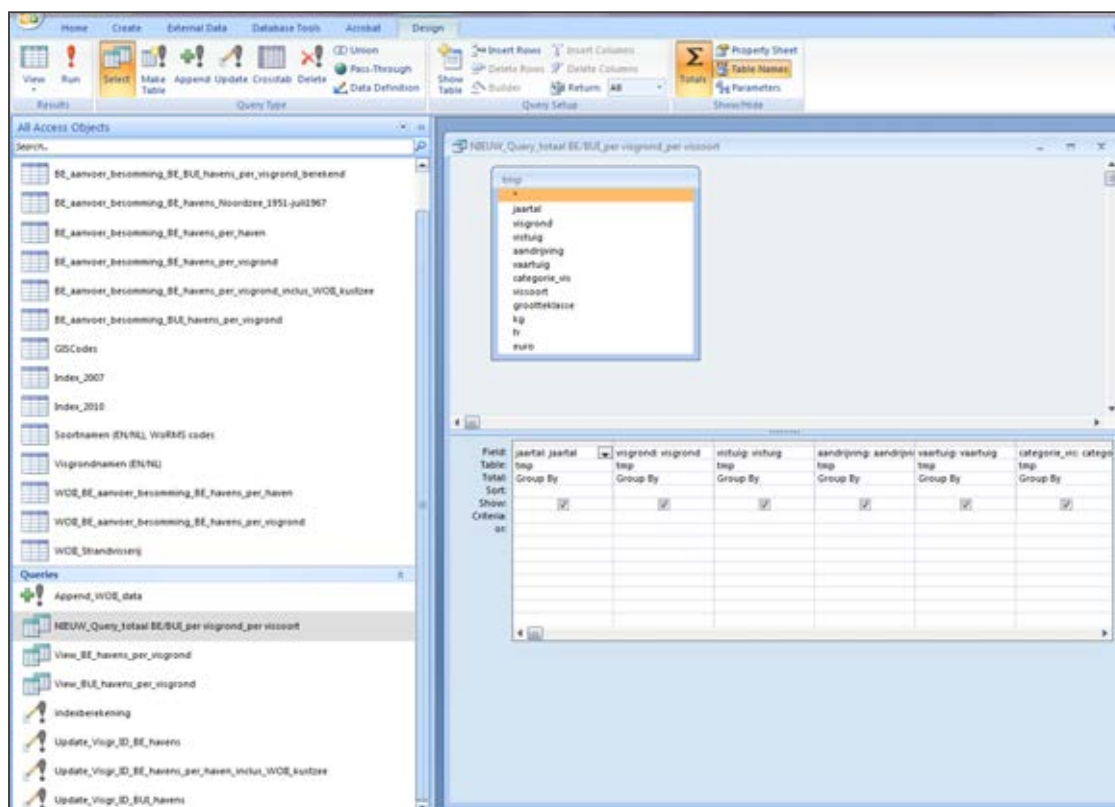
**Figure 2.7.:** Boundaries and names of fishing areas as reported in local data sources (HiFiDatabase), after standardization. Source: ‘A century of Sea Fisheries in Belgium’ (VLIZ 2009)



**Figure 2.8:** Boundaries and names of fishing areas around the North Sea and western fishing grounds, as reported in local data sources (HiFiDatabase) after standardization. *Source: 'A century of Sea Fisheries in Belgium' (VLIZ 2009)*

#### 2.4.4 GRAPHICAL ANALYSIS

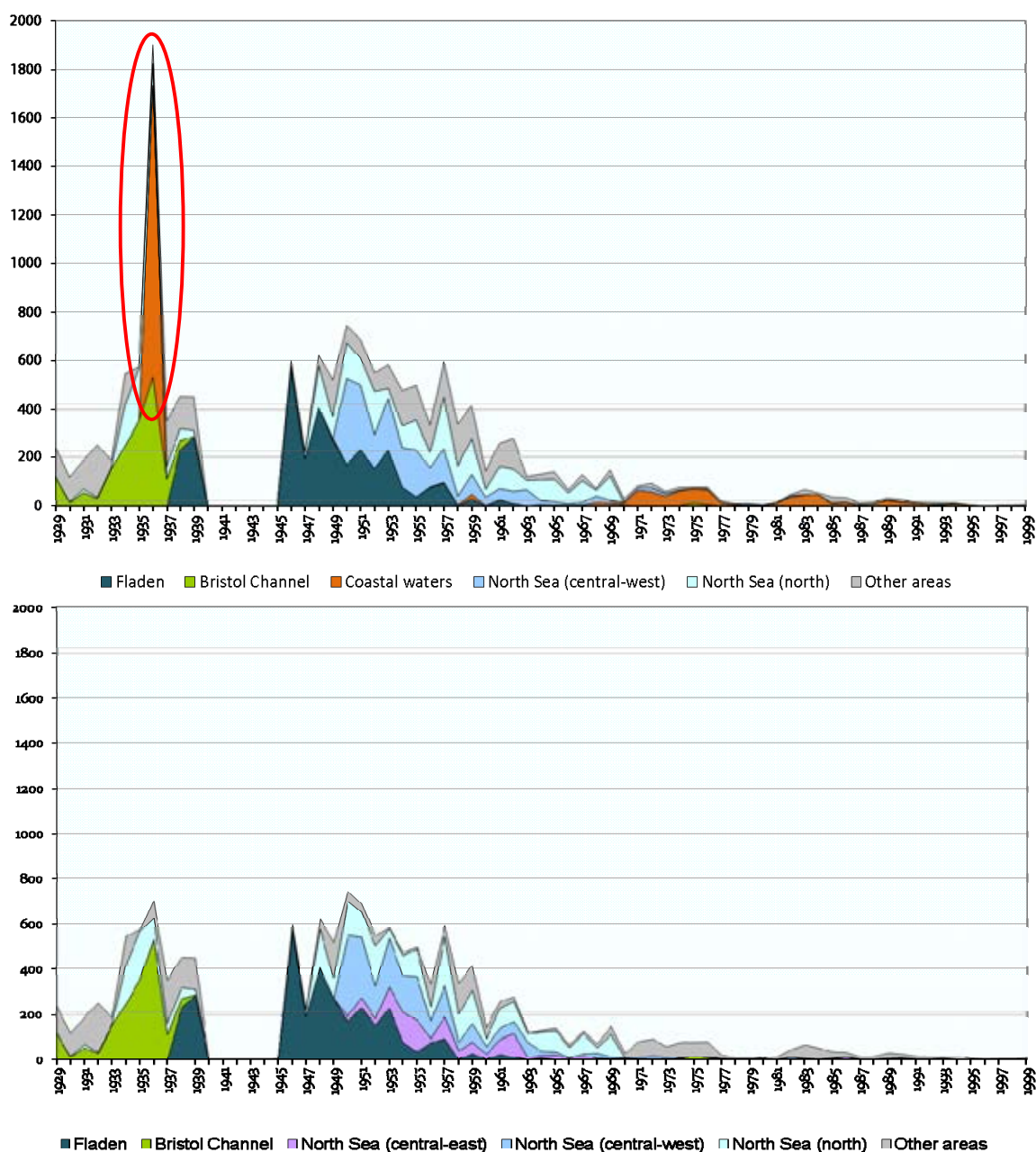
After quality control and standardization, annual tables were integrated as pivot tables in spreadsheets. Pivot tables are dynamic spreadsheet tables that can easily convert data for different visualization and analytical purposes, and allow simple statistical functions. Pivot tables were based on the joining and integrating of all 'corrected files', after standardization of species names, ports and fishing grounds (see above). Since the data fields were copy-pasted manually from the individual 'corrected files' (individual spreadsheets each corresponding to a given year and a given time-series) into the pivot tables, a control of the accuracy of this copy-pasting process was conducted on each of the resulting pivot tables to check consistency with corrected files. This was achieved by checking a minimum number of randomly chosen fields for each of the categories 'demersal', 'pelagic' and 'molluscs and crustaceans' (<10% of the fields); and by crosschecking the subtotals and totals (rows and columns) from the pivot tables with those of the corrected files.



**Figure 2.9.:** Example of structure of the database (series II). Source: 'HiFiDatabase: A century of Sea Fisheries in Belgium' (VLIZ 2009).

Graphs were drawn from the pivot table reports, showing trends in the value and volume of landings over time for each of the species and aggregated units were constructed from the pivot tables, a) by port and b) by fishing ground, and for the data on the fishing fleet. Visual inspection of these graphs allowed a second quality control of errors or anomalies in the data. Special attention in the graphical analysis was given to abnormally high landings for a given species from a specific fishing ground or sudden abrupt changes in observed trends. These errors were typically not detected in the first phase of quality control of numerical values, because they were not generated by simple calculation or copy errors.

A number of problems and errors were evidenced by this visual control and plausible explanations were looked for by checking additional sources (comparing 'row totals' from one data-series with another). As an example, a sudden increase from 0t in 1935 and 1937 to 1200t in 1936 was reported in the landings for mackerel in Coastal waters ('Kustzee') (Figure 2.10.). By checking the value of subtotals for mackerel reported in a second source (subtotals of landings by species in Belgian ports), we found a difference with a value similar to this anomaly. At the same time, the subtotal reported in this same source but for another species 'sprat' showed a difference of exactly the same value of the anomaly for mackerel. Part of the landings of sprat from coastal waters were incorrectly assigned to the reported values for mackerel. This error may have been induced by the fact that 'sprat' and 'mackerel' were located next to each other in the tables of reporting forms and the values were probably copied in wrong fields at the moment of producing the tables. This example illustrates the importance of graphical analysis and the different steps of quality control.



**Figure 2.10.:** Example of quality control based on graphical analysis of the data. Landings of mackerel by fishing area, for the 5 most important fishing areas ('Other areas' is an aggregation of the landings in the remaining fishing areas). The sudden increase in landings of mackerel (orange) originating from 'Coastal waters' from 0t in 1935 to 1,200t in 1936 (and again 0t in 1937) was attributed to an error in copying during the production of the statistics. Source: 'A century of Sea Fisheries in Belgium' (VLIZ 2009).



### 2.4.5 RELIABILITY OF RECONSTRUCTED TIME-SERIES

Reliability of fisheries data is a complex issue that starts at the moment the nets are hauled in. A combination of the selectivity of fishing gears, management regulations and socio-economic conditions affect the proportion of mortality that actually results in 'catch' and the proportion of 'catch' that is effectively reported as 'landings'. As an example, underwater towpath mortality is part of the fishing mortality that is not recorded as 'catch', and on board discarding is part of the catch that is not landed. The remaining proportion of the 'catch' is then considered either illegal, unreported, unregulated (IUU), or a combination of the previous, and may be either discarded or retained as by-catch. For an overview of terminology and estimates of these factors, see Alverson *et al.* (1994), Pauly *et al.* (1998), Gray *et al.* (2004), and Zeller *et al.* (2007). An example of unreported fisheries for Belgium is the recreational line fishing for highly valued economic species (such as cod), which is estimated to be in the range of the commercial landings for this species in recent years (Anon. 2006). Unreported catches may also include fisheries with fixed nets from the beach (for flatfish), artisanal shrimp fisheries by beach trawlers (by horse, on foot), or commercial catches of shrimp that are not landed at auction points. Illegal unreported catches include those that are landed in ports but are transferred for direct sale and consumption without passing the mandatory reporting procedures at the fish auctions.

As in many countries, the problem of incompleteness and reliability of the fisheries data in Flanders/Belgium has been persistent over time and hard to address. In fact, early publications (e.g., 'Bestuursmemoriaelen 1840-1870, De Zuttere 1909) acknowledge the fact that state subsidies were the drive for the collection of fisheries data. When subsidies in Flemish fisheries in the 19th century were abolished, data collecting stopped, as reported in *Bestuursmemoriael* (1867 in De Zuttere 1909). Still, considering the relative size of the fleet, the short coastline and the limited number of fish auctions and fishing ports, it is fair to say that the present historical reconstruction of landing statistics in Flanders/Belgium may depict a relatively complete picture of historical landings for this time period, compared to other countries.

The reconstructed time-series for volume and value of landings were tested for reliability by comparing the (sub)totals from two datasets that are part of the national reporting; one dataset reporting by fishing area (time-series I) and another reporting by fishing port (time-series II). The degree of consistency between both figures for a given species and year, can be regarded as an indication of the reliability of the data collecting process. This allowed to trace possible inconsistencies and correct remaining errors. A matrix was drawn in which the (relative) reliability of the data was expressed for each species, by year. This index was calculated as the % of difference between the absolute value (in tonnes or in Euro) for a given species and given year as reported in time-series I (value by fishing area 'F') compared to the corresponding value reported in time-series II (value by fishing port 'P'). This was achieved by combining the spreadsheet matrices (species in row headings; years in column headings) for each time-series in a new matrix and applying following formula:

$$" =IF(F="error" & P; P/F *100 - 100) "$$

The product is a colour-coded matrix of (relative) reliability of historical data on the composition and value of Belgian marine fisheries landings in Belgian ports (Figures 2.11. and 2.12.). Horizontal lines refer to species or aggregated taxa (e.g., rays) and vertical lines represent a given year of reporting. The green and yellow zones are considered to have excellent (0% difference) and good reliability (0% < difference <1%). The latter (yellow) is mainly due to differences in rounding. Gray zones stand for 'no data', which applies to the war period, as well as selected species such as salmon, tuna, or aggregated taxa which were not reported in specific periods. Blue codes are



inconsistent reporting between the first and the second time-series (e.g. one time-series reports values for a given species in a given year, while the second time-series does not report data on that species and year). The dark-red zones are considered as having lower reliability: e.g., the earlier years (1933-1935), and certain pelagic species (herring, sprat and horse-mackerel) in more recent years. In the latter case it may be the low amount of landings of pelagic species that results in higher percentage. A similar matrix was drafted for value of landings (Figure 2.12.). Reliability as defined in the present exercise is better scored for value of landings (Euro) than for landings (tonnes). The reliability of most of the time-series data are deemed excellent to good (0% and up to 1% difference), except during the pre World War II period for the intermediate aggregated levels of taxa ('miscellaneous', 'other species') and for pelagic species (herring, sprat, mackerel, horse mackerel) after 1980. Data from the HiFiDatabase were also compared to the (sub)total values as reported by ICES (Fishstat, see further).

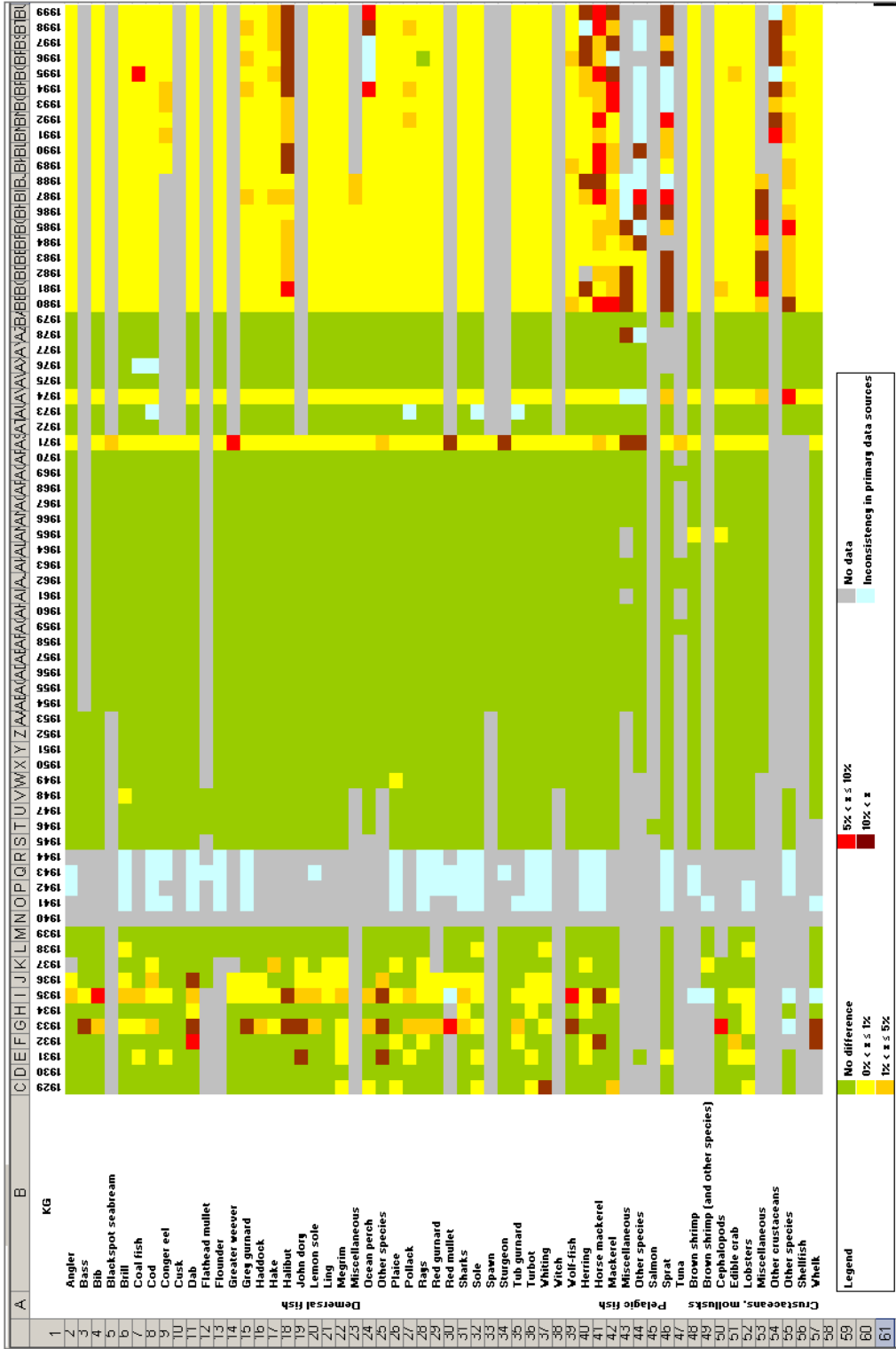
#### 2.4.6 A MEASURE OF THE RELEVANCE AND IMPACT OF THE PROCESS OF QUALITY CONTROL

The results of the first quality control of the data in the 'corrected files' and the graphical analysis yielded an overall absolute correction of approximately 12,643tonnes and €2.4 million (non-indexed values). Expressed in relative terms, these corrections amount to 73% of the entire landings of Belgian fisheries in Belgian ports in 2008 (17,307tonnes). Expressed in proportional value of the current landings for 2008, this would correspond with €48,6million.

It must be noted that the impact of the corrections may increase substantially when 'zooming in' on a particular species (graphical analysis). Table 2.5. gives an overview of the amended errors (magnitude and location in the files) in the HiFiDatabase compared to the original sources.

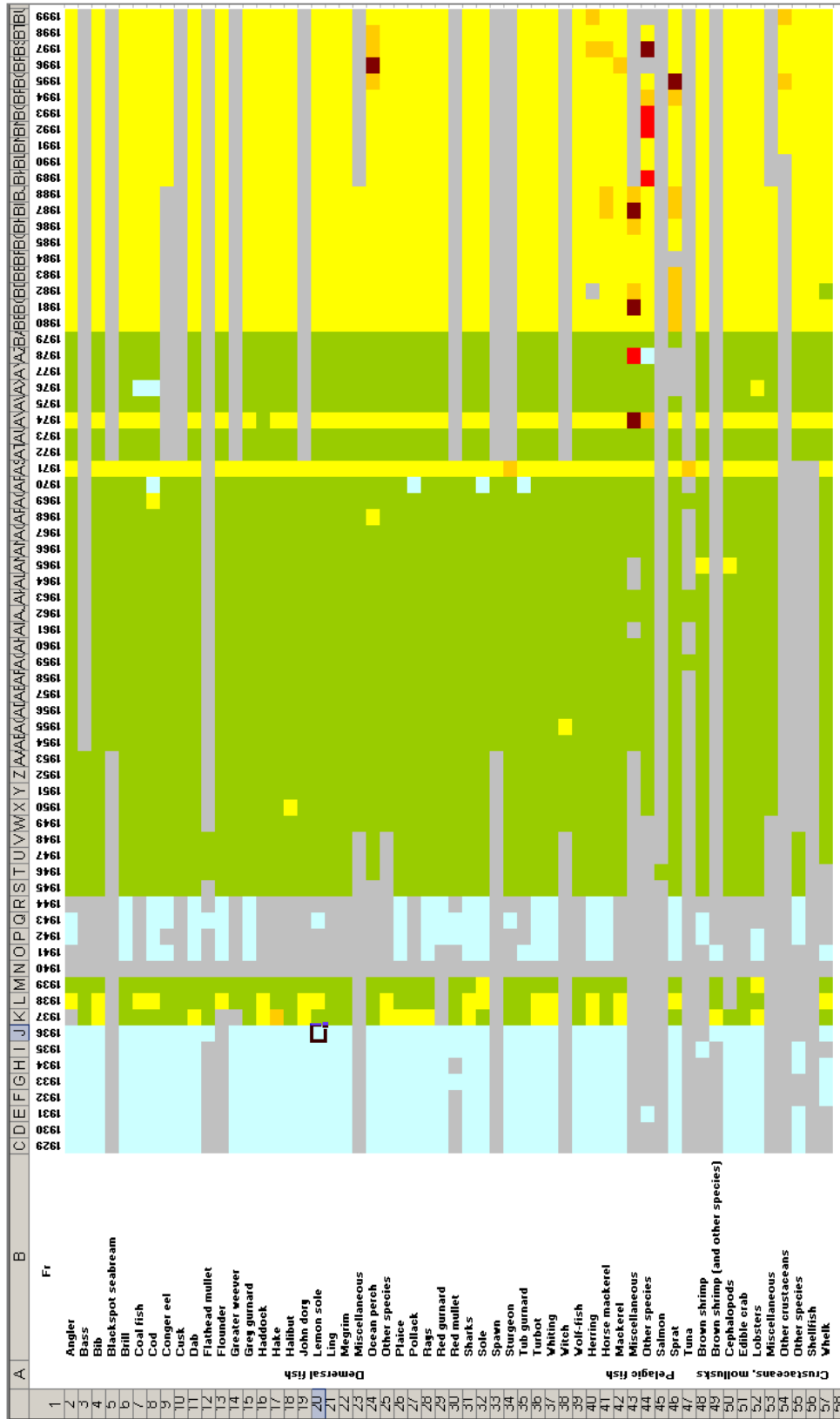
**Table 2.5.:** Absolute and relative values of the magnitude of corrections on the original data after first phases of quality control

Source (time-series)	Corrections in landings in kg (%)	Corrections in value of landings in EUR (%)
Belgian fisheries in Belgian ports, by port	3,920,921 (31)	1,593,798 (66)
Belgian fisheries in Belgian ports by fishing area	7,656,687 (61)	39,505 (2)
Belgian fisheries in foreign ports by fishing area	971,730 (8)	503,253 (21)
Totals Belgian fisheries in Belgian and foreign ports	94,176 (1)	281,244 (12)
<b>TOTAL absolute value of corrections in all files</b>	<b>12,643,514 (100)</b>	<b>2,417,800 (100)</b>



**Figure 2.11.:** Reliability matrix for the landings of Belgian fisheries landed in Belgian ports. Vertical: species or reporting units; horizontal: years (1929-1999) note the clustering of inconsistent reporting for pelagic species and for certain years. Source: 'HIFIDatabase' (VUIZ 2009)

**Key:** Green: no difference between two time-series (0%); Yellow: up to 1% of the value in time-series; Orange: difference ranges between 1% and up to 5% of the value in time-series; Red: difference ranges between 5% and 10% of the value in time-series; Dark red: difference is higher than 10% of the value in time-series; Grey: 'no data' or '0' reported in either of the time-series; Blue: inconsistent reporting; e.g., data (value) reported in time-series I while time-series II reports no data or '0' value.



**Figure 2.12.:** Reliability matrix for the value of landings of Belgian fisheries landed in Belgian ports. Vertical: species or aggregate taxa; horizontal: years (1929-1999). Note the clustering of inconsistent reporting for pelagic species and for certain years.

Key: Green: no difference between two time-series (0%); Yellow: up to 1% of the value in time-series; Orange: difference ranges between 1% and up to 5% of the value in time-series; Red: difference ranges between 5% and 10% of the value in time-series; Dark red: difference is higher than 10% of the value in time-series; Grey: 'no data' or '0' reported in either of the time-series; Blue: inconsistent reporting: e.g., data (value) reported in time-series I while time-series II reports no data or '0' value.

#### 2.4.7 COMPARISON OF THE 'LOCAL' DATASET TO ICES/FAO LANDING STATISTICS

Hoek and Kyle (1905) gave an overview of the situation of Belgian fisheries, in a country overview published by the International Council for the Exploration of the Sea (ICES). Since 1903, ICES member states report national fishing statistics in order to build joint catch ('capture production') statistics by marine areas, which are published in the 'Bulletins Statistiques'. Currently, reporting of catch statistics to ICES by Belgium (Flanders) is twice per year: the preliminary catches for the half year and the statlant27A data by 31<sup>st</sup> may, per annum (E.Tessens, pers. comm.). These statistics are collected by the Sea Fisheries Service of the Flemish government (and its predecessors) and are based on landing statistics as reported in the fish auctions (dead weight). A comparison between the ICES database and the local integrated database was conducted to look for possible inconsistencies. ICES data were obtained from Fishstat ('capdet'-download in June 2008). The landings reported by Belgium were reported as aggregated catch from the 'Northeast Atlantic' area (Statlant27), starting in 1950.

Some terms of reference were clarified as a context for this comparison:

1. The Fishstat database contains data from 1950 onwards. Therefore the comparison with the local data (HiFiDatabase) is restricted to the period 1950-1999 and data from the HiFiDatabase 1929-1949 were excluded.
2. The Fishstat database contains aggregated landings from Belgian sea fisheries landed both in Belgian ports and in foreign ports. This is also the case for the HiFiDatabase, however in this case the landings in Belgian ports and in foreign ports are reported separately and can be queried separately.
3. Fishstat data on total landings are based on landings expressed in fresh weight. These 'fresh weight' values are reported by countries after conversion of 'dead weight' as recorded in the auction, with species-specific conversion factors. Depending on the species and the processing, these factors may be further specified (with or without head, gutted, complete). The HiFiDatabase contains the original non-converted data (dead weight) as recorded in the auctions.
4. The total landings from Fishstat can not be compared to the total landings from the HiFiDatabase: Fishstat data represent the sum of the total landings by species, each converted to fresh weight by a species-specific conversion factor. Therefore, the sum of the components (all species landings) of Fishstat is not equal to the landings in the HiFiDatabase.

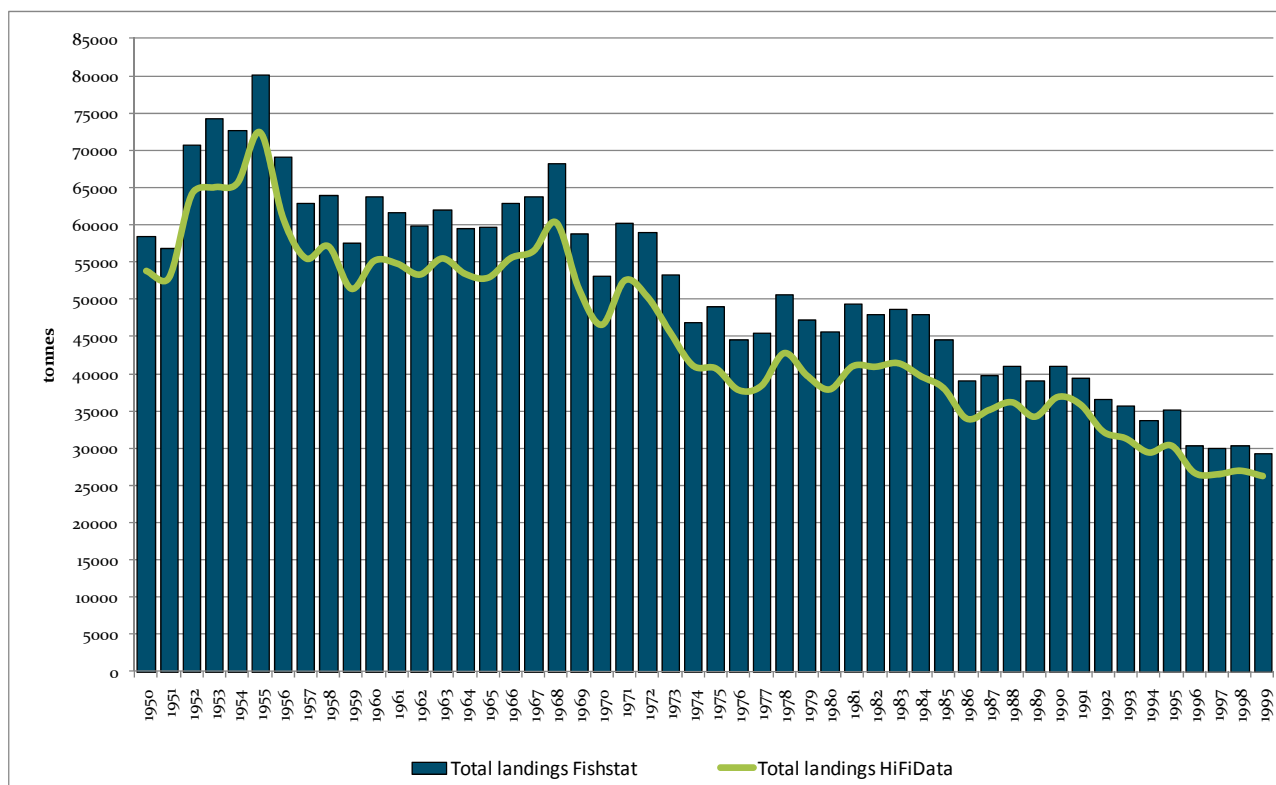
Since HiFiData are based on landings as registered in the fish auction (dead weight), conversion factors<sup>1</sup> were needed to calculate and convert to fresh weight. Therefore, total landings by species per annum were multiplied by the species-specific conversion factor (see appendix, source Mr. E.Tessens-DVZ) and compared to the corresponding value as reported by ICES/FAO (Fishstat). These conversion factors are established by ICES and used by the ICES members in annual reporting to ICES/FAO.

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<sup>1</sup> conversion factors aim to compensate for losses in biomass of the catch during transport (loss of body mass or water) or during processing (gutting or removing parts of the fish that is not commercialized).

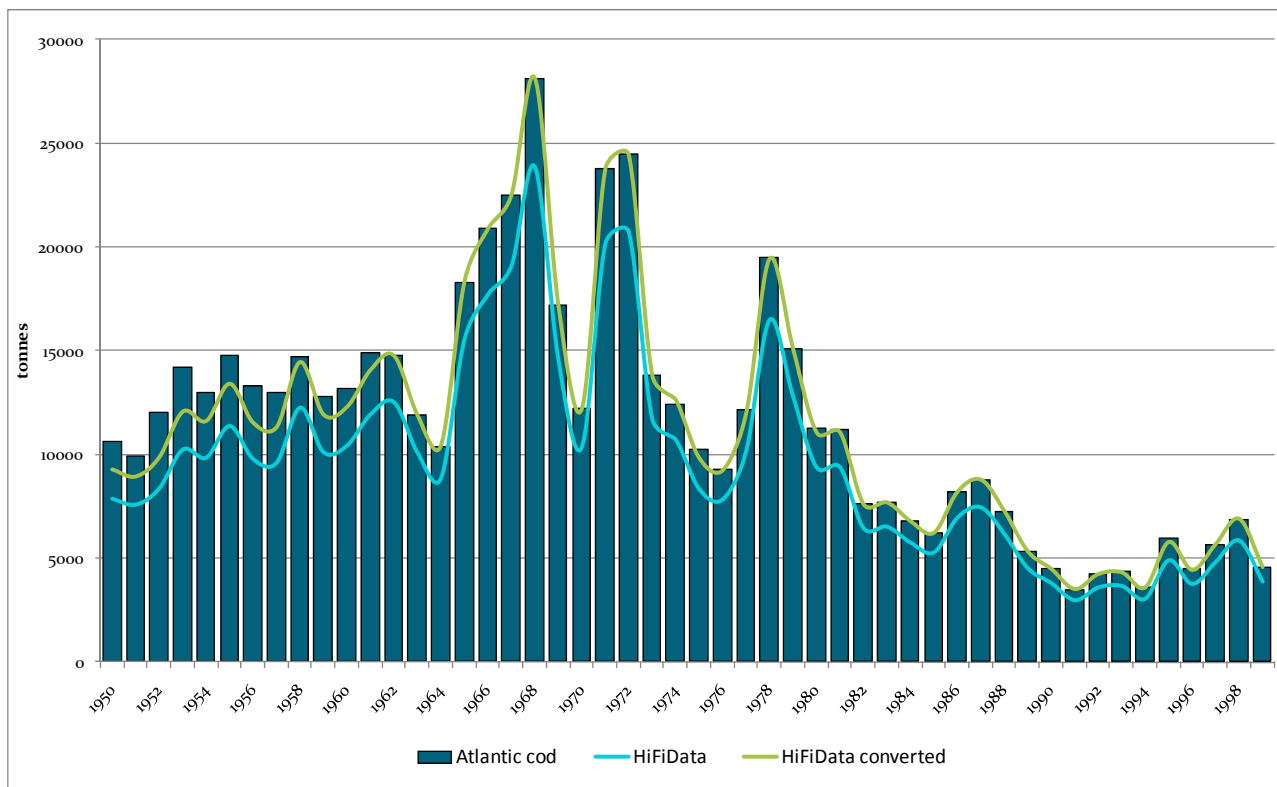
### 2.4.8 FINDINGS OF COMPARISON BETWEEN ICES AND HiFiDATABASE

As expected, the total landings from HiFiData are consistently lower than Fishstat landings over the entire period due to the difference between dead and fresh weight (Figure 2.13).



**Figure 2.13.:** Total annual landings (expressed in tonnes fresh weight) as reported by ICES/FAO (Fishstat) compared to the total landings (expressed in tonnes dead weight) as collected and integrated in the HiFiDatabase for Belgian sea fisheries 1950-1999. Source HIFiDatabase (VLIZ 2009) and Fishstat download in June 2008

Apparently not all species were subject to reporting, or the reported aggregations of species do not fully coincide between the two databases. Therefore, it was not feasible to conduct the conversion from HiFiData to Fishstat for the overall landings by simply adding up the converted values by single species. Subtotals (dead weight) by individual species from the HiFiDatabase were converted to fresh weight equivalents by multiplying with the corresponding species-specific conversion factor, where applicable. An example is provided for Atlantic cod (*Gadus morhua*, Figure 2.14.).

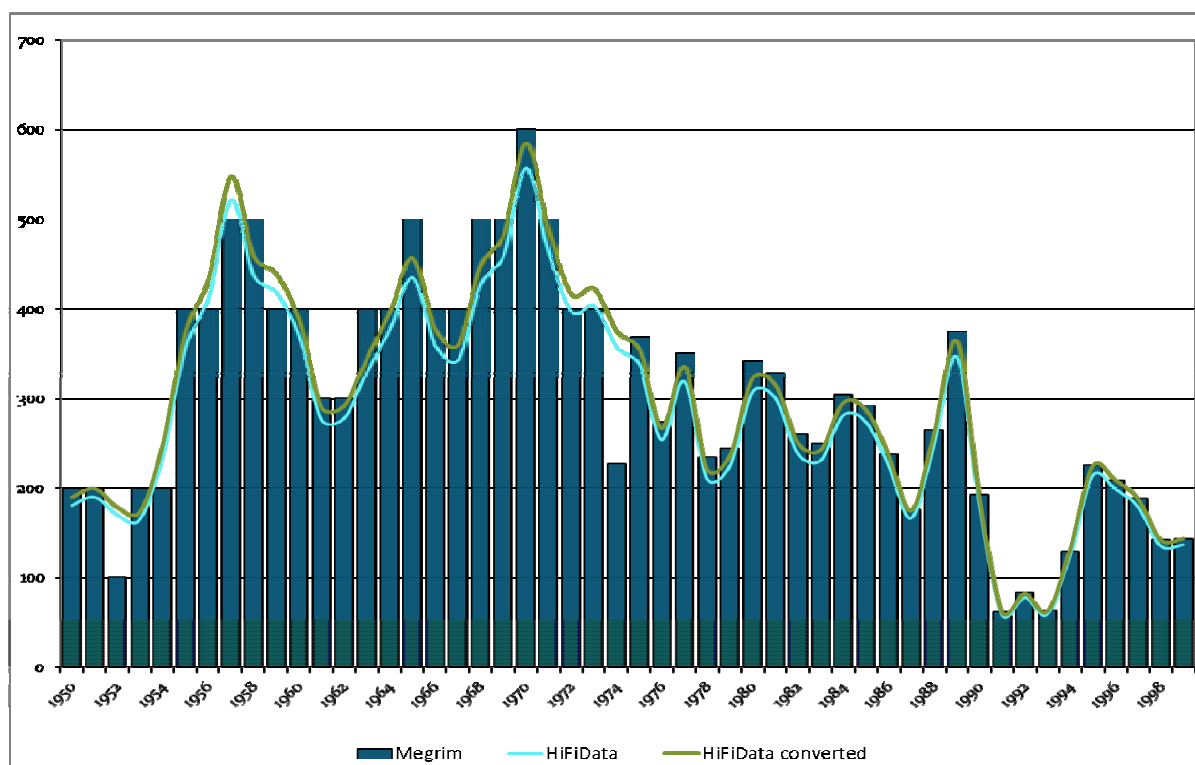


**Figure 2.14.:** Conversion for Atlantic cod (*Gadus morhua*) from HiFiData (dead weight) to fresh weight ('HiFiData converted') by conversion factor 1.18. Blue bars represent ICES data from Fishstat. Source: HiFiDatabase (VLIZ 2009) and Fishstat download in June 2008

Annual landings for this species as provided by the HiFiDatabase (blue line), were multiplied by conversion factor 1.18. The product is 'HiFiData converted' (green line). The overall landings for the period were reported as 581,725t (Fishstat), 478,330t (HiFiData) and 564,430t (HiFiData converted). Therefore a discrepancy of 17,295t (3%) was detected for cod, in favour of the Fishstat data.

Similar conclusions were drawn for Common sole (*Solea solea*): inconsistencies between both databases on a per annum basis for this species were noted particularly between 1950 and 1960 (up to 30%). The overall discrepancy for sole over the period 1950-1999 is 15,877tonnes (7%).

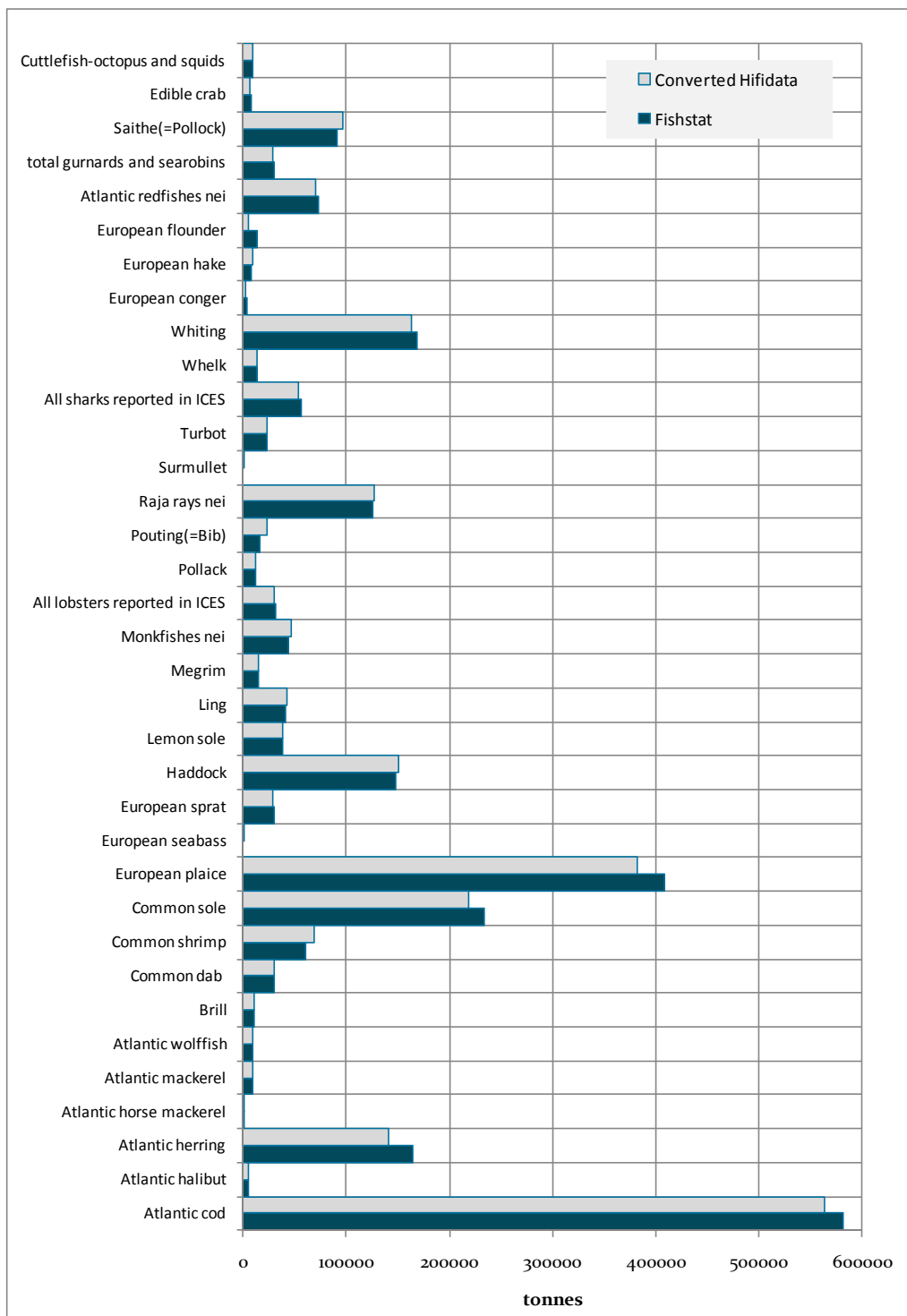
The differences may be due to changes in the conversion rates compared to earlier reporting years. However, the over- or underreporting was not systematical nor was it associated with the first decades of reporting as was clearly shown by the case of Megrim (*Lepidorhombus whiffiagonis*) for which over- and underreporting could be detected even between years (Figure 2.15.).



**Figure 2.15.:** Conversion for Megrim (*Lepidorhombus whiffiagonis*) from HiFiData (dead weight) to fresh weight ('HiFiData converted') by conversion factor 1.05. Blue bars represent ICES data from Fishstat. Source: HiFiDatabase (VLIZ 2009) and Fishstat download in June 2008

For some species (Atlantic horse mackerel, Atlantic wolffish, Common shrimp, European sea bass, European hake, Surmullet, Pouting, etc.- names as in the Fishstat database), the local HiFiDatabase reported overall or annual higher landings than the Fishstat data after conversion to fresh weight. For others (Atlantic herring, European plaice, European sole, Atlantic cod, European flounder, European conger, etc.) the Fishstat reports were higher (Figure 2.16). Also, the Fishstat database was not necessarily consistent in reporting higher values (or lower values if the case) for a particular species throughout the time-series 1950-1999, compared to the HiFiData. The data in Fishstat seemed to have been subject to rounding, at least in the earlier decades of reporting, and landings below 50kg were not included. However, the rounded figures do not match with converted HifiData. Also, certain species (e.g. pouting, surmullet) were not reported in the earlier years. Furthermore, the Fishstat database contained aggregations for certain groups of species, hence it was impossible to conduct a comparison at the species level. Still, even after the conversion process and in spite of the unreported species and the landings that were not accounted for, the Fishstat database seemed to report a higher total amount of landings, especially for the more abundant group of demersal fishes.





**Figure 2.16.:** Total reported landings (tonnes) in HiFiData (1950-1999) after conversion factors were applied, to convert dead weight or gutted weight into fresh weight (dark bars), compared with Fishstat data (grey bars). *Source: HiFiDatabase (VLIZ 2009) and Fishstat download in June 2008*

## 2.5 RESULTS: HISTORICAL FISHERIES DATABASE 'HiFiDATABASE' FOR BELGIUM

The results from the inventory and integrating of sources containing historical data on sea fisheries fleet and on the composition and economic value of landings in Belgium indicate that:

- Structurally embedded reporting based on detailed taxonomic and geographical resolution started in 1929 with an acceptable degree of consistency and continuity ever since. In spite of early efforts by government officials (at least since 1903) to achieve standardised collecting and centralized reporting on fisheries data in Belgium, all data on catches, landings, fleet and effort collected before 1929 are either spatially incomplete or taxonomically aggregated data. Exceptions are the surveys conducted in the context of the Commission of the Chamber of Representatives (1866) and the census conducted by De Zuttere (1909).
- At the time of initiating the present study (2008-2009), data on annual landings and value of landings collected and published before 1998 were only available in hard copy and none of the data were available electronically in the public domain. After 1998, the annual reports were published digitally and the annual data made available in spreadsheets. An electronic file (spreadsheet) with landings data from 1996 onwards was made available from the Fisheries Service.
- The International Council for the Exploration of the Sea ICES published a dataset containing data on landings (fresh weight) for reporting countries. The dataset was published in 2009 - after the onset of the present research work - and contains data from 1950-2010. The ICES data refer to fresh weight, i.e. landings as recorded in the fish auction (as dry weight), and multiplied by a factor correcting for loss of weight during transport, handling and processing. Contact was established with the project coordinators at ICES, to inform about the progress in work and next steps in the reconstruction of time-series for Belgium, and to make sure that duplication of efforts would be avoided. The 'HiFiDatabase' ('Historical Fisheries Database') is the result of the steps in data and information management described above. It contains a collection of time-series with standardised species names, reporting units, fishing areas and ports of landing.

### 2.5.1 LANDING STATISTICS

The datasets were partially integrated as the HiFiDatabase. HiFiDatabase allows querying data at the species level (41 species) and another 15 aggregate categories, by year (1929-1999), by fishing area (31 subareas) and by port of landing in Belgian (4 ports) and foreign ports (1 aggregate value). The main datasets include:

- Landings and value of landings **in Belgian ports, by species, by port**, and by year;
- Landings and value of landings **in Belgian ports, by species, by fishing area**, and by year;
- Landings and value of landings **in foreign ports, by species, by fishing area** and by year;
- Monthly landings and value of landings **in Belgian ports, by species, by fishing area**
- Monthly landings and value of landings **in Belgian ports, by species, by fishing area** by length class for 7 species
- Monthly landings and value of landings **in Belgian ports, by statistical rectangle (1946-1983)**, by type of fisheries and vessel class

The HiFiDatabase is further complemented with other datasets that could not be fully integrated because of changes in spatial reporting units or aggregation levels. The overview of the reconstructed time-series is included in Table 2.6., with the name of the dataset, a description, and an indication of its extent (number of rows and columns) and size (MB).

The timeframe of the reconstruction focuses on 1929-1999. Recent data from 2000 onwards were also collected to complement the historic data. For particular species (Atlantic herring *Clupea harengus* and Atlantic cod *Gadus morhua*) additional data was collected to extend the time-series further in the past.

The added value of the reconstructed time-series can be described in multiple aspects:

**Spatial Coverage:**

All fishing areas where the Belgian fleet has operated between 1929 to present. This includes at least 4 fishing areas not covered by ICES reporting: Fladen, Belgian coastal waters (part of ICES fishing area 'North Sea south' IVC), North Sea central-east, North Sea central-west (part of ICES fishing area 'North Sea central' IVb).

**Spatial resolution:**

All fishing areas and reporting units at the smallest available scale (=highest resolution). This includes datasets in which landings are reported by statistical rectangle (monthly values between 1946-1983).

**Temporal resolution:**

Monthly values

**Temporal Coverage:**

1929-1999

**Taxonomic coverage:**

41 species and 15 aggregated taxa

**Thematic Scope:**

Economic data

- Value of landings (in Belgian francs and converted into Euro, nominal values and values corrected for inflation)
- Average price of landings (in Belgian francs/kg and converted to Euro/kg, nominal values and values corrected for inflation).

Economic data have not been collected previously for the purpose of reconstructing historical time-series. All economic values were also expressed as values 2010 to allow for comparison of trends over time.

**Coverage of ports :**

In total, 6 ports/fish auctions where the fish was landed and sold, were included in the reporting since 1929. These are Blankenberge, Zeebrugge, Oostende, Nieuwpoort (Belgium) and the ports of Gravelines and Dunkerque (France). The 4 Belgian ports were included in reporting since 1929, although reporting for Blankenberge ceased in 1958 (last reported landings in 1957). The port of Nieuwpoort was the most important during WWII, while Gravelines and Dunkerque were also used to disembark the landings during WWII (Chapter 3).

**Table 2.6.:** Overview of reconstructed time-series for landings, value of landings, fishing effort, with the name of the dataset, a description, and an indication of its extent (number of rows and columns) and size (MB)

Title sheet	Content	Number of rows	Number of columns	MB
BE_aanvoer_besomming_BE_BUI_havens_per_visgrond_ber_incl_WOII_	This dataset combines the data of landings and value of landings per fishing ground in Belgian ports 'BE_aanvoer_besomming_BE_havens_per_visgrond_inclus_WOII_kustzee' with the data of landings and value of landings per fishing ground in foreign ports 'BE_aanvoer_besomming_BUI_havens_per_visgrond' into one value	44816	20	4,47
BE_aanvoer_besomming_BE_havens_Noordzee_1951-juli1967	This dataset integrates 17 individual reporting sheets based on handwritten documents obtained from the archives of the 'Dienst Zeevisserij' (Fisheries Service, Flanders Government). It contains data on landings (kg) and value of landings (in BEF and EUR) for different pelagic and demersal fish species, molluscs and crustaceans, landed by Belgian fishing vessels in the different Belgian fishing ports/fish auctions, and caught from the North Sea. The data are reported by month and per year. For a limited number of species (7), landings were reported by length classes. Average price per kg is calculated in the file and reported in BEF en EUR, as well as in current prices (corrected for inflation, expressed as values 2007 and values 2010). For particular years and months, data is available on number of catches, number of vessels, total HP (PK), number of fishing days, number of days at sea, hours at sea, hours spent fishing, HP(PK)*hours fishing, HP(PK)*hours at sea. This dataset was validated by comparing the values contained herein with those contained in 'BE_aanvoer_besomming_BE_havens_per_visgrond' and considering the reporting unit 'North Sea' was constructed by adding the values for the fishing areas 'Fladen', 'Coastal waters', 'Moray Firth', 'North Sea (central-east)', 'North Sea (central-west)', 'North Sea (north)', 'North Sea (south)'.	15680	32	2,02
BE_aanvoer_besomming_BE_havens_per_haven	This database is the result of the integration of 70 different datasets. It contains data on landings (kg) and value of landings (in BEF and EUR) of different pelagic and demersal fish species, crustaceans and molluscs landed by Belgian fishing vessels in Belgian ports, by port, per year. For a limited number of species (7), landings were reported by length classes for a number of years (1929 - 1933, 1935). Average price per kg is calculated in the file and reported in BEF en EUR, as well as in current prices (corrected for inflation, expressed as values 2007 and values 2010)	11735	18	1,82
BE_aanvoer_besomming_BE_havens_per_visgrond	This database integrates 66 different sub-components or datasets. It contains data on landings (kg) and value of landings (in EUR and EUR) of different pelagic and demersal fish species, crustaceans and molluscs landed by Belgian fishing vessels in Belgian ports, by fishing ground, per year. For a limited number of species (7), landings were reported by length classes for a number of years (1929 - 1933, 1935). For the period 1929 - 1933 a breakdown by type of fishing gear and vessel type is available. Average price per kg is calculated in the file and reported in BEF en EUR, as well as in current prices (corrected for inflation, expressed as values 2007 and values 2010)	45988	23	5,34
BE_aanvoer_besomming_BE_havens_per_visgrond_inclus_WOII_kustzee	This database combines data from "BE_aanvoer_besomming_BE_havens_per_visgrond" with the annual data from the database "WOII_BE_aanvoer_besomming_BE_havens_per_visgrond"	46132	23	4,27

BE_aanvoer_besomming_B UI_havens_per_visgrond	This database integrates 49 different sub-components or datasets. It contains data on landings (kg) and value of landings (in EUR and EUR) of different pelagic and demersal fish species, crustaceans and molluscs landed by Belgian fishing vessels in foreign ports, by fishing ground, per year. Average price per kg is calculated in the file and reported in BEF en EUR, as well as in current prices (corrected for inflation, expressed as values 2007 and values 2010)	46511	23	3,86
GISCodes	Codes for every fishing ground, to be able to present data on a map using a GIS application	30	3	
Index_2007	Factor for indexation 2007 (calculated using the consumptionpriceindices with basis 2004)	71	3	
Index_2010	Factor for indexation 2010 (calculated using the consumptionpriceindices with basis 2004)	71	3	
Soortnamen (EN/NL), WoRMS codes	Dutch (standardized), English and scientific fish species names, including species code from the World Register of Marine Species	54	5	
Visgrondnamen (EN/NL)	Dutch (standardized) and English fishing ground names	32	3	
WOII_BE_aanvoer_besom ming_BE_havens_per_have n	This database is the result of the integration of 68 different subcomponents or datasets (4 files, 68 spreadsheets). It contains data on landings (kg) and value of landings (in BEF and EUR) of different pelagic and demersal fish species, crustaceans and molluscs landed by Belgian fishing vessels in Belgian ports, by port, per year, per trimester and per month during WWII. For a limited number of species (5), landings were reported by length classes. Average price per kg is calculated in the file and reported in BEF en EUR.	7207	19	0,71
WOII_BE_aanvoer_besom ming_BE_havens_per_visgr ond	This database is the result of the integration of 68 different subcomponents or datasets (4 files, 68 spreadsheets). It contains data on landings (kg) and value of landings (in BEF and EUR) of different pelagic and demersal fish species, crustaceans and molluscs landed by Belgian fishing vessels in Belgian ports, by fishing ground, per year, per trimester and per month during WWII. For a limited number of species (5), landings were reported by length classes. Average price per kg is calculated in the file and reported in BEF en EUR.	2086	20	0,24
WOII_Strandvisserij	This database is the result of the integration of 54 different subcomponents or datasets (4 files, 54 spreadsheets). It contains data on landings (kg) and value of landings (in BEF and EUR) of different pelagic and demersal fish species, crustaceans and molluscs landed by Belgian fishing vessels in Belgian ports, per beach of the Belgian coast, per year, per trimester and per month during WWII. For a limited number of species (5), landings were reported by length classes. Average price per kg is calculated in the file and reported in BEF en EUR.	2615	19	0,22
BE_aanvoer_besomming_B E_havens_per_visgrond_pe r_maand_incl_groottkl	Data for 1947 - 1981 in this database are the result of the integration of 254 different sub-components or datasets (188 files and 254 spreadsheets). It contains data on landings (kg) and value of landings (in EUR and EUR) of different pelagic and demersal fish species, crustaceans and molluscs landed by Belgian fishing vessels in Belgian ports, by fishing ground, per year and month. Average price per kg is calculated in the file and reported in BEF en EUR, as well as in current prices (corrected for inflation, expressed as values 2007 and values 2010). Annual data for 1929 - 1933 were taken from the database "BE_aanvoer_besomming_BE_havens_per_visgrond". The data (year, month, trimester) for 1941-1944 were taken from the database "WOII_BE_aanvoer_besomming_BE_havens_per_visgrond"	353768	23	53,28

BE_aanvoer_besomming_effort_per_visgrond_per_visserij_gestandaardiseerd	<p>This database is the result of the integration of 43 different datasets or files based on handwritten and typed documents from the archives of the 'Dienst Zeevisserij' (Fisheries Service, Flanders Government). Depending on the time period following information is available in the database:</p> <ul style="list-style-type: none"> <li>• 1946 - 1949: Annual and monthly data by fishing ground, by fisherytype and vessel class with information on number of vessels, number of trips, days at sea, fishing days, hours at sea, fishing hours, HP (PK) x days at sea, HP (PK) x fishing days, HP (PK) x hours at sea, HP (PK) x fishing hours, total landings and value of landings</li> <li>• 1950 Annual and monthly data by fishing ground, by fisherytype and vessel class with information on number of vessels, number of trips, days at sea, fishing days, hours at sea, fishing hours, HP (PK) x fishing days, HP (PK) x hours at sea, HP (PK) x fishing hours, average HP (PK) per vessel, total landings and value of landings</li> <li>• 1956 - 1964 Annual data by fishing ground, by fishing rectangle, per fisherytype and per vessel class with information about number of vessels, number of trips, days at sea, fishing days, hours at sea, fishing hours, HP (PK) x hours at sea, HP (PK) x fishing hours, total landings and value of landings</li> <li>• 1965 - 1968, 1971 - 1983 Annual and monthly (from 1968) data by fishing ground, by fishing rectangle, per fisherytype and per vessel class with information on number of vessels, number of trips, days at sea, fishing days, hours at sea, fishing hours, HP (PK) x hours at sea, HP (PK) x fishing hours, total landings and value of landings and from 1972 onwards aslo GT x hours at sea, GT x fishing hours</li> </ul>	18119	31	4,82
BE_aanvoer_besomming_effort_ijsland_per_scheepsklasse_incl_soortgegevens	<p>This database is the result of the integration of 33 different sub-components or datasets (10 files, 33 spreadsheets) based on handwritten documents from the archives of the 'Dienst Zeevisserij' (Fisheries Service, Flanders Government). For fishing ground nr. 12 (Iceland), it contains annual and monthly data by fishery type, by vessel class with information on number of vessels, number of trips, days at sea, fishing days, hours at sea, fishing hours, HP (PK) x days at sea, HP (PK) x fishing days, HP (PK) x hours at sea, HP (PK) x fishing hours, average HP (PK) per vessel, total landings and value of landings, landings and value of landings per fish species (pelagic and demersal fish, crustaceans and molluscs, some of which information for length classes is available e.g.: plaice, sole, cod, ..)</p>	18573	21	1,69
BE_aanvoer_besomming_effort_kustzee_per_scheepsklasse_incl_soortgegevens_garnaalvisserij 6-7	<p>This database is the result of the integration of 46 different sub-components or datasets (10 files, 46 spreadsheets) based on handwritten documents from the archives of the 'Dienst Zeevisserij' (Fisheries Service, Flanders Government). For fishing ground nr. 1 (Coastal waters), it contains annual and monthly data by fishery type (shrimp fisheries nr. 6 &amp; 7), by vessel class with information on number of vessels, number of trips, days at sea, fishing days, hours at sea, fishing hours, HP (PK) x days at sea, HP (PK) x fishing days, HP (PK) x hours at sea, HP (PK) x fishing hours, average HP (PK) per vessel, total landings and value of landings, landings and value of landings per fish species (pelagic and demersal fish, crustaceans and molluscs, some of which information for length classes is available e.g.: plaice, sole, cod, ..)</p>	26776	21	2,09

BE_aanvoer_besomming_effort_kustzee_per_scheeps_klasse_incl_soortgegevens_overige visserijen	This database is the result of the integration of 124 different sub-components or datasets (10 files, 124 spreadsheets) based on handwritten documents from the archives of the 'Dienst Zeevisserij' (Fisheries Service, Flanders Government). For fishing ground nr. 1 (Coastal waters), it contains annual and monthly data by fishery type (other fisheries nr. 1, 2, 3, 4, 5, 8), by vessel class with information on number of vessels, number of trips, days at sea, fishing days, hours at sea, fishing hours, HP (PK) x days at sea, HP (PK) x fishing days, HP (PK) x hours at sea, HP (PK) x fishing hours, average HP (PK) per vessel, total landings and value of landings, landings and value of landings per fish species (pelagic and demersal fish, crustaceans and molluscs, some of which information for length classes is available e.g.: plaice, sole, cod, ..)	72304	21	6,69
BE_aanvoer_besomming_effort_overige visgronden_overige visserijen	This database is the result of the integration of different sub-components or datasets (10 files) based on handwritten documents from the archives of the 'Dienst Zeevisserij' (Fisheries Service, Flanders Government). For all fishing grounds (except fishing ground nr. 1 -coastal waters and nr. 12 – Iceland), it contains annual and monthly data by fishery type, by vessel class with information on number of vessels, number of trips, days at sea, fishing days, hours at sea, fishing hours, HP (PK) x days at sea, HP (PK) x fishing days, HP (PK) x hours at sea, HP (PK) x fishing hours, average HP (PK) per vessel, total landings and value of landings, landings and value of landings per fish species (pelagic and demersal fish, crustaceans and molluscs, some of which information for length classes is available e.g.: plaice, sole, cod, ..)	51718	21	4,41
TOTAL		764286		95,93

By querying the database, the change in landings of a particular species over time can be analyzed by port or by fishing area. Alternatively, changes in the species being landed in a particular port, or the shifts in species landed from a particular fishing area, can be analyzed. Trends in seasonal landings by species or by fishing area can also be studied. Detailed analyses related to specific research hypothesis are presented and discussed in Chapter 4. However, the main findings are described and commented in Chapter 3.

### 2.5.2 FLEET, FISHING EFFORT AND FISHING GEAR

As is the case for reported landings of fish and fish products, structurally embedded reporting on the fleet size and features in Flanders (Belgium) started in 1929 with a good level of consistency and continuity ever since then. The beginning of structural reporting on the fleet coincided with the period where most states in Europe developed a statistics approach to underpin policy development (Lescrauwaet et al. 2010a).

The Belgian fishing fleet has had an interesting evolution: vessels, boats and ships changed owner, immatriculation number (unique identifying code) or port of registration. A unique number or unique letter-number combination for each fishing vessel is required by law since the Royal Decree of January 6, 1884 (Official Journal March 31, 1884). These numbers must be listed on the hull on both sides of the bow. The letter stands for the port of registration. The format of the immatriculation number of ships of the Belgian fishing fleet has undergone some changes since then: Before 1947 the individual ports of call registered the immatriculation numbers. Each local port authority registered ships and assigned codes starting with the number '1'. Thus it was possible to find two identical codes within a given year, for two different ships, depending on the lists of different ports of call. E.g. number 5 was assigned in a given year in the list of Nieuwpoort, Oostende, as well as in De Panne and in Heist. Originally, no



letters were assigned before the number until after 1941. Generally, a letter.number combination is found on the bow, the sail or the stern of the ship, depending on the port of call or port of registration. From 1947 onwards, the registration of fishing vessels became a matter of centralized informationkeeping and many ships were reassigned new codes and numbers. In Oostende, ships were numbered from nr 1 and upwards, in Zeebrugge numbering started from nr 400, in Blankenberge ships were assigned numbers above 600, and in Nieuwpoort the lowest possible number on a ship was 700. The immatriculation number of a vessel is maintained when it is sold, unless the ship will change port of call after changing owner. In that case, the first port of call can keep the number and use it to register a new vessel.

**Table 2.7.:** List of ports of call or registration and the letter codes assigned to the Belgian Scheldt ports and coastal ports

Sea ports	Scheldt ports
B: Blankenberge	A: Antwerpen
DP: De Panne	BDR: Berendrecht
H: Heist	BOU: Boekhoute
N: Nieuwpoort	D: Doel
O: Oostende	K: Kieldrecht
OO: Oostduinkerke	L: Lillo
Z: Zeebrugge	M: Mariekerke
	R: Rupelmonde
	ZV: Zandvliet

Over time ships were converted to or equipped with more efficient technology: sailing ships were replaced by steamers and later the entire fleet was gradually motorized. Data on characteristics of individual fishing vessels, boats and ships were collected from official sources and inventoried (section 2.3.6). After digitization and quality control, the data were standardized and integrated in a database on the 'Belgian fishing fleet'. Based on (a combination of) attributes of a given 'casco' (i.e. the floating hull of a ship as the structure is taken to the water without propulsion or rigging) the lifetime of a ship was derived from this database and reconstructed. This reconstruction allows documenting the changes that a vessel has undergone e.g. in its name and immatriculation number but also in type of drive gear and even in the ships' owner. The resulting database counts 50 columns by 28,370 rows (10MB).

Data and time-series on fleet and fishing effort were reconstructed by vessel class, by type of fisheries, by fishing area and fishing rectangle. Historical time-series on fishing effort have not been reconstructed previously for the Belgian sea fisheries.

Data on total fishing effort of the Belgian sea fisheries fleet were obtained from the 'statistical tables V and VI' in the 'Landbouwstatistieken' (Agriculture statistics) from 1944 onwards. For specific research purposes, data on fishing effort for particular fisheries or vessel classes were collected. The resulting time-series and analysis on fleet dynamics are discussed in detail in chapter 5. A detailed analysis on the role of the Belgian fishing fleet fishing for Downs herring during the Second World War is available in Chapter 7, and on the Iceland otter trawlers fishing for gadoid, in Chapter 8.

### Fishing gear

In Belgium the transition from sail to motor engines was near to completion by 1929 and after WWII the commercial fleet consisted mainly of motor engine-powered vessels. The last steamer disappeared in 1964 (Lescrauwaet et al. 2012, Chapter 5). As was the case for the steamers, the motor engine-powered vessels used the otter trawl to catch fish. Before 1950, the otter trawl was the main fishing gear, together with drift nets (for pelagic fisheries). After 1960, the otter trawl was mainly used for roundfish (e.g. whiting and cod) fisheries and for shrimp (*Crangon crangon*). The pelagic trawl for herring and sprat was used from 1950 onwards and remained important until 1965 in terms of effort (SD) and landings (Gilis 1962). After 1960, the (re)introduction of the beam trawl (*boomkorvisserij*) – the most efficient gear for catching targeted flatfish – and the subsequent technological improvements to increase catch efficiency of the beam trawl required an increasing average engine power (Polet et al. 1998). The installment of the beam trawl was subsidized by the Belgian government and supported by royal decree 1/03/1958 (Lescrauwaet et al. 2012). In 1985 otter trawling targeting herring and sprat, shrimp, and other species represented respectively 1%, 11% and 21% of effort in SD while beam trawl targeting sole and plaice represented 62%. The remaining 5% effort was realized by twin trawling (*'spanvisserij'*) for cod. With the increasing cost of diesel, recent interest has been given to the otter trawl (10% of SD) compared to the shrimp beam trawl (14% of SD) the flatfish beam trawl (68% of SD) and passive gear (1% of SD) in 2010. Passive forms of fishing that recently (re)gained importance are angling (handlines) for cod and sea bass, trammel- and gillnetting.

### 2.5.3 BIOLOGICAL DATA AND STOCK MANAGEMENT

Due to the scarcity and the fragmentary and anecdotic nature of the historic sources related to species biology, it was not possible to integrate the data from these sources. Whereas the data on sea fisheries (landings, spatial dynamics, fleet dynamics) were systematically collected and described, the historical data and information on biology and stock assessments were collected in view of the scope of the specific research questions. These sources are identified and described in the different subchapters of chapter 6 (Impact by sea fisheries).

However, the literature sources were documented and described in IMIS, and in a next step screened for the purposes of biological databases (biogeographical databases e.g. OBIS, taxonomic databases e.g. ERMS and WoRMS, ...).

## 2.6 CONCLUSIONS

The present chapter reports on the process of inventory, data capture, data integration and quality control of historical sea fisheries data for Belgium. It gives an overview of the process, the methodologies applied and the metadata required for correct interpretation of the data integration. The results can be summarized in three main areas:

### 2.6.1 DIGITIZED INVENTORY (IMIS) AND ANNOTATED BIBLIOGRAPHY

The results of literature screening and inventory are available from the bibliography. All data and literature (context) sources were digitized, linked to context ('Historical Fisheries Data - *HiFiData*') and are now available in the public domain. They can be queried (by author, by keyword(s), by year of publication, other) through the modular *Integrated Marine Information System IMIS* managed by Flanders Marine Institute VLIZ.

## 2.6.2 INTEGRATED DATABASE

Datasets from single paper sources (different Tables from single annual reports) were digitized (to spreadsheet formats), standardized, quality controlled and integrated into one 'HiFiDatabase'. This database was stored according to professional data management standards and is available for further research purposes. The efforts of data mining have yielded a significant increase in readily available and high resolution data (by species, by fishing area, per annum). In practical terms this means that a continuous time-series is available in digital format since the first year of detailed and systematic reporting (1929) until 1999 (and can be extended up to current year). It improves the availability of digital information with approximately 60 years (from 1989 back to 1929) and the availability of data (previously available on paper and/or not in the public domain) with approximately 40 years. The data represent approximately 800,000 rows ( 96MB of file sizes). To our knowledge, and as far as the screening of literature, sources and archives have indicated, the present data rescue and integration of historical fisheries data is the first attempt in Belgium to collect, archive and integrate the available historical sea fisheries statistics and make these time-series publicly available. To our knowledge, it is also the first time that a country digitized to such a complete extent its historical fisheries data.

## 2.6.3 ACCESSIBLE RESULTS IN AN APPROPRIATE FORMAT FOR POLICY LEVEL, SCIENCE AND THE INTERESTED PUBLIC

Data were summarized in factsheets, timelines, articles for the general public, and web applications. A list of these products is available in the appendices. They contribute to awareness raising about the historical importance of fisheries, the dynamic features of the fleet, fishing areas and target species, the historical potential of sea fisheries as providers of proteins from wild fish stocks, and demonstration of the concept of 'shifting baselines'.

The data rescue process and metadata (standards, methods) are described in an on-line 'Users Guide'. The following products of the HiFiData are now available on-line or in preparation:

- Website:
  - a. Key message on the absolute and relative importance of a given species in Belgian sea fisheries (Dutch and English)
  - b. Links to further relevant sources for taxonomy and ecology of the species in a wider thematic and geographical context
  - c. Graphs: a total of 500 graphs were produced on a fixed number of parameters (landings, values, average price, in Belgian and foreign ports, by fishing area of origin, by port of landing)
  - d. Maps: reconstruction of the historical fishing areas based on available source in literature
  - e. Users guides: with detailed description of the standardization of the spatial data (published in Dutch and English) and the overall process of data integration
- Informative sheets: digitally published information sheets on Belgian sea fisheries. Contain key information on landings and value of landings by species in Belgian and foreign ports, by port of landing or by fishing area (available on-line in Dutch and English, work in progress)
- Context: IMIS collection of literature related to historical data on Belgian sea fisheries (most sources in Dutch)

The HiFiDatabase and the approach and methodology can serve as a blueprint for similar initiatives in other countries or regions. In the UK, a similar initiative is conducted through the '100 Years of Change project' which collated and digitized fish and fisheries data, collected over the past 100 years by DEFRA, CEFAS, and predecessors. DEFRA commercial fisheries 'Statistical Charts' (1913–1981) provide spatially detailed (by statistical rectangle) data on catches, effort, and CPUE by fish species and fishing fleet. The commercial data are used to examine changes in distribution of commercially important fish populations throughout the 20th and early 21st Centuries, in relation to climate change and fishing pressure (Engelhard 2005, Engelhard 2008). In both projects (UK and Belgium) a broad approach was taken, incorporating information from different fields of work (legislation, social, cultural, economic, ecological). Exchange of data, information and experiences should be of great benefit to both projects.

Finally, the data collection and integration disclosed data on the early 20<sup>th</sup> century that can be further used for basic research on fisheries and historical ecology of the (southern) North Sea. As an example, time-series were constructed from the data found in older sources for the period 1836-1907 (De Zuttere 1909, Cloquet 1842) for herring and salted cod. The original sources for these older data were identified and the data quality controlled. Although these datasets can not be fully integrated with the HiFiDatabase, they provide good insights into the importance of fisheries in the 19<sup>th</sup> century since associated data on the extent of the fleet is available for that period.

#### **2.6.4 POTENTIALITIES AND LIMITATIONS OF THE HiFiDATABASE**

There is an increasing demand for a historical baseline of marine ecosystems, in particular fish stocks, to evaluate them and set goals for sustainable management (Pinnegar and Engelhard 2008). However this requires a historical perspective, at least before the onset of industrial or large-scale intensive fishing practices, and estimations of historical biomass and fishing mortality to set baselines and evaluating the state of the marine ecosystems (Rijnsdorp et al. 1996, Cardinale et al. 2009a and 2009b, Roberts 2007, Pauly 1995). Historical time-series are scarce and available time-series typically date from after the start of intensive exploitation. Hence the baselines for rebuilding depleted fish stocks typically refer to strongly exploited situations (Pitcher 2001).

In the absence of catch statistics, data on landings have been used in a number of applications and models as a proxy for fishing mortality (Zeller and Pauly 2007, Eero et al. 2008, Walker and Heessen 1996, Daan et al. 1994). Landing statistics can serve as the basis for the estimation of total catch by involving diversity of sources and data (surveys, oral history and interviews, historical population data, consumption data etc.) and for further analysis related to the setting of historical baselines. Of particular interest are the datasets in which landings are reported in conjunction with fishing effort for particular segments of the fleet (by vessel type or engine power), fisheries type, and/or high temporal (by month) and spatial resolution (by fishing rectangle). In this sense, the HiFiDatabase offers an interesting basis for further research and analysis.

However, some limitations apply to the HiFidatabase, a number of which have been described above:

- Unlike with current landings, it is not possible to validate taxonomic identity of the landed species reported in earlier years. This is a limiting factor for interpretation and taxonomic validation of reported species that may not be straightforward to determine in the field (e.g. rays).
- It is not known what proportion of the catch was actually landed in the 4 ports that are included in historical landing statistics and if actually/what proportion was landed informally in other sites along the coast.

- No data were found on landings in foreign ports before 1950, in spite of the thorough screening of potential sources. Therefore, the data before 1950 may give an incomplete picture, although the landings from 1950 onwards did not indicate the existence of large amounts of landings in foreign ports.
- In some years and some sources, landings were rounded to '000kg.
- Except for the landings that were reported by statistical rectangle, the larger spatial units of reporting - although more detailed than the Fishstat data - remain quite coarse
- Uncertainty remains concerning the discrepancy between HiFiData and Fishstat<sup>2</sup> which could not be fully explained by converting to fresh weight equivalents.

## 2.7 NEXT STEPS

To achieve the present historical reconstruction and data integration, a thorough search and literature study was conducted in archives and physical collections. Though not all-encompassing, this exhaustive search disclosed data that was previously not known or accessible to the public domain. The current effort of data rescue and data integration will include these sources and be complemented with the following next steps:

- Conduct a detailed trend analysis of the HiFiData, by type of fisheries (métier) species and by fishing area of origin.
- Collect data and information that allow for a calculation of indices of catch per unit of effort (CPUE) or landings per unit of effort/power (LPUE/LPUP) and trends herein over time
- Collect evidence and indications that allow for an estimation of Illegal, Unreported and Unregulated catch (IUU) in Belgian sea fisheries, to complement the current landing statistics
- Explore the relevance of collected data, in combination with other time-series, for further use in policy making, i.a.:
  - for the description of historical baselines for the Belgian part of the North Sea and the wider North Sea area;
  - for inferences related to trophic level of sea fisheries, and the concept of fishing down the food web (Pauly et al. 1998).
- Explore with neighbouring countries (The Netherlands, UK, France), the feasibility of reconstructing historical sea fisheries by spatially defined area, in particular for the reconstruction of reported and unreported removals (which include discards) in the Belgian coastal waters (spatial unit which is not reported in the ICES database).

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<sup>2</sup> After the date of publication of the current Chapter, an update of the Fishstat database was released (2012). For Belgium, among others, French-language footnotes to the original data tables and other information was included. The discrepancies between HiFiDatabase and the updated Fishstat were checked (2013) and now found to be smaller.

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