
Long-term changes in the French fisheries for crustaceans in the Eastern English Channel: 1901 to 2020

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Abstract :

Small-scale crustacean fisheries in the English Channel have existed for centuries but have never been formally assessed; hence, concerns about their ecological and socio-economic sustainability could be raised. This study explores trends in this fishery's landings from 1901 to 2021, based on historical and recent landings data in two of the main administrative fishing divisions of the area, Cherbourg and Boulogne-sur-Mer quarters. Crustacean fisheries were reported for both divisions from the beginning to the end of the time period considered, demonstrating that a dedicated crustacean fishery existed in the area since at least the 20th century. The species composition of the crustacean's catch (e.g., edible crab, *Cancer pagurus* Linnaeus, 1758; European lobster, *Homarus gammarus* (Linnaeus, 1758); European spider crab, *Maja brachydactyla* Balss, 1922) was almost impossible to track before the 2000s. Important fluctuations were observed in catch volume reports along time that might be related to two phenomena: technological advances that would have improved the fishery performances and the decline of some previously targeted species that might have led to a transfer in fishing effort.

Résumé

En Manche Est les pêcheries artisanales de crustacés existent depuis plusieurs siècles et n'ont jamais été évaluées de manière formelles ; cependant leur durabilité socio-économique comme écologique n'est pas évidente. Cette étude explore les tendances en débarquements de cette pêcherie de 1901 à 2021 sur la base de données historiques et des données de débarquements récents pour deux des principales divisions administratives concernées par cette pêcherie, les quartiers de Cherbourg et de Boulogne-sur-Mer. Ces deux divisions apparaissent comme pratiquant la pêche aux crustacés depuis le début de la période considérée, mettant en évidence l'existence d'une pêcherie dédiée aux crustacés dans cette zone depuis au moins le 20ème siècle. La composition spécifique des captures (e.g., tourteau, *Cancer pagurus* Linnaeus, 1758 ; homard européen, *Homarus gammarus* (Linnaeus, 1758) ; araignée de mer européenne, *Maja brachydactyla* Balss, 1922) est presque impossible à retracer avant le début des années 2000. Des variations importantes ont été observé en termes de volumes des captures reportés au cours du temps, cela peut potentiellement être lié à deux phénomènes : des avancés technologiques

importantes qui auraient permis d'améliorer les performance de la pêche et un déclin en disponibilité de certaines espèces précédemment visées par des pêcheries locales qui auraient pu amener à des transfert d'efforts de pêche.

Keywords : Crustaceans, historical catches, small scale fishery, species composition

1. Introduction

Worldwide, the proportion of fish stocks that have been overexploited is consistent (Ye et al., 2013, Memarzadeh et al., 2019, Pauly, 2008), despite recent improvements in stock status (Froese et al., 2018, Hilborn et al., 2021). There is a growing need for sustainable fish stock management (Hilborn et al., 2020). Small scale and artisanal fisheries are central in this situation, as they provide food and employment for an important proportion of the population (Kolding et al., 2014).

The Food and Agriculture Organisation defines artisanal and small scale fisheries as “[...] fisheries involving fishing households (as opposed to commercial companies), using relatively small amount of capital and energy, relatively small fishing vessels (if any), making short fishing trips, close to shore, mainly for local consumption” (Garcia, 2009). Crustacean fishery in the English Channel involves daily trips that occurred close to the shore and concerns boats of an average length of 9 metres with one to three fishermen (SIH, 2022a, SIH, 2022b). Therefore, these fisheries match small scale and artisanal fisheries characteristics and concerns could be raised about their ecological and socio-economic sustainability.

Furthermore, pressures on marine ecosystem lower trophic levels have been increasing during recent decades (Pauly & Palomares, 2005). The decline of important finfish stocks, such as the sole (*Solea solea*) in the English Channel (ICES, 2017), resulted in shifts of fisheries to lower trophic levels (Molfese et al., 2014). Shellfish, including molluscs and crustaceans are particularly concerned by these shifts (Hodgdon et al., 2022). Moreover, stocks of these species are usually hard to assess (Punt et al., 2013, Smith & Addison 2003). There are almost no surveys dedicated to them or adapted to their ecological specificities. Crustaceans, in particular, are particularly hard to age; stock assessment models are usually not designed to match trap and pot fisheries characteristics (Hodgdon et al., 2022, Punt et al., 2013).

In the Eastern English Channel fisheries have taken place for centuries (Barrett, 2019). In 1760 de la Roche already reported the existence in France of dedicated fisheries for crustaceans in the Channel in the 18th century. Crustaceans might even have been exploited for a longer time period going back to

thousand years, since they are directly available from the coast based on beach fishing (Dupont & Gruet, 2022). Exploitation of shellfish over such a long time period is likely to have impacted the resource, with implications for the ecological status of these species at the beginning of the 21st century.

Despite the long history of fishing exploitation in European waters and its impact on the resource, little attention has been dedicated to rebuilding fish stocks past dynamics at regional and species or genus level (Novaglio et al., 2020). Several scientists have highlighted the ‘shifting baselines’ paradigm in resource ecological state perceptions (Guénette & Gascuel, 2012, Pinnegar & Engelhard, 2008, Pauly, 1995). This paradigm was defined by Pinnegar and Engelhard (2008) as the fact “ [...] that each generation of marine scientist tends to accept as a baseline the stock-size and species composition that occurred at the beginning of their career, and uses this to evaluate subsequent changes, often assuming that inadequate data exist for earlier periods”. Knowledge on the past state of the resource is of major importance in the use of stock assessment models and the definition of management measures (Engelhard et al., 2016).

To answer the increase in solicitations for management measures, stock assessment that relies on less information have been developed. Most of these Data Limited Stock (DLS) assessments require informative priors on the state of the resource at the beginning of the time period that data covered (Bouch et al., 2021, Wiedenmann et al., 2019). In the Eastern English Channel both the United Kingdom and France are fishing trap three crustacean species (edible crab, *Cancer pagurus*, European lobster, *Homarus gammarus* and European spider crab, *Maja brachydactyla*) (Gray, 1995, SIH 2022a, SIH 2022b). In France this trap fishery involves more than 200 vessels in different regions (SIH 2022c). The two main landing ports are Cherbourg in Normandy and Boulogne-sur-Mer in the Hauts de France (SIH 2022a, SIH 2022b). These two ports have had variable temporal fishing dynamics; in recent years this fishery has been considered decreasing in Normandy while increasing in the Hauts de France (SIH 2022a, SIH 2022b, SIH 2018a, SIH 2018b). No information was currently available on those regional past dynamics. In France, historical data going back to the 19th century are available but have had not been digitised until recently (Amelot, 2022). Since 2000 the SIH (‘Système d’Information Halieutique’) of IFREMER (Institut Français pour la Recherche et l’Exploitation de la Mer) reference all french catches.

This paper's objective was to analyse those historical data to get a better understanding of the fishery dynamic over the past century through (1) the analysis of the long-term changes in landing volumes; and (2) the analysis of the catch species composition variations over time.

2. Material and Methods

This study is based on historical landings data obtained from the French National Fishery Statistic (FNFS) reports as well as on recent landings data obtained from the SIH of IFREMER. Historical landings covered the period from 1901 to 1979, while the recent data covered the period from 2000 to 2021. In 1979, computers were introduced for the reporting of FNFS; as a result the format drastically changed, making it impossible to obtain port specific reports for those fisheries for a period until the 2000, when the current SIH system was introduced. Consequently, a gap of 20 years in data availability exists between those two periods.

2.1. Historical period (1901-1979)

Data from the FNFS reports (1901 to 1979) about crustaceans were digitised, all documentation about this database is available on Seanoe (Amelot, 2022). The database included information on crustacean landings on the Eastern English Channel French coast. Those information were reported at the best species and spatial definition.

The analysis has been conducted at the French administrative "quartier" level. The "quartier" denomination referred to fishing vessel administrative division affiliations. Since this study focused only on Boulogne-sur-Mer and Cherbourg quartiers, all other quartiers from the Eastern English Channel French coast have been grouped under the "Others" designation. Ports designed under this denomination were specified in the database and did not belong to Boulogne-sur-Mer or Cherbourg's quartiers. From 1913 to 1958 FNFS landings have been reported grouped for some ports of this coast.

During this time period ports that were not considered relevant enough to be specified were grouped under the name “Other ports” at the region level, and all landings from those ports were reported together. In the following analysis these ports were reported under the denomination “NAs” and could belong, or not, to Boulogne-sur-Mer or Cherbourg’s quartiers.

Species reports were not consistent during the whole time period covered by the FNFS historical data. As specified in Amelot (2022), three identification levels were defined. Hereafter, landings’ species compositions have been calculated at the third, and most precise, species identification level. At this identification level four categories did exist: ‘Crabs and spider crabs’ (including all crabs as Brown or Edible crab *Cancer pagurus* and European spider crab *Maja brachydactyla*), ‘Lobsters’ (*Homarus gammarus*), ‘Other crustaceans’ (all other crustaceans apart from nephrops, shrimps and spiny lobster), and ‘Unidentified crustaceans’ (crustaceans that were not reported at this identification level and mixed two or more categories from the previous groups).

Species composition was estimated as the species mean yearly proportion by decade.

2.2. Contemporary period(2000-2020)

Nominal catches were extracted from the French SACROIS (Ifremer SIH) database. For each species, total catches from France were extracted. Then, to match the previous historical data, only catches data reported in Boulogne-sur-Mer (BL) and Cherbourg (CH) quartiers were selected.

Catches were corrected for two types of potential errors: (1) catch unit mistakes, (2) misreporting. To correct catches unit mistakes (1), catches per vessel were compared to the median catch for the same vessel, if the catches were more than five times the median a correction factor was used (Table 1).

The misreporting (2) was corrected by removing all vessels which reported high volume catches (lobster catch > 300 kg, edible crab catch > 4000 kg, Spider-crab catch > 2000 kg) with non adapted gears (pelagic gears) or only for a year.

All analyses were conducted with the 4.2.2 version of the R software (R Core Team, 2022).

3. Results

3.1. Landing volumes

From 1901 to 1924, crustaceans landings from the Eastern Channel by the French fishery varied slightly and stayed low, with a total mean value of 308 tonnes (52-833) with only three years with values above 500 tonnes (1913,1914 and 1924), 110 tonnes (31-299) for Cherbourg and 20 tonnes (<1-65) for Boulogne-sur-Mer. From 1912 to 1924 an important amount of landings (57%) were not reported at the quartier levels. It could have led to the underestimation of both Cherbourg and Boulogne-sur-Mer 's landings. From 1924 to 1938 the quantities of landings reported for all ports jumped from a mean value of 308 to 981 tonnes, it increased from a mean value of 110 to 165 tonnes for Cherbourg, with a particular increase after 1930. During the same period Boulogne-sur-Mer landings stayed stable. After World War Two, Cherbourg landings stabilised around 137 tonnes until the 1960s, while Boulogne-sur-Mer landings were not reported anymore with a mean value of only 1 tonne. Furthermore, during this period the amount of landings that were not reported at the quartier level reached important volumes with at the highest 83 % of the landings not affiliated to any quartier. High landings were reported in 1960 (726 tonnes), 1961 (1033 tonnes) and 1962 (1217 tonnes) for Cherbourg. Finally, the landings increased progressively, from 126 to 1196 tonnes, between 1963 and 1979 for Cherbourg. A similar increase, from 10 to 96 tonnes, started later for Boulogne-sur-Mer, from 1970 to 1979 (Figure 1). During this latest period all catches were reported at the quartier level.

3.2. Species composition

The species identification report was more variable than the spatial distribution. The proportion of lobsters in catches appeared to decrease along the time period considered, from 18% in the 1920s to 4%

in the 1970s. Crabs and spider crabs comprised the majority of the landings as long as they were reported: 70%, from 1960 to 1969 and 95% from 1970 to 1979 (Figure 2).

From 2000 to 2020 catches increased from 65 tonnes in 2000 to 449 tonnes in 2021 for Boulogne-sur-Mer and increased from 490 tonnes to 1295 tonnes for Cherbourg (Figure 3). The species composition varied mainly from 2014 to 2021 with an increase in spider crab catch proportions 51% to 62% and a decrease in edible crab catch proportions, 41% to 25% (Figure 4).

4. Discussion

Crustacean fisheries were reported for both Boulogne sur Mer and Cherbourg's quartiers from the beginning to the end of the time period considered, apart from a data gap between 1979 and 1999. It demonstrated that a dedicated crustacean fishery existed in the Eastern English Channel in France since at least the 20th century. With values at the end of the seventies that were comparable to those observed in 2020.

4.1. Landing volumes

Important fluctuations were observed both in Cherbourg and Boulogne-sur-Mer. Those changes in landing volumes can be associated with two main phenomena. First, the technological advances that would have improved the fishery CPUE and consequently increased the catch without important changes in fishing efforts (Jones, 2016). Secondly at the end of the timeseries, the decline of some previously targeted species, especially the flatfishes as sole (e.g. 'fishing down marine food web'), that might have led to a report in fishing effort (Pauly & Palomares, 2005).

The first major changes in the 1960s for Cherbourg's fishery could be linked with the modernisation of fisheries through motorisation and positioning system progress (Rieucou, 1989). Those changes occurred progressively from the end of World War Two to the 1970s, leading first to the modernisation of offshore fisheries, then coastal fisheries (Rieucou 1989, Le Floch'h & Wilson, 2017). The increase in the 1970s for Cherbourg and Boulogne-sur-Mer might have been caused by subsequent progress in

trap design and materials with the use of plastic-based traps (Le Floch'h & Wilson, 2017, Banks et al., 2001). These technical changes would have improved the CPUE (Catch Per Unit of Effort) as well as the ability of fishermen to target specific species, without increasing their fishing effort (Stephenson et al., 2018, Kirkley et al., 2004, Eigaard, 2009).

Secondly, variations in crustaceans catches could also result from an increase in fishing effort. During the recent period (2000-2021) substantial decreases in other targeted stocks such as rays (Rajidae) in Cherbourg's quartier (Leblanc et al., 2014) and sole (*Solea solea*) in Boulogne-sur-Mer's quartier (ICES 2019a) led to switches in target species (Molfese et al., 2014). Furthermore, rays and soles are managed at the European level and have dedicated quotas. The existence of more restrictive management measures could have also motivated the switch from European-managed species to more locally managed species such as crustaceans (Lloret et al., 2018).

4.2. Species composition

While the catch amount from the historical database (1901-1979) seems consistent with the recent period (2000-2021) data, the species composition is almost impossible to track before this period. During this recent period the edible crab proportion in the catch decreased while the spider crab proportion increased, the lobster proportion stayed stable. Since the total catch increased during the same period it either be caused by an increase in spider crab catches and lobster, without any edible crab catch decrease.

Two other factors could have led to these changes in species proportions. First a change in demand, due to variation of social preference or species specific economic values (Olsen et al., 2008, Feelings et al., 2012). Secondly, a change in species specific biomass could have caused this shift. The pressure exerted on edible crab stock by English catches in the same area between 2005 and 2018 was between 75 and 150 tonnes (ICES, 2019b). Important decreases in edible crab abundances have been reported since the 2000s in other regions of the English Channel (ICES, 2019b). During the same period edible crab represented around 400 tonnes of landings by year for England

This study evidenced the existence of a dedicated crustacean fishery that might have impacted mainly edible crab stocks long before the 2000's. Furthermore, it demonstrated that historical data, while needed to be used carefully (Rosenberg et al., 2005, Coulter et al., 2020) still are coherent with current data at least for some metrics, here landing quantities. The information that could be inferred from those data such as previous fishing mortality or relative initial status are of major interest for fishery management and more specifically stock assessment (McClenachan et al., 2012).

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Author statement

Morgane Amelot: Conceptualization (equal); formal analysis (equal); writing – original draft (equal); writing – review and editing (equal). Ivan Schlaich: Conceptualization (equal); funding acquisition (equal); supervision (equal); writing– review and editing (equal). Eric Foucher: Conceptualization (equal); funding acquisition (equal); supervision (equal); writing – review and editing (equal).

Data availability statement

The data that support the findings of this study are derived from the following resources available in the public domain (Amelot, 2022).

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Tables and Figures

Table 1 Correction factor applied to the catch by fishing event according to the median of the catch from the same vessel.

Median different (factor)	>500	500<= & >50	<=50 & > 5
Applied correction factor	1000	100	10

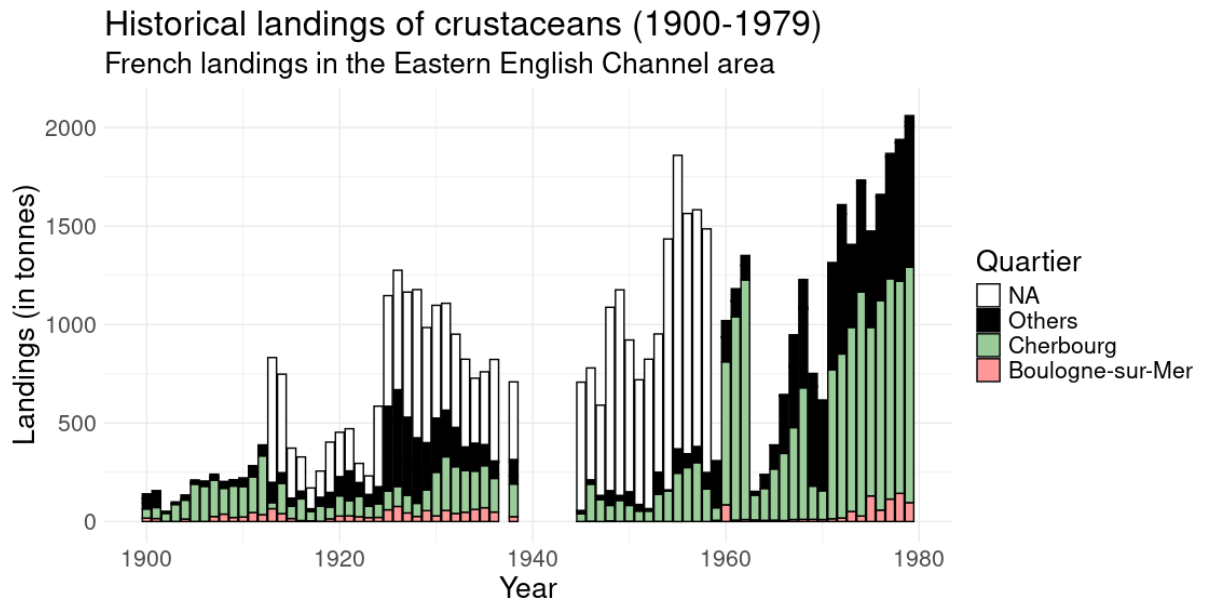


Figure 1 French historical landings (in tonnes) of crustaceans by year and quartier from 1900 to 1980 in the Eastern English Channel.

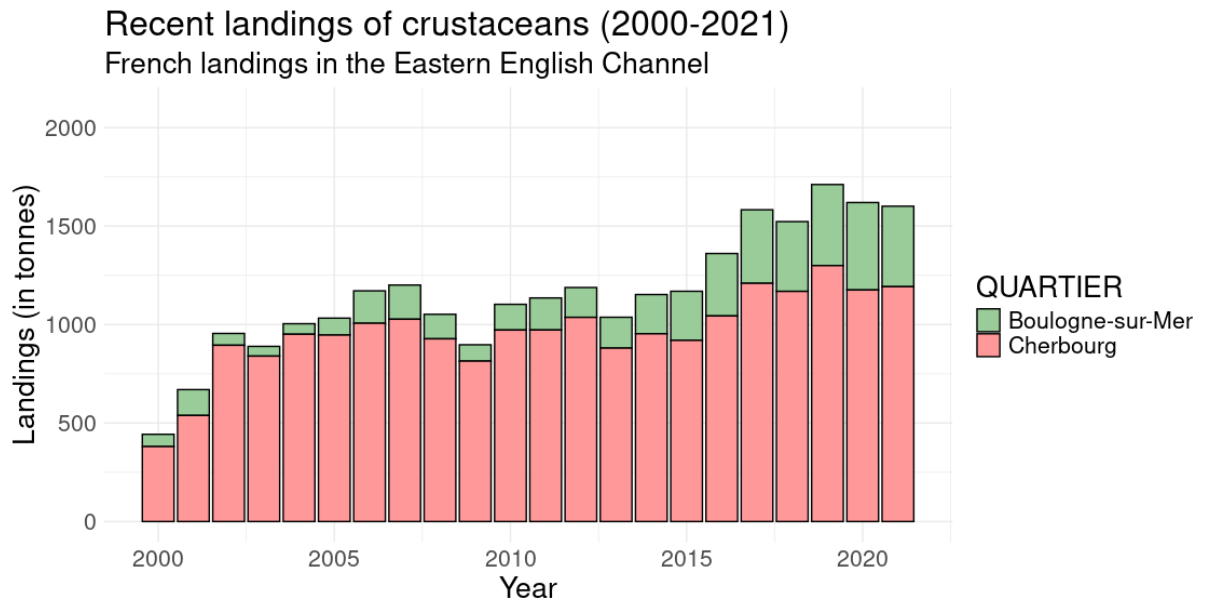


Figure 3 French historical landings (in tonnes) by year of crustaceans by Quartier from 2000 to 2020 in Boulogne-sur-Mer (BL) and Cherbourg (CH)

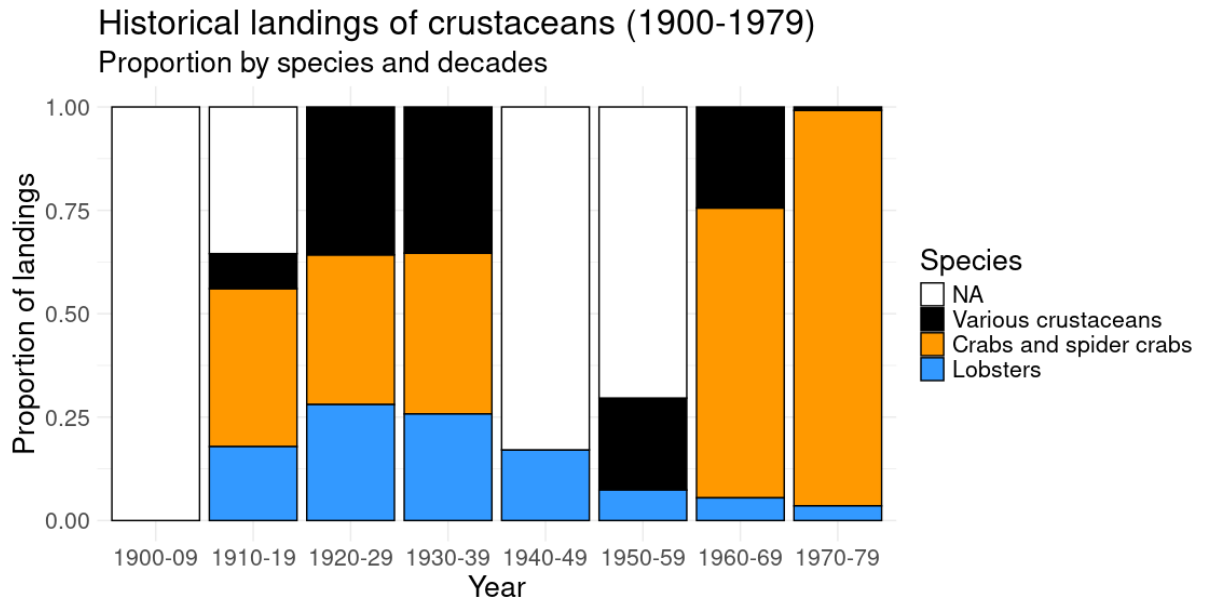


Figure 2 French historical landings proportion by decade from the 1900s to the 1970s by taxonomic group

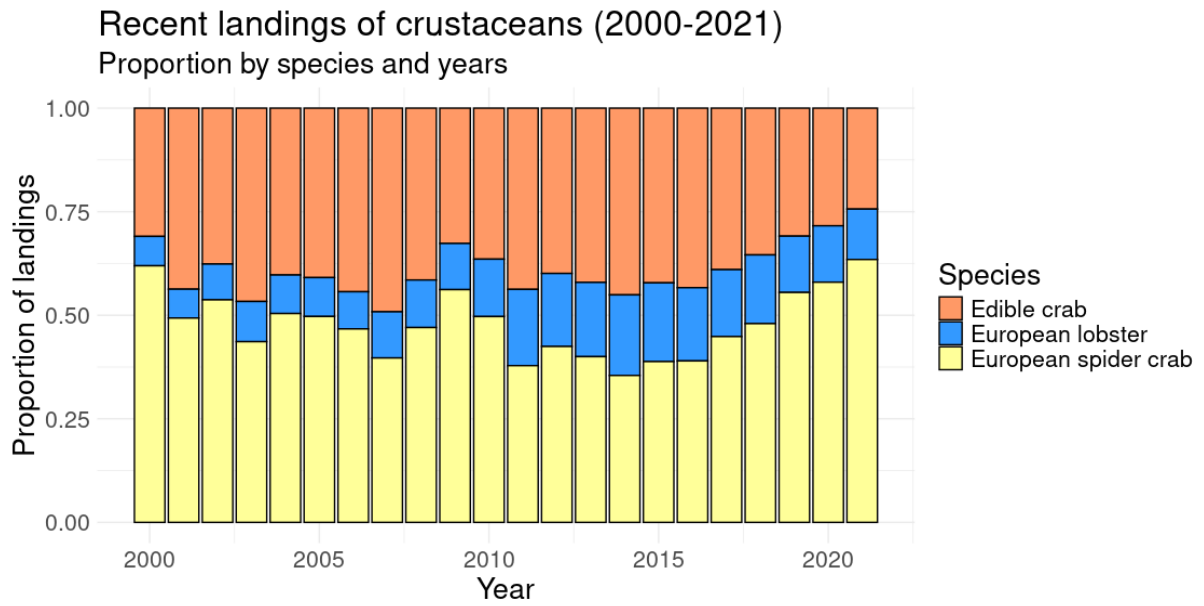


Figure 4 French historical landings proportion by year from 2000 to 2020 by FAO taxonomic group (CRE: edible crab, *Cancer pagurus*; LBE: European lobster, *Homarus gammarus*; SCR: European spider crab, *Maja brachydactyla*)