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Value and Volatility of Squid as a Fisheries Resource in the North Sea and Adjacent Waters—Starting Point for a Sustainable Management

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In the Greater North Sea, climate change has led to the redistribution of commercially important fish species (Perry et al. 2005; Engelhard et al. 2014; Gordó-Vilaseca et al. 2024) and management decisions, like the ban of pulse trawls by the EU parliament, or the reduction in quota due to Brexit, left many demersal fisheries searching for alternatives. Fishers had to switch back to heavy beam trawls to catch flatfish species, and increasing fuel costs are making that fishery more and more unviable (Kraan et al. 2020). The quota cuts from Brexit and less favourable conditions for quota exchange (Letschert et al. 2021; Döring 2023) intensified the economic hardship and were a further incentive to tap into alternative resources (Döring et al. 2017).

Species that benefit locally from climate change or have newly entered accessible fishing grounds present such an alternative fishing resource, given that they are marketable. They are often not subject to quota management, and only basic fishing restrictions exist; thus, they can be utilised with very few limitations. In the North Sea, squid is increasingly targeted by demersal fisheries. Within the last decades, new stocks have established themselves (Oesterwind et al. 2020), and landings increased substantially (ICES 2024). Among the 24 described cephalopod species in the North Sea (Oesterwind et al. 2022), 5 squid species are of particular interest for fisheries. These include three loliginids: *Loligo forbesii*, *Loligo vulgaris* and *Alloteuthis media* (formerly classified *as Alloteuthis subulata*) (Sheerin et al. 2022); and two ommastrephids: *Illex coindetii*, *Todaropsis eblanae*. Considerable knowledge on the biology, life cycle and fisheries impacts of these North Sea squids was gathered in numerous research projects, and several studies have been published within the last years (e.g., Boyle and Pierce 1994; de Heij and Baayen 1999; Boyle et al. 2002; Pierce and Boyle 2003; de Heij and Baayen 2005; Oesterwind et al. 2010; Oesterwind et al. 2015; Barrett et al. 2021; Laptikhovsky et al. 2022). However, there is no fishing regulation for cephalopods under the Common Fisheries Policy in EU waters, and in practice, squid fishing is only regulated via technical measures, e.g., with minimum mesh sizes, and the bycatch regulations of TAC-regulated species, such as *Merlangius merlangus*. Therefore, further increases in fishing effort due to the economic attractiveness of squid fishing hold the risk of overexploitation.

In the past decade, squid have passed cuttlefish and bobtail squids in terms of landing revenues in the North Sea (STECF 2024). A detailed spatial disaggregation of these squid catches reveals the volatility of these fisheries (Figure 1). In the northern North Sea, yields from the targeted spawning ground fishery on *Loligo forbesii* in the Moray Firth have declined since 2019, while landings from the southern North Sea squid and the eastern English Channel (most likely *Loligo vulgaris*, Sulanke, personal observation and communication) have been constantly increasing. 2020 and 2021 present a remarkable exception, attributable to the COVID-related closure of gastronomy in southern Europe, a major sales channel of cephalopods in Europe (Visserijnieuws 2025). After the reopening of restaurants and markets, the fishery has resumed, and especially in the Southern North Sea, the surge of landings from 470 t in 2022 to 2260 t in 2023 is striking.

In light of these developments, we aim to stimulate the discussion about sustainable squid fisheries in Europe and suitable management plans, which are still treated as a 'Cinderella subject'. The rapid increase in the economic value of squid fisheries in the North Sea and the English Channel underpins the need

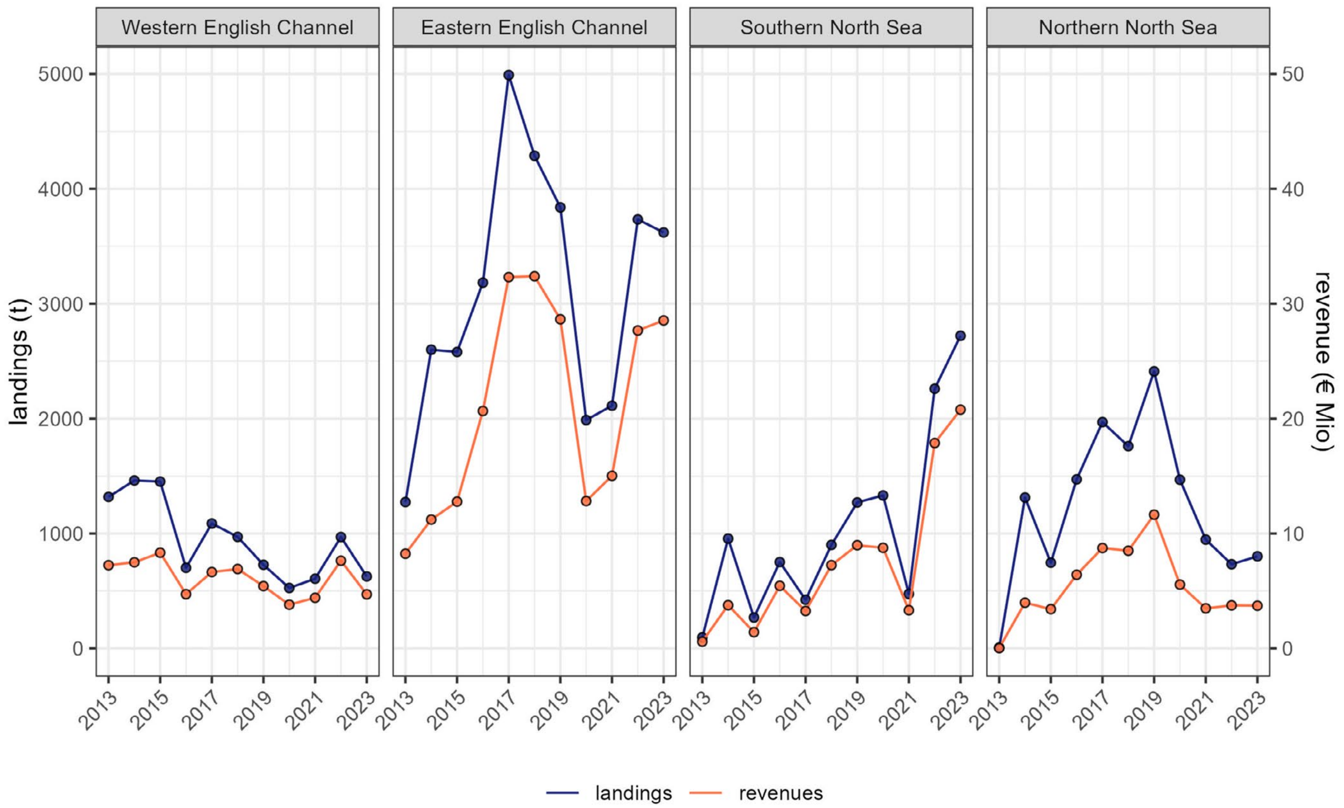

FIGURE 1 | Summarised squid landings in the Greater North Sea area from 2013 to 2023. The colours of lines and dots indicate the metric depicted (blue—landings in thousand tonnes; orange—revenues in million €). All landings' data were derived from the fisheries-dependent information (FDI) database of the European Union (STECF 2024). Landings were analysed for the following areas: 27.7e (Western English Channel); 27.7d (Eastern English Channel); 27.4.c (Southern North Sea); and 27.4.a (Northern North Sea).

for sustainable management. Besides the brief analysis shown, the latest news from the fishing sector hints at a steadily growing squid fishery in the southern North Sea, eyeing new record profits in the future (Visserijnieuws 2025). The combination of increasing fishing pressure and the short semelparous lifestyle of cephalopods, which means that they are fished before they spawn and thus before they reproduce, can lead to unforeseen collapses of stocks and very sudden onsets of overfishing (Rosenberg et al. 1990; Pierce et al. 2025). One of the world's major squid fisheries in the Falkland Islands area, providing more than half of the European demand, was closed entirely due to alarmingly low pre-season biomass levels (Science 2024). To prevent stock collapses of the European squid stocks, sustainable management needs to be implemented. Collapsing stocks will have major impacts not only on the fisheries relying on them but also on the environment, as cephalopods play an important role in marine food webs. They exert top-down pressure on lower trophic levels but also have a bottom-up function as major prey for various marine mammals and predatory fish species (Bello 1991; Clarke 1996; Caddy and Rodhouse 1998; Piatkowski et al. 2001; Oesterwind and Piatkowski 2023; Schäfer et al. 2024).

Although there are many approaches to assess squid "stocks", Caddy (1983) has already shown that many assessment methods are not applicable to cephalopods, as typical model assumptions do not reflect their ecology. More recent publications build on his findings and recommend real-time assessments and the use of depletion models (e.g., Arkhipkin et al. 2021; Roa-Ureta et al. 2021). In addition, the International Council for the Exploration of the Sea Working Group on cephalopod fisheries and life history (ICES WGCEPH) has applied several variants of production models with moderate success due to various reasons (ICES 2016, 2017, 2019, 2020). Furthermore, abundance indices (catch rates and monitoring data from standard research surveys) have been widely used in other areas (e.g., Hendrickson and Showell 2016) and, in some cases, recruitment indices are applied (Sobrino et al. 2020), but so far have never been implemented to inform managers for squid fisheries in Europe (see also Pierce et al. 2025).

In addition to the difficulties of squid population analyses stemming from their ecological traits, there are imprecise stock definitions that make it difficult to assess the stocks (ICES 2024; Bobowski et al. 2024). This is not only the case for the North Sea and European waters; thus, numerous examples of unregulated cephalopod fisheries also exist worldwide (Seto et al. 2023). However, there are few cephalopod fisheries in which assessments and sustainable management plans are implemented (Arkhipkin et al. 2021; Seto et al. 2023; Peng et al. 2024). A detailed overview of the challenges and needs for cephalopod management and the general status of squid fishing is given by Arkhipkin et al. (2015) and Pierce et al. (2025). Despite these challenges, even if they are already being tackled, such as the definition of European stocks (Göpel et al. 2022; Sheerin et al. 2022; Bobowski et al. 2023, 2024) and the development of assessment models in European waters (Keller et al. 2015; Alemany et al. 2017), sufficient data is already available to assess some cephalopod species like cuttlefish or squid and calculate simple biomass indices, illustrating biomass trends over time (Bobowski et al. 2023). First trend assessments were performed by the ICES WGCEPH. Annual updates of landing trends and biomass indices allow a relative trend-based indication of the stock status (e.g., ICES 2024), but are yet to be used as advisory tools. In addition, Bobowski et al. (2023) illustrate the possible evaluation of the cephalopod stock status in European waters within the European Marine Strategy Framework Directive based on the available public data. However, besides these efforts to evaluate the cephalopod stocks, it becomes clear that considerable data is missing, as, e.g., landing data is only available on higher taxonomic groups and not on the species level. There is no dedicated scientific monitoring for the species, no onboard observer programme for squid or other cephalopod fisheries, and current knowledge is based on non-dedicated surveys.

In addition to the technical implementation of management, there might also be a political problem, as a substantial amount of fishing activity of Dutch, German, French, British and Belgian vessels on squid takes place in the Eastern English Channel, where the EEZs of Belgium, the Netherlands, France and the UK are in proximity. So far, the same rules apply to all vessels, but this may not last, as the UK may alter its fishing policies further as it is no longer a part of the European Common Fisheries Policy (CFP). If governments decide to limit squid fisheries via fishing quotas, substantial time might be spent on negotiations of the quota distribution between the EU and the UK, and fishing pressure might push the stocks outside of safe biological limits in the meantime. In addition, there has been campaigning on banning fly shooting (or Scottish seining) (Fishing News 2023), which is mainly used to catch squid species, further complicating the playing field. Unified rules and coordinated management and enforcement would not only benefit the fisheries operating in the area, but they would also enable researchers to develop plans for sustainable harvesting strategies. Squid fishing in the North Sea is still a young and ever-changing business, yet it can serve as a trial case for the development of modern ecosystem-based fisheries management in the face of climate change.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are openly available in Data dissemination on EU Fisheries Dependent Information at https://stecf.ec.europa.eu/data-dissemination/fdi_en.

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