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**Common fisheries policy and bycatch:
European legislative context and strategies for the valorization of underutilized fish species**

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Abstract

Despite modern fishing being focused on a limited number of fish that are highly valuable on the market, other species, including those of limited commercial value and damaged or undersized specimens, are accidentally caught. These fish, generally identified as “unwanted catches”, have significant nutritional potential for human nutrition but are often discarded due to their limited commercial interest or used as category 3 by-products, as specified in Regulation (EC) No 1069/2009. The Common Fisheries Policy (CFP) promotes sustainable fishing and preservation of fish stocks; to this end, unwanted catches should be managed more efficiently. The objective of this review was to analyze the characteristics and critical elements of the European regulatory framework on fisheries, as well as the potential opportunities for valorizing neglected fish species. The main EU legislative reference is Regulation (EU) No 1380/2013, which focuses on the sustainability of fisheries and the prevention of overfishing in marine stocks. By imposing the obligation to land all fish caught, the regulation aims to eliminate discards and minimize unwanted catches. However, *de minimis* exemptions from the landing obligation for small pelagic and demersal fisheries in the Mediterranean Sea are established by Delegated Regulations (EU) 2023/2460 and 2023/2918. The EU legislative framework is supplemented by other related regulations, which mainly concern the management of discards, the sustainable exploitation of fisheries, the additional provisions on the landing obligation, and the establishment of a control system to ensure compliance with CFP rules. Review of current and historical legislation highlights a clear focus of legislators on the sustainability of fishing activities, but the existing rules need to be updated and clarified in certain parts. Available evidence indicates limitations in the reliability of discard data, and there is little evidence that the landing obligation has significantly reduced unwanted catches. Identifying new opportunities to valorize unwanted catches, as their transformation into ready-to-eat products, is crucial for reducing resource waste and ensuring compliance with the sustainability objectives of the CFP.

Introduction

Fish consumption and habits in the European population

Fishery products are among the most widely consumed food items worldwide. Over the decades, global fish production has steadily increased, rising from 19 million tons (live weight) in 1950 to over 185 million tons in 2022, with an average annual growth rate of 3.2% and a total first-sale value estimated at 452 billion dollars. Marine areas provided 115 million tons (62% of the total), with 69% coming from capture fisheries and 31% from aquaculture. Inland waters accounted for 70 million tons (38% of the total), with 84% coming from aquaculture and 16% from capture fisheries (FAO, 2024). The analysis of fisheries data highlights a clear trend towards increasing specialization in marine fishing in recent years, with a particular focus on the capture of a few fish species. Strong consumer demand for some types of fish, the yield and marketability of certain species, and advances in fishing techniques have undoubtedly contributed significantly to this growing trend in fisheries specialization. Consumer preferences are also highlighted by the 2024 EU Fish Market Report, that shows how per capita consumption among Europeans is largely concentrated on a few fish species. In particular, the most consumed are tuna (2.96 kg), salmon (2.51 kg), shrimp (1.68 kg), Alaska pollock (1.67 kg), and Nordic cod (1.63 kg) (European Commission, Directorate-General for Maritime Affairs and Fisheries, EUMOFA, 2024). The results of a survey conducted in 2024 showed that the most influential factor in European consumers' purchasing decisions was price, followed by appearance, origin, and ease of preparation. Furthermore, the survey revealed a clear preference among consumers for well-known species, such as cod and tuna (European Commission, 2024a). Moreover, some studies show that the ability of European citizens to recognize the appearance of fishery products is quite limited. In the study by Cusa *et al.* (2021), images of six commercially available fish species were presented to consumers of six European countries. Participants demonstrated a widespread lack of visual familiarity with fish, being able to correctly identify only about 30% of the species. The data and studies cited above demonstrate that European citizens are familiar with and consume only a few types of fish, while other lesser-known species are rarely

purchased. This limited variety of fish consumed may reduce awareness of marine biodiversity and the importance of consuming fishery products from sustainable sources. In line with market demands, fishing efforts are inevitably concentrated on a limited number of species. This can undoubtedly reduce unwanted catches, but it may also negatively impact the sustainability of fishing and the conservation of fish stocks. Fishing focused on a few species, if inadequately managed and monitored, could lead to the overexploitation of certain marine resources and subsequent negative effects on ecosystems. In this regard, however, it should be highlighted that the overall sustainability of fishing in the EU has recently improved, and a reduction in overfished stocks has been observed. However, additional efforts are required to ensure the resilience of the fishing industry and improve the health of global fish stocks. In order to support the sustainability of the entire sector, the Commission has proposed a package of measures aimed at addressing both economic and environmental challenges (European Commission, 2024b). In this context, promoting the consumption and market valorization of underutilized species and bycatch may contribute to reducing pressure on a limited number of highly demanded stocks, while simultaneously improving resource efficiency and supporting the sustainability objectives of European fisheries. Thus, based on the necessity to delineate the Common Fisheries Policy (CFP) and bycatch management, with a focus on the European strategies to valorize underutilized fish species, this review analyzed the literature and cogent regulations to advance a shared definition of discards and unwanted catches and to identify new opportunities for their valorization in compliance with the sustainability objectives of both the CFP and the consumer demands. Targeted literature research was carried out to identify recent scientific contributions related to fishery discards and bycatch. The databases explored included PubMed, Scopus, and Google Scholar. The search queries combined terms such as fishery discards, bycatch, fishery sustainability, valorization of unwanted catches and neglected and underutilized fish species (NUS). Peer-reviewed journal papers written in English were considered. In addition, cogent and abrogated EU regulations were included. Regarding the eligibility criteria, study selection followed a two-step process: initial screening of titles, abstracts, and keywords, followed by full-text review. For regulations, only the title was considered. To qualify for inclusion, studies had to meet the following criteria: i) be published between 2013, when the current CFP legal framework was adopted, and the present date; ii) be European regulations currently in force concerning fisheries sustainability and safety of fishery products, iii) reported detailed data or provide data syntheses relevant to the objectives of this review.

The issue of discards, bycatch, and unwanted catches

Accidental catches of non-target species with low commercial value are minimized in modern, highly targeted and selective fishing. However, these can still represent a significant problem. It is crucial to distinguish the concepts of discards, bycatch and unwanted catches, even if they are closely related. The term “discards” refers to all material of animal origin, dead or alive, that is returned to the sea for any reason during fishing operations. It does not include material of plant origin or post-harvest waste. Bycatch, instead, refers to any accidental capture of non-target species during fishing activities, including species that are not the primary objective of the fishery (Bellido *et al.*, 2011). The bycatch is not necessarily discarded. The term bycatch is often used as a synonym of unwanted catches, a more generic term that indicates fish discarded before the coming in force of the landing obligation, typically because they are undersized, have low market value, or would breach catch composition regulations (such as in the case of exhausted quotas) (Pérez Roda *et al.*, 2019; Uhlmann *et al.*, 2019). Bycatch and discards represent significant ecological concerns, as they can negatively impact biodiversity, marine ecosystems, and fish stocks. A study highlights that, over the years, most discards have been generated by large-scale industrial fishing. Between the 1950s and 1980s, the highest levels of discards were predominantly found in the waters of the North Atlantic. In more recent times, instead, fleets operating in the Northwest Pacific and Western Central Pacific have generated the largest volumes of discards. These often comprise edible and marketable species (Zeller *et al.*, 2018).

European regulatory framework on fishing

The Common Fisheries Policy: principles and historical steps

The main aim of the CFP is to ensure the environmental sustainability of fishing and aquaculture activities in the European Union, providing also economic, social, and employment benefits. The CFP contributes to food security by aiming for the long-term sustainable exploitation of fishery resources. The need for a coordinated fisheries policy arose as early as the 1970s, when the member states of the European Economic Community recognized the shared nature of fish stocks; this led to the creation of the first regulatory framework in 1976, which included catch quotas. This policy was strengthened in the 1980s through centralized management measures and the introduction of total allowable catches. In addition, in 1986 national quotas were introduced to regulate catches across individual states. Further reforms were implemented between the 1990s and 2000s to address overfishing and with a growing emphasis on sustainability. In particular, the 2002 reform significantly improved the monitoring and control of fishing activities. The main revision was in 2013 and aimed at ensuring sustainability through more stringent controls and the introduction of an ecosystem-based management approach, with the goal of restoring fish stocks by 2020. In 2020-2021, the evolution of the CFP continued, with reforms addressing issues related to climate change and biodiversity, integrating the European Green Deal and the Farm to Fork Strategy for more sustainable fishing practices (Lado, 2024; Popescu, 2026).

Main regulations

In Europe, several regulations related to fishing are now in force (Table 1). Reg. (EU) No 1380/2013 (European Parliament and Council of the European Union, 2013) is the legal basis for the CFP. It aims to ensure the long-term sustainability of fisheries and aquaculture in the European Union. This regulation is mainly focused on the proper management of fish stocks, the prevention of overfishing, and the protection of marine habitats. Article 14 concerns the prevention and reduction of discards and it is crucial for achieving the objectives of the regulation. Furthermore, to avoid, minimize, or eliminate unwanted catches, the implementation of pilot projects based on scientific input and stakeholder consultations is strongly encouraged. It is also possible for the Member States to develop a 'discard atlas' to assess and document discarded levels for each type of fishery; this would improve the monitoring and management of bycatch. Article 15, instead, describes in detail the landing obligation, a key element of the regulation introduced with the aim of reducing discards and promoting more responsible fishing practices. The landing obligation requires that all catches of fish species subject to catch limits or minimum size rules, particularly in the Mediterranean Sea, must be retained on board, recorded, and landed, unless used as live bait.

In certain cases, a *de minimis* exemption from the landing obligation prescribed by Article 15 of the Reg. (EU) No 1380/2013 has been provided for specific species and fishing activities. The *de minimis* exemption for small pelagic fishing activities in the Mediterranean Sea, for example, was firstly established by the Delegated Reg. (EU) 2018/161 (no longer in force) (European Commission, 2018a), subsequently replaced by the Delegated Reg. (EU) 2023/2460 (European Commission 2023a). This regulation, by way of derogation from Article 15 of Reg. (EU) No 1380/2013, permits the discarding of certain quantities of anchovies, sardines, mackerel, and horse mackerel in varying percentages (up to 5%, 3%, 1%) depending on the fishing area and the equipment used. Similarly, Delegated Reg. (EU) 2023/2918 (European Commission, 2023b) supplements Reg. (EU) No 1380/2013 establishing a *de minimis* exemption from the landing obligation for certain demersal fishing activities in the Adriatic Sea and the southeastern Mediterranean Sea, allowing discarding generally in the range of 1% to 5% of annual catches, depending on species, fishing area, equipment used, and specific conditions.

Other regulations

In addition to Reg. (EU) No 1380/2013 and the aforementioned provisions on *de minimis* exemptions, several other EU legislative instruments complement the CFP. The Delegated Reg. (EU) 2018/2036

(valid until 31/12/2021) (European Commission, 2018b) introduced a discard plan for certain demersal fisheries in the Mediterranean Sea. The purpose of this provision was to promote sustainable fishing practices by establishing catch limits proportional to the gear used. The regulation, in fact, provided guidelines for the release of bycatch under specific conditions, also establishing maximum discard percentages for certain species, such as sole, seabass, and various mollusks, depending on the area and gear type. Member States were required to submit additional data on discards and bycatch, which were then evaluated by the Scientific, Technical and Economic Committee for Fisheries. Management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea are indicated in the Reg. (EC) No 1967/2006 (Council of the European Union, 2006). The aim of this legal reference is to prevent overfishing and protect marine ecosystems. To achieve these goals, specific catch limits are defined, protected areas are designated, and specific rules for the most vulnerable species are imposed. Furthermore, the monitoring and reporting of bycatch data is required to assess the effectiveness of the measures; to this end, pilot projects are promoted to test new technologies and approaches. The implementation of these measures is based on the risk of bycatch in specific areas, with greater attention focused on the most vulnerable ones, and in relation to different fishing types. Finally, it is also important to consider Regulation (EC) No 1224/2009 (Council of the European Union 2009), which is of great importance because it established a comprehensive control system for the implementation of the CFP throughout the EU.

Evidence and assessments on the achievement of landing obligation objectives

In the previous chapters, we have observed how current and past EU regulations on fishing are strongly oriented to the sustainability of catches, with a range of measures, such as the landing obligation, designed to reduce bycatch as much as possible. Despite these commendable objectives, evidence suggests the presence of critical implementation issues in the practical application of all these provisions. A 2021 European Parliament resolution (European Parliament, 2021) clearly emphasized the need to improve the enforcement of Article 15 of the CFP (Borges, 2021). In particular, the document highlighted the need for complementary measures to ensure the full implementation of CFP rules, including better quota management, reduction of bycatch, and the use of more sustainable fishing practices. Furthermore, the need to engage fishermen and coastal communities and promote sustainable fishing is highlighted. Regarding compliance with the landing obligation, it is clarified that this must be ensured by strengthening monitoring and control systems and providing penalties for violations. Research and innovations aimed at improving selective fishing techniques, while reducing bycatch and supporting the fishing industry, are strongly encouraged. A key issue addressed in the document is linked to the reliability of data on discards. The authors emphasize that there is limited availability of reliable data on discards nor scientific evidence demonstrating that the landing obligation has substantially reduced unwanted catches. According to the authors, in order to avoid the waste of natural resources and maintain the sustainability objectives of the CFP, it would be appropriate to identify new commercial opportunities for the utilization of unwanted catches. Other authors have highlighted the importance of monitoring the landing obligation and management of discards. Belschner *et al.* (2019), for instance, pointed out the necessity of more effective implementation of certain measures, including improved surveillance systems, using tools such as on-board cameras, and the application of dissuasive sanctions by Member States in case of non-compliance. According to the authors, it is crucial to address the root causes of discards, including the use of more selective fishing gear and techniques, as well as adjusting quotas to reflect the actual composition of catches. A review by Prellezo and Villasante (2023) on the economic and social impacts of the landing obligation revealed that almost all existing studies focus on the expected consequences of the measure, rather than the actual ones. Overall, the scientific evidence indicates that the economic and social impacts of the landing obligation are likely to be negative in the short term. This is mainly due to the “choke” effect (operational limitations related to the landing obligation) and the fact that mitigation measures take time to produce results. “Choke effect” refers to a situation in mixed fisheries where the exhaustion of the quota for a single species constrains or

halts fishing activities, as any additional catches of that species must be landed and counted against quota under the landing obligation. In contrast, long-term impacts appear more variable and are largely dependent on the specific mitigation strategies adopted. However, these conclusions generally assume full compliance with the landing obligation by fishers, while the literature indicates that this is not always the case. The review concludes that studies on the economic and social impacts of the landing obligation based on actual data, rather than forecasts, are scarce. Consequently, it is recommended to produce analyses based on real data and compare them with the initial predictions.

Strategies to enhance the value of bycatch

According to Article 10 of Reg. (EC) No 1069/2009 (European Parliament, Council of the European Union, 2009) on animal by-products, bycatch may fall under category 3 depending on the intended use and compliance with relevant safety criteria. Category 3 by-products mean material not suitable for human consumption but permitted for alternative uses such as animal feed or biogas production. In more details, article 10 refers to three letters: (f) products of animal origin, or foodstuffs containing products of animal origin, which are no longer intended for human consumption for commercial reasons or due to problems of manufacturing or packaging defects or other defects from which no risk to public or animal health arise; (i) aquatic animals, and parts of such animals, except sea mammals, which did not show any signs of disease communicable to humans or animals; (j) animal by-products from aquatic animals originating from establishments or plants manufacturing products for human consumption. Based on the interpretation applied, all by-products derived from animals fit for human consumption but not intended for such use. In line with the European Parliament's resolution of 2021 (European Parliament, 2021), it would be advisable to identify business opportunities that enable better valorization of unwanted catches, in order to reduce food waste and prevent these fish from being used exclusively for category 3 by-products. Many neglected species, in fact, possess interesting nutritional characteristics and could serve as promising raw materials for the development of both traditional and innovative food products with high nutritional value. In this context, the need to valorize potential losses associated with discarded fishery products or neglected fish species has become evident. Literature highlights various potential applications for fishery discards, often framed within circular economy models, but this approach typically requires industrial processing and technological investment. Recently, dry-cured fish has been proposed as an alternative among restaurants and small enterprises. The necessity to valorize unwanted catches could align well with new trends in the restaurant and food industries. In recent years, for instance, controlled maturation techniques for fish products in dedicated cabinets have gained popularity (Panebianco *et al.*, 2024). These methods involve the preliminary preparation of fish (evisceration, removal of gills, optional filleting, addition of salt and aromatics) followed by preservation in dedicated cabinets with controlled temperature, relative humidity, and ventilation for a variable period. Controlled maturation processes determine a loss of excess liquids in the fish, along with the development of a characteristic aromatic and sensory profile which is highly appreciated by consumers. Few studies have investigated the safety of fish products subjected to dry curing or dry aging and a critical review of the literature is available (Troise *et al.*, 2026). Indio *et al.* (2024) reported that dry curing of salmon, swordfish, and yellowfin tuna fillets, conducted under controlled time, temperature, relative humidity, and ventilation, did not adversely affect the microbiological safety and the content of biogenic amines of the final products. In a recent study, challenge tests were performed to evaluate the behavior of *Listeria monocytogenes* during the dry curing of salmon, yellowfin tuna, and swordfish fillets (Savini *et al.*, 2024). The authors observed a significant reduction of the pathogen during the phases of salting, drying, and aging. In addition, predictive microbiology models were applied to model the behavior of the bacterium, but they tended to overestimate the growth of *L. monocytogenes*. Regarding dry-aged fish at foodservice level, Panebianco *et al.* (2024) assessed the safety of whole rainbow trout subjected to dry aging in a restaurant located in Turin (Italy). Results of quantitative microbiological analyses showed a minimal bacterial growth during fish maturation, with products that remained safe for consumption up to 10 days of dry aging conducted at approximately 3°C and 78% relative

humidity. In addition, the presence of *L. monocytogenes* and *Staphylococcus aureus* was investigated in muscle and skin samples, and neither pathogen was detected. Despite limited data on dry-aged and dry-cured fish, these preliminary studies demonstrated that maturation processes in dedicated cabinets, if carried out under controlled temperature, relative humidity, and ventilation, did not significantly affect the microbiological and chemical safety of fish. Considering the above, the proper application of these techniques could play a major role in a circular economy context, since it could lead to the valorization of unwanted catches by creating new and more appealing products for the final consumer. In fact, the finished products resulting from such maturation methods could represent valuable commercial innovations, potentially boosting the appeal and attractiveness of fish species typically overlooked by consumers. However, for the potential improvement of neglected fish through these processes, some critical points must be considered. Based on the aforementioned studies, maturation processes in dedicated cabinets seem to keep constant microbial loads in the fish muscle for a certain period of time. Based on this, it is clear that, in order to maximize the potential of these processes, the raw material placed in the dedicated cabinets must be of high quality and characterized by low initial microbial loads. With a view of promoting neglected fish species, specimens must be treated with the same care as high-value species from the earliest stages after capture. The level of attention paid by operators to different fish species may vary depending on their perceived economic value. As a result, neglected species may often be treated with fewer care during and after capture, for example by receiving less ice or less careful handling. This possible difference in treatment based on commercial value could result in high initial microbial loads in the product, potentially compromising the subsequent valorization efforts. A failure to maintain the cold chain could also favor the post-mortem migration of parasites into muscle tissue. Nematodes of the family *Anisakidae*, responsible for human anisakidosis, are widespread in various fish in the Mediterranean Sea, including neglected species. While these nematodes mainly reside in the coelomic cavity during the fish's life, they can migrate into the muscle tissue after death. Studies demonstrated a positive correlation between increased temperature and post-mortem larval migration into the muscle tissue (Cipriani *et al.*, 2016; Cipriani *et al.*, 2024). According to Commission Regulation (EU) 1276/2011 amending Annex III to Reg. (CE) No 853/2004 (European Parliament and Council of the European Union, 2004), fish species intended to be consumed raw or nearly raw must undergo preventive freezing to devitalize parasite larvae. However, even in case of preventing freezing of neglected species before controlled maturation processes, keeping low temperature immediately after capture is essential to minimize post-mortem migration of larvae and prevent the presence of numerous nematodes in the final product. A heavy infestation of larvae in the muscle, even if completely inactivated, could compromise subsequent processing and valorization efforts, while also posing potential risks related to allergic reactions to the parasites. Hitherto, no studies were available in the literature to address all the issues connected to the dry-curing of neglected species, primarily in terms of chemical hazards. A recent study has tried to fill the limited scientific data on the safety of the dry-curing process employed to valorize NUS. The authors monitored several microbiological and physico-chemical parameters to estimate the shelf-life of three dry-cured NUS-fish-product prototypes obtained from *Liza ramada* (thinlip grey mullet), *Trachurus trachurus* (horse mackerel), and *Phycis blennoides* (greater forkbeard). The results indicated that, following the dry-curing process, the vacuum-packaged ready-to-eat (RTE) fish products achieved a maximum shelf-life of 45 days (thinlip grey mullet), 30 days (horse mackerel), and 60 days (greater forkbeard) during storage at refrigeration temperature. These findings demonstrated the technological feasibility of the dry-curing process and confirmed the potential of this technology to obtain RTE products with extended storage stability from neglected fish species. Anyway, the authors emphasized that further research is needed to optimize dry-curing parameters and improve consumer acceptance, supporting the valorization of NUS species and sustainable local seafood choices (Pandiscia *et al.*, 2026). It is also important to emphasize the potential economic benefits arising from the processing of NUS using the innovative technologies described above. A recent study provided an overview of the fishery discards through a monetary quantification of the potential loss of value generated across Italian

territory, highlighting the market potential of landed discards under the landing obligation. During the period 2020-2022, fleets landed roughly 130,400 tons annually, worth about €700 million, while discarding around 6200 tons yearly. This corresponds to an average potential loss of value of approximately €21.5 million (Masi *et al.*, 2025). Although this estimation covers only the primary production step within the fisheries supply chain, it provides the opportunity to enrich the discussion on underutilized species and identify benchmarks for species that are still poorly tracked today.

Conclusions

This review highlights that the focus of European legislators is on the sustainability of fishing activities and the conservation of fish stocks. The landing obligation is a key component in achieving the objectives of the CFP. However, numerous authors and relevant committees highlighted the difficulties in obtaining reliable data on landings and discards. Further improvements are required in relation to the monitoring and data collection in the coming years to obtain more reliable statistics for assessing the proper implementation of the landing obligation. EU institutions promote and encourage the valorization of unwanted catches to ensure their effective and more profitable use than the simple classification as by-products. Emerging fish maturation technologies in dedicated cabinets, such as dry curing and dry aging, offer promising avenues for increasing the value of NUS. Nevertheless, to maximize the value of such species using these methods, it is essential to maintain the cold temperatures and ensure proper handling of raw materials throughout the entire supply chain. Effective cooperation between all the stakeholders is essential to create a virtuous system aimed at maximizing the value of bycatch. Critical gaps persist in understanding the effective resource management, the sustainability of fisheries under the landing obligation, and the valorization of NUS species and the efficacy of emerging innovative dry-curing technologies. This analysis underscores the need for interdisciplinary approaches integrating regulations, industries and consumers, and food safety to address risks and opportunities in global sustainable fish supply chains. The findings provide a roadmap for future research, advocating for advanced fisheries sustainability, innovative industrial interventions supported by greater market acceptance, and policy refinement to diversify consumer diets with nutritious, high-value seafood products derived from NUS.

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Table 1. Overview of the main EU Regulations in force related to the Common Fisheries Policy and the landing obligation.

Regulation	Description	Focus
Regulation (EU) No 1380/2013	Defines the purpose, objectives, and principles of the Common Fisheries Policy (CFP)	Landing obligation for species subjected to catch limits and minimum sizes
Delegated Regulation (EU) 2023/2460	Establishes a <i>de minimis</i> exemption to the landing obligation for certain small pelagic fisheries in the Mediterranean Sea	Allows the discards of specific percentages of small pelagic species based on the fishing area and the equipment used
Delegated Regulation (EU) 2023/2918	Establishes a <i>de minimis</i> exemption to the landing obligation for certain demersal fisheries in the Adriatic and south-eastern Mediterranean Sea	Allows the discards of specific percentages of species like hake, sole, seabass, etc.
Regulation (EC) No 1967/2006	Management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea	Prevents overfishing, protects marine environments, and ensures long-term sustainability
Regulation (EC) No 1224/2009	Establishes a control system for ensuring compliance with the rules of the CFP	Establishes procedures for monitoring, controlling, and enforcing fishing regulations
European Parliament Resolution (18 May 2021)	On securing the objectives of the landing obligation under Article 15 of the CFP	Focuses on reducing unwanted catches, strengthening quota management, and improving compliance with landing obligation