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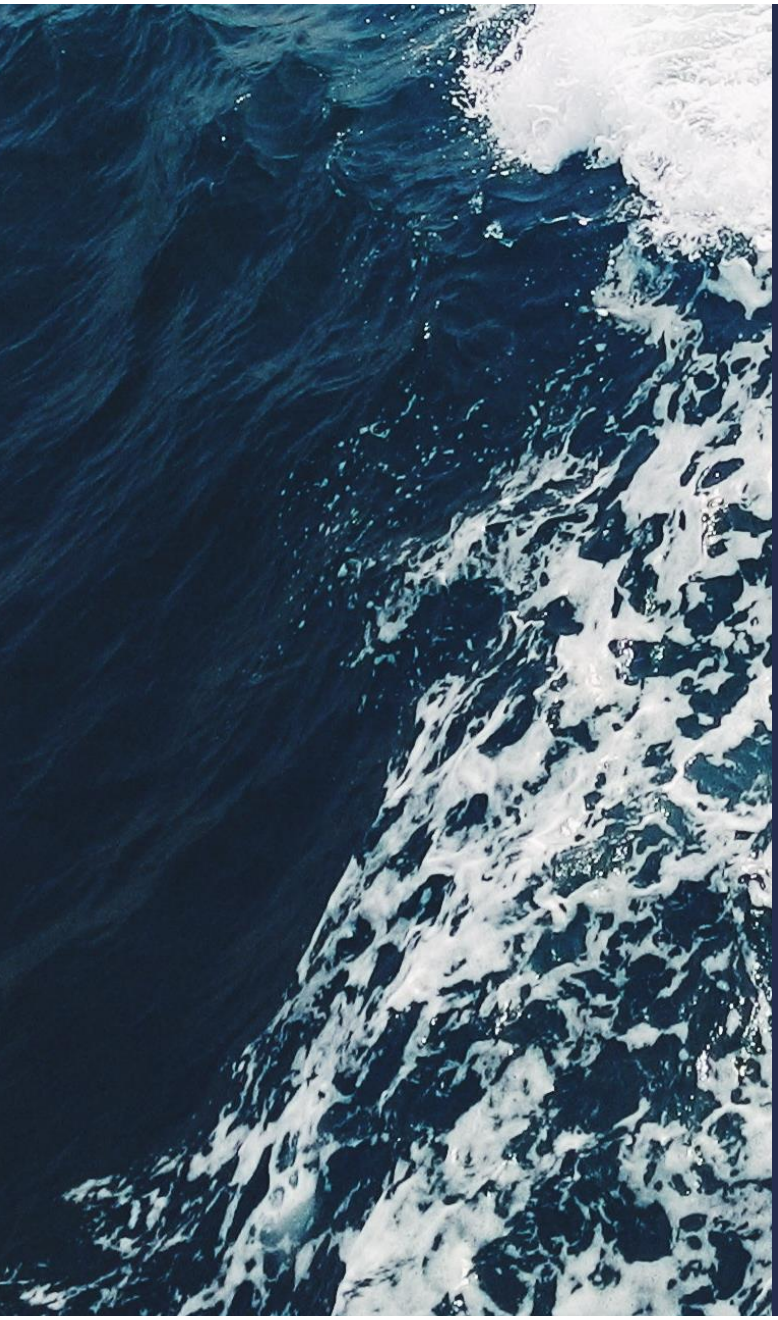

A Portuguese Fisheries Review and Evaluation of Fisheries Requirements Tools

The Development of Electronic Monitoring and Reporting Technologies for Fisheries in Portugal **(EMREP)**

Ref. PT-Innovation-0007

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The Development of Electronic Monitoring and Reporting Technologies for Fisheries in Portugal (EMREP)

1st output report: "A Portuguese Fisheries Review and Evaluation of Fisheries Requirements Tools"

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SUMMARY

This report is the first output stemming from “The Development of Electronic Monitoring and Reporting Technologies for Fisheries in Portugal” (EMREP) project which aims to develop Electronic Monitoring and Reporting (EMR) technology for fisheries in Portugal, by integrating a fisheries electronic logbook with video cameras. This project was made possible by the Blue Growth, Innovation and SME programme funded by the European Economic Area Financial Mechanism (EEAFM 2014-2021). This Literature review was collated by the promoter company, OLSPS International Unipessoal LDA, and the partner, the University of Algarve with the aim of providing a comprehensive understanding of Portuguese fisheries, specifically in relation to international, European, regional and local regulations. Additionally, this literature review outlines the biological and operational characteristics of the Portuguese fisheries related to discarded bycatch as well as the landing obligations of species subject to total allowable catches (TACs). Furthermore, it details the current data systems employed to manage the Portuguese fisheries in order to ensure that the Common Fisheries Policy is accomplished. The base documents used to create this report were the Scientific, Technical and Economic Committee for Fisheries (STECF, 2019) that contains relevant information from the European fishing fleet, the Annual Report of the Portuguese Fishing Fleet (2020), *Estatísticas da Pesca* (2020) and the Directorate-General for Natural Resources, Safety and Maritime Services (DGRM) webpage, all containing crucial information of fisheries in Portugal.

ACRONYMS AND ABBREVIATIONS

CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCBSP	Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CECAF	Fishery Committee for the Eastern Central Atlantic
CFP	Common Fisheries Policy
DGRM	Directorate-General for Natural Resources, Safety and Maritime Services
DivRP	*Divisão de modelação e Gestão de Recursos da Pesca*
EC	European Council
EEA	European Economic Area
EEZ	Exclusive Economic Zone
EIFAAC	European Inland Fisheries and Aquaculture Advisory Commission
EM	Electronic Monitoring
EMR	Electronic Monitoring and Reporting
EMREP	Electronic Monitoring and Reporting in Portugal
ET	Electronic Technology
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FMC-PT	Fisheries Monitoring and Surveillance Center
GFCM	General Fisheries Commission for the Mediterranean
HO	Human Onboard Observers
IATTC / CIAT	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICES	International Council for the Exploration of the Sea
IOTC	Indian Ocean Tuna Commission
IUU	Illegal, Unreported and Unregulated
LO	Landing Obligation

MCRS	Minimum Conservation Reference Size
MCSS	Monitoring and Control and Surveillance System
MSY	Maximum Sustainable Yield
NAFO	Northwest Atlantic Fisheries Organization
NASCO	North Atlantic Salmon Conservation
NEAFC	Northeast Atlantic Fisheries Commission
NFA	National Fisheries Authority
RAA	Autonomous Region of the Azores
RAM	Autonomous Region of Madeira
RFBs	Regional Fisheries Bodies
RFMOs	Regional Fisheries Management Organizations
SFPA	Sustainable Fisheries Partnership Agreements
SIFICAP	System of Information, Inspection and Control for Fishing Activities
SIOFA	South Indian Ocean Fisheries Agreement
SME	Small and Medium-Sized Enterprises
SPRFMO	South Pacific Regional Fisheries Management Organization
STECF	Scientific, Technical and Economic Committee for Fisheries
TAC	Total Allowable Catches
UN	United Nations
UNCLOS	United Nations Convention for the Law of the Sea
WCPFC	Western Central Pacific Fisheries Commission
WGTIFD	Working Group on Technology Integration for Fishery-Dependent Data

1. FISHING IN THE MODERN DAY

Fisheries are essential for livelihoods, trade and food security across the globe (Béné *et al*., 2015). Over the past two decades, global seafood consumption has risen by an astounding 122% as a direct result of exponential population growth, advancements in technology and the demand for increased production worldwide (Pérez Roda *et al.,* 2019). The expansion of fisheries and aquaculture sectors reached an all-time high in total-production, consumption and trade in 2018; this expansion can largely be attributed to the growth in production of aquaculture sectors since the early 1990's (+527%; Pérez Roda *et al*., 2019). While a relative stability can be observed in the capture fisheries production (+14%), the total global capture fisheries production reached a record high of 96.4 million tonnes in 2018 - which was a registered increase of more than 5% from the average of the previous years (Pérez Roda *et al*., 2019). Not surprisingly, following these consecutive rises, a general decline in fish populations within biologically sustainable levels from 90% to 65.8% during the period of 1990 to 2017 was recorded (Pérez Roda *et al*., 2019).

1.1 Discards and bycatch

The record increase in total capture fisheries production to meet the growing demand for seafood products, raise concerns on industry bycatch[1] and discards practices which in turn, threaten the sustainability of many critical global fisheries. The choice to discard an organism at sea, whether dead or alive, is made by fishers guided by a set of judgments and rules at the time they are sorting the catch onboard (Rochet and Trenkel, 2005; Eliasen *et al*., 2014). Reasons for why fishers may choose to discard catches onboard include avoidance of prohibitions on commercializing a species due to its landed size constraints, restrictive conservation status, season closure, designated quota fulfillment, lack of commercial value and/or incurred physical injury due to predation or fishing activity

[1] Bycatch is the unintentional catch of non-target species which can be kept by fishers (retained bycatch) or discarded at sea, i.e., discarded bycatch or discards of target species.

(e.g. Horsten and Kirkegaard, 2002; Fauconnet *et al*., 2019). However, it is the commercial market value of a species that is argued as the principal driver behind fishers' decision-making with regards to discarding catches – consequently species with a lower market value are often discarded at sea whilst those species that fetch a higher market value are instead kept onboard and recorded (Arnason, 1994; Feekings *et al.,* 2012; Catchpole *et al*., 2005, 2014).

The discarding practices at sea exposes inefficient fisheries management and policy implementation, and raises several key concerns around ethical incongruencies, along with the ecological, economic and technical repercussions of this practice (Kelleher, 2005). The mortality of discarded species may have serious ripple effects on target and non-target populations, particularly if most of the discarded individuals are undersized, which has the potential to lead to declines in future yield and breeding opportunities (Tingley *et al.* 2000). Conversely, detritivores and scavenger's benthic species, and other opportunistic varieties such as sharks, seabirds and marine mammals may in turn benefit from discards which could supplement other food sources in their diets (Olaso *et al.* 1998; Votier *et al.* 2004; Veiga *et al.* 2015).

Global estimations of discards from 2010-2014 were on average 9.1 million tonnes - i.e. 11% of the total annual global marine fisheries' catch. The type of gear responsible for the highest discard rates (45.5%) were the bottom trawlers with catches at 4.2 million tonnes per annum (Pérez Roda *et al.*, 2019). These include otter trawls, shrimp trawls, pair bottom trawls, twin otter trawls and beam trawls. Fisheries targeting crustaceans had the highest discard rates, 32% of the total catch (i.e.,1.4 million tonnes), and the ocean region with the highest discard rates was the northeast Atlantic with 33% of the total catch landed by bottom trawl fisheries (Pérez Roda *et al*., 2019). In the south of Portugal these numbers are even more concerning with discards averaging 70% of total catches across all its vessels and reaching as high as 90% within crustacean targeted bottom trawlers (Borges *et al*., 2001).

1.2 International fisheries

International fisheries are regulated and managed worldwide by the United Nations (UN) or by its specialized agency, the Food and Agriculture Organization (FAO) which provides legal advisory services to governments in the construction or revision of national fisheries legislation. In order to strengthen Regional Fisheries Bodies (RFBs), the FAO also provide supportive services to regional or sub-regional fisheries organizations to help improve their legal framework.

Another means for regulating international fisheries are through Sustainable Fisheries Partnership Agreements (SFPA) which are agreements between the European Union (EU) and developing world countries (especially in the African continent) that allow EU vessels to operate outside the EU waters and in developing world countries waters. The SFPA is composed of two types of agreements (Heredia and Oanta, 2015) as outlined below.

- **Tuna agreements** - which allow EU vessels to pursue migrating tuna populations as they move along the shores of Africa and through the Indian ocean. Currently, the EU has such agreements and maintain protocol in this regard with the following countries: Cape Verde, Cook Islands, Ivory Coast, Liberia, Mauritius, São Tomé e Principe, Seychelles and Senegal and Gambia which make provision for a hake component.

- **Mixed agreements** - which alternatively provide access to a wide range of fish populations in the exclusive economic zone (EEZ[2]) of the partner country. Currently the EU has protocols with the following countries: Greenland, Guinea-Bissau, Mauritania and Morocco.

[2] The EEZ is an area where coastal countries or states hold the right to exploit, manage and conserve natural resources occurring in that area. In doing so, countries exercise their sovereignty and jurisdiction responsibilities as per United Nations Convention for the Law of the Sea (UNCLOS).

The activity of the Union vessels operating outside of EU waters has been regulated by the Regulation (EC) 2017/2403[3], and falls within the context of the Regional Fisheries Management Organizations (RFMOs).

The RFMOs are international organizations formed by countries with fishing interests in a specific area and are purposed to regulate fishing activities related to the species of interest in the high seas concerned. They vary considerably in the species chosen for regulation and in the approach required to regulate migratory species like the tuna, as opposed to organizations focussed on regulating more terrestrial fish populations found within a specific area (Figure 1). While the RFBs play a purely advisory role, the RFMOs instead exercise the power to manage that particular area by setting catch and fishing effort limits, developing technical measures for ensuring compliance and controlling obligations that are mandatory for their members.

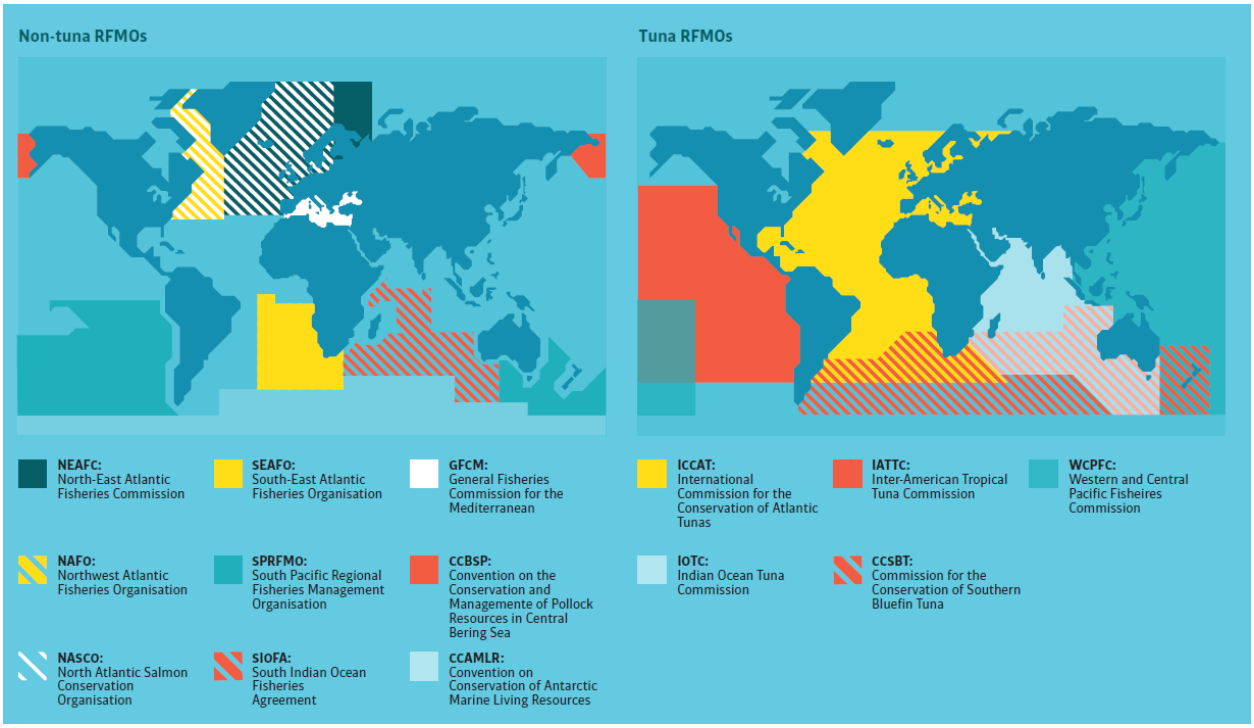


Figure 1: Non-Tuna RFMOs and Tuna RFMOs in which the EU is a member.
Source: European Union (2015)

[3] Regulation (EU) 2017/2403 of the European Parliament and of the Council of 12 December 2017 on the sustainable management of external fishing fleets and repealing Council Regulation (EC) N° 1006/2008. Available in: http://data.europa.eu/eli/reg/2017/2403/oj

The EU, represented by the European Commission, plays an active role in regulating six tuna and eleven non-tuna RFMOs or RFBs (Table 1). RFMOs make use of the Relative Stability Principle (RSP) established in the Common Fisheries Policy of 1983[4] when licensing fisheries within international waters – consequently any Portuguese fishing opportunity is subject to this principle. All quotas available for Portugal fisheries, as well as the terms of operation established by the RFMOs are issued annually in EU regulations, particularly in the annual TAC and Quotas Regulations.

The RFMOs scientific councils and/or International Council for the Exploration of the Sea (ICES), establish yearly TACs and catch limits through the assessment of the state of the populations.

[4] Council Regulation (EC) No 170/83 of 25 January 1983 establishing a community system for the conservation and management of fishery resources. Available in: http://data.europa.eu/eli/reg/1983/170/oj

Table 1: Regional Fisheries Management Organizations (RFMOs) in which the EU is a contracting party.

RFMO	DESCRIPTION
The Northwest Atlantic Fisheries Organization (NAFO)	Established in 1979, it is responsible to manage fisheries for the Northwest region of the Atlantic Ocean.
The Northeast Atlantic Fisheries Commission (NEAFC)	It was more recently developed than NAFO and manage fisheries in the Northeast region of the Atlantic Ocean.
The General Fisheries Commission for the Mediterranean (GFCM)	Established in 1949, adopts recommendations on the conservation and management of fisheries in the Mediterranean Sea.
The International Commission for the Conservation of Atlantic Tunas (ICCAT)	Established in 1966, is responsible for managing and restricting the catches of tuna and tuna-like species in the Atlantic, with quotas implications for EU countries.
Southern Indian Ocean Fisheries Agreement (SIOFA)	Established in 2012, regulates the international waters on the Indian Ocean through resolutions that establishes conditions and limitations for fishing.
The Indian Ocean Tuna Commission (IOTC)	Intergovernmental organization responsible for the management of tuna and tuna-like species in the Indian Ocean.
The Western Central Pacific Fisheries Commission (WCPFC)	Established in 2004, it manages and regulates fishing activity in the Pacific Ocean in the Western and Central areas.
The South Pacific Regional Fisheries Management Organization (SPRFMO)	Established in 2012, it manages and regulates fishing activity in the South Pacific Ocean.
The Inter-American Tropical Tuna Commission (IATTC/CIAT)	Is responsible to for the conservation and management of tuna and other marine species in Eastern Pacific Ocean.

Cont. Table 1

RFMO	DESCRIPTION
The Southeast Atlantic Fisheries Organization (SEAFO)	Aims at conserve and manage fish populations in the Southeast Atlantic Ocean.
Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)	Was established by international convention in 1982 with the objective of conserving the Antarctic marine life.
Commission for the conservation of southern bluefin tuna (CCSBT)	Intergovernmental organization responsible for the management of southern bluefin tuna populations throughout its distribution.
European Inland Fisheries and Aquaculture Advisory Commission (EIFAAC)	Stablished in 1957 by the FAO council, with the mission to promote responsible management of European inland fisheries and aquaculture.
North Atlantic Salmon Conservation (NASCO)	Established by convention in 1984 with the objective to conserve, restore, enhance and manage Atlantic salmon through international co-operation.
Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea (CCBSP)	Establish an international regime for conservation, management, and optimum utilization of pollock resources in the Convention.

2. THE CURRENT STATE OF THE PORTUGUESE FISHERIES

Portugal is positioned in a unique and productive geographical location within the Iberian Peninsula, bayed by the Northeast Atlantic Ocean with its south coast presenting a more sheltered area in the Gibraltar Strait. Moreover, the Portuguese Exclusive Economic Zone (EEZ) is one of the largest in Europe, highlighting the importance and favourability of its fishing waters (Figure 2).

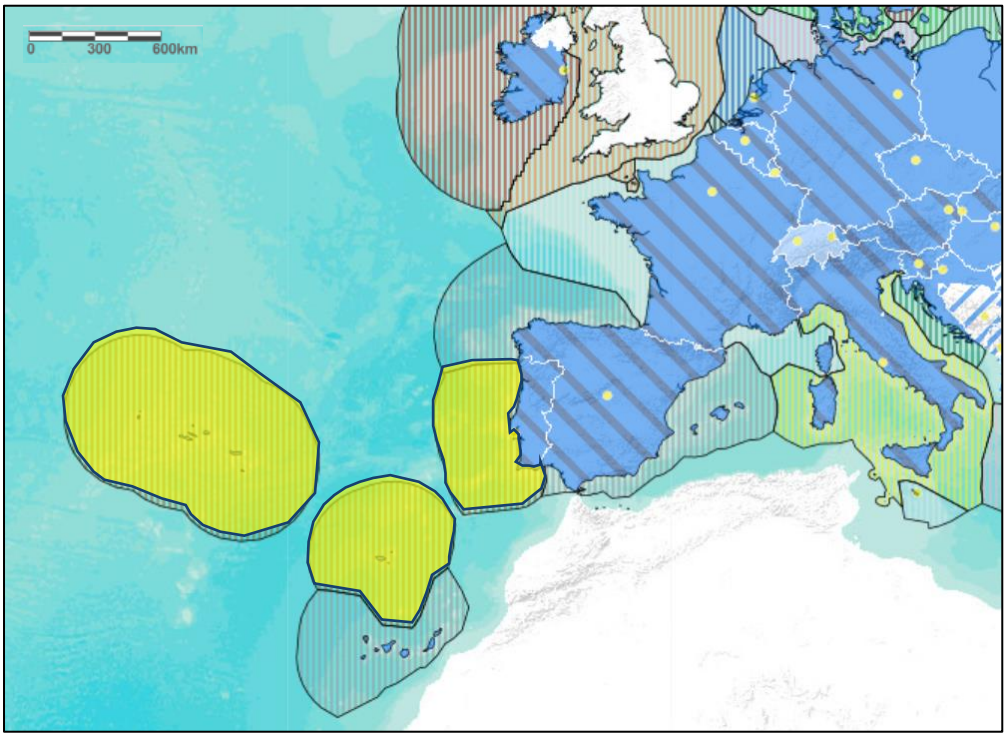


Figure 2: Part of the EU member states countries (in blue) and its respective EEZs (striped polygons at sea). The Portuguese EEZ area are the ones in yellow.
Adapted from: https://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas

The ocean constitutes an integral part of Portugal's identity and culture, a rooted connection which has existed since the time of the great discoverers such as Pedro Alvares Cabral. Fishing has been practiced in Portuguese waters for millennia and plays an important role in the everyday life of the Lusitanians, both culturally and economically. Consequently, Portugal is recorded to have the highest seafood consumption metric in

Europe (61.5kg/per capita), and the third globally, below Korea (78.5kg/per capita) and Norway (66.6kg/per capita; FAO, 2016) respectively. Furthermore, the Portuguese market in 2019 presented the highest expenditure per capita (€ 371) in fishery and aquaculture products in Europe; greater than three times the EU average expenditure (EUMOFA, 2020). Though there was an observed 5.3% decrease in the landed fresh fish price of 2.20 €/Kg in 2018 to 2.08 €/Kg in 2019 (INE, 2019), cost projections for the Portuguese market predict an increase in the average price of seafood and other ocean related products (Pérez Roda *et al.*, 2019).

2.1 Marine resources

The Portuguese State exercises all the powers to the maritime natural resources found in the seabed and subsoil forming the Portuguese continental shelf including beyond 200 nm; the Portuguese State can exercise their power to fully explore, exploit, conserve and manage the resources within this EEZ demarked area (Figure 3). Following a precautionary approach, several measures were adopted by the State to ensure efficient management and exploitation of all marine natural resources whilst protecting vulnerable marine ecosystems. Additionally, the State aims to maintain a good and healthy conservation status of the Portuguese water's marine biodiversity by improving the scientific knowledge of the area through the gathering and analysis of relevant data. One of the protection measures taken by the State was the creation of several marine protected areas as Figure 3 - these areas were specifically chosen based on the biological importance the area presented (DGRM, 2020a).

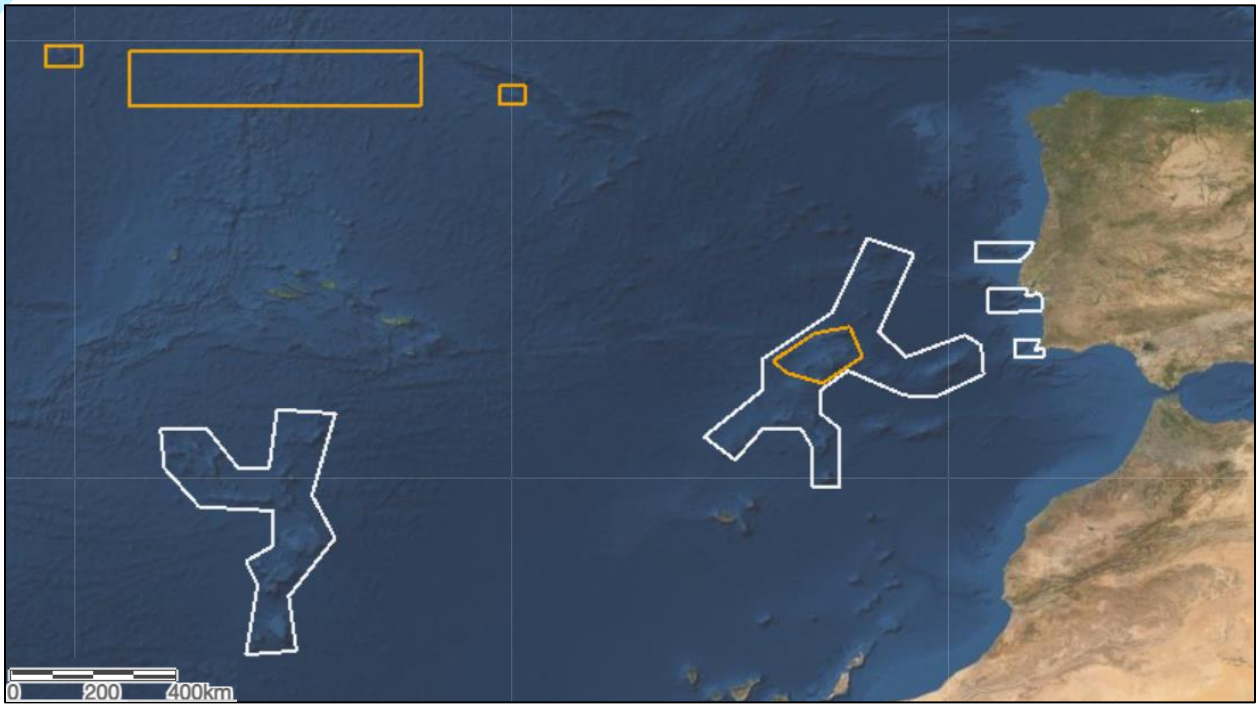


Figure 3: Marine protected areas in the Portuguese waters (yellow and white polygons).
Source: https://webgis.dgrm.mm.gov.pt/portal/apps/webappviewer/

To protect the seabed and its associated sensitive resources such as corals and sponges from the adverse impacts of fishing activity, Portugal have reaffirmed within several international forums, the States' determination to exercise its full power in management of Portuguese waters. Complimentary to the Minister's Council Resolution Nº. 82/2009[5], a sustainable development policy based on integrated and coordinated management of the coastal areas and holding a high regard for the environmental, economic, social, cultural and recreational importance of the coastal zones, the Ordinance N°. 114/2014[6] was created. This Ordinance stipulated the necessary conditions for the protection of the seabed from the impacts of fishing activities, namely the prohibition of fishing gear prone

Source: jccraigw.github.io

[5] Ministers Council Resolution N°. 82/2009, of 8th September National Strategy for the management and integration of the coastal zone. Available in: https://data.dre.pt/eli/resolconsmin/82/2009/09/08/p/dre/pt/html
[6] Ordinance N°. 114/2014 regulating activities of authorised National fishing vessels to protect ecosystem from the adverse impacts of fishing activity. Available in: https://www.dgrm.mm.gov.pt/en/web/guest/am-ec-exploracao-conservacao-e-gestao-dos-recursos-vivos

to cause negative impacts on the seabed along with the obligation to record and report captured corals and sponges.

Additionally, to ensure the protection of the deep-sea environments within Portuguese waters, bottom trawling activities closer than 6 miles from the coast and at depths below 800 m were prohibited (Prado *et al*., 2017). Moreover, the Council Regulation (EU) 2016/2336[7] was later promulgated and established specific conditions for deep-sea fishery activities. The regulation's main objectives were to avoid adverse effects on vulnerable marine ecosystems (Figure 3), to improve the scientific knowledge about deep-sea species and to ensure that EU measures regarding the sustainable management of deep-sea populations are upheld. The (EU) 2016/2336 regulation further established relevant fishing quotas and required the presence of onboard observers or the use of remote electronic monitoring to guarantee compliance.

2.2 Portuguese fisheries characterization

The Portuguese territory is comprised of the mainland (MFA) and the outermost regions, the islands of Azores (RAA) and Madeira (RAM), which all together consists of a fleet of approximately 7,768 fishing vessels. Of these, 3,902 are classified as active, with a total gross tonnage of 87.290 GT and a total propulsion power of 345 420 kW (INE, 2019), respecting the maximum proposed limits for Portugal in the annex II of the Common Fisheries Policy (Council Regulations EC nº 1380/2013[8]). The Portuguese fishing fleet presents three different classifications which are displayed in Table 2.

[7] Regulation (EU) 2016/2336 of the European Parliament and of the Council of 14 December 2016 establishing specific conditions for fishing for deep-sea stocks in the north-east Atlantic and provisions for fishing in international waters of the north-east Atlantic and repealing Council Regulation (EC) N° 2347/2002. Available in: http://data.europa.eu/eli/reg/2016/2336/oj

[8] Regulation (EU) N° 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC. Available in: http://data.europa.eu/eli/reg/2013/1380/oj

Table 2: Classification of the Portuguese commercial fishing fleet.

CLASSIFICATION	DESCRIPTION
Local	Small vessels (< 9 meters length overall) that operate in oceanic and non-maritime inland waters. The maximum permitted propulsion power is 75 kW (100 hp).
Coastal	Larger vessels (> 9 meters and ≤ 33 meters) an autonomy established according to the area of operation fixed for every vessel. The permitted propulsion engine power is ≥ 26 kW (35 hp).
Offshore	Vessels with a tonnage capacity of ≥ 100 GT and a minimum autonomy of 15 days operating beyond 12 nm.

Source: INE, 2019

The Portuguese national fleet has been registered with the European Union database since 1989 and is characterized by a prevalence of small fishing vessels, in which about 91% of registered vessels have an overall length of less than 12 meters. However, these vessels represent only 14% of the national fleet gross tonnage. From 2014 to 2019 there was a reduction in the number of vessels (-5.54%), which represents a decrease of 13.99% in gross tonnage capacity and a 5.68% decrease in propulsion power capacity. The evolution of the active Portuguese fleet over the last five years (2015-2019) also verified an estimated 6% reduction in the number of licensed vessels, although this reduction in vessel numbers corresponds to a 4.5% increase in gross tonnage (GT) and 1.5% in propulsion power (kW; INE, 2019).

The national fleet is characterised by the following fisheries and gear types employed: Gillnets and trammel nets, Dredges, Trawls, Traps, Lines and Hooks, Beach Seine, Seine, Beam Trawl and Polyvalent Vessels. With regards to the value from landings, the most critical are the Demersal Trawl and Seine over 40m length, Hook between 24m - 40m and Polyvalent Passive Gears only above 10m which together represent 49% in value landings (STECF, 2019).

2.3 Captures and landings

The Portuguese fleet have a range of vessels that target different species predominantly in the Portuguese Exclusive Economic Zone (27.IX.a for the mainland fleet, 27.X for the Azores's fleet and CECAF 34.1.2 for the Madeira's fleet). In the national ports in 2019, over 137 thousand tonnes of seafood were landed, including fishes (marine and freshwater, 119.698 tonnes), crustaceans (1.481 tonnes), molluscs (16.193 tonnes) and other aquatic species (298 tonnes; DGRM, 2019; INE, 2019). From 2018 to 2019 there was a recorded 6.1% increase in the capture fisheries (i.e.,188.537 tonnes). This intensified supply corresponds to an increased demand and interest from international buyers. The increased capture fisheries consisted of predominantly mackerel (*Scomber colias*) which increased by 38%, horse mackerel (*Trachurus trachurus*) with a 7.7% increase and anchovy (*Engraulis encrasicolus*) which increased by 11.2% (DGRM, 2019; INE, 2019). In reply of the increased market demand, the sardine management plan directed seiners' efforts toward mackerel, horse mackerel and anchovy species; a similar redirection can be observed in the trawling industry at the time. Seiners and trawling segments captured around 48% and 13% respectively of the total catch volume of fresh and chilled fish from 2018 to 2019. Mackerel, sardines and horse mackerel were the main landed species by the seine segment, representing 88.3% of the total landings with mackerel being the most abundant of the landings, with approximately 56.4% (37.483 tonnes) caught (INE, 2019). In the trawling segment, horse mackerel, mackerel and blue whiting were the three most commonly landed species of fresh and chilled fish and represented 68.7% of the total volume of fish landed by this segment from 2018 - 2019. Horse mackerel represented the highest catch percentage of the trawlers segment, with about 47.1% (8365 tonnes). In the polyvalent segment the main species caught and landed were tuna (*Thunnus* spp.) and other tuna-like species, along with mackerel, octopus (*Octopus vulgaris*) and black scabbard fish (*Aphanopus carbo*) collectively representing about 39% (53.745 tonnes) of the total catch of fresh and chilled fish (INE, 2019).

2.4 Fishing opportunities

To protect and manage fish populations and keep them within healthy and sustainable biological limits, Total Allowable Catches (TACs; or fishing opportunities) are deployed as a management measure - attributed in tonnes for most commercial fish stocks, unique to the species and region concerned. In Europe, TACs are annually set but biannually attributed for some deep-sea populations. In Portuguese waters, resources are also shared with other EU member states and areas of fishing operation and TACs are yearly defined by researchers from the *Divisão de Modelação e Gestão de Recursos da Pesca* (DivRP) at the Portuguese Institute for the Sea and Atmosphere (IPMA, 2020), and can be retrieved in the Directorate-General for Natural Resources, Safety and Maritime Services (DGRM) webpage, which is the national fishing authority for Portugal. Thus, whenever the designated TAC approaches the fulfillment of its threshold for a certain species and/or population, the potential risk for early closure of fisheries becomes prevalent.

The Regulation (EC) 2019/124[9] promulgated on January 30th presented positive changes and updates in the levels of abundance and availability of important species for fisheries in Portugal - the regulation addressed the state of the resources exploited by the Portuguese fleet and susceptible to TAC limitations. In 2019, the fishing opportunities for species subject to TAC such as horse mackerel (*Trachurus trachurus*), megrim (*Lepidorhombus* spp.), sea bream (*Sparus aurata*), skates (*Rajiformes* spp.), monkfish (*Lophius piscatorius*) and Norway lobster (*Nephrops norvegicus*) increased 29% in 2019 compared with 2018 (DGRM, 2019). The growth in fishing opportunities can be attributed to the responsible management of the fishing populations by the national administration and its subsequent approval of the good state of the populations concerned. Furthermore, there has also been an exhaustive review of fishing methodologies by scientific institutions, specifically those represented by the International Council for the Exploration

[9] Council Regulation (EU) 2019/124 of 30 January 2019 fixing for 2019 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters; Available in: http://data.europa.eu/eli/reg/2019/124/oj

of the Sea (ICES), who directly influence the perception of the state of the resources and in turn, affect fishing opportunities. The ICES saw the need to strengthen the quota of anchovy (*Engraulis encrasicolus*) in 2019 through quota exchanges with Spain given the abundance of this species in Portuguese waters. Although a high abundance level was observed for this species, there was a decrease in comparison with the levels recorded in 2018 (DGRM, 2019). Regarding other species, as in the case of sardines, productivity and abundance levels remained low in 2019, and as a result, ICES recognized that this resource requires management according to a precautionary exploitation rule[10].

Source: skyfood.com.tr

The Portuguese national fleet traditionally operates in the following international areas: NAFO, NEAFC, ICCAT, and IOTC areas (see figure 1). Important fishing activities are performed by the demersal trawlers in the NAFO and Svalbard/Irminger areas, by surface longliners in the Indian and Pacific oceans, and by the Madeiran fishing fleet near Madeira coast.

For 2020, the operating regions and fishing opportunities for Portugal remained steady in relation to previous years for the areas of Svalbard (targeting cod and shrimp), NEAFC (blackbelly rosefish), NAFO (cod, atlantic redfish and greenland halibut, shrimps, blackbelly rosefish, leerfish, skates, forkbeards, Neon flying squid, witch flounder) and ICCAT (atlantic bluefin tuna, swordfish, albacore, bigeye tuna, atlantic white marlin, blue marlin[11]). Furthermore, Portugal is also under the SFPA (see section 1.2), having vessels operating in third world countries.

[10] "Management according to the precautionary approach exercises prudent foresight to avoid unacceptable or undesirable situations, taking into account that changes in fisheries systems are only slowly reversible, difficult to control, not well understood, and subject to change in the environment and human values". Available in: http://www.fao.org/3/w3592e/w3592e07.htm

[11] For a list of the species scientific names, please see the Appendix I

The Portuguese fleet is currently present in seven countries, under the SFPA, namely:

- **The Republic of Cape Verde** with eight surface longline and pole-and-line tuna vessels.
- **Côte d'Ivoire** with two surface longline tuna vessels.
- **Guinea-Bissau** with two seiners and longline targeting mixed species.
- **Mauritius** with four surface longline tuna vessels.
- **Morocco** with 14 longline and demersal fishing vessels targeting mixed species.
- **São Tomé and Principe** with one surface longline tuna vessel.
- **Seychelles** with two surface longline tuna vessels.

2.5 Portuguese National Fisheries Authority

In Portugal, to control and monitor fishing activities, the Directorate-General for Natural Resources, Safety and Maritime Services (*Direção Geral de Recursos Naturais, Segurança e Serviços Marítimos* - DGRM) exists as the National Fisheries Authority (NFA). The DGRM exercises the power of the NFA within the framework of the rules of the Common Fisheries Policy (CFP[12]) and operates under the terms of the Union Control regime to prevent and eradicate illegal, unreported and unregulated (IUU) fishing. This regime includes the Council Regulations (EC) Nº 1224/2009[13], and (EC) Nº. 1005/2008[14], respectively, as well as the provisions of article 15-A of Decree-Law Nº 278/87[15], and in

[12] The CFP is a set of rules for managing European fishing fleets and for conserving fish populations. It was designed to manage a common resource, giving all European fishing fleets equal access to European Union waters and fishing grounds, allowing a fair competition among fishermen.
[13] Council Regulation (EC) N° 1224/2009 of 20 November 2009 establishing a community control system for ensuring compliance with the rules of the common fisheries policy, Available in: http://data.europa.eu/eli/reg/2009/1224/oj
[14] Council Regulation (EC) N° 1005/2008 of 29 September 2008 establishing a community system to prevent, deter and eliminate illegal, unreported and unregulated fishing. Available in: http://data.europa.eu/eli/reg/2008/1005/oj
[15] Available in: https://data.dre.pt/eli/dec-lei/278/1987/07/07/p/dre/pt/html

paragraph bb) of nº. 2 of article 2 of Decree Law Nº 49-A/2012[16]. The DGRM is responsible for coordinating the monitoring activities of all national supervisory authorities, and for assembling, processing and certifying information related to the reporting of fishing activities, cooperation as well as the transmission of information to the EU Commission, the European Fisheries Control Agency, other Member States and, where appropriate, developing world countries (paragraph 5 of article 5 of Regulation (EC) Nº. 1224/2009).

In Portugal, the Fisheries Monitoring and Surveillance Center (FMC-PT) was created by the Decree-Law Nº. 310/98[17] following the term of Council Regulation (EC) Nº. 2847/93[18], establishing a control system applicable to the CFP, followed by the Council Regulation (EC) Nº. 1224/2009. The FMC-PT was at first, responsible for monitoring national fishing vessels regardless of the waters in which they operate or the port in which they are located, as well as fishing vessels in other Member States and third countries operating in Union waters under national sovereignty or jurisdiction. With the development of the rules of the CFP, including the international obligations of the European Union, within the framework of RFMOs, treaties with third countries, and the implementation of Portugal's obligations, the FMC-PT has reinforced its position. This was especially true after the promulgation of the Council Regulation (EC) Nº. 1005/2008 and Council Regulation (EC) Nº. 1224/2009, as well as the new CFP, established by Council Regulation (EC) Nº. 1380/2013 of the European Parliament. With that, Portugal assumed a significant importance in the monitoring and coordination at the level of the System of Information, Inspection and Control for Fishing Activities (SIFICAP) and the EU, working under the DGRM on a permanent basis.

The SIFICAP endorses the surveillance, inspection and control of fishing activities at the national level, defining the competent designated authorities and participants in the system. It was the first Monitoring, Control and Surveillance System (MCSS) in the world to integrate subsystems of multiple entities to contribute to a better protection and

[16] Decree Law 49A/2012. Approval of the organic of the DGRM. Available in: https://data.dre.pt/eli/dec-lei/49-a/2012/02/29/p/dre/pt/html
[17] Available in: https://data.dre.pt/eli/dec-lei/310/1998/10/14/p/dre/pt/html
[18] Council Regulation (EEC) No 2847/93 of 12 October 1993 establishing a control system applicable to the common fisheries policy.Available in: http://data.europa.eu/eli/reg/1993/2847/oj

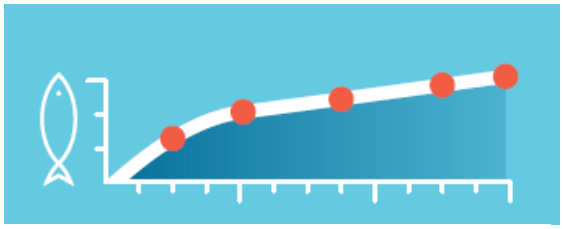
conservation of fisheries resources, having subsequently been instituted and regulated by Decree-Law Nº. 79/2001. The institutions combined in the SIFICAP are the following: DGRM, Navy, Air force, Republican National Guard, Regional Directorate of Fisheries in Madeira, and Regional Directorate of Fisheries in the Azores. In SIFICAP, the three components of a MCSS are contemplated, coordinated by DGRM in the exercise of the competences of the National Fisheries Authority (NFA), as currently stipulated in paragraph 5 of article 5 of the Regulation (EC) Nº. 1224/2009.

3. FISHERIES MANAGEMENT

European Union member states have taken action to guarantee that the European fishing industry is sustainable and does not threaten fish population size and productivity over the long term. Consequently, in the 1970s the EU ratified the Common Fisheries Policy (CFP). During the first years of its implementation, the CFP underwent continuous updates to its overall policy with the most recent update occurring in 2013 (EU Nº. 1380/2013) and its enforcement following on 1st January 2014.

The reform of the CFP is guided by principles of good governance with decision-making influenced by the best available scientific advice, comprehensive stakeholder engagement and the inclusion of a long-term perspective. The reform also changes the way in which the CFP is managed, giving the member states greater control at the national and regional level.

To achieve the objectives of the CFP, a combination of several conservation measures need to be adopted such as management plans, technical measures, and informed allocation of fishing opportunities. To guarantee a minimum stability for the fisheries sector, these conservation measures include the restriction of activity within areas of high biological importance, the defining of technical measures in terms of mesh sizes and fishing gears, as well as ensuring strict control, inspection and surveillance of fishing activity. Moreover, management plans need to establish targets in terms of fishing mortality or population biomass generally through the incorporation of maximum limits for the TAC inter-annual variations.



Source: European Union, 2015

The development of specific multi-annual plans for each fishery must cover the jointly exploited populations, with clearly defined time frames and management objectives so as to contribute to the sustainable exploitation of the populations whilst ensuring the protection of the marine ecosystems. These multi-annual plans should be adopted after

consultation with Advisory Councils, fishing industry, scientists, and other designated stakeholders (Position n° 9/2013[19]).

Fisheries management plans (see Table 3 for some examples) aim at reconstructing, managing, and maintaining populations within sustainable biological limits. The conservation and sustainable exploitation of fisheries resources and populations is achieved through the efficient implementation of recovery and management plans (articles 5 and 6 (EC) Nº. 2371/2002[20]) under the CFP.

Multiannual plans (Table 3) are one of the main instruments in the CFP for managing the annual number of days spent at sea (i.e., fishing effort). They are based on scientific, technical, and economic advice and are adopted as priority. Multiannual plans must contain conservation measures in accordance with Article 2 (2) of the CFP (EU 1380/2013) which apply the precautionary approach to fisheries management in order to ensure that the exploitation of living marine biological resources maintains populations of harvested species above levels which can produce the maximum sustainable yield (MSY).

[19] Position N° 9/2013 of 17 October 2013 council estatement on multi-annual plans. Available in: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A52013AG0009

[20] Council Regulation (EC) No 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy. Available in: http://data.europa.eu/eli/reg/2002/2371/oj

Table 3: Common Fisheries Policy and examples of Portuguese management plans.

The Eel Management Plan	Submitted by Portugal on April 5th, 2011, to the European Commission (EC) within the scope of EC N° 1100/2007, provides plan for the recovery of European eel (*Anguilla anguilla*) populations and involves measures to control fishing effort but also measures that allow the reconstruction of eel habitats and the elimination of barriers to their progression in courses of water.
The Sardine Management Plan	Designed to ensure the sustainability of the sardines (*Sardina pilchardus*) seine fisheries. Restrictions on fishing on the Portuguese mainland were implemented through Ordinance Nº.251/2010, amended by Ordinance Nº. 294/2011, Ordinance Nº. 173-A/2015, and by Ordinance Nº. 34-A/2016. The article 2 of Ordinance Nº. 294/2011, determines a ban on sardine seine fishing during weekends, with the possibility of changing the period in paragraph 4 of the same article.
The Fishing Effort Adjustment Plans	Plans to adjust member states' fishing efforts, in order to adapt the fishing fleet to the available resources. These plans follow the Commission Regulation (EC) N°. 1198/2006 regulated by Commission Regulation (EC) Nº. 498/2007.

Alternatively, recovery plans aim at reconstructing populations outside safe biological limits. Recovery plans always have a long-term management objective to recover resources at safe biological levels for up to ten years, with a wide range of management instruments, including the reduction of fishing opportunities, limitations on fishing effort, establishment of closed seasons, enforcement of minimum sizes, addressal of bycatch along with other specific control measures. Recovery plans have been adopted for several populations, but the most important currently operational plans for Portugal, are the following:

- Recovery plan for Southern White Hake (*Merluccius merluccius*) and Norway lobster (*Nephrops norvegicus*).
- Recovery Plan for Bluefin tuna (*Thunnus thynnus*) in the Eastern Atlantic and Mediterranean.

- Greenland Palm / Halibut Recovery Plan (*Reinhardtius hippoglossoides*).

In order to sustain and maintain fish populations in the long-term, the new CFP states that more strict catch limits should be adopted between 2015 and 2020. Since the impact of fisheries on the surrounding fragile marine environment in Portuguese waters remains poorly understood, the CFP adopts a precautionary approach, which acknowledges the impact of human activity on all the ecosystem components (Aranda *et al.,* 2019). It also seeks to improve the selectivity of fishing fleets and their respective gear types employed to reduce the practice of discarding bycatch. To enforce greater stringency, a landing obligation (LO) of species subject to the TAC, was developed in phases since 2015 (LO, article 15 of the EU 1380/2013).

3.1. Landing Obligations

As previously explained in section 2.4, total allowable catches (TACs) are the key mechanism used to achieve stock conservation objectives in the North-East Atlantic. More recently, in the new EU CFP (Article 15 of Regulation (EU) Nº 1380/2013) landing obligations (LO) were included to ban fishery discards, which, in addition to being a waste of resources, the practice of discarding affects the sustainable exploitation and economic viability of fisheries in the long run. The ban on discarding was gradually implemented from 1 January 2015 until 2019 relative to the different fisheries and targeted species among EU member states and is only applicable in the Atlantic to TAC-regulated species (e.g., skates, norway lobster, blue withing) and in the Mediterranean to species that have a minimum conservation reference size (MCRS), caught in European waters or by the European fishing fleet. The TACs previously limited the number of fish landed at harbour but not the entire catch onboard, however, since 2015 all catches of TAC-regulated species in the Northeast Atlantic must be landed and accounted against the relevant quota - a process that was intended to be fully implemented by 2019. Individuals below MCRS are not allowed to be sold for human consumption to avoid creating markets for undersized fish.

To implement the LO and reduce the economic impacts of the obligation on fishers, several concessions were made. Included in these concessions was the general increase

of TAC quotas by 36% since it was believed that, with the LO in force, the landing volume of TAC-regulated species would be higher and consequently, the risk of fisheries early closure due to choke species would be exacerbated. Other concessions were made, namely the exemption of the LO, which allowed for catches to be discarded and not deducted from the quota, however, it is still required to register the total catch including all discards in the logbooks. The exemptions are the following:

(1) Prohibited species exemption is attributed mainly to Protected, Endangered or Threatened species (PET) that if caught, must be released immediately, such as deep-sea sharks (REGULATION (EU) 2016/2336).
(2) Damage by predators was an exemption condition initially related with the seal predation in salmon fisheries in the Baltic Sea (Borges and Lado, 2019), however the validation of this exemption is extended to any European fishery.
(3) High survival rates exemption is attributed to all fisheries in which TAC-regulated species presented scientific evidence of high survival rates after being discarded. Although “high” survival rate was originally discussed to be above 50% (STECF, 2013) it is now considered above 17% (EC, 2018). The survival rates are intrinsically related to specific parameters, thus scientific evidence is advised on a species, fisheries and area basis.
(4) *de minimis* refers to the exemption related to minimal accepted discard percentages and is accepted up to 5% of total annual catches (up to 7 and 6% during the first two consecutive transitional 2-year period). It is applicable under two conditions: if there is scientific evidence that increases in selectivity are “very difficult” to achieve, or to avoid “disproportionate costs” of handling unwanted catches, but only where the bycatch by the gear in question does not represent more than a certain percentage of the catch.

Thus, to know if a species should be landed according to the LO, the following steps must be taken into consideration in the decision-making process (Figure 4).

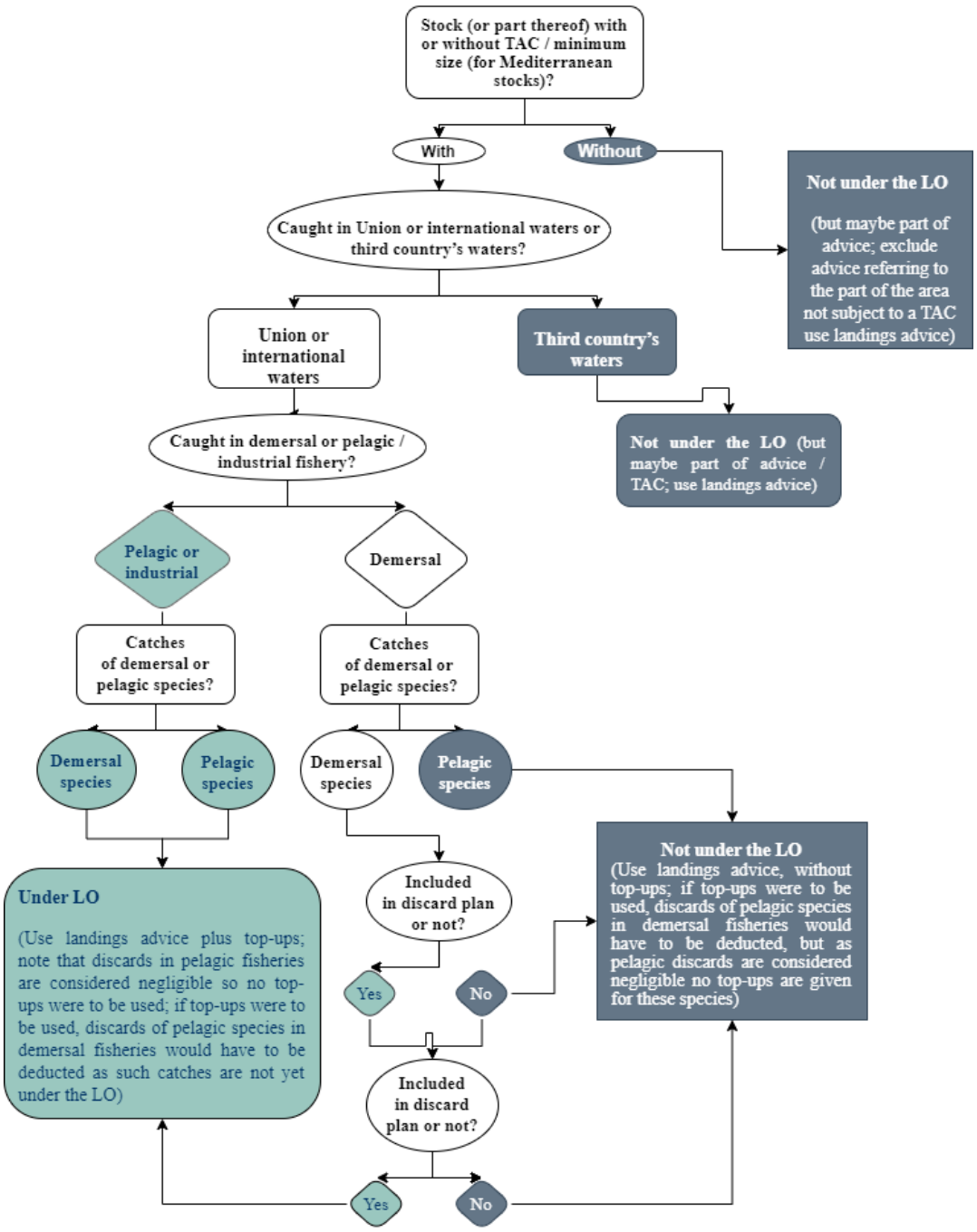


Figure 4: Decision tree adapted from the ClientEarth (2016) which indicates the steps taken in order to evaluate whether the catch is subject to the landing obligation (LO) or not depending on area, type of fishery and type of species. This diagram also indicates whether top-ups are used or not, and which part of the scientific advice TACs should be compared to.

The LO was fully implemented in Portugal as of January 2019 and is now in force following the Commission Delegated Regulation Nº. 1394/2014 and Commission Delegated Regulation Nº. 2019/2237. The species and fisheries subject to LO in Portugal are the following for **pelagic fisheries**: anchovy, mackerel and horse mackerel; and for **demersal**

fisheries: sand sole, anchovy, horse mackerel, picked dogfish, red seabream, alfonsinos, pollack, Norway lobster, common sole, ling, black scabbardfish, hake, rays and skates, flounder, monkfishes, mackerel blue whiting[21].

The main rules of the LO that apply in waters under the sovereignty and jurisdiction of Portugal are the following:

- Discards under *de minimis* exemption can be performed until they reach the authorized percentage. When the *de minimis* percentage is reached, the information is transmitted by the DGRM at a national level and by Regional Secretariats responsible for the fishing sectors in the Autonomous Regions of Madeira and Azores.
- TAC-regulated species captured above and below the minimum conservation reference size (MCRS) must be kept on board, except when any of the authorized exemptions apply.
- Registration is mandatory even for species discarded, however, the quotas are not deducted. These records are the basis for verifying *de minimis* exemptions.
- Landing of species below the MCRS can only be used for purposes other than human consumption, including fishmeal and fish oil, dog food, food additives, pharmaceuticals, and cosmetics.
- For non-TAC species, only quantities above the MCRS may be kept on board, whilst quantities below MCRS must be immediately discarded.
- The MCRS for anchovy (*Engraulis encrasicolus*) caught in ICES division IX and in the CECAF 34.1.2 is 9 cm although for certain pelagic fisheries within the scope of the discard plan established in national legislation the MCRS is 12 cm.
- For the ICES Divisions VIII-c and IX the horse mackerel (*Trachurus* spp.) MCRS is 12 cm for 5% of the Portuguese share in those areas. The artisanal beach seine fishery can catch 1% of this 5% limit in division IX-a.

[21] In Annex I there is a table with the most important commercialized species in Portugal and their respective commercialization rules in national or EU waters.

Despite the concerted efforts taken to implement the LO for the EU fishing fleet, there were no perceived changes in the reduction of bycatch and fishing practices (e.g. Savina, 2019, Borges, 2020). In fact, the European Council (EC) pointed out that, there is in general, a lack of compliance with the LO (EC, 2019, 2020) and that illegal and unrecorded discarding is in turn widespread (EC, 2018b, 2020), mostly due to insufficient monitoring and control along with slow shifts in policy. According to Borges (2020) the non-compliance of the LO linked with the 36% increase on the TAC quotas, is a reflection of the non-complementary at-sea monitoring schemes. In response to the increased quotas, fishing activities intensified in order to make use of the available TAC for commercial species and sizes; consequently, there was an observed increase in unwanted catch and discards, which Borges (2020) argued could wield a significant increase in fish mortality on European populations. Thus, it becomes paramount to intensify monitoring, control and inspection measures to ensure that the LO in the EU is enforced (Borges, 2020).

3.2. Monitoring and Reporting Systems

Safeguarding the sustained abundance of fish populations and the future of fisheries demands the implementation of effective monitoring, controlling and surveillance systems. While fish populations naturally forego seasonal cycles of renewal, the overall health and status of the populations remain dependent on the external pressure exerted upon them by the fishing industry, with many populations being continually overfished.

When deliberating how to sustainably harvest fish populations, fisheries managers need to take into consideration the three vectors of sustainability, namely the environmental, economic and social factors, all fundamental in their contribution to decision-making (Weaver *et al*., 2008). Thus, fisheries data collection, recording and reporting becomes critical for fisheries management through its indication of the sustainability of a fishery and/or its gear.

The last 10-15 years has seen a marked increased effort in the monitoring and reporting capacity of commercial fisheries within several countries, boosting the quantity of bycatch

and discard data available (Pérez Roda *et al*., 2019). Fisheries monitoring and reporting systems are conducted through various schemes worldwide listed below as presented by Gilman *et al.* (2012) and Mangi *et al*. (2013) as:

I. Dockside and onboard observer programs
II. Fisheries surveys, interviews and collaborative sampling schemes
III. Smartphone reporting
IV. Electronic monitoring and reporting (EMR)

Broadly, fishers understand the challenges of their operation as it relates to productivity and imposed legal obligations, yet the expansion and modernization of fishers' data collection remains slow due to the capacity constraints and levels of concern held by fishers regarding a loss of privacy and control for fear of their "trade secrets" being revealed (Eayrs *et al*., 2015; Mangi *et al*., 2013; Dowling *et al*., 2016).

Additionally, there is a widespread lack of formal training provided to fishers to record data according to the prescribed data collection methods (FAO, 2020). Discard data is of greatest concern since fishers can generally underestimate, or simply not record, the amount or volume of discarded organisms with ease (Brown, 2001; Walsh *et al*., 2005). Moreover, there are economic and regulatory concerns that might hinder fishers from recording data consistently, since this data may be used to discredit their fishery or otherwise impose additional restrictions (Brown, 2001; FAO, 2003; Walsh *et al.*, 2002, 2005; Gilman *et al*., 2018). Consequently, the data collected, particularly on discards, is considered to be less reliable than other methods. Thus, onboard observer programs are currently the most widespread, accurate and reliable source of fisheries related information through the manual recording of data by human onboard observers (HO) or electronically, using electronic technologies such as video cameras (electronic monitoring-EM) and electronic logbooks (electronic reporting-ER) than through fishers reporting logbook (e.g., Gilman *et al.* 2012; Pérez Roda *et al.*, 2019; WGTIFD, 2019).

The use of human observers is the most common process for data capture in commercial fisheries (Saila, 1983; Alverson *et al*., 1994; Kennelly, 1995; FAO, 1996; Liggins *et al*., 1996). This process involves an onboard observer recording data manually in paper

logbooks which is later manually digitized and saved on computerized databases for further analysis. This multi-step means of data capture often results in long delays of the analytical processes and in turn, the associated management actions by months or even years. Moreover, the nature of handling the data in such a manner that it must transfer through multiple 'hand's before it is ready for analysis, introduces much room for error and inaccuracy of results. Alternatively, the data capture process can be improved through the use of electronic technologies which are instead more reliable, efficient and provide a means for speeding up the analysis process (Borges, 2020). In addition to increasing the ease at which fishing activities can be monitored and reported, electronic technologies can hasten the feedback process of analysed fisheries data to aid fishery managers in their decision-making (Borges, 2020).

Electronic Monitoring (EM) is conducted using imagery (video or still cameras), sensors and global positioning systems (GPS) to independently monitor the fishing operations, effort and/or catch (Figure 5). This is all done in combination with the Electronic Reporting (ER) which is conducted using software and devices such as smart phones, tablets or laptops to record, transmit, receive and store data (EFCA, 2019). Several studies compared the precision and accuracy of the data collected by human onboard observers with EMR and found the data collected by EMR to have a higher precision than the data collected by human observers (e.g. Pérez Roda *et al.*, 2019; Van Helmon *et al*., 2020). Although EMR systems can be used to complement the data captured by human observers so as to increase data coverage, EMR systems can be solely used as a more cost-effective and accurate alternative to human observers (Needle *et al*., 2015). Further, EMR has the potential to provide a much wider data coverage than any other observer program and increase the precision of the registration and position of fishing activity (Van Helmond *et al.*, 2020). Thus, EMR systems are progressively being implemented throughout the world as a complementary or even alternative fisheries management tool, providing monitoring of activities 24h, 7 days a week, storing data and images for several months in a row. The data can either be stored in hard drives for later assessment and analysis or remotely transmitted via satellites, Wi-Fi and mobile data networks, i.e., remote electronic monitoring (REMR). Furthermore, EMR provides information on fishing activities such as catch handling and composition, fishery discard practices, and can even

be used as a means to verify information transmitted by the fishers where necessary (Gilman *et al.* 2018).

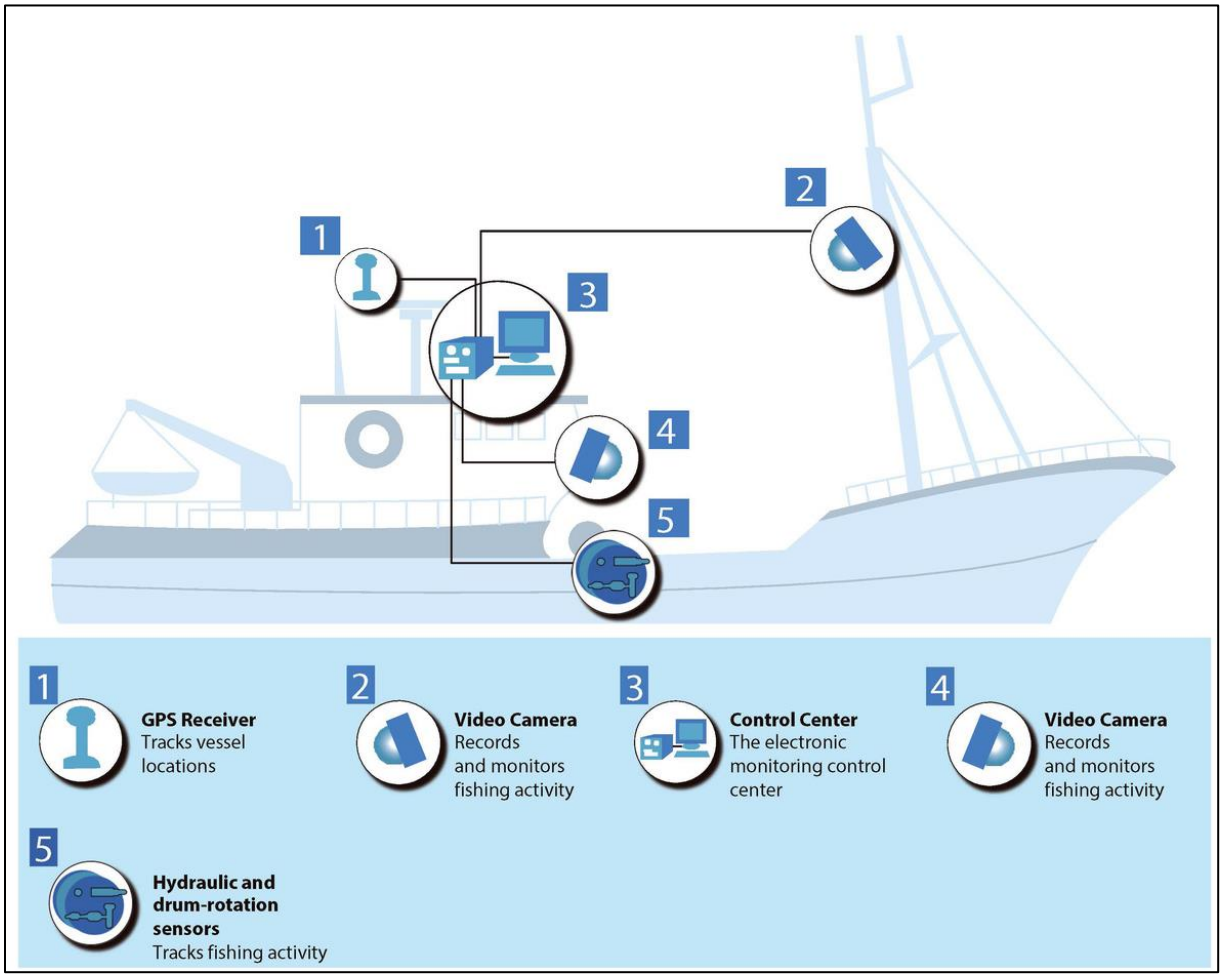


Figure 5: General diagram of an electronic monitoring system in a fishing vessel.
Source: https://www.fisheries.noaa.gov/feature-story/implementing-electronic-monitoring-alaska-fisheries

Though the EMR system is a powerful tool, there is still need for development in features such as the possible use of artificial intelligence to detect discarded species (Gilman *et al.*, 2018). The Working Group on Technology Integration for Fishery-Dependent Data (WGTIFD) identified the following challenges for implementation of this system:

- "**Industry buy-in and participation** - associated to low levels of monitoring, compliance programs, to privacy and data ownership concerns.
- **Cost effectiveness** - matching objectives and workload to different fisheries realities (vessels sizes, economic realities), scaling pilot studies to fisheries,

system details (storage and hardware set-up), and compliance with monitoring levels of Electronic Technology (ET) vs. Human Observers (HO) programs.

- **Lack of interoperability of programs and products** – different standards, requirements, and specifications for service providers, equipment, but also between EM and HO pro-grammes (such as monitoring levels and reporting requirements).
- **Coordination between different program actors** - industry, service provider, scientists, management agencies within the same program.
- **Reporting obligations** – there can be several reporting and monitoring requirements, at different temporal and spatial scales, across different jurisdiction and governances. It can be difficult for fishers trying to adhere to complex requirements, but also resource intensive for managers and scientists trying to integrate and analyze data across these systems.
- **Logistics** – difficulties in transmitting data from where vessels operate, to where video is reviewed, in tracking vessels, in providing physical support to systems.
- **Disparity in programs coverage of fishing activity**, especially during Covid-19, as EM continues to operate while HO stopped." (ICES, 2019, 4)

On the other hand, the WGTFD identified the following promising and positive aspects regarding the implementation of EMR systems:

- "**Engagement and empowering** the fishing industry from the beginning of an ET program increases transparency and trust, leading also to increased buy-in. Involve industry at the beginning of the process, in the design phase of a program.
- **Adding value** makes fishers more willing to incorporate and maintain ETs (e.g. (by) catch reporting, increased observer safety, greater confidence in collected data, deter illegal activity, increased transparency).
- **Good communication between stakeholders**, for example, reporting any catch handling or data quality issues back to fishers (feedback reports) after EM imagery is reviewed, but also integrating fisher's knowledge (in finding solutions).
- The right **balance** between reaching program technical requirements and objectives and building flexibility to adapt to fisheries and fishers' realities.

- **Long term success is difficult but possible**, by moving from a pilot program to an operational program at scale and integrating EM data into the current data streams.
- **ET allows fishing regulations to change and adapt**, while increases compliance.
- To **increase interoperability**, one should focus more on common data outputs from ET programs, and less on common hardware and software, to build the competitiveness of service providers.
- **Be mindful of scalability** – do not over limit the programs initial objectives and carry out pilot studies on only a few boats, before scaling up to the entire fishery.
- **Monitoring programs (ER, EM, HO) should complement each other**, and be used to validate data across tools. This will lead to improved data integrity, improve catch re-porting, and ultimately lead to a better understanding of assessing a fisheries stock. Using EM to validate reporting can also improve catch handling practices to improve data quality." (ICES, 2019, 3-4)

3.2.1. European electronic monitoring and reporting system

The monitoring of catches using Remote Electronic Monitoring (REM) has been applied in several fisheries around the world and shown to be an effective way to monitor the LO and generate catch evidence for science and compliance (STECF 2020; Suuronen and Gilman, 2020).

To monitor compliance with the LO requires ongoing monitoring of discards (Suuronen and Gilman, 2020), as specified in article 15, paragraph 13 of the CFP (EU, N° 1380/2013). Thus, member states must ensure detailed and accurate documentation of all fishing trips and adequate capacity and means of verification, such as observers, closed-circuit television (CCTV) or other methodologies. In doing so, member states should respect the principles of efficiency and proportionality.

The EM has been applied worldwide since 1999, for instance in the crab fisheries in British Columbia, Canada, in the Alaskan longline fisheries in 2002 and in 2012 to monitor the

bycatch of several fisheries in Australia (Van Helmond *et al.,* 2020). Europe is following the same trend and started the EM trials in 2008 in the North Sea mainly with demersal fisheries. The 16 trials took place from 2008-2018 specifically in Scotland, England, Denmark, Netherlands, Sweden and Germany and with application to a wide range of fisheries including the demersal, pelagic and beam trawls, gill nets, purse seine and longline fisheries (Van Helmond *et al*., 2020).

The Table 4 presents the usage of REM systems in Europe, from the date they started to be implemented up to nowadays. Some Member States such as Germany, Netherlands and Denmark discontinued the application of REM. Spain, despite having started only in 2012, it is the EU country with active REM that presents the highest numbers of vessels. The United Kingdom despite not being a member state anymore, it is portrayed for means of comparation since by the time of the REM implementation it was part of the EU.

Table 4: List of EU countries that have or had the REM system implemented for the fishing fleet portraying dates of the REM activity, the number of participating vessels and the vessel range in meters.

Country	Years of REM activity	N° of Vessels	Vessel range
Sweden	2008-present	17	~10-12m
United Kingdom*	2008-present	55	10-40m
Denmark	2008-2020	150	10-40m
Germany	2011-2016	5	12-37m
Netherlands	2011-2020	27	5-126m
France	2012-present	23	Up to 82m
Spain	2012-present	63	40-77m

* By the time REM systems were implemented UK was still part of the EU

Source: http://www.transparentfisheries.org/bringing-eu-fisheries-into-the-digital-age-how-remote-electronic-monitoring- can-improve-fisheries-management/

Even though EM has been demonstrated as a good tool for reporting catches and control and enforce the LO, EU managers remain reluctant to use EM due to their concern that the tool is unpopular among fishers due to the concern regarding the potential for invasion of privacy in fishers' workspace (Baker *et al*., 2013; Plet-Hansen *et al*., 2017) and the mistrust of the use of fishers' data (Mangi *et al*., 2013).

3.2.2. Portugal electronic monitoring and reporting system

In Portugal, it is mandatory for vessels of 10m to 12m in length to report their fishing activity in a paper logbook to the DGRM. For vessels over 12m in length, it is compulsory that their fishing activities are registered in an electronic fishing logbook (eLog). The Electronic Fishing logbook (DPE+ which stands for *Diario de Pesca Eletrónico*) was developed by the DGRM to comply with the EU Council Regulation (EC) N°. 1224/2009 which established the need to ensure a compliance community system with the rules of the CFP. The DPE+ has been in use since 2010 and is part of the public administration program SIMPLEX +2017 under the measure #230 – Electronic Fishing Diary+. However, as previously mentioned, the great majority of the Portuguese fishing fleet (i.e., 90%) is composed of vessels smaller than 12m length, and therefore much of the data gathered by the Portuguese fishing industry is missing or is not yet captured into the electronic system for sharing with management authorities. Furthermore, Portugal did not start any trial on EM systems and the suitability of this system to its fishing fleet is still unknown.

Therefore, the international company OLSPS International Unipessoal LDA based in Lisbon, in the scope of the project "The development of Electronic Monitoring and Reporting (EMR) technology for fisheries in Portugal (EMREP)" partnered with the University of Algarve and the company Imenco SA to adapt its eLog solution, the Olrac Dynamic Data Logger (OlracDDL) and the Olrac Dynamic Data Manager (OlracDDM), to be integrated with high technology cameras for use in the scope of a research project regarding bycatch and discards of elasmobranchs (sharks, rays and skates) by bottom-trawl fisheries and turn this the Olrac eLog solution into a fully compliant tool.

3.2.3. Olrac Electronic Reporting System

Vessel unit: Olrac Dynamic Data Logger (OlracDDL)

OlracDDL is a highly customizable electronic logbook (eLog) capable of collecting data in real-time and transmitting data reports via Wi-Fi, cellphones, or satellite networks. The Olrac software solution has been designed to withstand a high level of legal and technical scrutiny and has passed numerous certification tests in Australia, New Zealand, Europe, Canada and the USA. The Olrac software includes an optional, web based matching management utility (OlracDDM) that can manage the data of an entire fleet of OlracDDL users.

OlracDDL is presently installed and used on a daily basis on hundreds of vessels around the world, with virtually no software related problems. The OlracDDL eLog is a fully integrated unit backed by a carefully designed data model and it is not just a collection of many modules loosely connected to each other. As such, OlracDDL is extremely robust system and requires little support and maintenance. Further customization is relatively easy and unlikely to create software bugs. The OlracDDL software come into versions:

a) Windows based, that can be installed on any entry level PC hence there are typically no additional hardware costs.
b) Mobile version, that can be instaled on any Androids or iOS smartphone or tablet

OlracDDL almost completely eliminate the need for free typing as 95% of the data can be selected from predefined lookup lists and/or integrated sensors.

OlracDDL reports can encompass any subset of the data collected (raw or summarised), can be generated in any common computer format (e.g. XML, CSV, TXT), and can be sent to one or multiple end users (via HTTPS [SOAP], FTP, etc.). More than one report type (e.g. fishing activity, summarised catch, landings) can be generated during a given fishing trip, each with its own requirements and recipients. OlracDDL can serve as a stand-alone solution or interface with other third party databases.

Additionally, OlracDDL can be used for all compliance, commercial and scientific data collection and reporting. It can also be used for real time management if and when critical new information suggest an urgent need to take immediate management action. Apart from creating reports that can be sent to the main server in any format required, OlracDDL

can also process acknowledgements which the server sends in order to know if the report was received and if it was correctly added to the server system (if not, a correction report is generated). If required, there is also an option that will allow users to view report data in the paper formats that they are familiar with (logsheets). These log sheets can then be saved in pdf format.

OlracDDL is capable of being configured in many different ways in order to capture the data that is required by the user. Operational data is split into fishing activities and observations. The operational data is then used to generate the reporting data. Fishing activity data is captured at different levels such as trip, day, set, haul and catch. Based on the provided documentation, fishing vessels and observers need to capture very different information with some overlap. This will mean that it will be creating a vessel version and an observer version.

OlracDDL user interface has an uniform look and feel that can accommodate any fishery or fishing method at the press of a button. As such, the same software can be used for all fisheries and/or fishing methods. All data collected by the skipper are kept on the eLog database and can be used for future investigation or research.

OlracDDL can be used to collect sampling and size structure data as an integral part of the software catch recording utility. It can record any number of catch species (target, bycatch and discards). Catch can be recorded very accurately and at great details and can include: species names, product, grade, conversation factors from processed to green, packing container type and capacity, Packing material including additional contributors to gross weight (ice/water/other), fish quality, quality, variation in weight and quality overtime, destination (buyer of fish), quota tracker and more.

OlracDDL offers many value-added features over and above providing the ability to meet regulations in terms of reporting.

OlracGIS

OlracDDL include an integrated GIS mapping utilities named OlracGIS. This tool may include an optional, visual data analysis modules specifically designed to work with the OlracDDL main database. It allows the user to analyse subsets of data captured by OlracDDL for a particular analysis or presentation. For example, graphs can be drawn showing CPUE a function of time, moon phase, current strength etc. Also, spatial CPUE density distributions can be plotted on a map, which can then be filtered for different target species or to reflect differing environmental conditions. Subsets can be swapped in order to explore different scenarios and data relationships. For example, CPUE at new moon time compared to CPUE at full moon. The subset definitions, i.e. the list of classes and fields selected for the subset, can be saved for re-use. With OlracGIS it is possible to add calculated fields and to use them just as pre-entered data. For example, the calculations of CPUE by dividing catch weight by fishing duration.

Shore Unit: Olrac Dynamic Data Manager (OlracDDM)

OlracDDM is a sophisticated web-based application which can house fishery records, as well as manage, store, analyse and distribute submitted reports (e.g. port departure and entry, fishing activity, catch, landing, vessel movement, sales and transhipment). Access to OlracDDM is controlled by secure user access with different levels of accessibility. For example, an “Administrator” would have complete access and control, a “Fisher” might have access to submit and view his/her own reports and analyses of his submitted data, an “Inspector” might have access to reports enabling him to inspect a particular vessel’s data for law enforcement purposes, whilst a “Fishing Company” might have rights to view data from vessels owned by that company. OlracDDM allows users to view real-time reports coming from different vessels into OlracDDM; to view, analyse and summarize vessel activity data; and to view vessels and catch locations via a map interface. OlracDDM also includes an extensive validation, auditing, and cross check system to validate data as it is entered and to automatically identify data inconsistencies, as well as a mechanism to transmit report acknowledgements. It incorporates a map interface to graphically visualize reported information. Further, OlracDDM can facilitate the push and

pull of data between itself and other Olrac tools as well as other third party systems, as required.

OlracDDM limits access for each user to only visualize those data which he/she is permitted to view. Thus, the fisher's need to keep data secure from unauthorised access, is met. The data in OlracDDM can be analysed and aggregated via the integral reporting tool. This tool, much like the GIS utility of OlracDDL, allows the user to construct queries on subsets of data held within the OlracDDM database, and to display these graphically, on the map, or in tabular format (which can be exported to other tools in csv format, and can be filtered for further analysis of the results). Conditions can also be applied to the query extracting the subset, and the resulting report can be saved so that it may be run again at a later stage. Furthermore, the results of queries shown on the map can be saved as map layers, thus allowing for density map comparisons between, for example, one year and another.

Typical implementation methodology

The Olrac Fishing Management Solution is typically far quicker to deliver than custom-built software. This is due to business philosophy behind the development of the Olrac platform.

When OLSPS first commenced development of electronic logbook solutions, it rapidly became apparent that each potential user often had different requirements in terms of the information that he wished to record and/or report, and in terms of the rules governing collection of this information. During the early development phases of the Olrac solution, each new set of requirements took considerable time to deliver, as each such requirement could only be met through the writing of specific code.

On realising the problems inherent in coding bespoke solutions for each client, the OLSPS team spent considerable time and effort in developing a generic electronic logbook platform that is able to be automatically generated. Thus, instead of always writing new code to meet to each client's specific requirement, the Olrac development team wrote codes that would generate the data logging software from the configuration files as defined by a client specific requirements analysis.

For each new client (fishery/nation), OLSPS apply the following steps:

a) Undertake a business (requirements) discovery exercise with the client, to understand specific requirements and the rules relating to such requirements (e.g. frequency of data collection and reporting, criteria governing when certain fields are to be collected).

b) Take an existing configuration file, one most closely related to the client's requirements, and modify the content to meet exactly the new client's requirements. The files will be altered to not only match the activities (e.g. trips, shots, wildlife interactions) and events (e.g. catch landed; port departures; landings; transhipments) of importance to the client, but will also be modified to contain the master data (e.g. ports, species) specific to that client and the rules (e.g. mesh size is mandatory for gillnet, trawls and purse seine gear; number of hooks is mandatory for longline gear; depth fished is required for static gear) pertinent to that client.

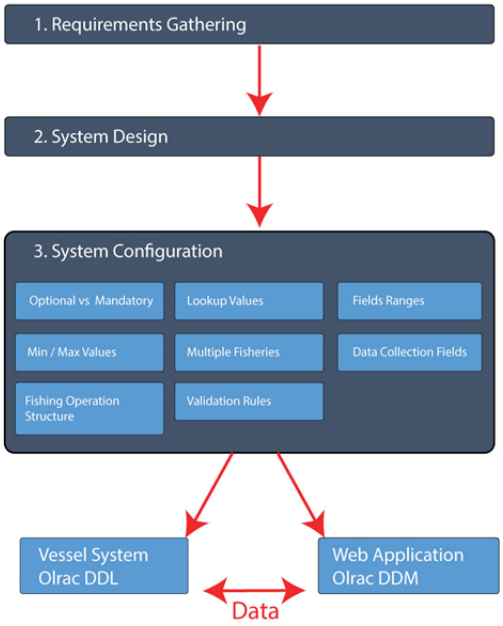


Figure 6: Typical development and deployment process of the Olrac technology.

c) Generate both the OlracDDL and OlracDDM using the client-specific configuration files.

The dynamic nature of the development approach has numerous benefits for the client. Firstly, development is significantly quicker. Secondly, modification to the system, should the need arise, is also significantly quicker, as one can simply make a change to the configuration files, re-generate the system, and the screens are automatically updated to reflect the change. Finally, the fact that both the vessel-based and shore-based systems are generated from the same files, means that the databases are identical in structure. Thus, the transfer of data between the two systems is easily accommodated via existing import/export functionality.

4. GAP Analysis

Even though the Portuguese commercial fishing fleet, already make use of the solution DPE+ to mandatory report its catches, there exist several distinctions between the two electronic technology solutions, i.e. DPE+ and Olrac system. The DPE+ is an electronic reporting system able to send crucial information to the fishing authorities for fishermen to remain compliant with the relevant legislation. The Olrac system is alternatively, a more comprehensive tool used for reporting as represented in item 3.2.3. The figure 7 presents a general view of both eLogs, where the DPE+ is portrayed on the left column and OlracDDL on the right column.

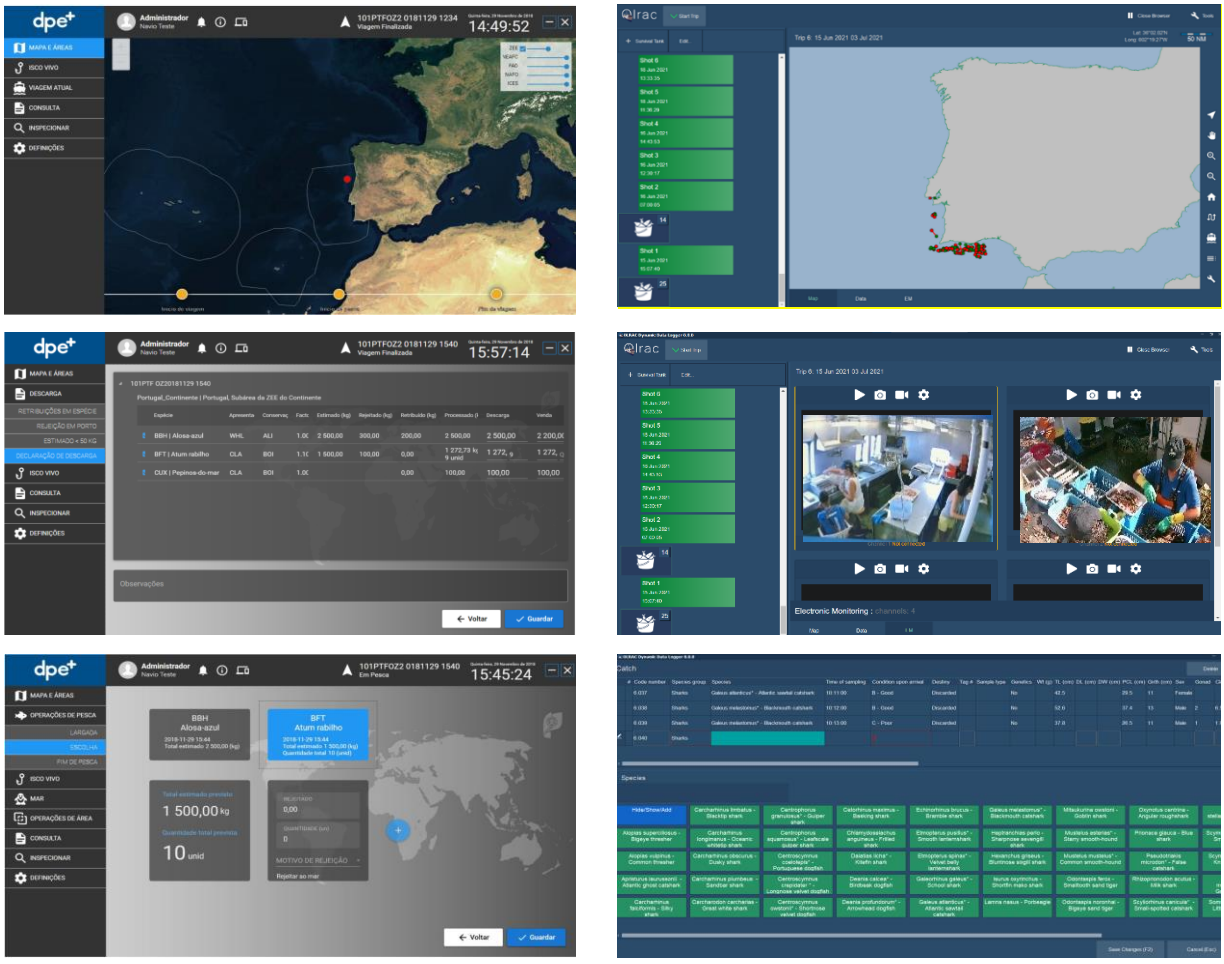


Figure 7: General overview from both DPE+ (left column with images collected from DGRM webpage) and Olrac eLog solution.

User Experience

The currently available electronic reporting (ER) system for the Portuguese EEZ the DPE+ enables data capture related to fishing events in international waters regulated by Regional Fisheries Management Organisations (RFMOs) and third countries fulfilling the Union Control Regime, established by Council Regulation (EC) 1224/2009 of 20 November 2009. It fulfils the fishing log obligation applicable to Union fishing vessels and provides a reporting opportunity to update relevant reporting authorities for every piece of information captured. It meets the compliance requirements for vessels 12 metres and above.

The OlracDDL is an onboard fishing eLog solution for the collection and reporting of operational, biological and environmental fishing data. The OlracDDM complements the OlracDDL in that it is a web-based shore system for data and reports management. It can read and store data from multiple fleets enabling real-time analysis of fishing activities. The Device Logger complements the OlracDDL and connects to various sensors onboard the vessel including connected GPS (UDP/ Comm Port), CTD's (conductivity, temperature and salinity), echosounders and other sensors.

A key benefit of the Olrac solution is its powerful capacity for electronic reporting, electronic monitoring and capture of other scientific and biological data to ensure compliance obligations are met with the added value of capturing information and providing insights on fishing activities to complement compliance. The Olrac eLog Solution follows fishing activities logic and is also a touch-screen ready application for ease of use.

Solution Compatibility with different Operating Systems

The currently available DPE+ solution is compatible with Windows XP, 7, 8 and 10. However, the solution is limited to deployment within Windows gadgets only; use on alternative Operating Systems is hindered. In comparison, the Olrac eLog solution is compatible with Windows, Android and iOS Operating Systems. The use of the OlracDDL presents an appealing alternative to the DPE+ solution for fishers since the use of a handheld smartphone and/or tablet would be more convenient for its ease-of-use and

reduction of time demanded on administrative activities and data capture where fishers would otherwise be fishing.

Intelligent Data Capture and Analysis

The current DPE+ software meets compliance requirements as fishers are mandated to report to the DGRM, the Portuguese National Fisheries Authority. It provides an opportunity to capture required fields for electronic reporting (as was required in paper logbooks) and allows for the generation of e.g. Fishing Activities, Fishing Region Entry and Exit, Return to Port and Landing Reports. It is also integrated with the Satellite Ship Monitoring System (MONICAP), which have a global coverage for Continuous Monitoring of Fishing Activities and provides periodically or immediately provides various data (e.g. location, date, time, speed, use of unauthorized gears) to the Fisheries Control and Surveillance Center (FMC-PT) whenever needed.

From the description of the Olrac system in item 3.2.3, it is clear that Olrac eLog offer many capabilities, far above the very limited scope of the minimum EU compliance reporting requirements. This Olrac tool is unique in that it can analyze data collected by fishermen or onboard observers and send that vessel data (OlracDDL) to at-shore facilities (OlracDDM) which in turn, can retrieve, treat and scrutinize the data, either for compliance with fishing authorities or the fishing company concerned; otherwise the data can be used for scientific purposes through research facilities. Olrac also offers a bycatch avoidance tool which provides fishermen with information regarding areas of high bycatch so that fishers can make informed decisions about how to avoid bycatch and instead focus efforts on higher target species areas. Further, the tool combines the technical and environmental information that is inputted in the logbook to understand the best conditions for fishing and the areas with the highest likelihood of productivity. Lastly, the Olrac solution can integrate with images taken from onboard cameras so that information on discarded TAC species might be remotely assessed by fishermen themselves or by the relevant authorities if necessary (Figure 7). The system integration and a full compliant tool will be available by the end of the EMREP project.

Electronic Monitoring (EM)

As previously stated, the major objective of the EMREP project is a fully integrated Electronic Monitoring and Reporting (iEMR) solution within the Olrac eLog. Within the iEMR solution, the Electronic Monitoring system will exist as a verification tool to verify the accuracy of the data captured by the fisher within the Electronic Reporting system. The iEMR solution offers a reliable and effective tool for the capture and recording of vessel, effort, catch, discard and environmental data as demanded fisheries management compliance, whilst simultaneously ensuring the authenticity of the data captured. It may as well serve as means of verifying discards and aids on the enforcement and compliance of landing obligation for TAC-related species. It will also integrate artificial intelligence (AI) developed especially as means to verify the elasmobranch bycatch. The Electronic monitoring capability or a similar utility is currently not available within the DPE+ system.

Ease of Customisation

The DPE+ enables fishing vessels to remain compliant and report to the relevant fishing authority as mandated. However, in addition to meeting compliance requirements for fishers, the Olrac eLog solution enables backend customisation possibilities for fishers that are driven by user requirements related to fishing operations, while maintaining the integrity of fisheries compliance. It is also customizable for scientific purposes for research and development (R&D) institutions. OlracDDL enables amongst other backend configurations, additional field configurations including the inclusion of favourite catch entries (i.e., Quick Catch feature), thus reducing data entry steps by over 50% for the user. Other customisations include normal vs. bold font, dark vs. light theme and day vs. night contrast mode of the Olrac eLog Solution amongst others.

Shore System Analysis Tools

The DPE+ solution offers vessels a data entry and reporting tool but does not provide an analysis platform for the solution's user/s. Whereas, the OlracDDM has many built-in, smart, and user-friendly queries and visualization tools that can be accessed via the tool's web interface. Moreover, the OlracDDM can read data from an entire fleet, aggregating it for further analysis in real-time (where internet connectivity between the vessels and shore is sustained). In essence, the complete Olrac eLog solution introduces a new

dynamic to fisheries data capture and management where shore personnel can play an active role within at-sea activities without being present onboard to enable enhanced, powerful and on-the-go management of fishing effort and activity. Much likely, the DPE+ also provides with a similar tool to collect and manage the fishing reports that are sent to DGRM by fishers, although this information is not available at the DGRM webpage.

Value for Money

The main differences between the DPE+ and the Olrac solution as captured within this analysis and more specifically within Table 5[22], highlight the power of the Olrac solution to improve fisheries management by not merely ensuring compliance of fishing activities, but additionally, empowering fishers to make informed decisions on their harvesting activities through the real-time analysis of Olrac captured data demonstrated by the DDM, and the subsequent ability of shore-based management personnel to interact with active fishers onboard. The powerful capabilities of the Olrac solution offer fishers a compelling value for money alternative to the DPE+.

[22] The lack of information on the DPE+ column, does not necessary means that the DPE+ does not contain the specific feature outlined. It means that no such information could be retrieved from the available documentation that it is freely accessible in the internet, specifically from https://www.dgrm.mm.gov.pt/en/diariodepescaeletronico

Table 5: GAP analysis between the Portuguese compliant Electronic Reporting tool, the DPE+ from the DGRM and the Electronic Monitoring and Reporting tool, the Olrac eLog solution from OLSPS.

MAIN FEATURES	DPE+	OLRAC eLog
User Experience		
Data capture in international waters regulated by RFMOs	x	x
Collects and transmit fishing-related technical data (e.g. fishing gear, fishing areas, ports of departure and arrival)	x	x
Collects and transmit fishing activity (e.g. catch, bycatch data)	x	x
Collects and transmit fishing-related environmental data (e.g. wind direction		x
Collects and transmit fishing-related basic biological data (e.g.		x
Reports to DGRM	x	x
Reports for Commercial purposes		x
Reports for Scientific purposes		x
Real-time analysis of fishing activity		x
Compliance tool	x	x
Sensor's integration (e.g. temperature, depth, salinity)		x
GPS integration	x	x
Compatibility with different operating systems		
Windows XP, 7, 8 and 10	x	x
Android and iOS systems		x
Intelligent data capture and analysis		
OlracGIS		x
Spatial visualization for hotspots areas		x
Bycatch avoidance tool		x
Catch density maps		x
MONICAP integration	x	x
Electronic monitoring		
EM integration		x
Compliance with the landing obligation		x
Artificial intelligence (AI)		x
Ease of customisation		
For compliance	x	x
For fishers		x
For R&D institutions		x
Shore system analysis tool		
Shore based management system for data and reports management	x	x
Value for money		
Freely downloadable and mandatory	x	

5. REMARKS

This review has highlighted specific remarks on the importance of fisheries across the world. Though the ever-increasing rise in the global demand for seafood has placed intensified pressure upon fisheries, consequently, in order to ensure that the growing demand for productivity is met, the need to effectively manage fisheries has become paramount. Expounded upon above, to date, most fisheries still make use of manual means of data capture and monitoring which reduce the accuracy, reliability and comprehension of the fishery records and further delay the analysis process and feedback to fisheries management authorities who in turn, make less informed and often compromised decisions.

In Portugal the annual seafood consumption *per capta* is amongst the highest worldwide due to a number of factors considering that the Portuguese fishing waters falling within a unique and highly productive geographic location, and the connection of Portugal's citizens with the ocean, that has long been highly integral to the culture and identity of the nation. The national fishing fleet of Portugal is predominantly (i.e., 91%) characterised by smaller fishing vessels that are less than 12 m in length though most of its tonnage (i.e., 86%) is expressed by larger vessels. Seiners and trawling segments collectively land the greatest volumes of seafood caught by the Portuguese fleet – with the seine industry catching mainly mackerel, sardines and horse mackerel whilst the trawling industry most commonly land horse mackerel, mackerel and blue whiting.

In conjunction with defined marine protected areas designed to protect against mining operations of the seabed in certain biodiversity hotspots and areas of fishing operations, Total Allowable Catches (TACs) are yearly stipulated by researchers from the Divisão de Modelação e Gestão de Recursos da Pesca (DivRP) at the Portuguese Institute for the Sea and Atmosphere (IPMA) to sustainably manage fish populations within Portuguese fishing waters and ensure that the Common Fisheries Policy is accomplished.

More recently, Landing Obligations (LO) have been introduced to the management of Europe's fisheries and used to address the concerns regarding unregulated discards. Despite much effort made to implement the LO in the EU fishing fleet – little change has

been observed in dishonest fishing practices and in the reduction of bycatch. Ongoing illegal and unrecorded discarding practices at sea can be attributed to insufficient monitoring and control onboard fishing vessels.

Safeguarding the sustained abundance of fish populations and the future of fisheries demands the implementation of effective monitoring, control and surveillance systems. Yet the expansion and uptake of the modernization of fishers' data collection remains slow due to the capacity constraints and levels of concern held by fishers regarding a loss of privacy and control for fear of their "trade secrets" being revealed.

The DGRM in Portugal has deemed it mandatory for vessels of 10 to 12m in length to report their fishing activity in a paper logbook to the NFA, while vessels greater than 12m in length are required to register their fishing activity in an eLog. The DPE+ is the electronic fishing logbook that has been in use since 2010 and is part of the public administration program in the Portuguese fishing fleet. This review has however, argued that the Olrac DDL-DDM system is a much more powerful tool than the DPE+ for reporting and capturing fishing activity with its ability to transfer vessel data to either at-shore facilities for processing and analysis, directly to fishing authorities and/or to research facilities for further analysis. Moreover, the Olrac system is uniquely powerful in its ability to advise fishers on bycatch avoidance as well as its ability to remotely assess the compliance of fishers with the LO of discarded TAC species through its integration with onboard cameras.

Specifically modified to fit the Portuguese commercial fishing fleet, the deployment and use of the Olrac system is presented by this review as possessing the potential to improve the overall fishing data collection and reporting capabilities in Portugal and reducing bycatch and discards. Though, the development and integration of the Olrac with the EM system is underway, and trials are to be performed in research and commercial fishing vessels, the results from the Olrac system trials are to be shared and discussed in the forthcoming reports of the EMREP project.

REFERENCES

Aranda, M., Ulrich, C., Le Gallic, B., Borges, L., Metz, S., Prellezo, R., Santurtún, M. (2019). Research for PECH Committee — EU fisheries policy – latest developments and future challenges, European Parliament, Policy Department for Structural and Cohesion Policies, Brussels

Arnason, R. (1994). On Catch Discarding in Fisheries. Marine Resource Economics, 9(3), 189–207. https://doi.org/10.1086/mre.9.3.42629080

Alverson, D., Freeberg, M., Murawski, S. & Pope, J. (1994). A global assessment of fisheries bycatch and discards (Vol. 339). Food & Agriculture Org.

Baker, M. S., Von Harten, A., Batty, A., & McElderry, H. (2013). Evaluation of electronic monitoring as a tool to quantify catch in a multispecies reef fish fishery. In 7th International fisheries observing and monitoring conference, 8-12 April 2013, Vina del Mar, Chile.

Béné, C., Barange, M., Subasinghe, R., Pinstrup-Andersen, P., Merino, G., Hemre, G. I., & Williams, M. (2015). Feeding 9 billion by 2050–Putting fish back on the menu. Food Security, 7(2), 261-274 https://doi.org/10.1007/s12571-015-0427-z

Borges, L. (2020). The unintended impact of the European discard ban. ICES Journal of Marine Science, 78(1), 134-141.

Borges, T., Erzini, K., Bentes, L., Costa, M., Gonçalves, J., Lino, P., Pais, C. & Ribeiro, J. (2001). By-catch and discarding practices in five Algarve (Southern Portugal) métiers. Journal of Applied Ichthyology. 17. 104 - 114. 10.1111/j.1439-0426.2001.00283.x.

Borges, L. & Lado, E. (2019). Discards in the common fisheries policy: The evolution of the policy. In The European Landing Obligation (pp. 27-47). Springer, Cham.

Brown, C. (2001). Revised estimates of bluefin tuna dead discards by the U.S. Atlantic pelagic longline fleet, 1992-1999. Collective Volume of Scientific Papers ICCAT, 52: 1007–1021.

Catchpole, T., Frid, C. & Gray, T. (2005). Discards in North Sea fisheries: Causes, consequences and solutions. Marine Policy. 29. 421-430. 10.1016/j.marpol.2004.07.001.

Catchpole T., Feekings J., Madsen N., Palialexis A., Vassilopoulou V., Valeiras J., Garcia T., Nikolic, N. & Rochet, M-J. (2014). Using inferred drivers of discarding behaviour to evaluate discard mitigation measures, ICES Journal of Marine Science, 2014, vol. 71 (pg. 1277-1285)

DGRM (2019) Available in: <https://acessoreservado.dgrm.mm.gov.pt/xportal/xmain?xpid=dgrm&selectedmenu=1469969&xpgid=genericPageV2&conteudoDetalhe_v2=209429> Accessed in: 07/03/2021

DGRM (2020a) available in: <https://webgis.dgrm.mm.gov.pt/portal/apps/webappviewer/index.html?id=df8accb510bc4f33963d9b03bf3674b8.> Accessed in: 06/05/2021.

DGRM (2020b) Available in: <https://www.dgrm.mm.gov.pt/peixes >. Accessed in: 06/03/2021.

DGRM (2020c) Available in: <https://www.dgrm.mm.gov.pt/web/guest/moluscos>. Accessed in: 06/03/2021.

DGRM (2020d) Available in: <https://www.dgrm.mm.gov.pt/en/crustaceos>. Accessed in: 06/03/2021.

Dowling, N., Wilson, J., Rudd, M., Babcock, E., Caillaux, M., Cope, J., ... & Victor, S. (2016). FishPath: a decision support system for assessing and managing data-and capacity-limited fisheries. Assessing and Managing Data-Limited Fish Stocks. Alaska Sea Grant, University of Alaska Fairbansk.

Eayrs, S., Cadrin, S. & Glass, C. (2015). Managing change in fisheries: a missing key to fishery-dependent data collection? ICES Journal of Marine Science, 72(4), 1152-1158.

EC (2018). Commission Delegated Regulation (EU) 2018/2035 of 18 October 2018 specifying details of implementation of the landing Unintended impact of the European discard ban 7 obligation for certain demersal fisheries in the North Sea for the period 2019–2021. Official Journal of the European Union, L327, 2018: 17–26.

EC (2019). Communication from the Commission to the European Parliament and the Council on the State of Play of the Common Fisheries Policy and Consultation on the Fishing Opportunities for 2020. COM(2019) 274 final. 11 pp.

EC (2020). Communication from the Commission to the European Parliament and the Council. Towards more sustainable fishing in the EU: state of play and orientations for 2021. COM(2020) 248 final. 11 pp.

Eliasen, S., Papadopoulou, K.-N., Vassilopoulou, V. & Catchpole, T. (2014). Socioeconomic and institutional incentives influencing fishers´ behavior in relation to fishing particles and discards. ICES Journal of Marine Science, 71(5): 1298‑1307. https://doi.org/10.1093/icesjms/fst120.

EUMOFA (2020). European Market Observatory for Fisheries and Aquaculture Products. European Comission. https://doi: 10.2771/664425.

EFCA (2019). European Fisheries Control Agency: Annual Report 2019. Available in: <https://www.efca.europa.eu/sites/default/files/EFCA%20Annual%20Report%20for%20year%202019.pdf>.

FAO (1996). The State of World Fisheries and Aquaculture 1996. Contributing to food security and nutrition for all. Rome: Food and Agriculture of the United Nations.

FAO (2003). The State of World Fisheries and Aquaculture 2003. Contributing to food security and nutrition for all. Rome: Food and Agriculture of the United Nations.

FAO (2016). The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome: Food and Agriculture of the United Nations.

FAO (2020). The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome. https://doi.org/10.4060/ca9229en

Feekings, J., Bartolino, V., Madsen, N., & Catchpole, T. (2012). Fishery discards: factors affecting their variability within a demersal trawl fishery. PloS one, 7(4), e36409.

Fauconnet, L., Pham, C., Canha, A., Afonso, P., Diogo, H., Machete, M. & Morato, T. (2019). An overview of fisheries discards in the Azores. Fisheries Research, 209, 230-241.

Gilman, E., Suuronen, P., Hall, M. & Kennelly, S. (2012). Causes and methods for estimating the components of unobservable fishing mortality. IN Proceedings of the World Fisheries Congress, 7-11 May 2012, Edinburgh, UK.

Gilman, E, Chaloupka, M & Musyl, M. (2018). Effects of pelagic longline hook size on species- and size-selectivity and survival. Fish Biology and Fisheries, 8(2): 417-433. http:// link.springer.com/10.1007/s11160-017-9509-7

Heredia, J. & Oanta, G. (2015). The Sustainable Fisheries Partnership Agreements of the European Union and the Objectives of the Common Fisheries Policy: Fisheries and/or Development?. SYbIL, 61, 85.

Horsten, M. & Kirkegaard, E. (2002). *Bycatch from a perspective of sustainable use*. IUCN - European Sustainable Use Specialist Group (ESUSG)/Fisheries Working Group.

ICES (2019). Working Group on Technology Integration for Fishery-Dependent Data (WGTIFD). ICES Scientific Reports. 1:46. 28. http://doi.org/10.17895/ices.pub.5543

INE (2019). Instituto Nacional de Estatística: Estatística da Pesca 2019. Lisboa. ISBN 978-989-25-0540-4

IPMA (2020). Estado dos stocks em 2019 e aconselhamento científico para a sua gestão em 2020. Available in: <https://www.ipma.pt/export/sites/ipma/bin/docs/publicacoes/pescas.mar/RA-estado.recursos.explorados.2020.pdf> .

Kelleher, K. (2005). Discards in the World's Marine Fisheries. An Update. FAO Fisheries Technical Paper. 470. ISSN 0429-9345

Kennelly, S. (1995). The issue of bycatch in Australia's demersal trawl fisheries. Reviews in Fish Biology and Fisheries, 5(2), 213-234.

Liggins, G., Kennelly, S. & Broadhurst, M. (1996). Observer-based survey of by-catch from prawn trawling in Botany Bay and Port Jackson, New South Wales. Marine and freshwater research, 47(7), 877-888.

Mangi, S.C., Dolder, P.J., Catchpole, T.L., Rodmell, D. & de Rozarieux, N. (2013). Approaches to fully documented fisheries: practical issues and stakeholder perceptions. Fish and Fisheries, 16(3): 426–452. https://doi.org/10.1111/faf.12065

Needle, C., Dinsdale, R., Buch, T., Catarino, R., Drewery, J., & Butler, N. (2015). Scottish science applications of Remote Electronic Monitoring. ICES Journal of Marine Science, 72, 1214–1229. https ://doi.org/10.1093/icesj ms/fsu225

Olaso, I., Velasco, F. & Pérez, N. (1998). Importance of discarded blue whiting (*Micromesistius poutassou*) in the diet of lesser spotted dogfish (*Scyliorhinus canicula*) in the Cantabrian Sea. ICES Journal of Marine Science 55: 331-341.

Pérez Roda, M., Gilman, E., Huntington, T., Kennelly, S., Suuronen, P., Chaloupka, M. & Medley, P. (2019). A third assessment of global marine fisheries discards. FAO Fisheries and Aquaculture Technical Paper No. 633. Rome, FAO. 78 pp. (also available at www.fao.org/3/CA2905EN/ca2905en.pdf).

Plet-Hansen, K., Eliasen, S., Mortensen, L., Bergsson, H., Olesen, H., & Ulrich, C. (2017). Remote electronic monitoring and the landing obligation – Some insights into fishers' and fishery inspectors' opinions. Marine Policy, 76, 98–106. https ://doi.org/10.1016/j. marpol.2016.11.028.

Prado, J., Queiroga, H., Pierce, G. & Grilo, C. (2017). Arrasto em Portugal e se fosse em terra? Fundação Calouste Gulbenkian, Lisboa, 1.

Rochet, M.-J. & Trenkel, V. (2005). Factors for the variability of discards: assumptions and field evidence. Can. J. Fish. Aquat. Sci. 62, 224–235. https://doi.org/10.1139/f04-185.

Saila, S. (1983). Importance and assessment of discards in commercial fisheries. FAO Fish. Circ. 765, 67. https://doi.org/10.1002/iroh.19850700627

Savina, E., Noack, T., & Karlsen, J. D. (2019). Effects of season, target species and codend design on the survival of undersized plaice (Pleuronectes platessa) discarded in the bottom otter trawl mixed fisheries in Skagerrak. Fisheries Research, 219, 105311.

STECF (2013). Landing obligation in EU fisheries (STECF-13-23). Publications Office of the European Union, Luxembourg, 115. doi:10.2788/37460

STECF (2019). The 2019 Annual Economic Report on the EU Fishing Fleet (STECF 19-06), Dentes De Carvalho Gaspar, N., Keatinge, M. and Guillen Garcia, J. editor(s). EUR

28359 EN, Publications Office of the European Union, Luxembourg. doi:10.2760/911768.

STECF (2020). Evaluation of Joint Recommendations on the Landing Obligation and on the Technical Measures Regulation (STECF-20-04). Publications Office of the European Union, Luxembourg. doi:10.2760/328463, JRC121260

Suuronen, P. & Gilman, E. (2020). Monitoring and managing fisheries discards: New technologies and approaches. Marine Policy, 116. https://doi.org/10.1016/j.marpol.2019.103554

Tingley, D., Erzini, K. & Goulding, I. (2000). Evaluation of the state of knowledge concerning discard practices in European fisheries. Megapesca Final Report. Megapesca Lda. 2460 207 Alfeizerão, Portugal.

Van Helmond, A., Mortensen, L., Plet-Hansen, K., Ulrich, C., Needle, C., Oesterwind, D., ... & Poos, J. (2020). Electronic monitoring in fisheries: Lessons from global experiences and future opportunities. Fish and Fisheries, 21(1), 162-189. https://doi.org/10.1111/faf.12425

Veiga, P., Pita, C., Rangel, M., Gonçalves, J., Campos, A., Fernandes, P., Sala, A., Virgili, M., Lucchetti, A., Brčić, J., Villasante, S., Ballesteros, M., Chapela, R., Santiago, J., Agnarsson, S., Ögmundarson, O. & Erzini, K. (2015). The EU landing obligation and European small-scale fisheries: what are the odds for success? Marine Policy, 64, 64-71. https://doi.org/10.1016/j.marpol.2015.11.008

Votier, S., Furness, R., Bearhop, S., Crane, J., Caldow, R., Catry, P., Ensor, K., Hamer, K., Hudson, A., Kalmbach, E., Klomp, N., Pfeiffer, S., Phillips, R., Prieto, I. & Thompson, D. (2004). Changes in fisheries discard rates and seabird communities. Nature 427: 727-730. https://doi.org/10.1038/nature02315

Walsh, W., Ito, R., Kawamoto, K. & McCracken, M. (2005). Analysis of logbook accuracy for blue marlin (*Makaira nigricans*) in the Hawaii-based longline fishery with a generalized additive model and commercial sales data. Fisheries Research, 75(1–3): 175–192. https://doi.org/10.1016/j.fishres.2004.11.007

Walsh, W., Kleiber, P. & McCracken, M. (2002). Comparison of logbook reports of incidental blue shark catch rates by Hawaii-based longline vessels to fishery observer data by application of a generalized additive model. Fisheries Research, 58(1): 79–94. https://doi.org/10.1016/S0165-7836(01)00361-7

Weaver, A., Pope, J., Morrison-Saunders, A. & Lochner, P. (2008). Contributing to sustainability as an environmental impact assessment practitioner. Impact Assessment and Project Appraisal, 26(2), 91-98. https://doi.org/10.3152/146155108x316423

Appendix I

Table I: This table was adapted from DGRM (2020b, c,d) and encompass a summary with the main management measures applicable to fishing for some of the main species in Portuguese national waters and includes species common and scientific names, minimum conservation reference sizes (MCS), TAC/quotas, and national and European rules and legislations. The species with an asterisk * are subject to landing obligation but some exemption might be applied.

FISHES	
Megrins – *Lepidorhombus* spp*	Minimum conservation reference size: 20 cm Species subject to TAC/quota Rules applicable to Trawl fishing: target species with mesh size ≥ 70 mm Rules applicable to gillnet fishing: mesh size ≥ 100 mm Species subject to a multiannual plan for the demersal populations, Regulation (EU) Nº 2019/472, of 19 march Landing obligation exemption by de minimis: - up to 5% of the total annual catch of these species with beam trawls, bottom trawls and trawls (abbreviations for fishing gear categories: OTB, OTT, PTB, TBN, TBS, TBB, OT, PT, TX, SSC, SPR, SDN, SX, SV) in ICES sub-areas 8 and 9; - up to 4% of the total annual catch of these species with nets in ICES sub-areas 8 and 9.
Atlantic Bluefin Tuna - *Thunnus thynnus**	Minimum conservation reference size: 30 kg or 115 cm[(a)] Species subject to TAC/quota and a Recovery Plan: ICCAT. In Portugal there is no direct fishing and can be caught with surface longlines and traps.

Azevia - *Microchirus azevia*	Minimum conservation reference size: 18 cm Rules applicable to Trawl fishing: target species with mesh size 65-69 mm Rules applicable to gillnet fishing: target species with mesh size 60-79 mm, 80-99 mm and ≥ 100 mm
Whiting - *Merlangius merlangus*	Minimum conservation reference size: 27 cm Rules applicable to Trawl fishing: target species with mesh size ≥ 70 mm Rules applicable to gillnet fishing: target species with mesh size 80-99 mm and ≥ 100 mm Species subject to a multiannual plan for the demersal populations, Regulation (UE) Nº 2019/472, of 19th March
Axillary seabream – *Pagellus acarne*	Minimum conservation reference size: 18 cm Rules applicable to Trawl fishing: target species with mesh size ≥ 70 mm Rules applicable to gillnet fishing: target species with mesh size ≥ 100 mm
Common pandora – *Pagellus erythrinus*	Minimum conservation reference size: 15 cm Rules applicable to Trawl fishing: target species with mesh size ≥ 70 mm Rules applicable to gillnet fishing: target species with mesh size ≥ 100 mm
Anchovy - *Engraulis encrasicolus**	Minimum conservation reference size: 12 cm Species subject to TAC/quota Rules applicable to Trawl fishing: target species with mesh size 65-69 mm Not referred in the regulation of gillnet fishing Target species of purse seine fishing Landing obligation exemption for high survival, in artisanal fisheries with purse seines (they can be released as long as

	the net has not been fully lifted on board); and by *de minimis*: - up to 1% of the total annual catches of anchovy with purse seines in ICES sub-areas 8, 9 and 10 and in CECAF zones 34.1.1, 34.1.2 and 34.2.0.
Horse mackerel – *Trachurus* spp.*	Minimum conservation reference size: 15 cm[(b)] Species subject to TAC/quota (in zone 9 the TAC refers only to horse mackerel) Rules applicable to Trawl fishing: target species with mesh size 65-69 mm and ≥ 70 mm Rules applicable to gillnet fishing: target species with mesh size 60-79 mm, 80-99 mm and ≥ 100 mm Target species of purse seine fishing Landing obligation exemption for high survival, in artisanal fisheries with purse seines (they can be released as long as the net has not been fully lifted on board); and by *de minimis*: - up to 7% of the total annual catches of these species by beam, bottom trawls and trawls (abbreviations for fishing gear categories: OTB, OTT, PTB, TBN, TBS, TBB, OT, PT, TX, SSC, SPR, SDN, SX, SV) in ICES sub-areas 8 and 9; - up to 3% of the total annual catch of these species with gillnets (abbreviations for fishing gear categories: GNS, GND, GNC, GTR, GTN) in ICES sub-areas 8, 9 and 10 and in CECAF 34.1.1, 34.1 .2 and 34.2.0; - up to 4% of the total annual catch of each of these species with purse seines in ICES sub-areas 8, 9 and 10 and in CECAF zones 34.1.1, 34.1.2 and 34.2.0.

Chub mackerel/ Scomber Mackerel nei - *Scomber* spp	Minimum conservation reference size: 20 cm Rules applicable to Trawl fishing: target species with 65-69 mm mesh Rules applicable to gillnet fishing: target species with 60-79 mm, 80-99 mm and ≥ 100 mm mesh Target species of purse seine fishing Landing obligation exemption for high survival, in artisanal fisheries with purse seines (they can be released as long as the net has not been fully lifted on board); and by *de minimis*: - up to 7% of the total annual catch of this species with beam trawls, bottom trawls and trawls (abbreviations for fishing gear categories: OTB, OTT, PTB, TBN, TBS, TBB, OT, PT, TX, SSC, SPR, SDN, SX, SV) in ICES sub-areas 8 and 9; - up to 3% of the total annual catches of this species with gillnets (abbreviations for fishing gear categories: GNS, GND, GNC, GTR, GTN) in ICES sub-areas 8 and 9 and in CECAF 34.1.1, 34.1.2 and 34.2.0; - up to 4% of the total annual catch of each of these species with purse seines in ICES sub-areas 8, 9 and 10 and in CECAF zones 34.1.1, 34.1.2 and 34.2.0;
Black seabream – *Spondyliosoma cantharus*	Minimum conservation reference size: 23 cm Rules applicable to Trawl fishing: target species with mesh size ≥ 70 mm Rules applicable to gillnet fishing: target species with mesh size 60-79 mm, 80-99 mm and ≥ 100 mm
Conger - *Conger conger*	Minimum conservation reference size: 58 cm Rules applicable to Trawl fishing: target species with mesh size 65-69 mm and ≥ 70 mm

	Rules applicable to gillnet fishing: target species with mesh size 60-79 mm, 80-99 mm and ≥ 100 mm
Gilthead seabream – *Sparus aurata*	Minimum conservation reference size: 19 cm Rules applicable to Trawl fishing: target species with mesh size 65-69 mm and ≥ 70 mm Rules applicable to gillnet fishing: target species with mesh size 60-79 mm, 80-99 mm and ≥ 100 mm
Eel - *Anguilla anguilla*	Minimum conservation reference size: 22 cm Object of a Management Plan Commission Regulation (EC) Nº. 1100/2007 Caught essentially in non-oceanic inland waters, with Portuguese artisanal gears like “galrichos”, “chinchorro” and “Minhocada”
Swordfish - *Xiphias gladius**	Minimum conservation reference size: 25 kg or 125 cm Species subject to TAC/quota Fished with longlines which also catches by-catch and other pelagic sharks Rules for licensing and allocation of fishing quotas per vessel provided for in Ordinance Nº 90/2013, of 28 February, in its current version
Pouting or Bib – *Trisopterus luscus*	Minimum conservation reference size: 17 cm Rules applicable to Trawl fishing: target species with mesh size 65-69 mm and ≥ 70 mm Rules applicable to gillnet fishing: target species with mesh size 60-79 mm, 80-99 mm and ≥ 100 mm
Blackspot/Red Seabream - *Pagellus bogaraveo**	Minimum conservation reference size: 33 cm Species subject to TAC/quota

	Deep-sea species covered by annex I of Regulation (EC) Nº 2016/2336, 14th of December Caught mainly with longlines Species subject to a multiannual plan for the demersal populations, Regulation (EU) Nº 2019/472, of 19th March Landing obligation exemption for high survival caught in ICES sub-areas 8 and 10 and in division 9a with lines and hooks.
Sea lamprey - *Petromyzon marinus*	Minimum conservation reference size: 35 cm Fished mainly in non-oceanic inland waters, with staked gears and drift trammel nets Closed seasons fixed under river regulations
Sole nei - *Solea* spp*	Minimum conservation reference size: 24 cm Species subject to TAC/quota Captured essentially with trammel nets. Legitimate sole (*Solea solea*) can be targeted with gillnets of mesh size 80-99 mm and ≥ 100 mm Rules applicable to Trawl fishing: target species with mesh size ≥ 70 mm Species subject to a multiannual plan for the demersal populations, Regulation (EU) Nº 2019/472, of 19th March
Black scabbardfish – *Aphanopus carbo**	Minimum conservation reference size: not applicable Species subject to TAC/quota Deep-sea species of Annex I of Regulation (EU) Nº 2016/2336, of 14th of December Can only be fished with demersal longlines by vessels with a specific license The gear that is used also captures deep-sea sharks (Portuguese dogfish and Gulper sharks) Species subject to a multiannual plan for the demersal populations, Regulation (EU) Nº 2019/472, of 19th March

Hake - *Merluccius merluccius**	Minimum conservation reference size: 27 cm Species subject to TAC/quota Rules applicable to Trawl fishing - target species with mesh size ≥ 70 mm Rules applicable to gillnet fishing - target species with mesh size 80-99 mm It can also be captured with hooks > 3.85 ± 1.15 cm long > 1.6 ± 0.4 cm wide Species subject to a multiannual plan for the demersal populations, Regulation (EU) Nº 2019/472, of 19th March Landing obligation exemption by *de minimis*: - up to 5% of the total annual catch of this species with trawls and seine nets (abbreviations in the fishing gear categories: OTB, OTT, PTB, TBN, TBS, TBB, OT, PT, TX, SSC, SPR, SDN, SX, SV) ICES sub-area 8 and 9.
Sea bass - *Dicentrarchus labrax*	Minimum conservation reference size: 36 cm Rules applicable to Trawl fishing: target species with mesh size ≥ 70 mm Rules applicable to gillnet fishing: target species with mesh size 80-99 mm and ≥ 70mm Species subject to a multiannual plan for the demersal populations, Regulation (EU) Nº 2019/472, of 19th March
Rays/skates – Rajidae*	Minimum conservation reference size: 52 cm with the exception of Undulata ray which is 78 cm Species subject to TAC/quota. The capture of several species is prohibited Rules applicable to Trawl fishing: target species with mesh size ≥ 70 mm Rules applicable to gillnet fishing: target species with mesh size ≥ 100 mm

	Landing obligation exemption caught in ICES sub-areas 8 and 9 with any gear
Salmon - *Salmo salar*	Minimum conservation reference size: 55 cm Captured in non-oceanic inland waters. Rare species. Catching it in some rivers is prohibited
Sardine/pilchard - *Sardina pilchardus*	Minimum conservation reference size: 11 cm Object of a Management Plan, Ordinance nº. / 2010, of 4th May amended by Ordinance Nº. 294/2011, of 14th November, by Ordinance Nº. 173-A / 2015, of 8th June and by Ordinance Nº. 34-A / 2016, of 29th February Captured with purse seines Rules applicable to Trawl fishing: only bycatch up to 10% of the total on board
Sargos breams nei – *Diplodus* spp.	Minimum conservation reference size: 15 cm Rules applicable to Trawl fishing: target species with mesh size 65-69 mm and ≥ 70 mm Rules applicable to gillnet fishing: target species with mesh size 60-79 mm, 80-99 mm and ≥ 70 mm
Surmullet - *Mullus surmuletus*	Minimum conservation reference size: 18 cm Rules applicable to Trawl fishing: target species with mesh size 65-69 mm and ≥ 70 mm Rules applicable to gillnet fishing: target species with mesh size 60-79 mm, 80-99 mm and ≥ 70 mm
Anglerfish – Lophiidae*	Minimum conservation reference size: not applicable Species subject to TAC/quota Rules applicable to Trawl fishing: target species with mesh size> 70 mm Rules applicable to gillnet fishing: target species with mesh size ≥ 220 mm, if more than 30% of the total catch on board

	Species subject to a multiannual plan for the demersal populations, Regulation (EU) Nº 2019/472, of 19th March Landing obligation exemption by *de minimis*: - up to 5% of the total annual catch of these species with beam trawls, bottom trawls and seine nets (abbreviations for fishing gear categories: OTB, OTT, PTB, TBN, TBS, TBB, OT, PT, TX, SSC, SPR, SDN, SX, SV) in ICES sub-areas 8 and 9; - up to 4% of the total annual catches of these species using gillnets (abbreviations for fishing gear categories: GNS, GND, GNC, GTR, GTN) in ICES sub-areas 8 and 9.
Blue whiting/Poutassou – *Micromesistius poutassou**	Minimum conservation reference size: not applicable Species subject to TAC/quota Rules applicable to Trawl fishing: target species with mesh sizes 55 to 59 mm, 65-69 mm and ≥ 70 mm Rules applicable to gillnet fishing: target species with mesh size ≥ 100 mm
Alfonsino nei – *Beryx* spp.	Landing obligation exemption by *de minimis*: - up to 5% of the total annual catch of these species with lines and hooks (abbreviations for fishing gear categories: LHP, LHM, LLS, LLD) ICES sub-area 10.
Saithe/Pollock - *Pollachius virens*	Landing obligation exemption by *de minimis*: - up to 5% of the total annual catch of this species with beam trawls, bottom trawls and trawls (abbreviations for fishing gear categories: OTB, OTT, PTB, TBN, TBS, TBB, OT, PT, TX, SSC, SPR, SDN, SX, SV) in ICES sub-areas 8 and 9; - up to 2% of the total annual catch of this species with gillnets (abbreviations for fishing gear categories: GNS, GND, GNC, GTR, GTN) ICES sub-area 8 and 9.

European plaice - *Pleuronectes platessa*	Landing obligation exemption by *de minimis*: up to 2% of the total annual catch of this species with gillnets (abbreviations for fishing gear categories: GNS, GND, GNC, GTR, GTN) ICES sub-area 8 and 9.
(a) With the exception of specimens caught by fishing vessels with longline (bait) and trawl fishing, in this case 8 kg or 75 cm. (b) specimens between 12 and 14 cm in length may be landed, in accordance with applicable Community legislation. Not applicable in the waters of the Azores sub-area of the exclusive economic zone (EEZ).	

CRUSTACEANS

Common Prawn *-Palaemon serratus*	Minimum conservation reference size: 6 cm Rules applicable to trawl fishing: target species with mesh sizes 20-31 mm and 32-54 mm with a minimum 50% for all target species which also includes Henslow's swimming crab and another species of shrimp Fishing with gillnets is prohibited, except as bycatch, up to 5% of the total on board Can be captured with 8-29 mm mesh size cage traps, provided that a minimum percentage of 80% is caught per tide Closed season: January
Blue or Red Shrimp – *Aristeus antennatus*	Minimum conservation reference size: 9.4 cm (2.9 cm carapace length) Rules applicable to trawl fishing: target species with mesh size 55-59 mm with a minimum 30% for all target species which also includes Giant red shrimp and Deep-water rose shrimp (20% if mesh size ≥ 70 mm is also on board) Fishing with gillnets is prohibited, except as bycatch, up to 5% of the total on board

	Closed season: January
Deep-water rose shrimp – *Parapenaeus longirostris*	Minimum conservation reference size: 9.4 cm (2.4 cm carapace length) Rules applicable to trawl fishing: target species with mesh size 55-59 mm with a minimum 30% for all target species which also includes Blue or red shrimp and Deep-water rose shrimp (20% if mesh size ≥ 70 mm is also on board) Fishing with gillnets is prohibited, except as bycatch, up to 5% of the total on board Closed season: January
Lobsters - *Palinurus* spp.	Minimum conservation reference size: 9.5 cm (carapace length) Can be captured with cage traps, mesh size > 50 mm with 100% target species of the total on board Fishing with gillnets is prohibited, except as bycatch, up to 5% of the total on board Closed season with cage traps: From October to the end of December
Norway lobster - *Nephrops norvegicus**	Minimum conservation reference size: 7 cm (2 cm carapace length) Species subject to TAC/quota Rules applicable to trawl fishing: target species with mesh size ≥ 70 mm Can be captured with cage traps, mesh size 30-50 mm, with 80% for the set of target species that includes, octopus, Velvet swimcrab and lobsters and mesh size > 50 mm, with 100% of the target species Fishing with gillnets is prohibited, except as bycatch, up to 5% of the total on board

	Species subject to a multiannual plan for the demersal populations, Regulation (EU) Nº 2019/472, of 19th March Closed season: January Landing obligation exemption for high survival caught in ICES sub-areas 8 and 9 with bottom trawls
Velvet swimcrab and Liocarcinus swimcrabs – *Necora puber* and *Liocarcinus* spp.	Minimum conservation reference size: 5 cm Can be captured with cage traps, mesh size 8-29 mm and 30-50 mm, with 80% for the set of target species that includes, octopus, norway lobster and lobsters and mesh size > 50 mm, with 100% of the target species Fishing with gillnets is prohibited, except as by-catch, up to 5% of the total on board Closed season: From 15th February to 15th June
Barnacle - *Pollicipes pollicipes*	Minimum conservation reference size: 2 cm (without prejudice to the minimum size set for Natural Reserve of Berlengas) Can be captured with arrilhada (artisanal Portuguese gear) by licensed catchers The harvest has specific rules in the Natural Reserve of Berlengas (RNB) and in the Natural Park of Southwest Alentejo and Costa Vicentina (PNSACV) There is a maximum catch limit of 20 kg per day/catcher (without prejudice to other quantities set out in RNB and PNSACV) Closed season: From 15th September to 15th October (without prejudice to the longer closed seasons, provided for in the two zones mentioned above)
Spinous spider crab - *Maja squinado*	Minimum conservation reference size: 12 cm Can be caught with cage traps, mesh size > 50 mm Fishing with gillnets is prohibited, except as by-catch, up to 5% of the total on board

	Closed season: From 15th February to 15th June
Edible crab – *Cancer pagurus*	Minimum conservation reference size: 13 cm Can be caught with cage traps, mesh size > 50 mm Fishing with gillnets is prohibited, except as bycatch, up to 5% of the total on board

BIVALVES

Solid surf clam and Atlantic surf clam – *Spisula solida* and *Spisula solidissima*	Minimum conservation reference size: 2.5 cm Captured in ocean waters with dredges There are catch limits set by day
Pullet carpet shell – *Venerupis pullastra*	Minimum conservation reference size: 3.8 cm (3 cm - applicable in non-maritime inland waters) Captured in inland waters with rake or, in the case of the Tagus River with manual dredge There are daily catch limits on the Tagus River
Japanese carpet shell – *Ruditapes philippinarum*	Minimum conservation reference size: 4 cm Captured in ocean waters with dredges There are catch limits set by day
Donax clams - *Donax* spp.	Minimum conservation reference size: 2.5 cm Captured in ocean waters with a dredge operated from a vessel or with a fisherman by foot with a manual dredge There are catch limits set by day

CEPHALOPODS	
Common Cuttlefish – *Sepia officinalis*	Minimum conservation reference size: 10 cm Rules applicable to Trawl fishing: target species with mesh size ≥ 70 mm Rules applicable to gillnet fishing: target species with mesh sizes 60 to 79 mm, 80-99 mm and ≥ 100 mm Can be captured with cage traps with mesh size 30-50 mm and> 50 mm Captured frequently with trammel nets in coastal and inland non maritime areas
European squid - *Loligo vulgaris*	Minimum conservation reference size: 10 cm Rules applicable to Trawl fishing: target species with mesh size ≥ 70 mm Capture with gillnets is not foreseen in legislation
Common Octopus – *Octopus vulgaris*	Minimum conservation reference size: 0.75 kg Rules applicable to Trawl fishing: target species with mesh size ≥ 70 mm Possible to be captured with cage traps with mesh size 8-29 mm (according to the conditions of article 9-A of Ordinance Nº 1102-D/2000), mesh size 30-50 mm, with 80% of minimum percentage of target species and mesh size ≥ 50 mm Capture with gillnets is not foreseen in legislation