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EXPOSING THE HIDDEN COSTS OF TRAWLING IN THE WESTERN MEDITERRANEAN

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SUMMARY

Bottom trawling activities in the Western Mediterranean Sea have taken place for centuries, and they are an important part of Mediterranean fisheries.

Nevertheless, social concern about the ecological consequences of these activities for the marine environment and their impact on climate change have intensified in recent years.

In this context, standard economic analyses provide an incomplete picture of the economic reality of the sector, ignoring most of its ecological impacts and several social issues and costs.

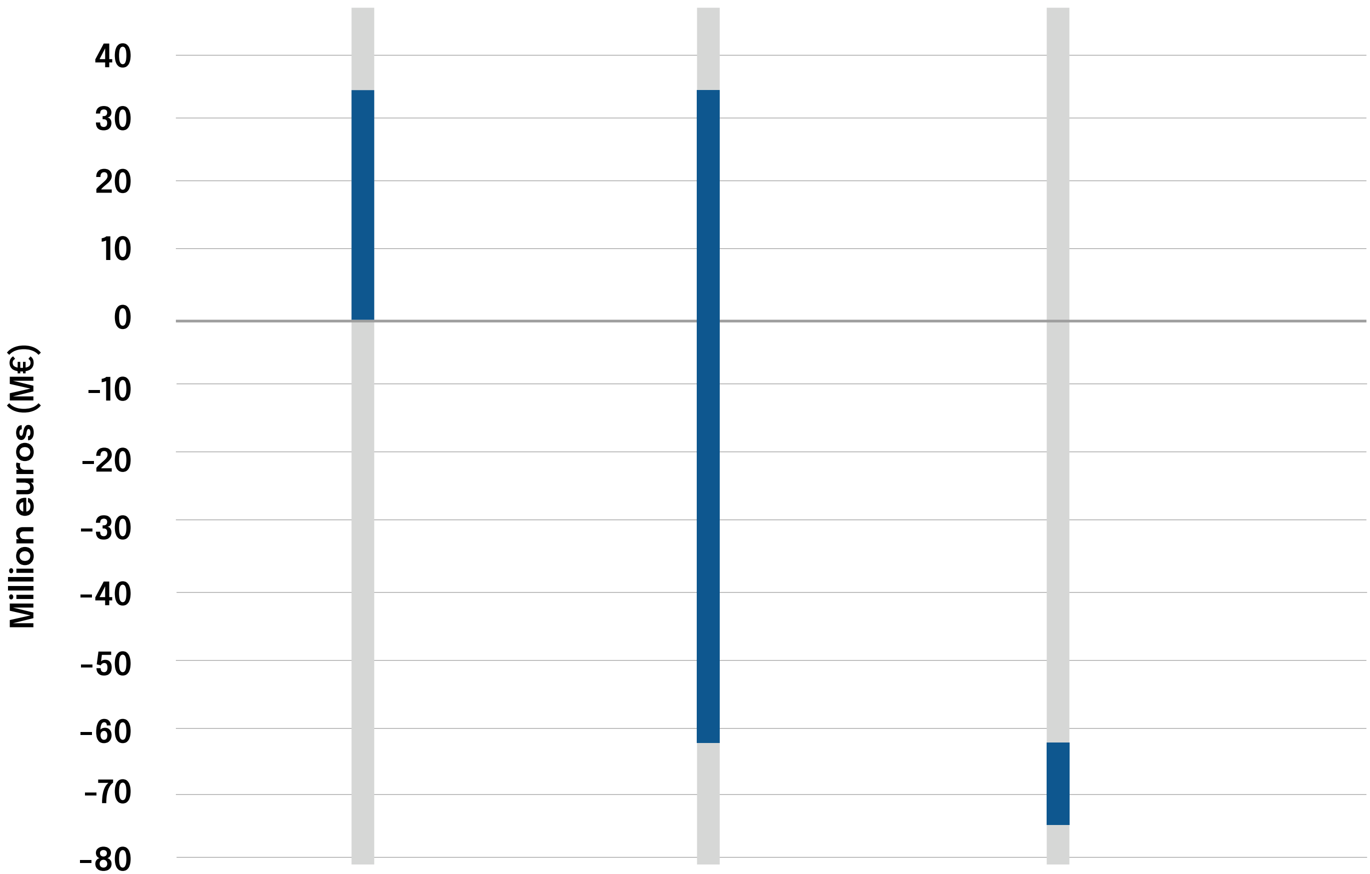
In this report we provide a broader economic analysis of bottom trawl fisheries in the Western Mediterranean Sea, not only addressing the figures usually included in standard analyses, but also some of their externalities. We also consider the key governmental financial transfers, i.e., subsidies, that influence the viability of the fleet and the sustainability of fish stocks.

When possible, these often-ignored economic realities are quantified and monetary estimations are provided.

BOTTOM TRAWLING ACTIVITIES IN THE WESTERN MEDITERRANEAN SEA ARE ECONOMICALLY VIABLE ONLY BECAUSE OF GOVERNMENTAL FINANCIAL TRANSFERS AND THE LACK OF INTERNALISATION OF THEIR NEGATIVE EXTERNALITIES.

CLIMATE COSTS, BIODIVERSITY COSTS, HIDDEN LABOUR COSTS AND OVERFISHING COSTS AMONG OTHERS ENTAIL THAT THE BOTTOM TRAWLING SECTOR IS CURRENTLY UNECONOMIC.

NET PROFIT OF EU WESTERN MEDITERRANEAN TRAWLING FLEET TAKING INTO CONSIDERATION THE MONETARISED COSTS (2019)



34 M€
EU Western Mediterranean trawling fleet net profit

−96 M€
EU Western Mediterranean trawling fleet net profit excluding: fuel tax exemptions, operative and investment subsidies

−13 M€
EU Western Mediterranean trawling fleet net profit excluding: fuel tax exemptions, operative and investment subsidies, and climate cost associated to direct emissions

OTHER NON-MONETARISED COSTS

- Biodiversity loss due to bycatch and impacts on vulnerable ecosystems
- Indirect climate-induced costs
- Loss of opportunity revenues due to overfishing
- Loss of opportunity revenues due to loss of marine biodiversity preventing new business to be initiated
- Governmental financial transfers and climate change direct emissions costs of the non-EU Western Mediterranean trawling sector
- The opportunity cost of losing revenues due to inability to access high-value niche markets
- Unreported labour costs

1. INTRODUCTION

The Mediterranean basin is a biodiversity hotspot with high diversity and endemism of flora and fauna. It makes up 0.3% of global ocean volume, but is home to 4-18% of all known marine species (UNEP/MAP-Plan Bleu, 2020).

Today, severe pressures are affecting its ecological balance: fishing, pollution, coastal uses, maritime transport, climate change, and the invasive species all influence its characteristics (Coll et al., 2010). Following the increase of these stressors, the marine ecosystems of the Mediterranean are continually changing: since the 1950s, the biomass of demersal and pelagic fish, and of marine mammals species has decreased by about 17%, 40% and 41%, respectively, while invertebrates have increased by about 23% (Piroddi et al., 2020).

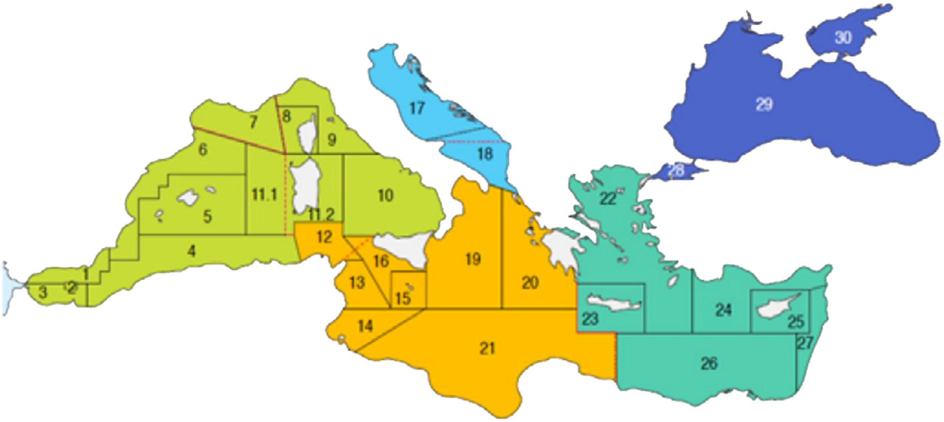
Fisheries, as a sector directly of the economy directly linked to and dependent on marine ecosystems are key in understanding these changes, which also directly affect them. In this context the state of the main demersal stocks in the Western Mediterranean Sea (Figure 1) is of growing concern, with most being overexploited and at low historical biomass levels (Table 1).

GFCM subregions

- Western Mediterranean
- Central Mediterranean
- Adriatic Sea
- Eastern Mediterranean
- Black Sea

--- FAO Statistical Divisions

— GFCM - Geographical Subareas (GSAs)



GFCM SUBSEGIONS

1. Northern Alboran Sea	7. Gulf of Lion	13. Gulf of Hammamet	19. Western Ionian Sea	25. Cyprus
2. Alborand Island	8.Corsica	14. Gulf of Gabes	20. Eastern Ionian Sea	26. South Levant
3. Southern Alboran Sea	9. Ligurian Sea and Northern Tirrenian Sea	15. Malta	21. Southern Ionian Sea	27. Eastern Levant Sea
4. Algeria	10. South and Central Tirrenian Sea	16. South of Sicily	22. Aegean Sea	28. Marmara Sea
5. Balearic Islands	11.1 Sardinia (west) 11.2 Sardinia (east)	17. Northern Adriatic Sea	23. Crete	29. Black Sea
6. Northern Spain	12. Northern Tunisia	18. Southern Adriatic Sea	24. North Levant Sea	30. Azov Sea

Figure 1. Map of the General Fisheries Commission for the Mediterranean Geographical Sub-Areas (GSAs)

TABLE 1. BIOMASS LEVELS AND EXPLOITATION RATES OF THE MAIN WESTERN MEDITERRANEAN KEY COMMERCIAL DEMERSAL SPECIES BY GSA

Species	GSA 1	GSA 2	GSA 3	GSA 4	GSA 5	GSA 6	GSA 7	GSA 8	GSA 9	GSA 10	GSA 11
European hake	5.58		8.50	6.50	5.58	5.58	5.58	4.19	4.19	4.19	4.19
Red mullet	6.33		3.42	3.42		4.81	1.32		2.72	1.17	
Deep-water rose shrimp	1.17		2.14	2.14	1.14	1.36			0.95	0.95	0.95
Blue and red shrimp	1.42	1.4			2.00	6.18			3.72	3.72	3.72
Norway lobster					5.62	1.00			1.55		
Giant red shrimp									3.04	3.04	3.04
Blackspot seabream	1.70		1.70								

Note: Grey indicates low biomass, yellow intermediate biomass, and green high biomass in reference to available time series. Figures indicate exploitation ratio (F/FMSY) by priority species and geographical subarea, with average value per species (FAO, 2020).

It is also important to note that fishing activities influence not only commercial species, but also other ecologically important species and marine ecosystems. A recent analysis of the threats affecting 77 Mediterranean marine species classed as at risk of extinction on the IUCN Red List (categories CR, EN and VU) (IUCN, 2018) showed that fishing (through overfishing, bycatch and habitat damage) is the main driver increasing species extinction risk (UNEP/MAP-Plan Bleu, 2020).

There are multiple fishing techniques in use, and they have very different implications in ecological and social terms. Globally, there is particular concern over the adverse effects of bottom trawls on seabed habitats and on the structure and functioning of benthic ecosystems. Nevertheless, these mobile, bottom-contacting gears are widely used for catching a range of fish and shellfish species. In the Mediterranean trawling activities have taken place for centuries (Chato Osio, 2012) and they have left a significant footprint on the marine environment.

In the Tyrrhenian Sea, more than 63% of the seabed surface at depths between 0-200 m and 18% of the surface at depths between 200-1000 m is being trawled annually (Eigaard et al., 2017). This activity reduces the biomass and biodiversity of the benthic ecosystems and the complexity of seabed habitats and affects their functioning and productivity, while decreasing the capacity of the marine environment to sequester carbon (Sumaila, U. R., & Tai, T.C. 2020) (Figure 2).

In this report we provide an economic analysis of bottom trawling activities in the Western Mediterranean Sea, not only explaining the figures usually included in standard cost benefits analyses, but also some of the externalities often neglected (Sumaila, 2021). Moreover, we explore the governmental financial transfers that affect the structure of the trawl fleet and distort its economic viability (Schuhbauer, A., & Sumaila, U.R. 2016).

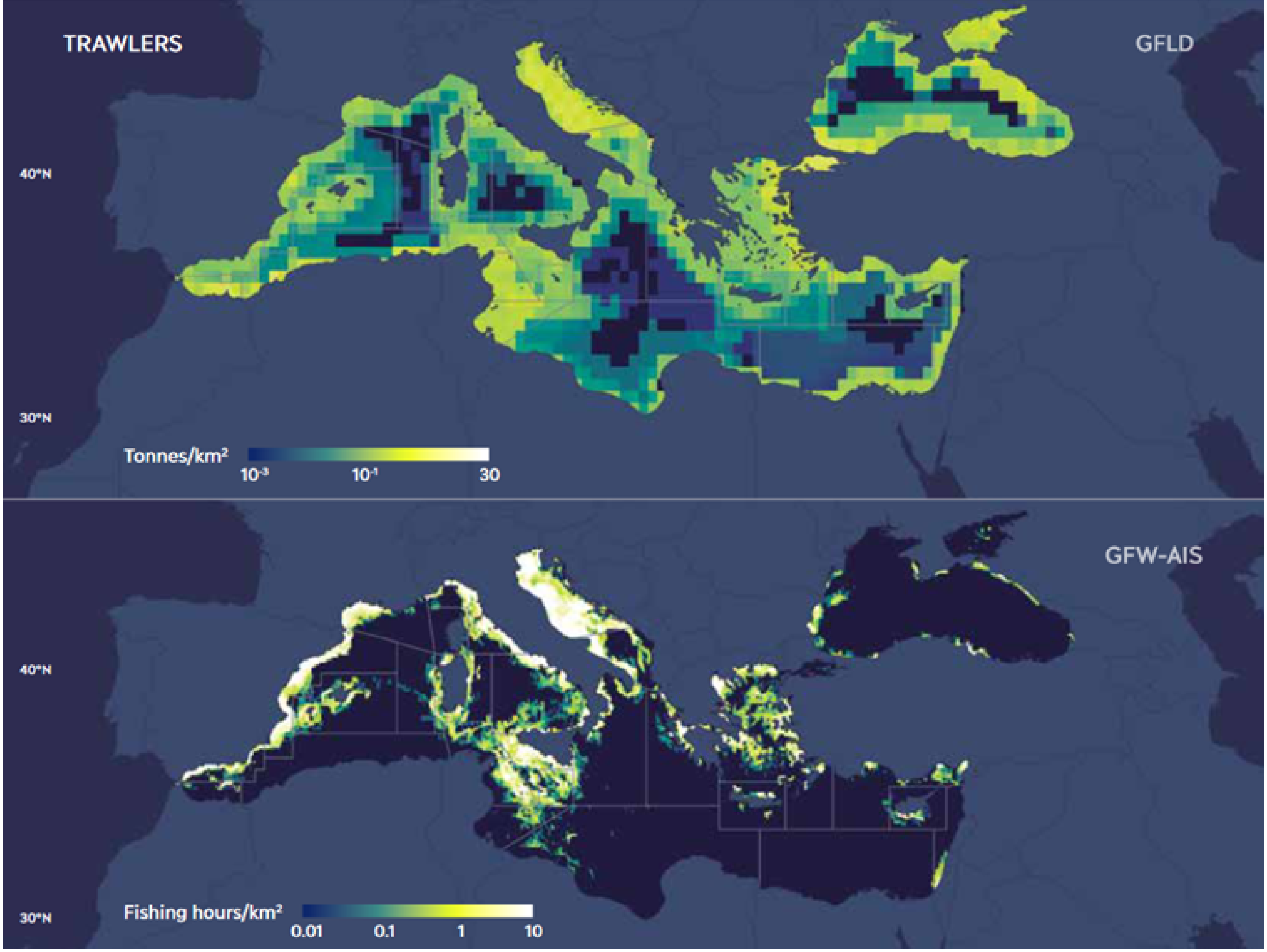


Figure 2. Trawling catches and activity in the Mediterranean Sea (2010-2014) - (Source: Taconet et al., 2019)

Note: European fishing fleets in the northern part of FAO Area 37 have adopted the Automatic Identification System (AIS) for all vessels larger than 15 metres, whereas African and Middle Eastern fishing fleets have extremely low AIS use.

In this report externalities refers to situations when the effect of production or consumption of goods and services imposes costs or benefits on others which are not reflected in the prices charged for the goods and services being provided (as defined by the OECD[1]).
In this particular case we therefore analyse the implications inflicted by the trawling fleets that usually are not monetarised and/or considered in the economic evaluation of this fishing activity.

1 stats.oecd.org/glossary/detail.asp?ID=3215

2. THE WESTERN MEDITERRANEAN TRAWL FLEET: KEY FIGURES

According to the General Fisheries Commission for the Mediterranean (GFCM), in 2018 there were 1,985 trawlers and beam trawlers beyond 15 meters registered in the Western Mediterranean Sea, representing 10.8% of the total fishing fleet of this region. This segment of the fleet provided 13,026 full-time equivalent (FTE) jobs (18% of the total), with an annual revenue of €423 million (41%) and a gross value added of €94 million (36%) (FAO, 2020). Italy, Spain and Algeria have the largest trawl fleets in the region, followed by Morocco and France. Figure 3 shows the key fleet descriptors.

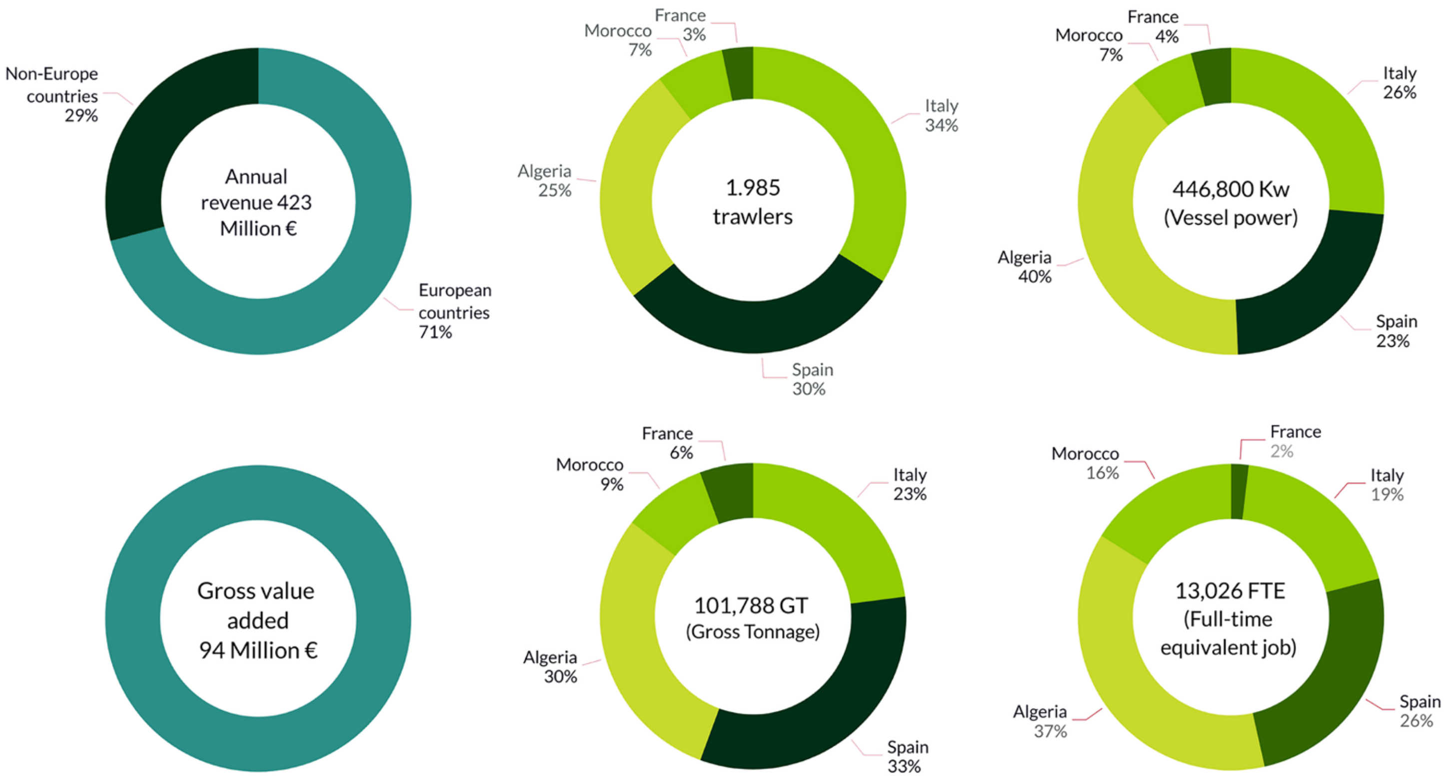


Figure 3. Key figures for the Western Mediterranean Sea trawl fleet. (Source: See Table 5 in the Annex 1. The Western Mediterranean trawl fleet: key figures and estimates)

The trawling sector is important in terms of its contribution to port and sales infrastructures, since these are at least partially financed by the fishing sector with a small amount (4-5%) of the value of total landings. The relative importance of the trawling sector is quite variable depending on the country - e.g. in the Spanish Mediterranean 51% of the gross value of landings comes from trawl fisheries, 56% in Italy and 16% in the French Mediterranean.

In terms of economic efficiency, information is only available for the EU Western Mediterranean trawl fleet[2]. If we look at the short- and long-term economic indicators (RoFTA and CR/BER)[3] for the period 2010-2015, we generally find poor economic results, while results improved in the second part of the decade. If we compare the different trawl fleet segments, in most of the cases the worst economic performances are observed by the largest vessels, the 18-24 m and >24 m segments[4].

Following the methodology[5] used in the 2020 Annual Economic report on the EU fishing fleets, net profit has been calculated as the difference between revenue and explicit costs and opportunity costs. Explicit costs include all operational costs, such as wages, energy, repair and other variable. Net profit differs from gross profit in that it includes depreciation and opportunity costs of capital. As a result, in 2018 the Spanish, French and Italian trawl fleets in the Western Mediterranean had a total net profit of €34 million. While Italy and Spain had a net profit of €18 million and €17 million respectively, France had a negative net profit of -1€ million (Figure 4).

2 A request for information was sent to the Moroccan and Algerian GFCM focal points, but no feedback was received.
3 The Return on Fixed Tangible Asset (RoFTA) is a long-term economic return indicator which compares the long-term profitability of fishing fleet segments to other available investments. If RoFTA is less than zero and less than the best available risk-free long-term interest rate, this is an indication of long-term economic inefficiency. The ratio of Current Revenue to Break-even Revenue (CR/BER) is an indicator of short-term return. It measures the economic capability of fishing fleets to keep fishing, i.e. does the revenue cover the operating costs and salaries? A CR/BER above 1 indicates good economic performance in the short term.
4 RoFTA and CR/BER figures for the EU Western Mediterranean trawl fleets can be found in Tables 6-10 of the Annex 2.
5 stecf.jrc.ec.europa.eu/documents/43805/1489224/2016_AER_6_METHODOLOGY.pdf

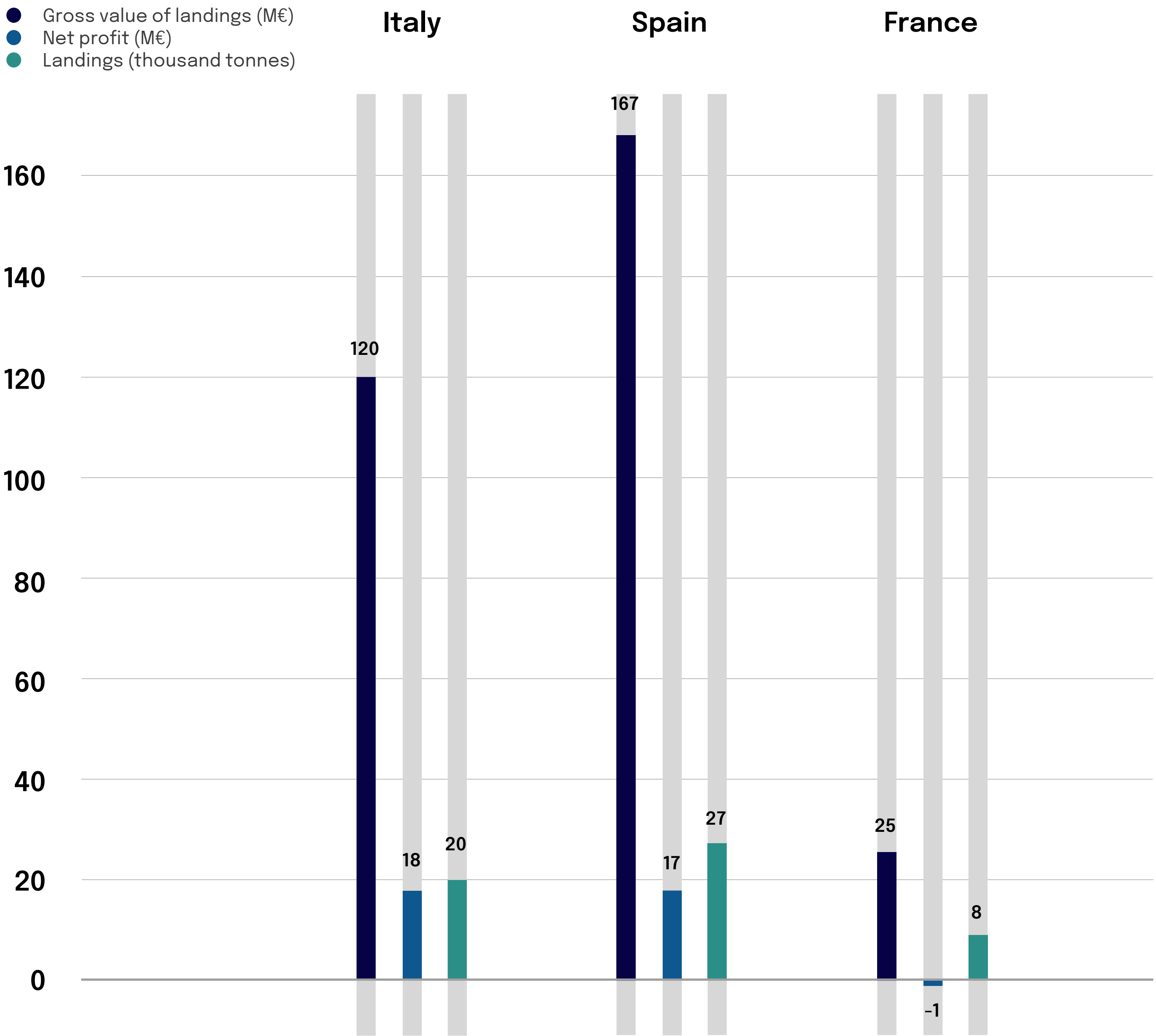


Figure 4. Landings, gross value of landings and net profits of EU trawl fleets in the Western Mediterranean. (Source: Authors elaboration of 2018 data from the 2020 Annual Economic Report on the EU Fishing Fleet for Spain and France, and 2017 data from Sabatella et al., 2019 for Italy)

2.1. GAINING A BROADER PERSPECTIVE ON THE ECONOMICS OF TRAWL FISHERIES

The usual economic criteria for assessing trawl fisheries in the region, however, provide only an incomplete picture of the economic reality of the sector (Sumaila, 2021). In the following sections we analyse some of its less known economic aspects, such as governmental financial transfers, opportunity costs, carbon costs, labour costs and biological costs. Where possible, these costs are quantified and monetary estimations provided.

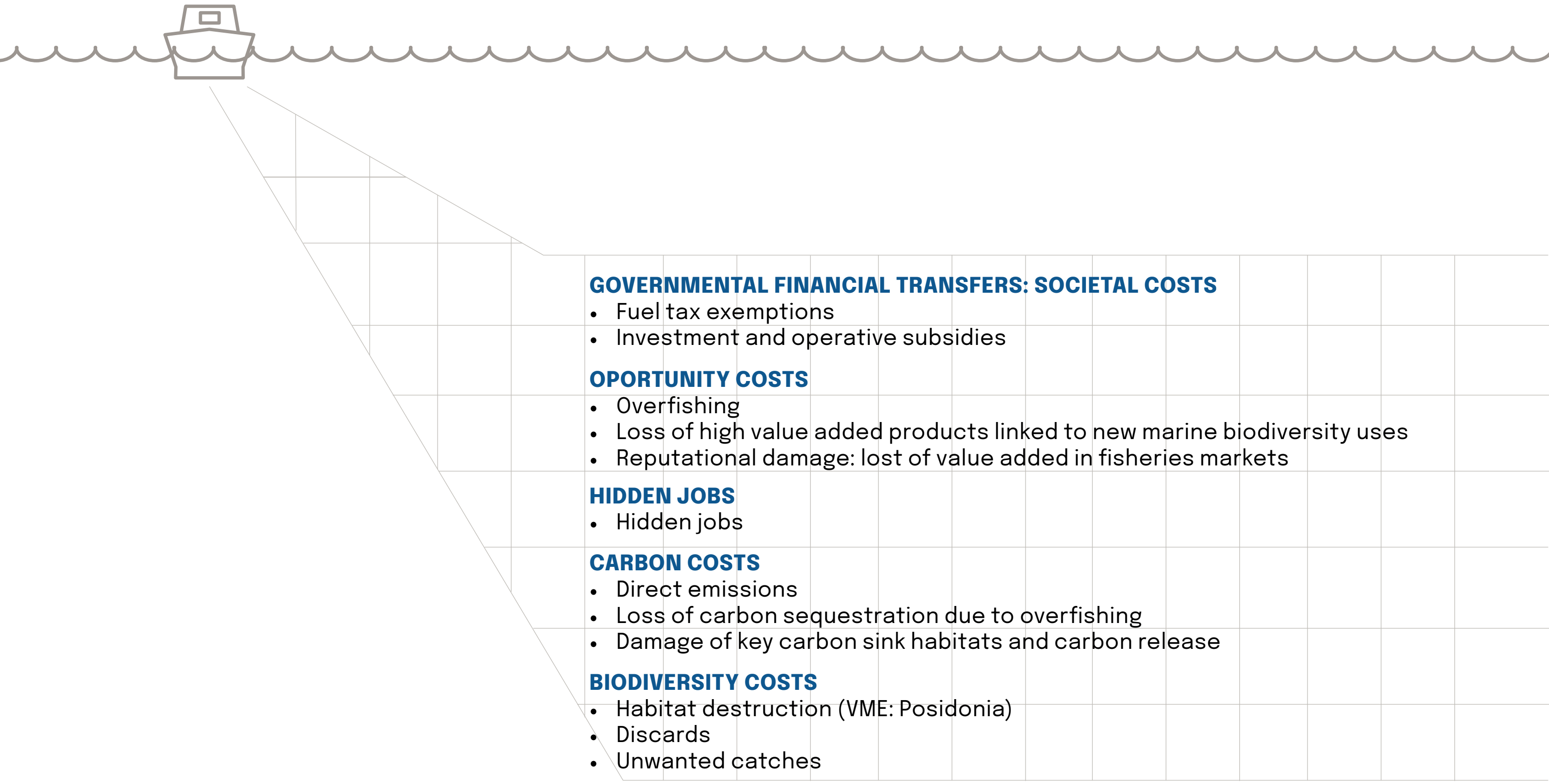


Figure 5. Governmental financial transfers and externalities. (Source: Authors elaboration)

3. GOVERNMENTAL FINANCIAL TRANSFERS

The current characteristics of the Western Mediterranean trawling sector cannot be fully understood without analysing the governmental financial transfers (or subsidies) that fuelled its development, some of which are still available to the sector.

The OECD defines governmental financial transfers as the monetary value of government interventions associated with fishery policies. They are primarily classified according to how the transfer is implemented (Figure 6). More detailed information can be found in Annex 3 (governmental financial transfers).

DIRECT PAYMENTS
Enhance the revenue of recipients and are paid from government budgets (that is, financed by taxpayers) directly to fishers
- Grants for new vessels
- Grants for modernisation
- Vessel decommissioning payments
- Compensation for closed or reduced seasons (...)

GENERAL SERVICES
Catch-all category that covers transfers that are not received directly by fishers, but that reduce the costs faced by the sector as a whole
- Expenditures on research, management and enforcement
- Expenditures on infrastructure that benefit the industry as a whole (...)

COST-REDUCING TRANSFERS:
Reduce the costs of fixed capital and variable inputs
- Fuel tax exemptions
- Subsidised loans (for new vessels or modernisation)
- Government funding for the introduction of new gear and technology (...)

Figure 6. Governmental financial transfers. (Source: Authors elaboration from OECD, 2000)

In the following sections we will first analyse fuel tax exemptions (Sumaila et al., 2008), which are considered as cost-reducing transfers and are the largest governmental financial transfers to the trawling sector; then we will look at the operative and investment subsidies, mostly linked the European Fisheries and Aquaculture Funds.

3.1. FUEL TAX EXEMPTIONS

Fuel costs make up a significant part of the total operating costs of the trawl fleets. According to the EU Scientific, Technical and Economic Committee for Fisheries, in 2018 fuel costs were responsible for 16.9% of the EU fleet's total costs, and were only exceeded by labour costs at 37% (STECF, 2020c).

Trawlers consume more fuel than the fishing fleet average. In the Mediterranean fuel is the main cost for bottom trawlers and beam trawlers, making up 36.7% of the total costs (FAO, 2020), despite the fact that fisheries fuel prices are much lower than public prices, as they benefit from tax exemptions. Fuel tax exemptions are not specific to Mediterranean fisheries: globally they were estimated to be worth about $7.7 billion in 2009; overall, they constitute the largest government financial transfer to the fishing sector.

The value of governmental transfers for bottom trawlers and beam trawlers can be calculated for the EU Mediterranean fleet[6]. In 2018 fuel tax exemptions in these fleet subsegments were worth more than €93 million, or more than 30% of the landings gross value (Figure 7).

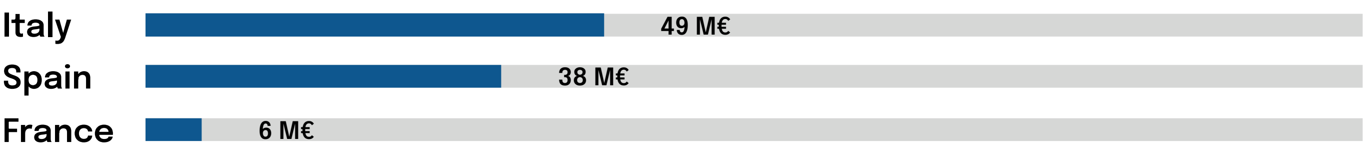


Figure 7. Fuel tax exemption for the Western Mediterranean EU trawlers (2018). (Source: Authors elaboration[5])

[6] Methodological explanation and data used can be found in the Annex 4. Fuel exemption methodology.

REVENUES AND FUEL COSTS

Due to the revenue scheme generally used in the Mediterranean, there is a direct relation between fuel costs and revenues. A lower ratio of fuel costs to revenues indicates that fuel costs are being spent efficiently in terms of their capacity to produce revenues. In both, the Western and Eastern Mediterranean, trawlers and beam trawlers are the least efficient fleet segment with a ratio at around 22%, while this figure decreases to 14.1% for small-scale fisheries (FAO, 2020).

In Morocco the average fuel consumption of coastal trawlers is 61 tonnes per vessel and year. This fleet segment is the most sensitive to oil price increases (Kamili, 2019). Since 2015 Morocco has largely phased out fuel subsidies, but this does not mean that there are no governmental financial transfers linked to fuel. For example, the tax incentives granted to marine fisheries includes the deduction of fuel on cost from the turnover generated by the sale of the fish.[7]

The Algerian case is different: the oil price is heavily subsidised, and thus it does not follow the international price market. Algeria has the fourth lowest petrol prices in the world (after Venezuela, Iran and Angola) at as little as €0.29/litre, which is much lower than in other Western Mediterranean countries.[8]

7 www.comunitapmimediterraneo.org/en/news/fishing-industry-in-morocco/
8 statisticstimes.com/economy/countries-by-petrol-prices-and-gdp-per-capita.php

3.2. OPERATIVE AND INVESTMENT SUBSIDIES

The European Maritime Fisheries and Aquaculture Fund (EMFAF) with a budget of €6.108 billion for 2021-2027 is one of the five European Structural and Investment Funds, and with its predecessors (FIFG, EFF and EMFF) has been the main mechanism to drive governmental financial transfers to the EU Mediterranean trawl fisheries.

It is beyond the scope of this report to evaluate the overall role of the EU Maritime Fisheries Aquaculture Funds in the development of EU fisheries policy,[9] but it is worth noting that the European Court of Auditors (ECA) has pointed out the limited use of the European Maritime and Fisheries Fund (EMFF) for conservation purposes.

Until up to 2019, only 6% of the total EMFF funding used in the analysed countries was directly related to conservation measures, with a further 8% having an indirect relationship to conservation objectives (European Court of Auditors, 2020). It is worth noting that in the past, subsidised investment in fishing vessels through the European Fisheries Fund (EFF, 2007-2013) may in practice have increased their ability to catch fish (European Court of Auditors, 2011), and that previous public funding programmes for shipbuilding and modernisation contributed to the failure of reducing overcapacity in the EU fleet, persisting since 1986 (European Court of Auditors, 2007).

The EMFF is still providing direct operative subsidies and subsidies for investments. According to the European Commission Annual Economic Report on fisheries, in 2018 the Italian fleet received €2.5 million,[10] the Spanish fleet €0.8 million and the French fleet €0.1 million (AER, 2020).

It is important to note that these figures do not reflect the public support that the current trawl fleet would have received in the past, including direct support for construction or modernisation.

Most Mediterranean trawlers fleet subsegments have a mean age of over 20 years (Figure 19) and both their construction and modernisation were substantively subsidised by the EU. For example, between 2000 and 2006 the EU allocated €6.7 billion for the EU fleet, 13% of which was used for the construction of new vessels and 4.3% for the modernisation of existing vessels. In the following funding period (2007-2013), the EU allocated 4% of its €5.1 billion budget to modernisation, while construction of new vessels was no longer eligible for financing (Skerritt et al., 2020).

It is important to note that the European trawl fleet has not been the only one to benefit from governmental financial transfers. For example, according to Sumaila et al. (2019), in 2018 Morocco had the third highest subsidised fisheries sector of the 'low' High Development Index Countries, with a total of US$297 million. Tax exemptions for investments, sales, etc., are used on a regular basis by the Moroccan fishing fleet.[11]

3.3. THE IMPACT OF GOVERNMENTAL FINANCIAL TRANSFERS ON NET PROFITS

While it has not been possible to calculate all the governmental financial transfers to the EU trawling sector operating in the Western Mediterranean, it is worth noting that if we exclude fuel exemptions and operative and investment subsidies that were previously calculated for the three European Mediterranean trawl fleets, the sectorial net profits become negative in 2018 (Figure 8).

9 An updated analysis on the impacts of last 20 years of public fishing funds use in Europe can be found in Skerritt et al., 2020.

10 Information for Italy is only available for the whole trawl fleet. We have estimated the amount relevant to their Western Mediterranean fleet by assuming a proportional distribution of subsidies based on the number of trawlers registered in the area.

11 Royaume du Maroc, 2021. Article 59, 91, 92, 99, 121 and 123 of the Code Général des Impôts.

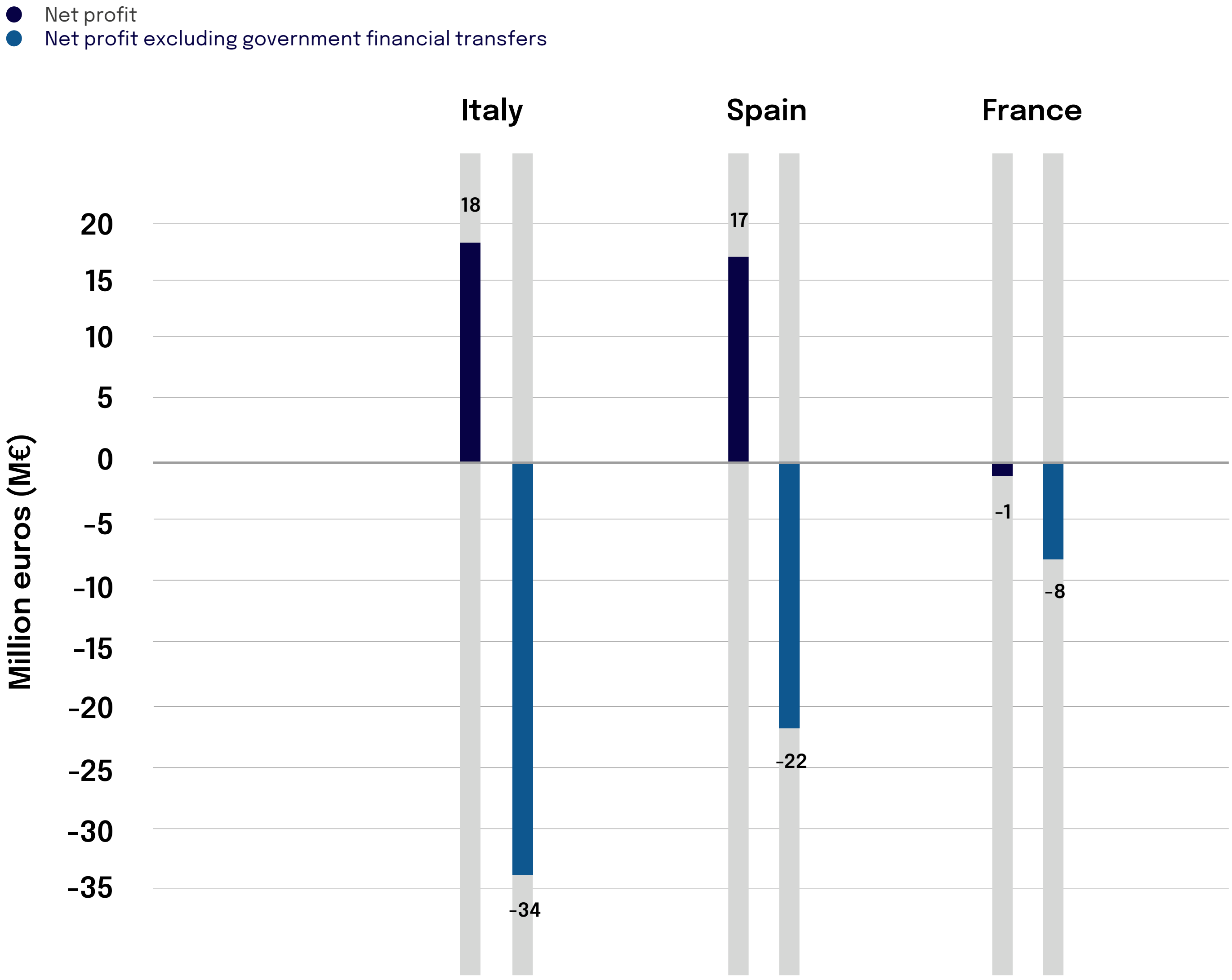


Figure 8. Net profit and net profit excluding fuel tax exemptions and operative and investment subsidies of the EU Western Mediterranean trawl fleet (2018). (Source: Authors elaboration based on sections 3.1 and 3.2 estimates)

It has not been possible to evaluate the impact of government financial transfers on net profits of the Algerian and Moroccan trawling sectors due to lack of available information.

4. CARBON COSTS

Trawling contributes to climate change through a range of factors including the burning of fossil fuel by fishing vessels (direct emissions), upstream emissions linked to mining, refining and distribution of fuel, as well as the emissions associated with vessel construction and maintenance, and the manufacture of gear and fishing equipment (Parker et al., 2018; Sumaila and Tai, 2020).

Bottom trawling also contribute to the increase of CO^2 emissions by causing physical damage to key carbon sink habitats such as Posidonia oceanica seagrass meadows (González-Correa et al., 2005), or through the physical disturbance of marine sediments, which make up the world's largest pool of organic carbon. This disturbance has the potential to remineralise sedimentary carbon to CO^2, leading to an increase of ocean acidification as well as of atmospheric CO^2. Based on data for the period 2016-2019 (Sala et al., 2021), it is estimated that 1.3% of the world's oceans (4.9 million km2) are trawled every year. This study estimated that the physical disturbance of sediments, and the consequent increase in their carbon metabolism, leads to 1.47 Pg of aqueous CO^2 emissions in the first year after trawling. Despite being only 0.02% of total marine sedimentary carbon, this quantity represents up to 20% of the atmospheric CO^2annually absorbed by the ocean. Emissions decline after the first year of trawling due to an exhaustion of the marine sediment carbon stocks but stabilise at around 0.58 Pg CO^2(Figure 9).

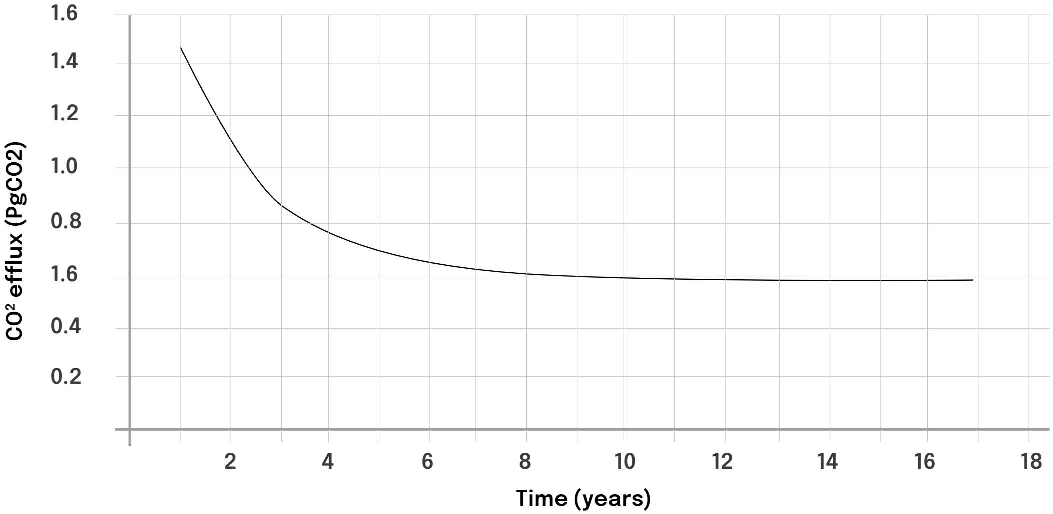
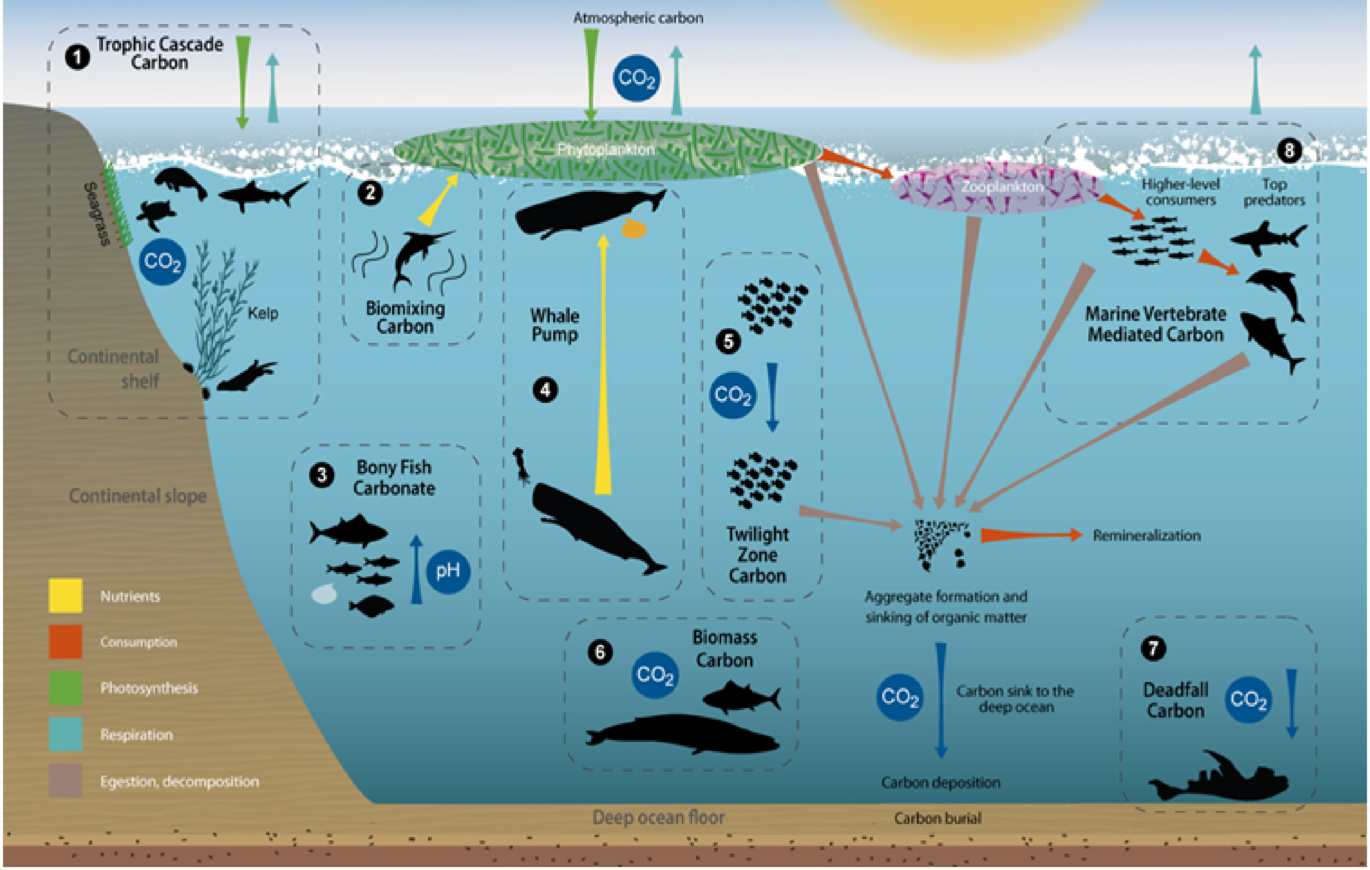


Figure 9. Changes in CO^2 remineralisation rates over successive years of physical disturbance of sediments by bottom-trawling. (Source: Supplementary information provided in Sala et al., 2021)

In another recent study, Paradis et al. (2021) analysed the effect of a two-month closure of deep-sea bottom trawling areas in the Palamós submarine canyons in Catalonia (Spain, NW Mediterranean). The results showed that the continuous impact of trawling on the sea bottom contributes to the erosion of marine sediments and to a decrease in the quantity and quality of organic matter in trawling sites when compared to un-trawled areas. One important effect is the depletion of organic carbon from continental slope trawling grounds, which are estimated to store about 20 Pg of organic carbon in the upper metre worldwide.

Moreover, fish and marine mammals provide important carbon services (Rogers et al., 2014). Figure 10 describes eight biological carbon cycling mechanisms associated with these groups. One example is that fish, in contrast to most terrestrial animals, do not release CO^2 into the atmosphere after natural death; instead, fish sequester carbon into the deep sea (see 7 Deadfall carbon in Figure 10). Overfishing disrupts this and other carbon-related mechanisms, contributing to a reduction in carbon sequestration and an increase in atmospheric carbon emissions (Lutz and Martin, 2014; Mariani et al., 2020).



1	Tropic Cascade Carbon	Food web dynamics help maintain the carbon storage and sequestration function of coastal marine ecosystems (e.g. the health of primary producers such as seagrass meadows and kelp forests is maintained by herbivory and predation).
2	Biomixing Carbon	Turbolence and drag. associated with the movement of marine vertebrates, causes enhanced mixing of nutrient rich water from deeper in the water column towards the surface, where it enhances primary production by phytoplankton and thus the uptake of dissolved CO^2.
3	Bony Fish Carbonate	Bony fish excrete metabolised carbon as calcium carbonate ($CaCO^3$) enhancing oceanic alkalinity and providing a buffer against ocean acidification.
4	Whale Pump	Nutrients from the faecal material of whales stimulate enhanced primary production by phytoplankton, and thus uptake of dissolved CO^2.
5	Twilight Zone Carbon	Mesopelagic fish feed in the upper ocean layers during the night and transport consumed organic carbon to deeper waters during daylight hours.
6	Biomass Carbon	Marine vertebrates store carbon in the ocean as biomass through their natural lifetime, with larger individuals storing proportionally greater amounts over prolonged timescales.
7	Deadfall Carbon	The carcasses of large pelagic marine vertebrates sink through the water column, exporting carbon to the ocean floor where it becomes incorporated into the benthic food web and is sometimes buried in sediments (a net carbon sink).
8	Marine Vertebrate Mediates Carbon	Marine vertebrates consume and repackage organic carbon through marine food webs, which is transported to deep waters by rapidly sinking faecal material.

Figure 10. Marine vertebrate carbon services. (Source: Lutz and Martin, 2014; based on Barber, 2007; Wilmers et al., 2012; and Heithaus et al., 2014)

The following analysis presents a quantification of the greenhouse gas (GHG) emissions associated with the consumption of fuel, providing an estimate of the related social cost of carbon.

4.1. DIRECT CARBON EMISSIONS

European trawl fleets operating in the Western Mediterranean consumed a total of 1.2 billion litres of fuel between 2013 and 2018, which corresponded to approximately 3.3 million tonnes of CO^2-equivalent emissions.[12] During this period Italy increased fuel consumption and related emissions by 40%, whereas Spain and France decreased theirs by 7% and 13%, respectively (see Figure 11 and Table 11 in Annex 5).

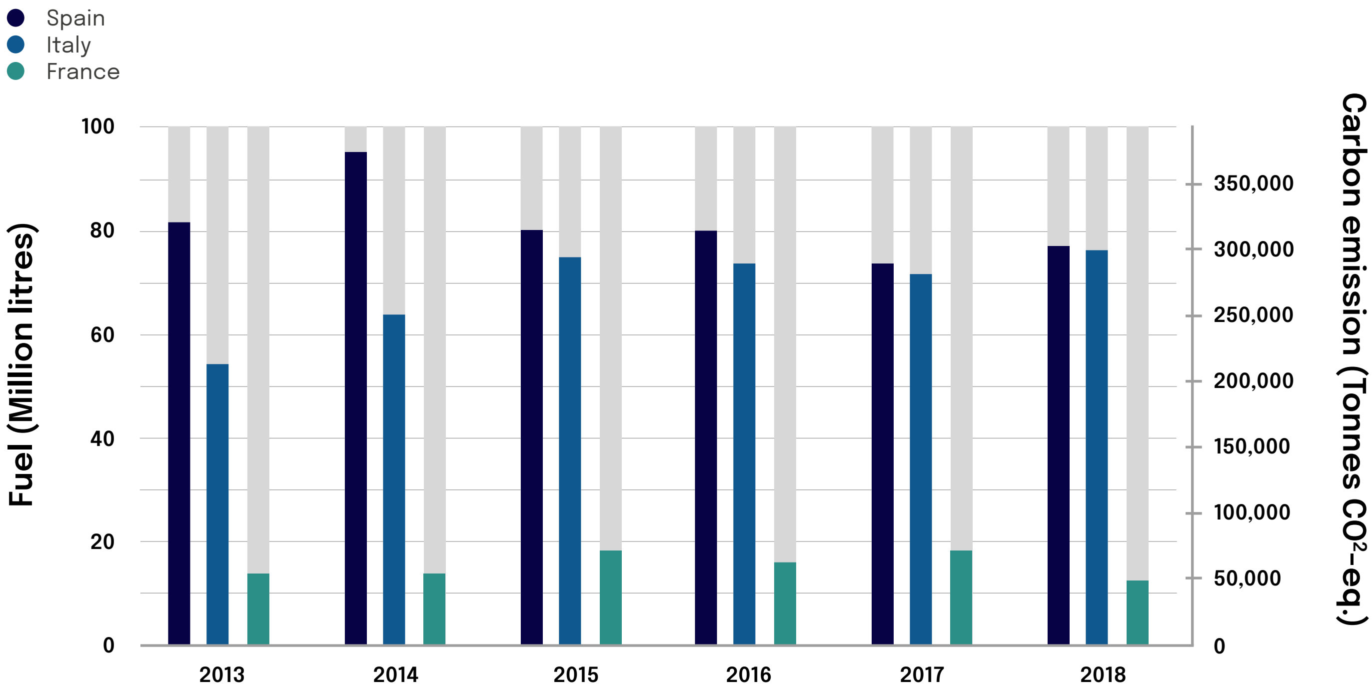


Figure 11. Fuel consumption and carbon emissions by EU trawlers in the Western Mediterranean. (Source: Authors elaboration based on: STECF 20-06 - EU Fleet Economic and Transversal data fleet segment; and Parker et al., 2018)

12 The estimation of direct emissions from fuel consumption was made by applying the factor of 2.8 kg CO^2-eq per litre of fuel in accordance with Parker et al., 2018.

Figure 12 compares the evolution of the binding annual emissions allocations (AEA) for non-EU Emission Trading System sectors defined in the Effort Sharing Decision for the period 2013-2020[13] with the evolution of trawl fisheries emissions from fuel consumption. Despite not being included in the AEA, fisheries are a non-ETS sector, so this analysis is relevant to check the differences between emissions trajectories. The analysis covers the period 2013-2018 and applies two indexes of base 100 (starting period=2013). The results indicate that the fisheries sector did not follow the same tendency of reduction in GHG emissions as the AEA.

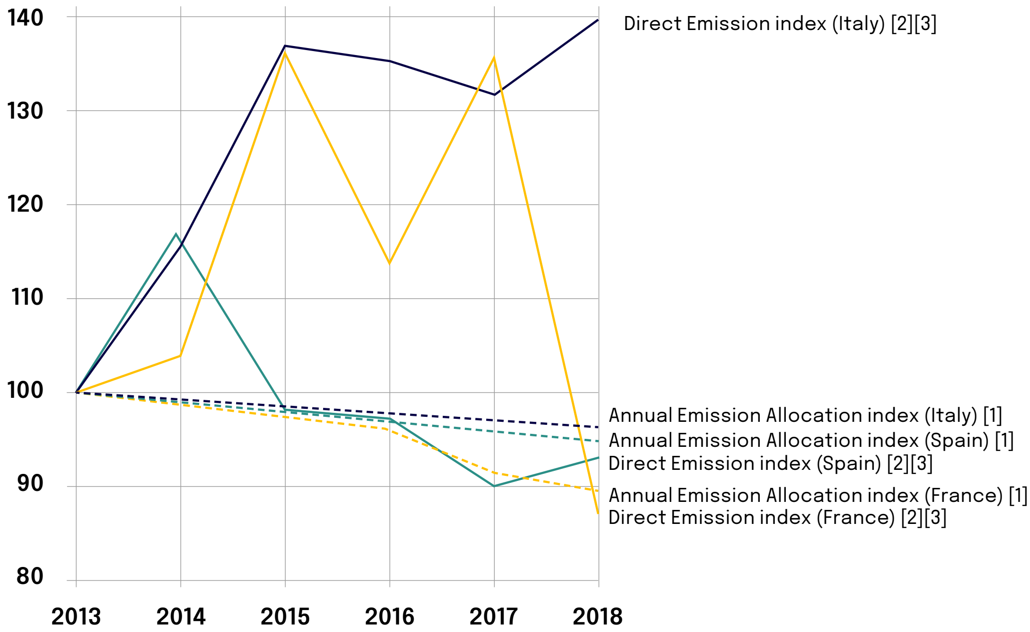


Figure 12. Index of Annual Emissions Allocations (AEA) for non-ETS sectors vs. Index of Direct Emissions (DE) of EU trawl fisheries in the Western Mediterranean (base 100 = 2013). (Source: Authors elaboration based on: ec.europa.eu/clima/policies/effort_en[14]; STECF 20-06-EU Fleet Economic and Transversal data fleet segment; Parker et al., 2018)

13 "The Effort Sharing legislation establishes binding annual greenhouse gas emission targets for EU Member States for the periods 2013-2020 and 2021-2030. These targets concern emissions from most sectors not included in the EU Emissions Trading System (EU ETS), such as transport, buildings, agriculture and waste." More information on: ec.europa.eu/clima/policies/effort_en (Last visit: 11/03/2021).
14 Last visit: 11/02/2021.

Based on the previous results, it was possible to compare the emissions of the EU Western Mediterranean trawl fisheries with the emissions levels needed for their flag state to comply with the AEA path. The results indicated show that these trawl fisheries emitted 326.3 thousand tonnes of emissions (in CO^2-eq) more than the AEA compliance scenario (Figure 13). Based on this gap or deficit, the related social cost of carbon was estimated by applying price levels of €7.59, €40.37 and €66.84/tonne of CO^2-eq. The lower bound corresponds to the average EU Emissions Trading System (ETS) carbon market price for the period 2013-2018, the middle level to the EU ETS price reported on 8 March 2021,[15] and the upper bound to the maximum carbon price needed in 2020 to meet the Paris Agreement goals according to a Report of the High-Level Commission on Carbon Prices (Stiglitz et al., 2017). Results show a total carbon hidden cost that, depending on the national trawl fleet, ranged between €0.2 million and €17.5 million (Figure 14).

15 ember-climate.org/data/carbon-price-viewer (Last visit: 11/03/2021).

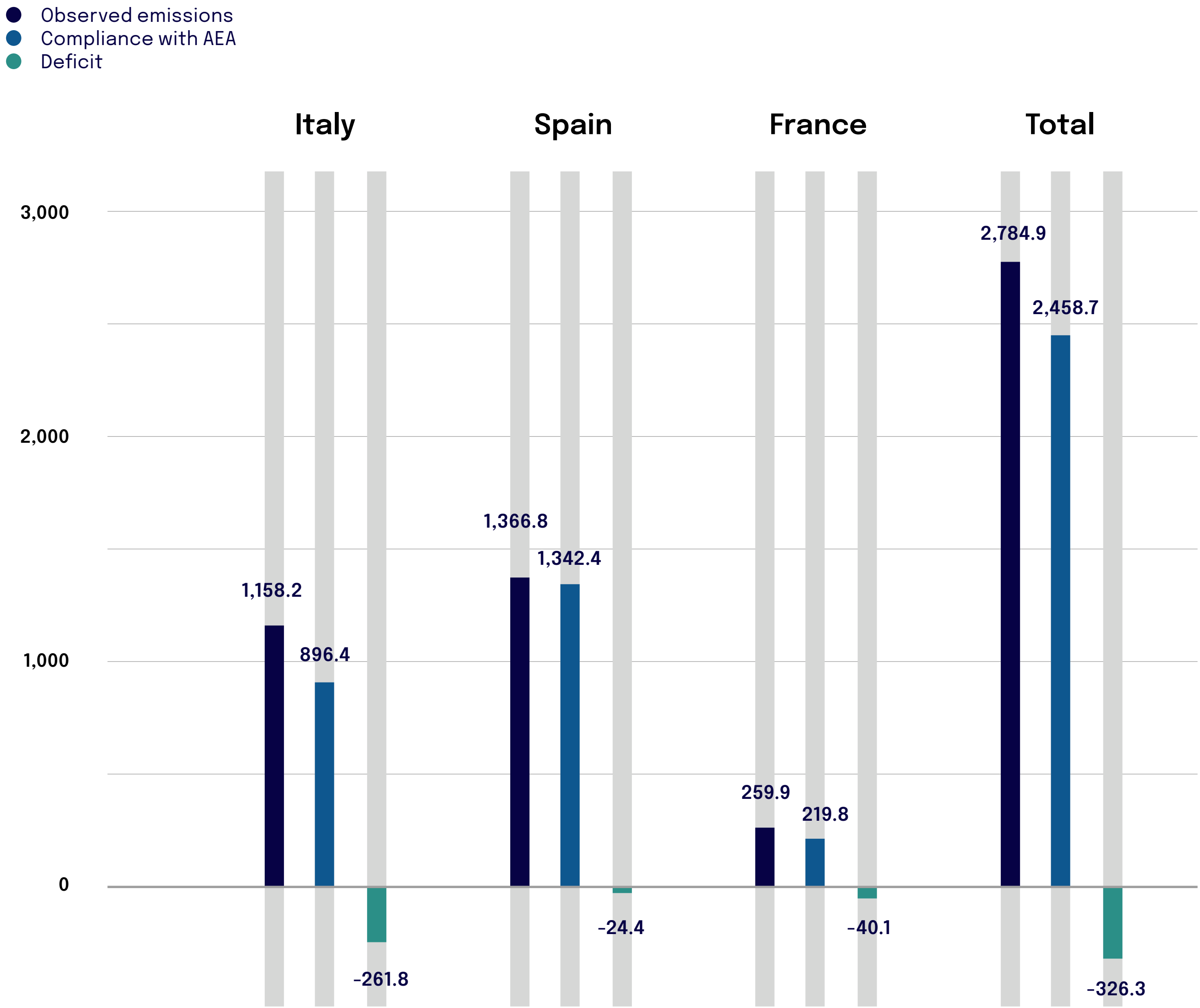


Figure 13. Comparative analysis between emissions observed and emissions required for the trawling sector to meet the AEA path (2013-2018; thousand tonnes of CO^2-eq). (Sources: Authors elaboration based on: ec.europa.eu/clima/policies/effort_en;[16] STECF 20-06 - EU Fleet Economic and Transversal data fleet segment; and Parker et al., 2018)

16 Last visit: 11/02/2021.

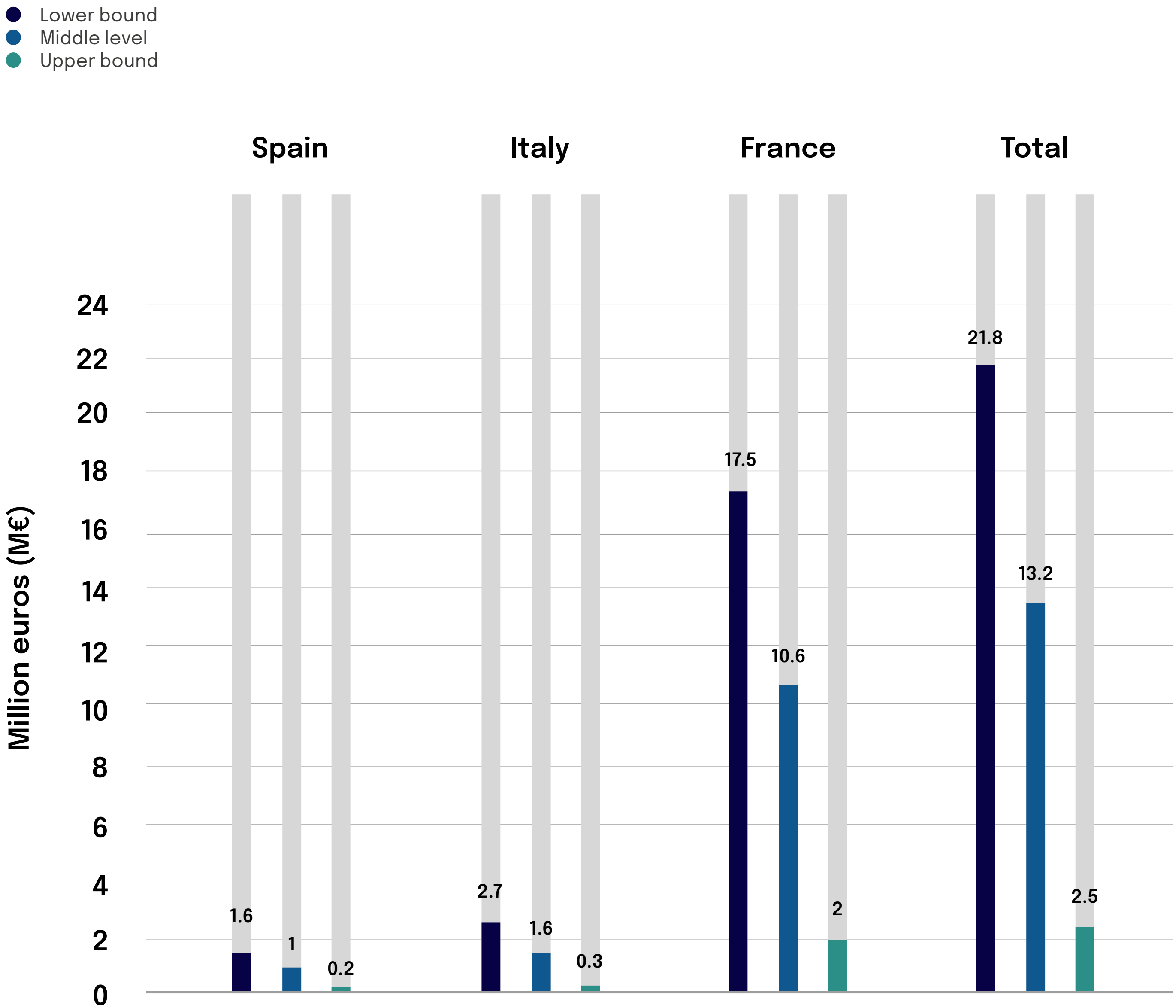


Figure 14. Carbon costs associated with direct emissions from fuel consumption in the EU Western Mediterranean trawl fisheries. (Sources: Authors elaboration based on the results presented in Figure 12 and social price of carbon defined in ember-climate.org/data/carbon-price-viewer [17] and Stiglitz et al., 2017)

[17] Last visit: 11/03/2021.

5. OPPORTUNITY COSTS

5.1. OVERFISHING

The EU Scientific, Technical and Economic Committee for Fisheries (STEFC) and the GFCM fish stocks assessments show that fishing mortality, in most Mediterranean commercial stocks, must be strongly reduced, particularly for demersal species, to achieve maximum sustainable yield (MSY).[18]

The Western Mediterranean demersal fleet is composed of trawlers, set longliners, and vessels working with fixed or bottom nets such as gillnets or trammel nets. However, bottom trawlers are responsible for the highest demersal catches – this means that any marked reduction of fishing mortality on demersal stocks will affect bottom trawlers.

Therefore, what would be the economic consequences of ending overfishing, for example on the North-Western Mediterranean demersal stocks? This is a complicated issue since it involves the application of bio-economic models to mixed fisheries using data which is often poor, or which only covers short periods of time. Moreover, economic results may differ significantly according to the combination of strategies used to decrease total mortality. These may include efforts to reduce fishing pressure, increase selectivity, or to recover ecosystems and fish stocks with permanent fisheries closures.

While it is not yet possible to provide a comprehensive answer to this question, some useful information is already available and summarised in Table 2, while a more in-depth discussion can be found in the Annex 6 (Overfishing opportunity costs).

18 Maximum sustainable yield (MSY) is the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological and environmental conditions.

TABLE 2. RESULTS OF SOME BIOECONOMIC MODELS UNDER DIFFERENT MANAGEMENT SCENARIOS ON FISHING MORTALITY REDUCTION BY TRAWLERS IN THE WESTERN MEDITERRANEAN SEA		
Area	Reference	Potential benefits
Spain (GSA6)	(Sola et al., 2020)	Net profits of the bottom trawl fisheries are expected to increase by 68% and 72% depending on the scenario applied, 7-10 years after reducing fishing effort by 1-2 days per week and introducing changes to selectivity patterns; also, the average daily wages could increase by 76% to 148%. Additionally, the decrease of fishing mortality would also lead to clear improvements in profitability and crew wages in the bottom longline fleet.
Spain (GSA6)	(Merino et al., 2015)	The expected profits after a transitional period would increase by 47% over current results.
France (GSA7)	(STEFC, 2020b)	Gross value of landings (i.e., revenues) of the trawling sector would decrease, while mid-term gross value added (i.e., profit) depends on the management scenario.
Italy (GSA 9, 10 and 11)	(STEFC, 2020b)	The passive gears fisheries would benefit from a decrease in fishing pressure mostly by trawling, with increases in revenues of over 20% in all fleet segments and very significant increases (from 8% and 108%) in revenues/break-even revenues. However, economic losses would be produced in almost all trawling segments, causing the inability to cover fixed costs.
Morocco and Algeria (GSA 3, 4)	n/a	We are unaware of any bioeconomic models.

There is a growing consensus that current fishing practices in the Mediterranean prevent the biological recovery of the ecosystems, while a strong decrease in fishing mortality would improve the status of most of the commercial fish stocks and of many marine species.

Most bioeconomic models suggest that higher net profits and average daily wages could be achieved after a period of rebuilding fisheries (Sumaila et al., 2012; World Bank, 2017) and transition for passive gears; on the other hand, the results for the trawling sector are more ambiguous. It is also important to note that, according to some models, the total revenues generated by the fisheries (after a transitional period that vary from fishery to fishery) would be higher than at present and in the business-as-usual scenario (Teh and Sumaila, 2020).

OVERFISHING IS UNECONOMICAL AND INVOLVES A WASTEFUL USE OF MARINE LIVING RESOURCES.

5.2. NEW ECONOMIC USES FOR BIODIVERSITY

In the context of the development of the Blue Economy – understood as all the marine-related activities which create new opportunities for investment and development in coastal communities – aquatic organisms are increasingly being used to generate new products and services such as biofuels, pharmaceuticals and bioremediation, among others. The marine biotechnology sector is of increasing interest (European Commission, 2019b). The main applications of marine biotechnology are divided into four main groups:

TABLE 3. FIELDS OF APPLICATION, OUTPUTS AND BENEFITS OF MARINE RESOURCES IN BIOTECHNOLOGY (SOURCE: AUTHORS ELABORATION WITH DATA FROM EUROPEAN COMMISSION, 2019)

Field of application	Outputs	Benefits
Healthcare and pharmaceutical	Advanced medicines Vaccines	Therapies and diagnostics
Agriculture, livestock, veterinary products and aquaculture	Animal feed Vaccines for livestock Human nutrition	Diagnostics for detecting diseases
Industrial processes and manufacturing	Detergents Pulp and paper Textiles Biomass	Use of enzymes Process efficiency Decreased energy and water consumption Toxic waste reduction
Energy production	Biofuel	Micro- and macro- algae production

To date, no comprehensive studies have evaluated the conservation status of Mediterranean species with bioactive potential, but it is crucial that we improve our understanding on how these species cope with human impacts. Several animal species found in the Mediterranean Sea are known to have bioactive potential (García-de-Vinuesa et al., 2021), the majority of which are benthic organisms such as tunicates, sponges, bryozoans and cnidarians. In this context the loss of marine biodiversity decreases opportunities to find new biologically-derived applications, and thus reduces and compromises potential option values, for e.g., future economic opportunities and the potential development of health therapies.

A recent example illustrates this potential. A sea squirt found in Spain's Mediterranean coastal areas – *Aplidium albicans* – produces plitidepsin, a compound already approved for cancer treatment by Australia's Therapeutic Goods Administration that can also be used against COVID-19 (White et al., 2021).

Moreover, the direct impact of trawling in some specific ecosystems has recently been shown to produce a loss of species that could be of biotechnological interest. According to a recent paper on the Blanes area (North-Western Mediterranean) "14% of the species discarded by trawling on crinoid beds produce molecules with some type of bioactive potential" (García-de-Vinuesa et al., 2021). These species contain molecules with antioxidant, antitumour, antihypertensive and antibacterial properties, meaning they may have potential as sources for new marine-based compounds for medical applications. The results of the investigation state that 68% of these species show medium to high vulnerability to trawling (García-de-Vinuesa et al., 2021).

5.3. ACCESS TO HIGH SEGMENT AND SECURE MARKETS

Most fish consumed in the European Union is imported. Products of European origin made up 42.5% of total apparent consumption (self-sufficiency rate) in 2018 (EUMOFA, 2020).

The EU's extraction from Mediterranean fish stocks is much lower than the total consumption of fish by EU citizens. Most of the sales are imported from other seas and wholesalers control the first-sale price. This means that local fishers are unable to influence price of their products under the prevailing auction-based systems.

In response, several new marketing initiatives have emerged locally to increase the value of catches. These include direct marketing arrangements and so-called alternative food networks, among others (Gómez and Maynou, 2021).

Among the alternative sale strategies, community-supported fisheries (CSF), often supported by specific local labels, and short supply chains (including direct sales by fishers) are based on social values and relations transmitted through the food system (Witter et al., 2021). Consumers value the relationships established along the exchange network by linking production and consumption directly as a two-way socio-environmental commitment process, establishing a social relation of mutual knowledge between the fisher and end-user (Gómez and Maynou, 2021). Through this relation better economic conditions – in terms of resilience, use of previously discarded products, and increased margins – can be obtained by fishers (Witter et al., 2021).

Nevertheless, these schemes rely on the buyer's perception of increased value in comparison to the usual market channels, including product-process requirements such as quality, price, health, tradition and increasingly environmental conservation. In this context, it is important to be able to guarantee that fishing practices are environmentally sustainable. If they are perceived as being environmentally harmful or as leading to overfishing, their implementation, expansion and credibility may suffer. Fishers lose the opportunity to become more economically resilient while enhancing ecosystem health by boosting fishing diversification.

Certification schemes are another strategy used to increase fish value through mainstream marketing channels. However, given the widespread overfishing of most Mediterranean stocks, certifying the sustainability of fishery products is extremely challenging and controversial.[19] As a consequence, competitors who have already implemented low-impact fisheries management schemes are better able to meet the needs of consumers willing to pay a premium to ensure the good ecological status of the fisheries.

19 www.project-medfish.com

6. BIODIVERSITY COSTS

Trawling activities alter the ecosystem in several complex ways, some of which have not been fully quantified, while others cannot be translated into monetary terms because either a market for them does not exist, or because of the difficulty to quantify certain values – how is it possible, for example, to estimate the value of a species at risk of extinction? In this section we will describe some of the complex biological factors that should not be ignored, but also cannot be (or should not be) properly monetarised.

6.1. DISCARDS

Discarding is the practice of dumping overboard, dead or alive, unwanted fish or any type of marine animal caught as bycatch during fishing operations. The practice has been linked to mortality of juvenile fish, benthic species, and loss of biodiversity (Stithou et al., 2019).

Discards produce costs at the level of the fisher (e.g. resources are used for managing and recording fish that generate no revenue), the fisheries authorities (e.g. monitoring and control, observer programmes), and society in general (e.g. costs associated with the impact on the ecosystem and biodiversity).

The reasons for discarding are multiple. Several authors reported that much of the discarding is not only related to undersized fish (individuals below the minimum length authorized to land), but also to high grading (only the best quality fish are brought ashore while the rest is discarded) and market issues (many catches do not find a market). In Mediterranean bottom trawl fisheries, of the 300 species caught, only around 10% are consistently marketed and 30% are occasionally retained (depending on their size and market price), whereas up to 60% are always discarded (Bellido et al., 2017).

While the volume of discards may vary considerably in amount and composition depending on region, season, fisheries, etc., bottom trawling is one of the least selective fishing practice used to fish (UNEP/MAP-Plan Bleu, 2020; FAO, 2020).

The volume of fishery discards in the Mediterranean is around 230,000 tonnes per year, or around 18% of the total catch (FAO, 2018). Most of the discards come from bottom trawl fisheries (Tsagarakis et al., 2014) with rates that vary widely across the region (Tsagarakis et al., 2017). For example, demersal trawl fisheries discard an average of nearly 35% of their total catch by weight (Tsagarakis et al., 2014). While small-scale fisheries tend to have discard rates below 10%, discard rates for bottom trawl fisheries in the Western Mediterranean subregion are usually higher, with most of the reported fisheries with medium (15%-39%) or high (>40%) discards rates (Figure 15; see also FAO, 2018).

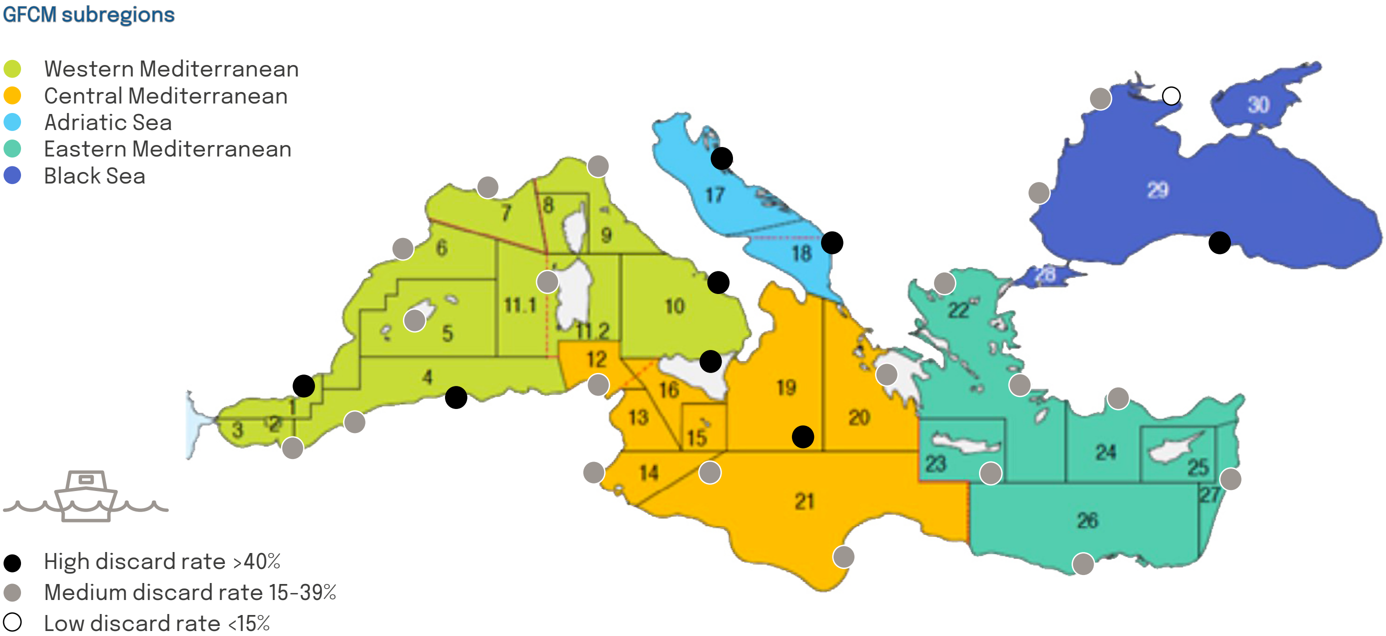


Figure 15. Discard rates as a percentage of total catch for bottom trawling fisheries operating in the different GSAs of the Mediterranean. (Source: FAO, 2018)

If we consider the discard rates shown in Figure 15 and the total value of landings by Western Mediterranean bottom trawlers in 2018 (59,519 tonnes) (FAO, 2018), the yearly volume of discards by Western Mediterranean trawlers can generally range from 15% (10,503 tonnes) to 40% (39,679 tonnes).

BETWEEN 10,503 AND 39,679 TONNES OF MARINE SPECIES ARE DISCARDED EACH YEAR BY WESTERN MEDITERRANEAN BOTTOM TRAWLERS.

These discards contain many different marine species including commercial, non-commercial and sometimes-commercial species – and regardless of their market value, they are all important to the ecosystems in which they live (Table 4).

TABLE 4. MAIN COMMERCIAL AND NON-COMMERCIAL SPECIES DISCARDED BY BOTTOM TRAWL FISHERIES IN THE WESTERN MEDITERRANEAN

GFCM subregion	Commercial species	Non-commercial species
Western Mediterranean	European common squid (Allotheuthis subulata), Red gurnard (Aspitrigla obscura), Bogue (Boops boops), Spotted founder (Citharus linguatula), European conger (Conger conger), Annular seabream (Diplodus annularis), European anchovy (Engraulis encrasicolus), Broadtail shortfn squid (Illex coindetii), Thinlip grey mullet (Liza ramada), European hake (Merluccius merluccius), Red mullet (Mullus barbatus), Common octopus (Octopus vulgaris), Axillary seabream (Pagellus acarne), Common pandora (Pagellus erythrinus), Deep-water rose shrimp (Parapaenaeus longirostris), White glass shrimp nei (Pasiphaea spp.), Greater forkbeard (Phycis blennoides), Sardine (Sardina pilchardus), Pink cuttlefish (Sepia orbignyana), Picarels nei (Spicara spp.), European sprat (Sprattus sprattus), Jack and horse mackerels nei (Trachurus spp.), Poor cod (Trisopterus minutus capelanus)	Ascidiacea, Echinoderms (Astropecten irregularis, Holoturia tubulosa, Spatangus purpureus, Stichopus regalis, Trachythyone spp.), Boarfish (Capros aper), Curled picarel (Centracanthus cirrhus), Hollowsnout grenadier (Coelorynchus caelorhyncus), Velvet belly (Etmopterus spinax), Silvery pout (Gadiculus argenteus), Blackmouth catshark (Galeus melastomus), Gastropods (Murex brandaris, Galeodea spp.), Smalltoothed argentine (Glossanodon leioglossus), Mediterranean slimehead (Hoplostethus mediterraneus), Jewel lanternfish (Lampanyctus crocodilus), Silver scabbardfish (Lepidopus caudatus), Liocarcinus swimcrabs nei (Liocarcinus spp.), Longspine snipefish (Macroramphosus scolopax), Demon-faced porter crab (Medorippe lanata), Common atlantic grenadier (Nezumia aequalis), Snake blenny (Ophidion barbatum), Right-handed hermit crabs nei (Paguridae), Arrow shrimp (Plesionika heterocarpus), Small-spotted catshark (Scyliorhinus canicula), Brown comber (Serranus hepatus), Atlantic mud shrimp (Solenocera membranacea), Dark tonguefish (Symphurus nigrescens), Marbled electric ray (Torpedo marmorata), Grenadier fishes (Trachyrincus spp.)

6.2. INCIDENTAL CATCH OF VULNERABLE SPECIES

The State of the Mediterranean Sea report (UNEP/MAP-Plan Bleu, 2020) shows that bycatch is one of the main drivers of increasing species extinction risk.

Among those most reported as incidental catch are some species of turtles followed by sharks and rays, including loggerhead turtle (*Caretta caretta*) and common smooth-hound shark (*Mustelus mustelus*).

In the Mediterranean, bottom trawlers cause the greatest impacts on some of these species. Together with longliners, they have the highest bycatch of sea turtles (Figure 16); and in the Western Mediterranean, bottom trawling is responsible for more than 90% of the incidental catch of elasmobranchs (Figure 17).

WESTERN MEDITERRANEAN BOTTOM TRAWLERS ARE RESPONSIBLE FOR MORE THAN 90% OF THE INCIDENTAL CATCH OF ELASMOBRANCHS

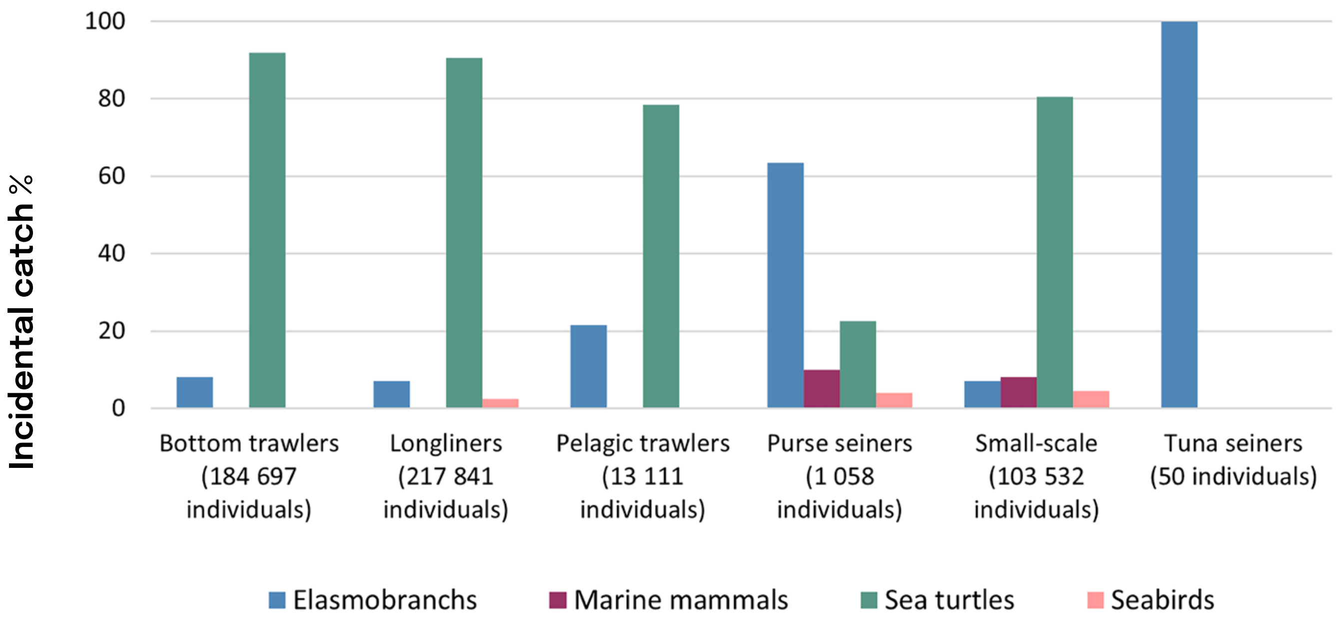


Figure 16. Incidental catch by species group and vessel group. (Source: FAO, 2020)

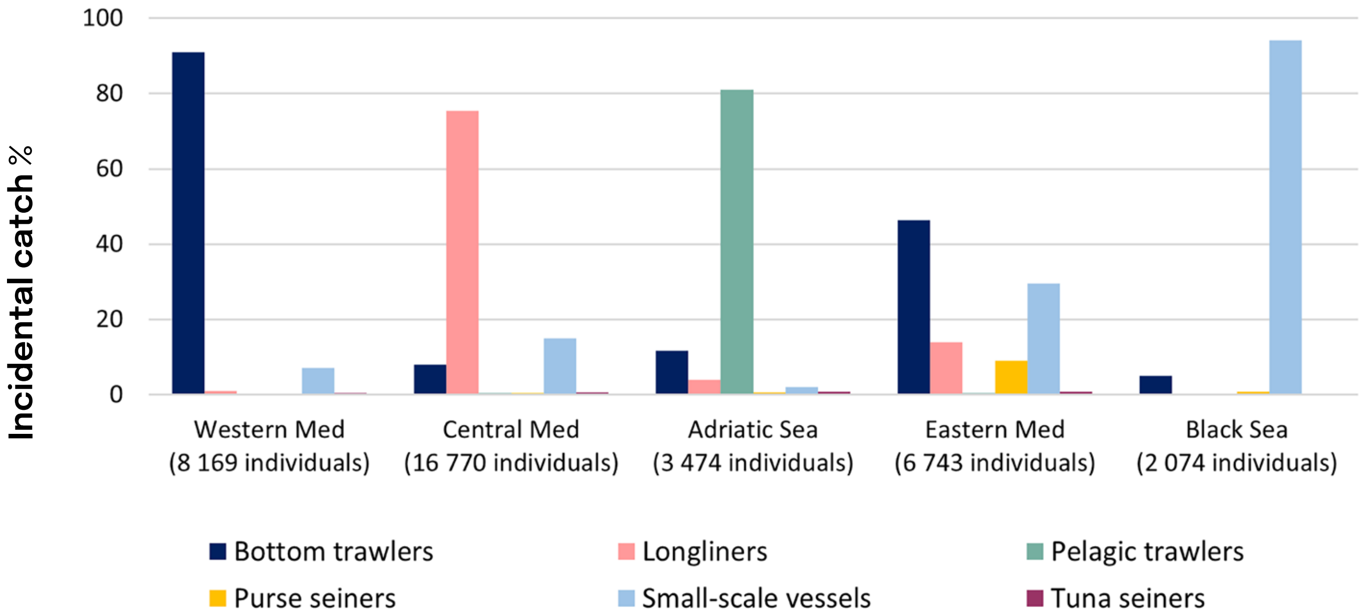


Figure 17. Incidental catch of elasmobranchs by fleet segment and subregions. (Source: FAO, 2020)

6.3. BENTHIC COMMUNITIES AND VULNERABLE MARINE ECOSYSTEMS (VMEs)

Bottom trawling impacts benthic communities (UNEP/MAP-Plan Bleu, 2020). The intensity and effects of the impacts are variable depending on the trawl characteristics, the trawling pressure and the habitats and species that are affected by this fishing activity (Vaz and Lafargue, 2021).

Direct impacts on species may include among others the uprooting of some elements, their being crushed, buried or exposed out of the water. The impact on the benthic ecosystem can be significant at species and habitat levels. In some cases, such as for coralligenous habitats or seagrass beds, the impacts of bottom trawling are such that these habitats can take decades to recover; often, these impacts may even be irreversible.

In addition, repeated trawling can affect benthic living organisms that play an important role in ecosystems, such as the recycling of organic matter, and can also significatively affect the chemistry of the sea bottom including the remineralization of carbon to carbon dioxide.[20]

The Mediterranean Sea has a wide variety of deep-sea species which are unique to the region, and which are key to maintaining the health of Vulnerable Marine Ecosystems (VMEs), that are negatively impacted by bottom fishing. VMEs are particularly susceptible to bottom-fishing activity as they are easily disturbed and slow to recover (Figure 18).

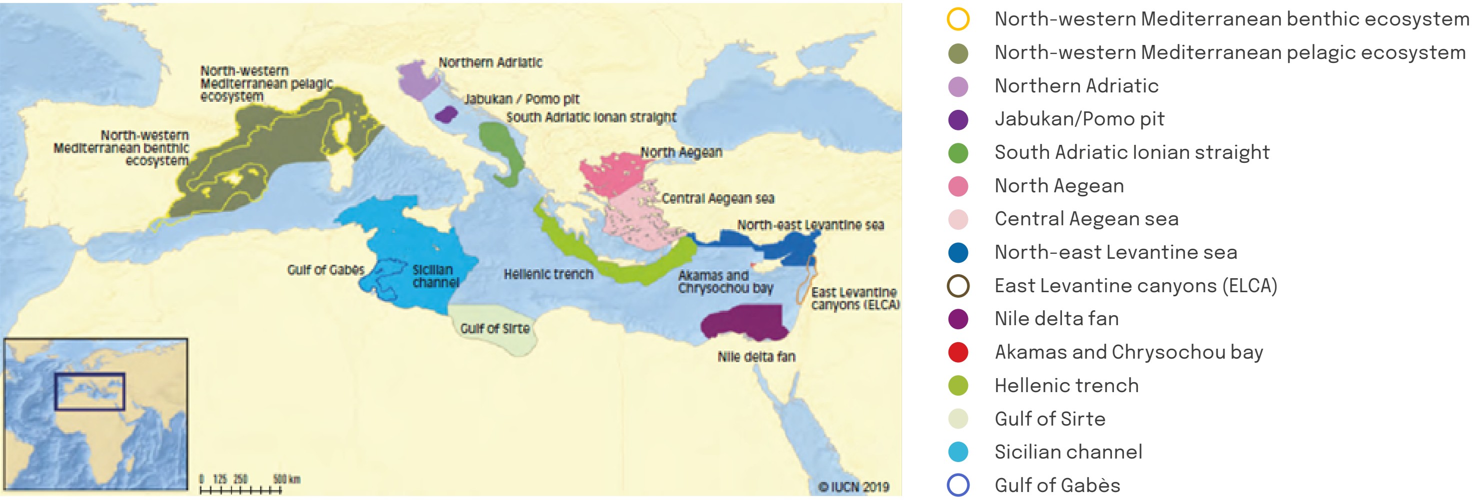


Figure 18. Mediterranean Ecologically or Biologically Significant Marine Areas (EBSA). (Source: UNEP/MAP-Plan Bleu, 2020)

[20] All these effects have been studied at different intensities in the Mediterranean Sea. See De Juan and Demestre, 2012; Grinyó et al., 2020; Muntadas et al., 2014; Palanques et al., 2014; Sarah Paradis et al., 2021; Paradis et al., 2017; Paradis et al., 2021; Puig et al., 2012; Pusceddu et al., 2014, 2005; Romano et al., 2016.

In 2005, the GFCM closed waters deeper than 1,000 m to trawling and began establishing Fisheries Restricted Areas to protect benthic habitats. In 2019, the GFCM adopted measures to prevent significant adverse impacts on VMEs formed by cnidarian (coral) communities in the Mediterranean Sea. These measures include the regulation of bottom trawl activities of fishing vessels above 15 m targeting deep-water shrimps, or operating at depths below 300 m or on seamounts.[21]

There are 150 species of corals in the Mediterranean Sea, of which 26 are endemic. They are a significant indicator of VMEs, including hard and soft corals, gorgonians, sea pens, black corals and sea anemones. Given their morphology – characterised by a rigid and calcareous skeleton and living on the sea floor – hard corals are often entangled by demersal fishing gears and landed by trawlers (Otero et al., 2019).

The GFCM is creating a database of sensitive benthic habitats and species of the Mediterranean Sea; this already includes 600 records of the priority species bamboo coral *Isidella elongate* (Esper, 1788), mostly in the Western Mediterranean. There have been several studies on *Isidella elongata* and its relation to VMEs over the past decade, which showed that trawling on VMEs removes coral habitats and decreases species diversity, which affects fish populations targeted by fisheries (Maynou and Cartes, 2012; Grinyó et al., 2020).

THE LACK OF A COMPREHENSIVE DATABASE ON SENSITIVE BENTHIC HABITATS AND SPECIES OR A BROAD LIST OF VMES TO BE PROTECTED, TOGETHER WITH INSUFFICIENT CONSERVATION MEASURES, ALLOWS TRAWLING TO CONTINUE CAUSING IRREVERSIBLE DAMAGE TO KEY BENTHIC ECOSYSTEMS.

[21] Resolution GFCM 43/2019/6 on the establishment of a set of measures to protect vulnerable marine ecosystems formed by cnidarian (coral) communities in the Mediterranean Sea.

7. LABOUR COSTS: HIDDEN JOBS

The collection of social indicators for the EU fishing fleet – such as employment or unpaid labour by gender – was introduced by Regulation (EU) 2017/1004. Social data on the EU fisheries sector is collected under the Data Collection Framework (DCF/EU-MAP),[22] nevertheless, there is still a lack of quantitative and qualitative information to assess the social impact of fisheries management measures (STECF, 2020b).

In Western Mediterranean fisheries (as in many parts of the world – Harper et al., 2017), unreported part-time jobs in the family business are quite common, particularly by women and the elderly (fishers' wives, parents and grandparents, daughters, mothers, etc.) (Huisman et al., 2015; European Commission, 2019b). This means that not all those who work in the sector are recorded in statistics, so there are no reliable data on which to base an estimation of their total number (European Commission, 2019a).

An EU survey of Fisheries Local Action Groups (FLAGs)[23] revealed that the number of businesses reliant on the unpaid support of women was high in some Western Mediterranean countries, including Spain and Italy (European Commission, 2019a). Across all Member States studied, fishing was identified as the sub-sector with the highest number of (unreported) women working in support roles without a specific legal status or remuneration (Harper et al., 2020). This is particularly the case in small-scale, family-run businesses. More information on the situation in each country and the tasks performed by women can be found in Annex 7 (Women's roles in fisheries by country).

Women perform many tasks without proper recognition, such as shopping and ship provisioning, administrative business management (banking, loans, legal procedures,

22 STEFC Expert Working Group (EWG) 19-03.
23 FARNET: webgate.ec.europa.eu/fpfis/cms/farnet2/node_en

taxes etc.), advising shipowners about sales at harbours, providing support during fish landings, attending fish auctions, packaging fish, and mending and making nets (MAGRAMA, 2016; Harper et al., 2018).

In France, the status of 'collaborating spouse' is an attempt to legally recognise these activities and internalise their real costs. It was created in 1997 and became mandatory in 2007. The status provides women with the same social benefits as any crew member, but differs in terms of formal remuneration and representation (European Commission, 2019a). 'Collaborating spouses' contribute 60% to the third category of the French fisheries sector's social security system,[24] which corresponds to an annual income of €11,463.09 Full Time Equivalent. Nevertheless, there is no data available on the number of women involved in the French trawl fisheries with a legal working status.

In the Spanish Basque country, the Special Social Security Scheme for Sea recognises a similar figure – known as a Neskatilla – as self-employed.[25] Neskatillas usually work for a single vessel, with a variable workday depending on the needs of the fishery: the role can range from a part-time job to a double shift. In most of Spain's Mediterranean regions the role of Neskatilla is known as "Pocera" and it is linked to family businesses, but it has not been legally recognised. They usually have a presence in Spain's fisher guilds, but their numbers have not been quantified. Again, there are not enough data to express in monetary terms the true magnitude of this hidden cost, even though the practice has been well known for decades.

In Italy the phenomenon of 'invisible' female work is widespread (Harper et al., 2020). Women work both on boats and on land, repairing nets, marketing fish, maintaining boats, and handling relations with port authorities and control bodies. Moreover, it

24 Le régime social des marins. (www.enim.eu/)
25 BOE (5/2/2021). Ministerio de inclusión, Seguridad Social y Migraciones

has been recognised that relying on ‘invisible’ female workers has helped to mitigate the effects of increases in production costs for small-scale fisheries. In small family fish processing enterprises, women frequently play supporting roles with no formal status. They are usually relatives (wives, daughters, mothers) of the fishers (European Commission, 2019a).

8. CONCLUSIONS

The Mediterranean Sea is a fragile biodiversity hotspot with high diversity and endemism of flora and fauna. Severe pressures are affecting its ecological balance such as fishing activities, pollution, coastal uses, maritime transport, and the introduction of invasive species. Adding to all of them, climate change is severely influencing its characteristics.

In this context urgent action is needed to reverse its environmental degradation, achieve a good environmental status, and ensure a sound environmental legacy to future generations.

Fisheries should also contribute to this overriding objective by adapting its practices and tools. Economic sciences can contribute to improve the sustainability of fisheries by providing into its analysis a holistic perspective of the economic implications of fishing activities, accounting also for the externalities produced by this economic activity (e.g., Sumaila, 2021).

The aim of this report is to contribute to this objective by offering a first broader economic evaluation of the Western Mediterranean trawling sector, whose environmental social externalities are not usually monetarised and/or considered in fisheries analysis, policy and management. Integrating, for example, the multiple linkages between bottom trawling and climate change in economic analyses produces a very different perspective than that offered by standard evaluations. The trawling sector as it is today would not be economically viable if fuel taxes subsidies were to be removed (Sumaila et al., 2010), or if this fishing sector was fully integrated in the emissions trading system, as it is the case in many other economic sectors.

The presence of these externalities must be addressed to correct them not just for the environment, but also to avoid an environment injustice in relation to other low-impact fishing practices.

An ecosystem approach to fisheries that reduces the current externalities would require also measures to decrease the footprint of trawling to overfishing and biodiversity loss. This may only be achieved through a new approach to fisheries management.

This report supports an extensive, urgent and combined use of conservation measures such as a strong reduction of fishing pressure, technical measures such as net adaptations, and the wider implementation of areas closures (McConnaughey et al., 2020) to reduce trawling externalities.

These changes should be introduced together with accompanying measures that can support the sector to cope with the transition. This is first because, on the one hand, the responsibility to reduce these externalities is shared with other sources of impacts (i.e. CO^2 and other form of pollution, offshore exploration and exploitation, costal development affecting marine ecosystems, etc.), but also because some of the existing problems could be prevented or minimized with better legislation, implementations and enforcement, a task for decision-makers and public administrations.

To conclude, considering the poor state of the Mediterranean Sea fish stocks, the depletion of its ecosystems and the loss of biodiversity, trawl fisheries represent not only an uneconomical use of common resources but is accelerating the ecological crisis of the Mediterranean Sea.

This report calls for an urgent and radical shift to low impact fisheries, stronger and more effective environmental measures in fisheries management, supported by transitional public funding, that will lead to a new, and different fisheries policy and management that are able to respond to mounting twenty-first century environmental and social challenges and needs.

ACRONYMS

AEA: Annual Emissions Allocation

AER: Annual Economic Report on the EU fishing fleet

CR/BER: current revenue (CR) and break-even revenue (BER)

ECA: European Court of Auditors

EFF: European Fisheries Fund

EMFAF: European Maritime, Fisheries and Aquaculture Fund

EMFF: European Maritime Fisheries Fund

ETS: European Union Emissions Trading System

EU: European Union

FAO: Food and Agriculture Organization of the United Nations

FIFG: Financial Instrument for Fisheries Guidance

FLAG: Fisheries Local Action Group

GFCM: General Fisheries Commission for the Mediterranean

GHG: Greenhouse Gas

GSA: GFCM Geographical Sub-Areas

GVA: gross value added

MSY: Maximum Sustainable Yield

ROFTA: Return on Fixed Tangible Assets

STEFC: Scientific, Technical and Economic Committee for Fisheries

VME: Vulnerable Marine Ecosystem

REFERENCES

Abdelkabir Kamili (2019). World price of oil and fish production in Morocco: Coupling approach of a MEGC and a Halieutic Model | Revue Marocaine des Sciences Agronomiques et Vétérinaires. Available at: www.agrimaroc.org/index.php/Actes_IAVH2/article/view/665/1080 [Accessed May 17, 2021].

Barber, R. T. (2007). Oceans: Picoplankton do some heavy lifting. Science (80-.). 315, 777–778. doi: 10.1126/science.1137438.

Bellido, J. M., García-Rodriguez, M., García-Jiménez, T., González-Aguilar, M., and Carbonell-Quetglas, A. (2017). Could the obligation to land undersized individuals increase the black market for juveniles: evidence from the Mediterranean? Fish Fish. 18, 185–194. doi: 10.1111/faf.12166.

Carvalho, N., and Guillen, J. (2021). Economic impact of eliminating the fuel tax exemption in the eu fishing fleet. Sustain. 13, 1–15. doi: 10.3390/su13052719.

Chato Osio, G. (2012). The historical fisheries in the Mediterranean Sea: A reconstruction of trawl gear, effort and trends in demersal fish stocks. Dr. Diss. Available at: scholars.unh.edu/dissertation/678 [Accessed April 30, 2021].

Coll, M., Piroddi, C., Steenbeek, J., Kaschner, K., Ben Rais Lasram, F., Aguzzi, J., et al. (2010). The Biodiversity of the Mediterranean Sea: Estimates, Patterns, and Threats. PLoS One 5, e11842. Available at: doi.org/10.1371/journal.pone.0011842.

Darasi, F., and Aksissou, M. (2019). Longline, trawl, and purse seine in coastal fishing of Tangier port in North-West of Morocco. Egypt. J. Aquat. Res. 45, 381–388. doi: 10.1016/j.ejar.2019.11.005.

De Juan, S., and Demestre, M. (2012). A Trawl Disturbance Indicator to quantify large scale fishing impact on benthic ecosystems. Ecol. Indic. 18, 183–190. doi: 10.1016/J.ECOLIND.2011.11.020.

Eigaard, O. R., Bastardie, F., Hintzen, N. T., Buhl-Mortensen, L., Buhl-Mortensen, P., Catarino, R., et al. (2017). The footprint of bottom trawling in European waters: distribution, intensity, and seabed integrity. ICES J. Mar. Sci. 74, 847–865. doi: 10.1093/icesjms/fsw194.

EUMOFA (2020). The EU Fish Market 2020 Edition. Eur. Union, 170. doi: 10.2771/664425.

European Commission (2019a). Study of the role of women in fisheries in the Mediterranean and the Black Sea. Luxembourg: Publications Office of the European Union, 2019.

European Commission (2019b). The EU Blue Economy Report 2019. Available at: ftp://ftp.fao.org/docrep/fao/011/i0250e/i0250e.pdf%0Aec.europa.eu/fisheries/sites/fisheries/files/docs/body/op-united-kingdom-fact-sheet_en.pdf.

European Court of Auditors (2007). On the control, inspection and sanction systems relating to the rules on conservation of Community fisheries resources together with the Commission's replies. doi: Special report 7. OJ C 317.

European Court of Auditors (2011). Have EU measures contributed to adapting the capacity of the fishing fleets to available fishing opportunities? Luxembourg doi: Special Report 12. ISSN 1831-0834.

European Court of Auditors (2020). Marine environment: EU protection is wide but not deep. Luxembourg doi: Special Report 26.

FAO (2018). The State of Mediterranean and Black Sea Fisheries. General Fisheries Commission for the Mediterranean. Rome. 172.

FAO (2020). The State of Mediterranean and Black Sea Fisheries 2020. General Fisheries Commission for the Mediterranean. Rome. 175. doi: 10.4060/cb2429en.

García-de-Vinuesa, A. and, Demestre, M., Carreño, A., and Lloret, J. (2021). The Bioactive Potential of Trawl Discard: Case Study from a Crinoid Bed Off Blanes (North-Western Mediterranean). Mar. Drugs 19, 83. doi: 10.3390/md19020083.

Gómez, S., and Maynou, F. (2021). Alternative seafood marketing systems foster transformative processes in Mediterranean fisheries. Mar. Policy 127, 104432. doi: 10.1016/j.marpol.2021.104432.

González-Correa, J. M., Bayle, J. T., Sánchez-Lizaso, J. L., Valle, C., Sánchez-Jerez, P., and Ruiz, J. M. (2005). Recovery of deep Posidonia oceanica meadows degraded by trawling. J. Exp. Mar. Bio. Ecol. 320, 65–76.

Grinyó, J., Lo Iacono, C., Pierdomenico, M., Conlon, S., Corbera, G., and Gràcia, E. (2020). Evidences of human impact on megabenthic assemblages of bathyal sediments in the Alboran Sea (western Mediterranean). Deep. Res. Part I Oceanogr. Res. Pap. 165. doi: 10.1016/j.dsr.2020.103369.

Harper, S., Adshade, M., Lam, V. W. Y., Pauly, D., and Sumaila, U. R. (2020). Valuing invisible catches: Estimating the global contribution by women to small-scale marine capture fisheries production. PLoS One 15, 1–16. doi: 10.1371/journal.pone.0228912.

Harper, S., Grubb, C., Stiles, M., and Sumaila, U. R. (2017). Contributions by Women to Fisheries Economies: Insights from Five Maritime Countries. Coast. Manag. 45, 91–106. doi: 10.1080/08920753.2017.1278143.

Harper, S., Salomon, A. K., Newell, D., Waterfall, P. H., Brown, K., Harris, L. M., et al. (2018). Indigenous women respond to fisheries conflict and catalyze change in governance on Canada's Pacific Coast. Marit. Stud. 17, 189–198. Available at: doi.org/10.1007/s40152-018-0101-0.

Heithaus, M. R., Alcoverro, T., Arthur, R., Burkholder, D. A., Coates, K. A., Christianen, M. J. A., et al. (2014). Seagrasses in the age of sea turtle conservation and shark overfishing. Front. Mar. Sci. 1, 28.

Huisman, J., Botezatu, I., Herreras, L., Liddane, M., Hintsa, J., Luda di Cortemiglia, V., et al. (2015). Countering WEEE Illegal Trade (CWIT) Summary Report, Market Assessment, Legal Analysis, Crime Analysis and Recommendations Roadmap. Lyon, France: CWIT doi: 978-92-808-4560-0.

IFREMER (2020). Synthèse des flottilles de pêche 2019 - Façade Méditerranée - Flottille des Chalutiers de fond. Available at: http://www.ifremer.fr/sih [Accessed May 3, 2021].

Keznine, M., Benaissa, H., Barylo, Y., Loboiko, Y., Aksissou, M., and Analla, M. (2021). The coastal fleet of the Moroccan Mediterranean: the sea of Al Hoceima as a case study. Egypt. J. Aquat. Biol. Fish. 25, 37–47. doi: 10.21608/ejabf.2021.157313.

Lutz, S. J., and Martin, A. H. (2014). Fish carbon: exploring marine vertebrate carbon services. Arendal, Norw. GRID-Arendal.

MAGRAMA (2016). Diagnóstico sobre la situación profesional del colectivo de neskatillas y empacadoras. 54.

Mariani, G., Cheung, W. W. L., Lyet, A., Sala, E., Mayorga, J., Velez, L., et al. (2020). Let more big fish sink: Fisheries prevent blue carbon sequestration—half in unprofitable areas. Sci. Adv. 6, eabb4848.

Maynou, F., and Cartes, J. E. (2012). Effects of trawling on fish and invertebrates from deep-sea coral facies of Isidella elongata in the western Mediterranean. J. Mar. Biol. Assoc. United Kingdom 92, 1501–1507. doi: DOI: 10.1017/S0025315411001603.

McConnaughey, R. A., Hiddink, J. G., Jennings, S., Pitcher, C. R., Kaiser, M. J., Suuronen, P., et al. (2020). Choosing best practices for managing impacts of trawl fishing on seabed habitats and biota. Fish Fish. 21, 319–337. doi: 10.1111/FAF.12431.

Mennad, M., Bouhadja, M. A., Khouas, B., Bahria, D., and Bernardon, M. (2021). Informations socioéconomiques de la pêche à Annaba, Algérie - Analyse des données des enquêtes réalisées en 2017 et 2018. Rome doi: doi.org/10.4060/cb1914fr.

Merino, G., Quetglas, A., Maynou, F., Garau, A., Arrizabalaga, H., Murua, H., et al. (2015). Improving the performance of a Mediterranean demersal fishery toward economic objectives beyond MSY. Fish. Res. 161, 131–144. doi: doi.org/10.1016/j.fishres.2014.06.010.

Muntadas, A., Demestre, M., de Juan, S., and Frid, C. L. J. (2014). Trawling disturbance on benthic ecosystems and consequences on commercial species: a northwestern Mediterranean case study. Sci. Mar. 78, 53–65. doi: 10.3989/SCIMAR.04024.19A.

OECD (2000). Transition to Responsible Fisheries: : Economic and policy implications. 272. doi: 10.1787/9789264188020-en.

Otero, M. del M., Serena, Fabrizio, Gerovasileiou, V., Barone, M., Bo, M., Arcos, J. M., Vulcano, A., et al. (2019). Identification Guide of Vulnerable Species.

Palanques, A., Puig, P., Guillén, J., Demestre, M., and Martín, J. (2014). Effects of bottom trawling on the Ebro continental shelf sedimentary system (NW Mediterranean). Cont. Shelf Res. 72, 83–98. doi: 10.1016/j.csr.2013.10.008.

Paradis, S., Goñi, M., Masqué, P., Durán, R., Arjona-Camas, M., Palanques, A., et al. (2021a). Persistence of Biogeochemical Alterations of Deep-Sea Sediments by Bottom Trawling. Geophys. Res. Lett. 48, e2020GL091279. doi: doi.org/10.1029/2020GL091279.

Paradis, S., Lo Iacono, C., Masqué, P., Puig, P., Palanques, A., and Russo, T. (2021b). Evidence of large increases in sedimentation rates due to fish trawling in submarine canyons of the Gulf of Palermo (SW Mediterranean). Mar. Pollut. Bull. 172, 112861. doi: 10.1016/J.MARPOLBUL.2021.112861.

Paradis, S., Puig, P., Masqué, P., Juan-Diáz, X., Martín, J., and Palanques, A. (2017). Bottom-trawling along submarine canyons impacts deep sedimentary regimes. Sci. Reports 2017 71 7, 1–12. doi: 10.1038/srep43332.

Parker, R. W. R., Blanchard, J. L., Gardner, C., Green, B. S., Hartmann, K., Tyedmers, P. H., et al. (2018). Fuel use and greenhouse gas emissions of world fisheries. Nat. Clim. Chang. 8, 333–337.

Piroddi, C., Colloca, F., and Tsikliras, A. C. (2020). The living marine resources in the Mediterranean Sea Large Marine Ecosystem. Environ. Dev. 36, 100555. doi: 10.1016/j.envdev.2020.100555.

Puig, P., Canals, M., Company, J. B., Martín, J., Amblas, D., Lastras, G., et al. (2012). Ploughing the deep sea floor. Nat. 2012 4897415 489, 286–289. doi: 10.1038/nature11410.

Pusceddu, A., Bianchelli, S., Martín, J., Puig, P., Palanques, A., Masqué, P., et al. (2014). Chronic and intensive bottom trawling impairs deep-sea biodiversity and ecosystem functioning. Proc. Natl. Acad. Sci. U. S. A. 111, 8861–8866. doi: 10.1073/pnas.1405454111.

Pusceddu, A., Grémare, A., Escoubeyrou, K., Amouroux, J. M., Fiordelmondo, C., and Danovaro, R. (2005). Impact of natural (storm) and anthropogenic (trawling) sediment resuspension on particulate organic matter in coastal environments. Cont. Shelf Res. 25, 2506–2520. doi: 10.1016/J.CSR.2005.08.012.

Rogers, A., Sumalia, U., Hussain, S., and Baulcomb, C. (2014). The High Seas and Us: Understanding the Value of High-Seas Ecosystems. (Report commissioned by the Global Ocean Commission). 1–13.

Romano, C., Fanelli, E., D'Anna, G., Pipitone, C., Vizzini, S., Mazzola, A., et al. (2016). Spatial variability of soft-bottom macrobenthic communities in northern Sicily (Western Mediterranean): Contrasting trawled vs. untrawled areas. Mar. Environ. Res. 122, 113–125. doi: 10.1016/j.marenvres.2016.10.002.

Sabatella, R. F., Accadia, P., Cozzolino, M., Gambino, M., and Malvarosa, L. (2019). La politica comune della pesca e gli impatti economici e sociali sulla pesca a strascico. Roma.

Sala, E., Mayorga, J., Bradley, D., Cabral, R. B., Atwood, T. B., Auber, A., et al. (2021). Protecting the global ocean for biodiversity, food and climate. Nature. doi: 10.1038/s41586-021-03371-z.

Schneider, J., Karigl, B., Reisinger, H., OLIVA, J., SÜßENBACHER, E., and Proofreader, B. R. (2011). A European refunding scheme for drink containers. European Parliament.

Schuhbauer, A., & Sumaila, U. R. (2016). Economic viability and small-scale fisheries - A review. Ecol. Econ. 124, 69–75. doi: 10.1016/j.ecolecon.2016.01.018.

Skerritt, D. J., Arthur, R., Ebrahim, N., Le Brenne, V., Le Manach, F., Schuhbauer, A., et al. (2020). A 20-year retrospective on the provision of fisheries subsidies in the European Union. ICES J. Mar. Sci. 77, 2741–2752. doi: 10.1093/icesjms/fsaa142.

Sola, I., Maynou, F., and Sánchez-Lizaso, J. L. (2020). Bioeconomic Analysis of the EU Multiannual Management Plan for Demersal Fisheries in the Western Mediterranean. Spanish Fisheries as a Case Study. Front. Mar. Sci. 7, 459. doi: 10.3389/fmars.2020.00459.

STECF (2020a). Assessment of balance indicators for key fleet segments and review of national reports on Member States efforts to achieve balance between fleet capacity and fishing opportunities (STECF-20-11). ISBN 978-92-76-27163-5, doi:10.2760/414107, JRC123057: EUR 28359 EN, Publications Office of the European Union, Luxembourg, 2020 doi: 10.2760/414107.

STECF (2020b). Scientific, Technical and Economic Committee for Fisheries (STECF) - Social dimension of the CFP (STECF-20-14). Doering, R., Fitzpatrick, M. and Guillen Garcia, J. editor(s), EUR 28359 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN. doi: 10.2760/255978.

STECF (2020c). The 2020 Annual Economic Report on the EU Fishing Fleet (STECF 20-06). Luxembourg doi: http://dx.doi.org/10.2760/500525.

STEFC (2020). Evaluation of fishing effort regime in the Western Mediterranean –part V (STEC-20-13). EUR 28359 EN, Publications Office of the European Union. Luxembourg doi: 10.2760/143313.

Stiglitz, J. E., Stern, N., Duan, M., Edenhofer, O., Giraud, G., Heal, G. M., et al. (2017). Report of the high-level commission on carbon prices.

Stithou, M., Vassilopoulou, V., Tsagarakis, K., Edridge, A., Machias, A., Maniopoulou, M., et al. (2019). Discarding in Mediterranean trawl fisheries–a review of potential measures and stakeholder insights. Marit. Stud. 18, 225–238. doi: 10.1007/s40152-018-00131-0.

Sumaila, U. R. & Tai, T. C. (2020). End Overfishing and Increase the Resilience of the Ocean to Climate Change. Front. Mar. Sci. 7, 1–8. doi: 10.3389/fmars.2020.00523.

Sumaila, U. R. (2021). Infinity Fish: Economics and the Future of Fish and Fisheries. Elsevier, Netherlands, Elsevier-Associated Press. 265.

Sumaila, U. R., Cheung, W., Dyck, A., Gueye, K., Huang, L., Lam, V., et al. (2012). Benefits of rebuilding global marine fisheries outweigh costs. PLoS One 7. doi: 10.1371/journal.pone.0040542.

Sumaila, U. R., Ebrahim, N., Schuhbauer, A., Skerritt, D., Li, Y., Kim, H. S., et al. (2019). Updated estimates and analysis of global fisheries subsidies. Mar. Policy 109, 103695. doi: 10.1016/j.marpol.2019.103695.

Sumaila, U. R., Khan, A., Teh, L., Watson, R., Tyedmers, P., and Pauly, D. (2010). Subsidies to high seas bottom trawl fleets and the sustainability of deep-sea demersal fish stocks. Mar. Policy 34, 495–497. doi: 10.1016/j.marpol.2009.10.004.

Sumaila, U. R., Teh, L., Watson, R., Tyedmers, P., and Pauly, D. (2008). Fuel price increase, subsidies, overcapacity, and resource sustainability. ICES J. Mar. Sci. 65, 832–840. doi: 10.1093/icesjms/fsn070.

Taconet, M., Kroodsma, D., and Fernandes, J. A. (2019). Global Atlas of AIS-based fishing activity - Challenges and opportunities. Rome Available at: http://www.fao.org/3/ca7012en/CA7012EN.pdf.

Teh, L. S. L., and Sumaila, U. R. (2020). Assessing potential economic benefits from rebuilding depleted fish stocks in Canada. Ocean Coast. Manag. 195, 105289. doi: 10.1016/j.ocecoaman.2020.105289.

Tsagarakis, K., Carbonell, A., Brčić, J., Bellido, J. M., Carbonara, P., Casciaro, L., et al. (2017). Old info for a new Fisheries Policy: Discard ratios and lengths at discarding in EU Mediterranean bottom trawl fisheries. Front. Mar. Sci. 4. doi: 10.3389/fmars.2017.00099.

Tsagarakis, K., Palialexis, A., and Vassiloupoulou, V. (2014). Mediterranean fishery discards: review of the existing knowledge. ICES J. Mar. Sci. 71, 1219–1234. doi: 10.4135/9781412953924.n678.

Ulrich, C., and Jardim, E. (2018). Scientific, Technical and Economic Committee for Fisheries (STECF)-Fishing effort regime for demersal fisheries in the western Mediterranean Sea (STECF-18-09). doi: 10.2760/94831.

UNEP/MAP-Plan Bleu (2020). State of the Environment and Development in the Mediterranean - SOED 2020. United Nations Environ. Program. Action Plan Plan Bleu.

Vaz, S., and Lafargue, P. (2021). Pêche : ce que la science nous dit de l'impact du chalutage sur les fonds marins. Conversat. Available at: theconversation.com/peche-ce-que-la-science-nous-dit-de-limpact-du-chalutage-sur-les-fonds-marins-172325.

White, K. M., Rosales, R., Yildiz, S., Kehrer, T., Miorin, L., Moreno, E., et al. (2021). Plitidepsin has potent preclinical efficacy against SARS-CoV-2 by targeting the host protein eEF1A. Science (80-.). 371, 926–931. doi: 10.1126/science.abf4058.

Wilmers, C. C., Estes, J. A., Edwards, M., Laidre, K. L., and Konar, B. (2012). Do trophic cascades affect the storage and flux of atmospheric carbon? An analysis of sea otters and kelp forests. Front. Ecol. Environ. 10, 409–415.

Witter, A., Murray, G., and Sumaila, U. R. (2021). Consumer seafood preferences related to alternative food networks and their value chains. Mar. Policy 131, 104694. doi: 10.1016/j.marpol.2021.104694.

World Bank (2017). The Sunken Billions Revisited: Progress and Challenges in Global Marine Fisheries. The World Bank. doi: 10.1596/978-1-4648-0919-4.

Annex 1. The Western Mediterranean trawl fleet: key figures and estimates

TABLE 5. KEY FIGURES FOR THE WESTERN MEDITERRANEAN TRAWL FLEET				
Country	n° vessels	Power (kw)	Tonnage (GT)	FTE
Italy	643[5]	117,820[1]	23,377[5]	1,950[5]
Spain	577	102,431[4]	33,224[4]	2,612[3]
France	62[3]	18,905[3]	5,731[3]	192[10]
Morocco	137[2]	**30,414[7]**	9,038[2]	**1,644[8]**
Algeria	479[2]	**177,230[6]**	30,409[2]	**3,832[6]**
Total	1,9859	**446,800**	101,778	13,026[9]

(Source: Authors elaboration with data from the GFCM database, EU Fleet Register and FAO reports. Estimates highlighted in bold)

Notes:

1. *Active vessel power has been estimated using 2013-2015 data from Ulrich and Jardim, 2018 and updating values to 2018 proportionally to the national Italian DTS (Demersal trawl and demersal seiner) decrease rate in the period 2015-2018 obtained from ARE yearly data.*
2. *GFCM authorised vessel list (last visit: February 2020), includes both demersal and pelagic trawl.*
3. *DTS Mediterranean fleet according to AER STECF 20-06 - EU Fleet Economic and Transversal data national level (2018 data). It has been assumed that DTS (Demersal trawlers and/or demersal seiners could reasonably reflect the number of trawlers (STEFC-21-01).*
4. *Combined information of national authorised vessels and EU Fleet Register.*
5. *Data from 2017. (Source: Sabatella et al., 2019).*
6. *In order to calculate total Full Time Equivalent (FTE), eight FTE per trawler have been used, this value has been extrapolated from Annaba region studies (Mennad et al., 2021). In order to calculate power, 500 kw per trawler has been used as a reference value. This value is coherent with the information provided in the FAO Parapenaeus and European hake stock assessment fleet description and with the previously mentioned Annaba region study of 2017.*
7. *In order to calculate total power, 300 kw per trawler has been used as a reference value. This value has been estimated based on FAO stock assessments on European hake, Mullus barbatus and Parapenaeus and fleet characteristics among others.*
8. *Data from the port of Tangiers (Morocco) have been used (Darasi and Aksissou, 2019), these are coherent with those of Al Hoizema (Keznine et al., 2021).*
9. *(FAO, 2020). It should be noted that the figures for individual countries add up to less than the total amount, due to the different sources used. Percentages have been used, taking into consideration the sum of specific countries' information.*
10. *(IFREMER, 2020)*

According to the GFCM, the annual revenue of Western Mediterranean trawlers and beam trawlers in 2018 was €423,397,742,[26] and their gross added value was €94,099,144 (FAO, 2020).

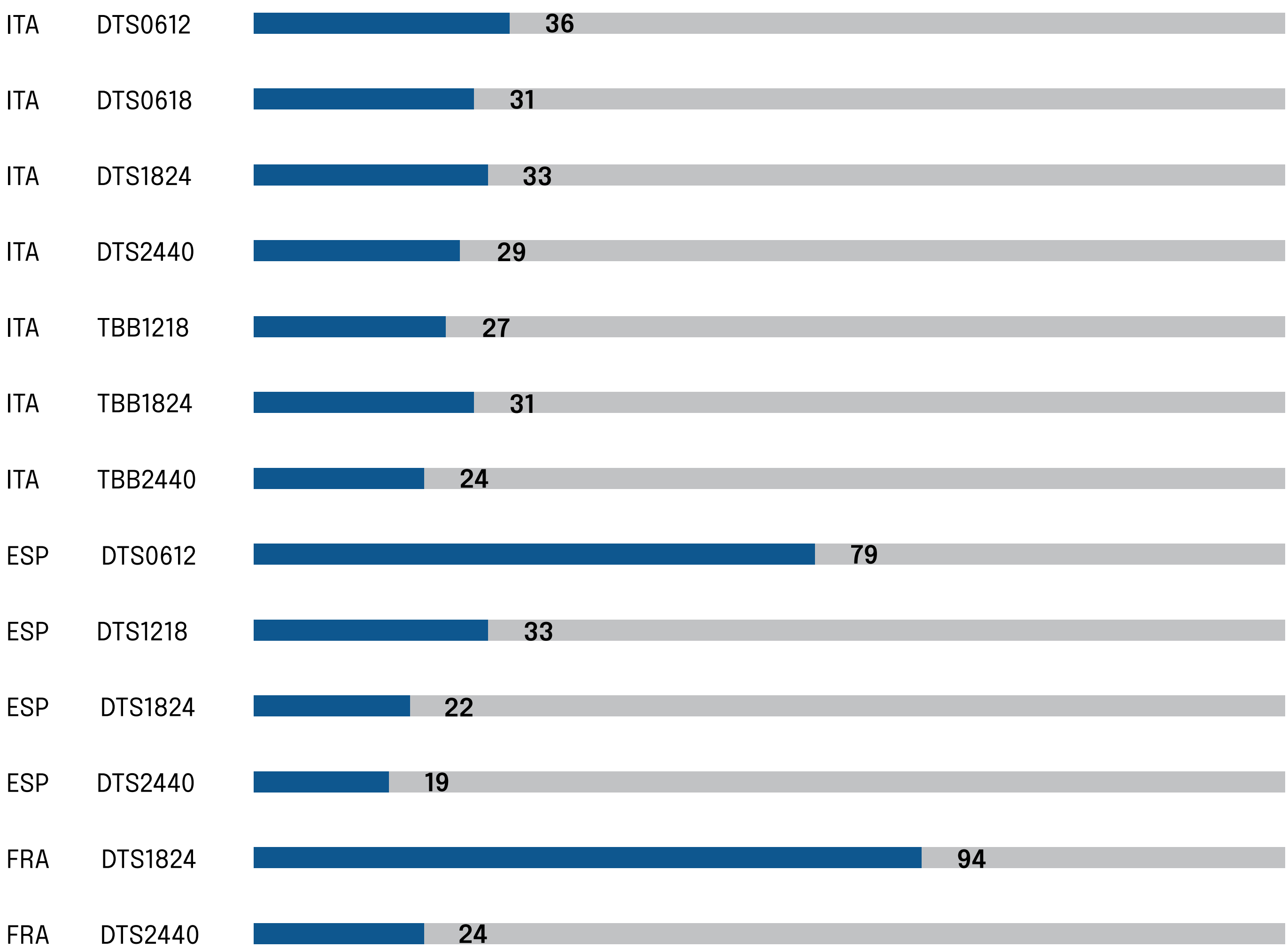


Figure 19. Mean age of EU trawl fleets active in the Western Mediterranean Sea (years). (Source: Authors elaboration from AER 2020 database data for DTS (Demersal trawl and demersal seiner) and TBB (Beam trawl) active in the French, Italian and Spanish fleets in the Mediterranean Sea for the different length fleet subsegments)

[26] Exchange rate: 1.18 €/US$.

Annex 2. CR/BER and RoFTA indicators for the European trawl fleets operating in the Western Mediterranean

TABLE 6. CR/BER AND ROFTA INDICATORS OF THE WESTERN MEDITERRANEAN SPANISH TRAWL FLEET											
CR/BER	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
6-12 m	0.3	0.9	2.4		2.5	2.2		3.0	7.5	1.9	
12-18 m	0.8	1.1	0.1	0.2	1.3	0.7	1.5	1.8	4.9	2.6	3.3
18-24 m	0.0	0.6	0.4	0.8	0.9	1.6	1.2	1.3	3.4	1.9	2.0
>24 m	0.4	0.3	0.3	0.1	0.7	-0.4	1.1	1.3	2.9	1.3	1.2
ROFTA (%)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
6-12 m	-82	-9	88		229	91		91	63	42	
12-18 m	-7	7	-40	-34	18	-11	19	33	73	64	85
18-24 m	-38	-18	-21	-5	-4	13	13	16	48	39	47
>24 m	-12	-17	-8	-34	-4	-36	8	15	45	16	10

Note: Grey indicates poor economic performance. (Source: STECF, 2020c)

TABLE 7. CR/BER AND ROFTA INDICATORS OF THE WESTERN MEDITERRANEAN ITALIAN TRAWL FLEET (LIGURIAN SEA, GSA9)								
CR/BER	2011	2012	2013	2014	2015	2016	2017	2018
6-12 m	1.83	1.53	1.37	2.68	1.71	1.08	1.44	1.73
12-18 m	2.33	1.45	1.7	2.15	3.07	3.26	3.02	5.29
18-24 m	1.04	1.35	0.48	1.03	1.76	2.04	1.33	1.87
24-40 m	0.89	0.67	0.53	0.82	1.21	1.22	0.6	0.91
ROFTA (%)	2011	2012	2013	2014	2015	2016	2017	2018
6-12 m	23	-10	-21	69	22	1	15	22
12-18 m	37	10	16	34	61	70	61	145
18-24 m	-4	6	-19	2	22	27	10	24
24-40 m	-8	-13	-15	-4	6	5	-13	-4

Note: Grey indicates poor economic performance. (Source: Authors elaboration with data from national fleet capacity reports)

TABLE 8. CR/BER AND ROFTA INDICATORS OF THE WESTERN MEDITERRANEAN ITALIAN TRAWL FLEET (SOUTH AND CENTRAL TYRRENIAN SEA, GSA 10)								
CR/BER	2011	2012	2013	2014	2015	2016	2017	2018
12-18 m	2.89	0.9	0.49	1.37	1.09	1.61	2.11	2.21
18-24 m	0.74	1.06	0.92	1.14	0.76	1.38	1.48	1.5
ROFTA (%)	2011	2012	2013	2014	2015	2016	2017	2018
12-18 m	58	-2	-17	6	2	15	34	42
18-24 m	-12	0	-4	-1	-5	11	13	12

Note: Grey indicates poor economic performance. (Source: Authors elaboration with data from national fleet capacity reports)

TABLE 9. CR/BER AND ROFTA INDICATORS OF THE WESTERN MEDITERRANEAN ITALIAN TRAWL FLEET (SARDINIA, GSA 11)								
CR/BER	2011	2012	2013	2014	2015	2016	2017	2018
12-18 m	0.89	0.57	0.86	1.14	2.85	2.17	3.46	0.83
18-24 m	0.77	0.64	1.16	1.01	1	1.2	1.46	1.45
24-40 m	0.65	0.46	0.21	0.56	0.56	0.94	1.03	1.07
ROFTA (%)	2011	2012	2013	2014	2015	2016	2017	2018
12-18 m	-8	-14	-3	0	55	31	71	-9
18-24 m	-10	-14	10	-4	-2	4	10	11
24-40 m	-12	-15	-21	-15	-12	-3	-1	0

Note: Grey indicates poor economic performance. (Source: Authors elaboration with data from national fleet capacity reports)

TABLE 10. CR/BER AND ROFTA INDICATORS OF THE WESTERN MEDITERRANEAN FRENCH TRAWL FLEET (GULF OF LION, GSA 07)											
CR/BER	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
18-24 m	1.3		1.2	0.8	0.8	1.1	1.2	0.9	1.2	1.3	1.2
>24 m						0.5	0.6	0.6	0.7	0.8	0.7
ROFTA (%)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
18-24 m	15		8	-5	-8	6	7	-3	6	12	5
>24 m						-9	-8	-8	-7	-5	-9

Note: Grey indicates poor economic performance. (Source: STECF, 2020c)

Annex 3. Governmental financial transfers

According to the OECD, governmental financial transfers are defined as the monetary value of interventions associated with fishery policies. Governmental financial transfers are primarily classified according to how they are implemented:

Direct payments

Direct payments are transfers that enhance the revenue of recipients and are paid from government budgets (that is, financed by taxpayers) directly to fishers. The objective of these direct payments is not to reduce fishing costs for fishers, but to increase their incomes. This includes payments to fishers based on the level of catches, the level of sales, vessel ownership, overall fishing income and/or fishers' historical interest in a fishery or fisheries.

Some examples: price support payments to fishers, grants for new vessels, grants for vessel modernisation, vessel decommissioning payments, income support, unemployment insurance, retirement grants for fisheries, compensation for permanent or temporal fishing restrictions, compensation for damage by predators to fish stocks, disaster relief payments, grants to purchase second-hand vessels, grants for temporary withdrawal of fishing vessels, direct aid to participants in particular fisheries, income guarantee compensation, vacation support payments, temporary grants to fishers and vessel owners, price support payments directly to fishers, etc.

Cost-reducing transfers

Cost-reducing transfers are payments from the government to fishers that reduce the costs of fixed capital and variable inputs. In this regard, they are a revenue-enhancing transfer that will affect the operating decisions of fishers with respect to either output and/or the levels and types of inputs employed.

Examples: fuel tax exemptions, subsidised loans for vessel construction, subsidised loans for vessel modernisation, payments to reduce accounting costs, provision of bait services, loan guarantees, underwriting of insurance costs, low-cost loans to young fishers, low-cost insurance, government payment for access to other countries' waters, low-cost loans to specific fisheries, income tax deduction for fishers, government funded training of fish processing workers, government funding for the introduction of new gear and technology, support for crew insurance, tax exemptions for deep-sea vessels, interest subsidies for the purchase of machines and equipment for fishing vessels, interest subsidy for the purchase of second-hand vessels, support to improve economic efficiency, reduced charges by government agencies, support to build facilities for commercial fishers at ports, etc.

General services

This is a catch-all category that covers transfers that are not received directly by fishers, but that reduce the costs faced by the sector as a whole. About half of this category includes expenditures on research, management and enforcement.

General services also include expenditures by governments to support prices (for example, by withdrawing fish from markets) and expenditures on infrastructure that benefit the industry as a whole (in contrast with cost-reducing transfers that benefit individual fishers directly).

Examples of the latter include stock enhancement schemes and investments in fishing ports. Examples: research expenditure, management expenditure, enforcement expenditure, market intervention schemes, regional development grants, support to build port facilities for commercial fishers, protection of marine areas, grants to local authorities for retraining fishers into other activities, payments to producer organisations, expenditure on the protection of marine areas, payments to support community-based management, fisheries enhancement expenditure, support to enhance the fisheries community environment, expenditure on research and development, expenditure to promote international fisheries co-operation, support to improve the management of co-operatives, support to improve fishing villages, expenditure on fisheries policy advice, expenditure on prosecution of fisheries offences, support for artificial reefs, expenditure on exploratory fishing, support to establish producers' organisations, aid for restocking of fish resources, funding of information dissemination, funding for the promotion and development of fisheries, expenditure for information collection and analysis, expenditure on conservation and management, etc.

Annex 4. Fuel exemption methodology

The methodology used to calculate the fuel exemption is based on Carvalho and Guillen (2021).

First the oil consumption and fuel prices of each of the trawling fleets is calculated using AER data.

Then prices without the fuel tax exemption are calculated taking into consideration the volume used by each fleet and the fully taxed (i.e. the same as the public pays) gasoil price without value-added taxes in the analysed year (the VAT paid on fuel prices can be supported by the fishing sector's VAT on the sale of its landings).

Fuel tax exemption is the difference between the two values.

Annex 5. Direct CO^2 emissions

TABLE 11. COMPARISON BETWEEN ANNUAL EMISSIONS ALLOCATIONS (AEA) FOR NON-ETS SECTORS AND DIRECT EMISSIONS (DE) OF TRAWL FISHERIES IN THE WESTERN MEDITERRANEAN - (SOURCES: [1] EC.EUROPA.EU/CLIMA/POLICIES/EFFORT_EN (11/02/2021); [2] STECF 20-06 - EU FLEET ECONOMIC AND TRANSVERSAL DATA FLEET SEGMENT; [3] BASED ON [2] AND PARKER ET AL., 2018; [4] ESTIMATED)

	Indicators	2013 (reference year)	2014	2015	2016	2017	2018	Total
ITALY	AEA (t CO^2-eq)[1]	317,768,849	315,628,134	313,487,419	311,346,703	307,153,729	304,562,057	1,869,946,891
	AEA index, base 100 (%)[4]	100	99.3	98.7	98	96.7	95.8	-
	Oil consumption (l)[2]	77,792,342	89,956,638	106,842,712	105,399,397	102,728,238	108,739,937	591,459,264
	DE from oil consumption (t CO^2-eq)[3]	217,819	251,879	299,160	295,118	287,639	304,472	1,656,086
	DE index, base 100 (%)[4]	100	115.6	137.3	135.5	132.1	139.8	-
	DE following compliance with AEA (t CO^2-eq)[4]	217,819	216,351	214,884	213,416	210,542	208,766	1,281,778
	Gap between DE following compliance with AEA and DE (t CO^2-eq)[4]	-	-35,527	-84,276	-81,702	-77,097	-95,706	-374,308

	Indicators	2013 (reference year)	2014	2015	2016	2017	2018	Total
SPAIN	AEA (t CO^2-eq)[1]	235,551,490	233,489,390	231,427,291	229,365,191	225,664,376	223,560,157	1,379,057,895
	AEA index, base 100 (%)[4]	100	99.1	98.2	97.4	95.8	94.9	-
	Oil consumption (l)[2]	81,891,530	95,792,481	80,308,285	79,861,049	73,736,036	76,553,091	488,142,472
	DE from oil consumption (t CO^2-eq)[3]	229,296	268,219	224,863	223,611	206,461	214,349	1,366,799
	DE index, base 100 (%)[4]	100	117	98.1	97.5	90	93.5	-
	DE following compliance with AEA (t CO^2-eq)[4]	229,296	227,289	225,282	223,274	219,672	217,623	1,342,436
	Gap between DE following compliance with AEA and DE (t CO^2-eq)[4]	-	-40,930	418	-337	13,211	3,275	-24,363

	Indicators	2013 (reference year)	2014	2015	2016	2017	2018	Total
FRANCE	AEA (t CO^2-eq)[1]	408,762,813	403,877,606	398,580,044	393,282,481	371,789,603	366,284,473	2,342,577,020
	AEA index, base 100 (%)[4]	100	98.8	97.5	96.2	91	89.6	-
	Oil consumption (l)[2]	13,699,110	14,228,498	18,715,333	15,621,679	18,653,012	11,919,858	92,837,489
	DE from oil consumption (t CO^2-eq)[3]	38,358	39,840	52,403	43,741	52,228	33,376	259,945
	DE index, base 100 (%)[4]	100	103.9	136.6	114	136.2	87	-
	DE following compliance with AEA (t CO^2-eq)[4]	38,358	37,899	37,402	36,905	34,888	34,371	219,823
	Gap between DE following compliance with AEA and DE (t CO^2-eq)[4]	-	-1,941	-15,001	-6,836	-17,340	996	-40,122

Total gap between DE following compliance with AEA and DE (t CO2-eq)[4]	-	-78,398	-98,858	-88,874	-81,226	-91,435	-438,793

Note: AEA (Annual Emission Allocations); DE (Direct Emissions).

Annex 6. Overfishing opportunity costs

Balearic islands and northern Spain (GSA 05 and 06)

GFCM 2020 stock assessments suggest that mtitost of the evaluated demersal fish stocks in GSA 6 are overexploited with fishing well beyond sustainable levels (F > FMSY). For GSA6, the economic consequences of recovering the stocks to maximum sustainable yields by 2025 was recently analysed (Sola et al., 2020). The MEFISTO multispecies, multi-gear model was used under different combinations of fishing pressure decrease and distribution, and included technical measures such as selectivity improvements.

The model shows that current overfishing practices are decreasing potential revenue, profit and daily wages. An optimal decrease in fishing pressure combined with selectivity measures would lead, after a short transition period of short-term loss for the trawler fleet compared with the status quo, to an increase in profits for all fleet segments analysed (Figure 20). In the bottom trawler fleet net profits would be expected to increase by between 68% and 72% depending on the scenario. Additionally, average daily wages could increase by 76% to 148%. Decreasing fishing mortality would also lead to clear improvements in profitability and crew wages in the bottom longline fleet segment.

Merino et al. also used the MEFISTO bioeconomic model to evaluate the economic results for trawling of ending overfishing in the Balearic Islands (Merino et al., 2015). They analysed different fishing pressure reductions targeted to obtain four management outcomes:

1. maintain the main target fish stocks at levels equal or below their MSY;
2. maximise the sustainable aggregated catch of the target species; and
3. maximise the net economic profit from the fishery (Maximum Economic Yield, MEY) under four exploratory fish price/fuel price ratios.

Again, the study showed that current overfishing practices lead to an inefficient situation in economic terms. In this case the study had some limitations because fishing mortality reductions were analysed only through fishing effort reductions, without any improvements in selectivity being introduced into the scenarios or the effects of closed areas.

Nevertheless, the study showed that even without the use of selectivity measures and with a limited decrease in fishing pressure (20% decrease, or a reduction in fishing of one day per week with the same number of vessels) the expected profits after a transitional period would increase by 47% over current results. The analysis pointed out that even better results could be obtained with a combination of selectivity measures and the establishment of Fish Stock Recovery Areas.

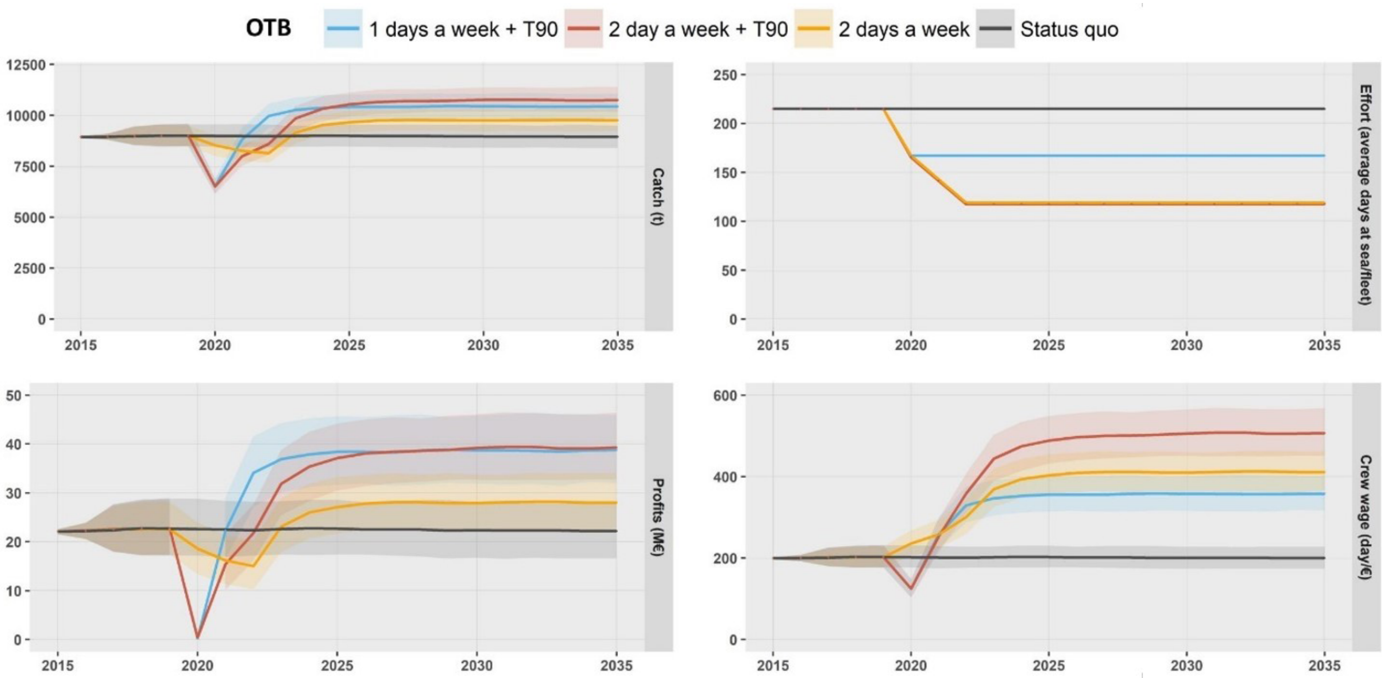


Figure 20. Results of MEFISTO bioeconomic model for the GSA6 trawl fleet under different scenarios. (Source: Sola et al., 2020)

Note: Scenario 0: status quo; Scenario 3: selectivity change to T90; Scenario 4: selectivity change plus 10% annual reduction over 4 years; and Scenario 5: selectivity change plus 20% annual reduction over 4 years.

Gulf of Lion (GSA 07)

According to a 2020 STEFC analysis (STEFC, 2020), it was possible to use the IAM model to evaluate the economic implications of different management scenarios for the French trawl fleet, moving from linear reductions of fishing effort in the period 2021-2024 to achieve a global reduction of 10%, to reductions of up to 50% at the end of the period (2024).[27] The expected outcome is quite different than for the Spanish case because in all the scenarios the total gross value of landings (i.e. revenues) decreases, while in terms of total gross value added (i.e., profits), the results in the midterm depend on the management scenario. Scenarios including effort reductions for trawling and other gears point to an anticipated recovery in profits.

Moreover, landings per unit of effort of other species (i.e., those which are not explicitly modelled) are assumed to be constant in time. Consequently, the potential positive impacts of effort reduction on those other stocks are not simulated, so total landings and profits might be underestimated. As the proportion of the landings of those other species is very high for the two French demersal trawler fleet segments modelled, the negative economic impacts of the effort reduction management scenarios might be overestimated, and better economic results may be expected. This is especially true in the long run, as the positive effects of effort reduction on stock biomasses are not instantaneous.

It Is important to note that in this model there is no evaluation of the implications of a reduction in trawling activities for non-trawling sectors, which is a key element in understanding its overall economic impact on the fishing fleet as a whole.

[27] The Spanish trawling fleet is also active in the area, but Spanish economic cost data were not provided in time to perform the evaluation. (Source: Sola et al., 2020)

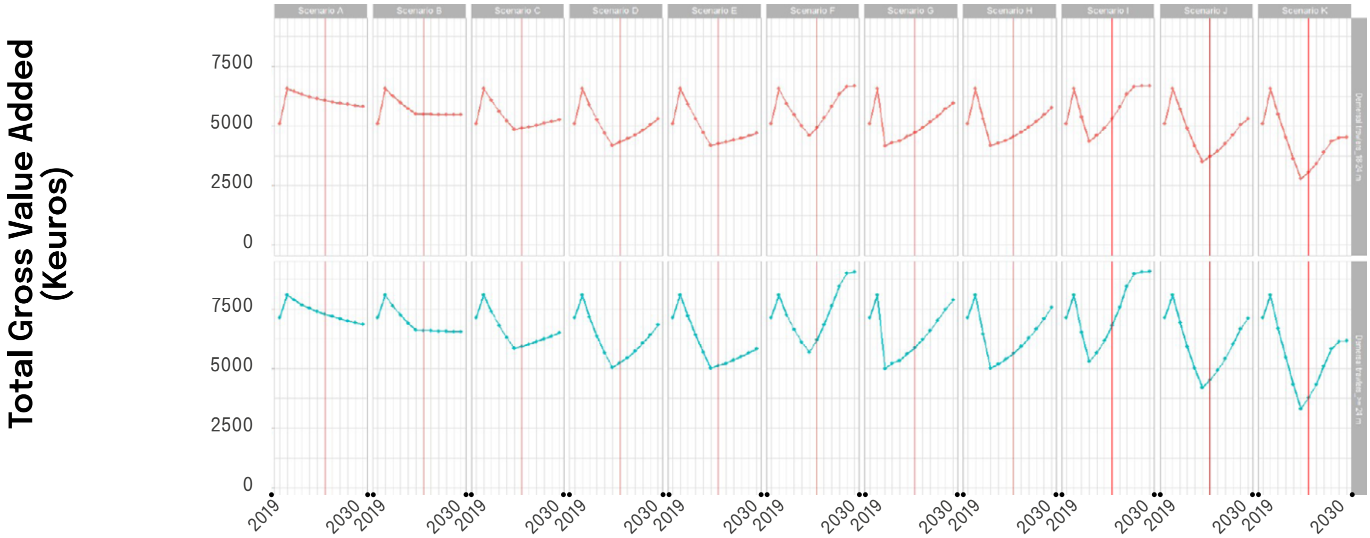


Figure 21. Prediction to 2030 of the total gross value added (GVA, i.e., profit) by French demersal trawlers. (Source: STEFC, 2020)

Note: Prediction to 2030 of the total gross value added (GVA, i.e. profit) to the fleet by French demersal trawlers of 18-24 m and above 24 m according to 11 alternative management scenarios. Vertical red lines indicate the year 2025. Scenarios are in columns and fleets in rows. The top row corresponds vessels of 18-24 m and the bottom row to vessels above 24 m.

Ligurian and Thyrrhenian Sea, (GSAs 09, 10 and 11)

Seven scenarios were run using the BEMTOOL model in the 2020 STEFC evaluation of the fishing effort regime in the Western Mediterranean. In all effort reduction scenarios, after a transitional period, fleet combined revenues and revenues/break-even revenues (R/BER) were expected to grow - so again this clearly shows that today's overfishing practices do not produce the best economic outcomes.

The internal distribution of winners and losers shows the passive gears fleet would clearly benefit, with revenue increases of more than 20% in all segments and very significant increases (between 8% and 108%) in revenues/break-even revenues. Almost all trawling segments, by contrast, would face losses.

Morocco and Algeria (GSAs 03 and 04)

There are no bioeconomic models available.

Annex 7. Women's roles in fisheries by country

Women play a wide variety of roles in the different subsectors of traditional fisheries and their related activities – however, it is difficult to get the same information from each country.

TABLE 12. ROLES PERFORMED BY WOMEN IN WESTERN MEDITERRANEAN FISHERIES AND SUB-SECTORS, BY COUNTRY (SOURCE: EUROPEAN COMMISSION (2019B) AND WWW.THEARABWEEKLY.COM - LAST VISIT: 8/3/2020)	
France	According to regional fisheries authorities and producers' organisations, official statistics do not reflect the real presence of women in the catching sector, as women who work under the status of assisting spouse are not recorded in statistics. Assisting spouses in small-scale fisheries still play a significant role in direct sales of fish, administrative and accounting tasks, and gastronomic activities. They are almost exclusively involved in land-based tasks (sorting, crating, packaging and ground shipping).
Italy	There are not yet gender-disaggregated statistics for the catching sub-sector; therefore, all women who work in this sub-sector remain 'invisible'. Information provided by a women's association indicates that the phenomenon of 'invisible' female work is widespread throughout Italy, and that there are entire areas of fish production entrusted to women who are not formally employed. They work both on boats and on land, repairing nets, marketing fish, maintaining boats, and handling relations with port authorities and control bodies. Moreover, using 'invisible' female workers has helped to mitigate the effects of increases in production costs for small-scale coastal fishing. In small family fish processing enterprises, it is also common to find women who play supporting roles without being formally employed. They are usually relatives (wives, daughters, mothers) of the fishers.
Morocco	Women help their husbands in fishing-related activities but receive no recognition. They work mostly on land, mending fishing nets and cleaning the boats, without salary. Women's access to formal jobs is difficult due to a lack of training. In the village of Belyounech (north Morocco), a group of women has founded the country's first female artisanal fishing cooperative. The cooperative was established in March 2018, to help women to enter the market.
Spain	Official statistics do not consider 'invisible' female workers. Based on research conducted by the Spanish government, women carry out multiple on-shore tasks without a specific legal status (e.g. 'poceras'). However, there are no estimates that account for the number of women in these activities. The current legal framework may allow for the formal recognition of this assisting role in some cases, but assisting spouses are usually not officially registered. Other 'invisible' female workers are involved in making and repairing nets, work as fishmongers ('aranderas'), and in some cases develop fish gastronomy.

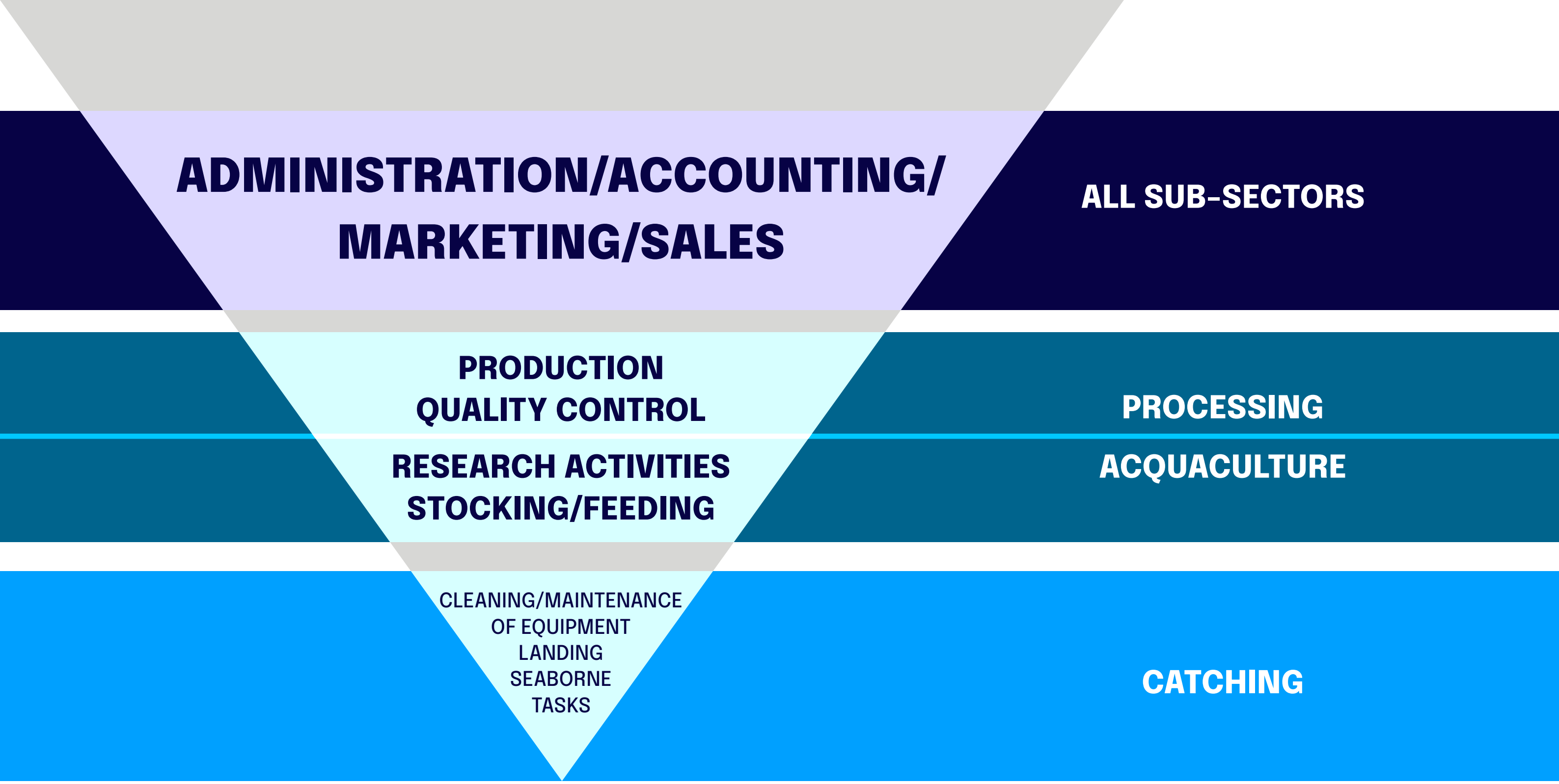


Figure 22. Roles most frequently performed by women across the sector and within subsectors. (Source: European Commission, 2019b)

In the catching sub-sector across all the Member States studied, women are predominantly found performing administrative tasks (permits, licences, registrations, contracts etc.) and in accounting and marketing activities. In Italy (and Spain), women are also involved in cleaning and maintenance of certain fishing equipment (such as mending nets). In Italy and Spain, female boat owners were reported; however, there was no evidence to indicate that these women both fished on and managed the vessels (European Commission, 2019a).

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