



Synthesis of the Landing Obligation Measures and Discard Rates for the Mediterranean and the Black Sea

Final Report

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LIST OF ACRONYMS

Acronym	Description
AHP	Analytical Hierarchy Process
ARA	Blue and red shrimp
ARS	Giant red shrimp
BISAC	Black Sea Advisory Council
CA	Contracting Authority
CCTV	Closed-Circuit Television systems
CINEA	European Climate, Infrastructure and Environment Executive Agency
CLLD	Community-Led Local Development
CFP	Common Fishery Policy
CS	Case Study
DCF	Data Collection Framework
DEMSP	Demersal species
DGMARE	European Commission's Directorate-General for Maritime Affairs and Fisheries
DPS	Deep-water rose shrimp
EASME	Executive Agency for Small and Medium-sized Enterprises
EC	European Commission
EFCA	European Fisheries Control Agency
EMFF	European Maritime and Fisheries Fund
EMFAF	European Maritime, Fisheries and Aquaculture Fund
ERS	Electronic Reporting System
EU	European Union
EWG	Expert Working Group
FAO	Food and Agriculture Organization
FDI	Fisheries Dependent Information
FLAG	Fisheries Local Action Group
FPN	Stationary uncovered pound nets
FRA	Fishery Restricted Area
GAM	Generalised Additive Model
GFCM	General Fisheries Commission for the Mediterranean
GSA	Geographical Sub Area
HKE	European hake
HLG	Representative of High-Level Groups
HOM	Horse mackerel
ICES	International Council for the Exploration of the Sea
ICCAT	International Commission for the Conservation of Atlantic Tunas
IOF	Institute of Oceanography and Fisheries
JR	Joint Recommendations
JRC	Joint Research Center
LH	Last Haul Method
LO	Landing Obligation
LOA	Length overall
L50	Size at which 50% of the individuals are discarded
MAC	Market Advisory Council

MAP	Multiannual plan
MCDA	Multi Criteria Decision Analysis
MCRS	Minimum Conservation Reference Size
MEDAC	Mediterranean Advisory Council
MED&BS	Mediterranean and Black Sea
MS	Member States
MUR	Striped red mullet
MUT	Red mullet
NEP	Norway lobster
NGO	Non-governmental organization
OTB	Bottom otter trawl
OTM	Midwater otter trawl
PAC	Common pandora
PS	Purse seine
PTM	Midwater pair trawl
RCGMED&BS	Regional Coordination Group of the Mediterranean and Black Sea
REC_CM	Recommendation of GFCM
REM	Remote Electronic Monitoring
SOL	Common sole
STECF	Scientific, Technical and Economic Committee for Fisheries
TAC	Total Allowable Catch
TBB	Beam trawl
TUR	Turbot

ABSTRACT

In 2013 the Common Fisheries Policy introduced the landing obligation (LO). The MedBLand study aims at an improved understanding of the management measures put in place in the Mediterranean and Black Sea to implement the LO, to evaluate if discard reduction took place, the main reasons for discarding and to ensure enforcement and control. The review of documents, mainly in the phasing-in period (2015-2019), combined with interviews to stakeholders and modelling of the discard data from the Data Collection Framework was the integrated methodology applied along the study. Results highlighted some improvements as well as the need for further developments.

EXECUTIVE SUMMARY

The landing obligation (LO) was one of the new elements for conservation that the reformed Common Fisheries Policy (CFP) introduced in 2013, to reduce the wasteful practice of discarding, by inciting fishers to fish more selectively and avoid unwanted catches. The phasing-in period of the LO, from 2015 to 2019, intended to provide time for the fishing industry to adapt to the requirements and to Member States authorities to devise the measures, structures and resources to ensure control.

Since the beginning, the regime of “*de minimis exemption*” has been requested for most fisheries on the basis of considerations on high survival after discarding, difficulties in increasing selectivity, and disproportionate costs for managing unwanted catches onboard and at landing sites.

An overview of the management measures established and enforced to facilitate the implementation of the LO in the Mediterranean and Black Sea was gathered by reviewing relevant documents and initiatives as well as through questionnaires with stakeholders. **Results from the qualitative assessment show that most of the different identified initiatives are related with spatial and temporal measures to promote a better selectivity of the catches (105), followed by initiatives to facilitate control (76), to improve gear selectivity (74), and to provide incentives to fishers to improve selectivity, improve compliance and to land and record all catches (45).**

Some concrete examples of initiatives towards the implementation of the LO are the amendments to the national management plans of several Member States aimed at introducing additional measures, such as spatial and temporal closures to protect nursery areas. As for control and enforcement, some legal initiatives that are related, to some extent, to enforcement of LO are reported by several Member States, such as updating specifications for Vessel Monitoring System (VMS), complementing measures for the functioning of the Electronic Reporting System (ERS) and updating the sanction system for infringements. These are expected to have a positive impact on discards reduction by increasing compliance.

One of the main initiatives not designed specifically for the LO, but expected to produce positive effects for reducing discards of European hake and protect one of the main nursery of this species is the establishment of the fisheries restricted area (FRA) of the Pomo Pit in the Adriatic Sea, following the recommendation GFCM/41/2017/3 and related acts at national level. Initiatives for closure areas to protect nurseries of European hake are also ongoing in the western Mediterranean, following the implementation of the Multi Annual Management Plan (MAP).

Several pilot studies were implemented in the framework of DiscardLess and MINOUW projects in the western, central and eastern Mediterranean Sea to provide the knowledge, tools and technologies as well as the involvement of the stakeholders to achieve the gradual elimination of discarding. However, very few initiatives are reported to actually implement the results of such pilot studies in current fishing practices. For example an initiative at local level established an improvement of gear selectivity (45 mm square mesh in the codend), but it applies to a very small number of vessels (16) of the harbour of Palamós. However, as regards gear selectivity, new ongoing projects (e.g., IMPEMED in the western Mediterranean and Adriatic Sea) are looking for more generalizable results before their implementation.

Our results are in accordance to other studies (STECF 18-06, STECF 20-04) that indicates that the avoidance of unwanted catches through improved selectivity or other means should be the primary focus in implementing the LO.

Regarding the project Case Studies (CS), related to the Mediterranean and

Black Sea regions, most of the documents and initiatives are related with Western Mediterranean (127) followed by Central Mediterranean (66) and Eastern Mediterranean (60). The lowest number of documents was obtained for the Black Sea (32).

It should be considered that most of the initiatives referred to the above CS are the result of local pilot studies and have not been implemented on a larger scale. This might also explain the small percentage of stakeholders that have participated or have knowledge of some of these initiatives.

Consultation of stakeholders through questionnaires pointed out that LO has not produced significant changes up to the moment towards the reduction of discards, but some of them indicate that the awareness of fishers has increased. This is proven by the fact that the more common initiatives aimed at mitigating unwanted catches, apart from discard plans and joint recommendations, were reported to be those related to streamline communication and to inform and train the fishery sector on the measures adopted to reduce discards and to implement the LO. However, the situation is rather different in the CS: in the Western Mediterranean and Central Mediterranean most of the respondents were aware of the measures related to LO, while in the Eastern Mediterranean and in the Black Sea the majority of the respondents were not informed on the measures related to the LO.

From the review of the management measures and the questionnaires it may be concluded that the LO probably has not produced significant changes towards the reduction of discards up to the moment, since most of the initiatives are local, but LO may have increased the awareness of fishers and increased the number of studies and pilot projects, as DISCATCH, DiscardLess, MINOUW, GALION and IMPEMED that may contribute to a more effective implementation in the near future.

The outcome of the review to assess the impact of the measures' combination showed that there has been some progress in discarding patterns, since the 1990s, but these may be diverse or even contrasting among species, fisheries and CS. In the Western Mediterranean, the discard L50 for deep-water rose shrimp (DPS), European hake (HKE) and red mullet (MUT) in bottom trawl fisheries has increased by approximately 10%, 65% and 34% respectively, but it is still below the Minimum Conservation Reference Size (MCRS). However, specifically for HKE, this is accompanied by an increase of discard ratio. In the Central Mediterranean CS, the percentage of discards in gillnets and trammel nets seems to have decreased in the last decade compared to the previous ones, while the opposite is shown for bottom trawls (but not for HKE). The discard L50 for HKE and DPS in bottom trawls have progressively increased since the 1990s, but it remains still below the Minimum Conservation Reference Size (MCRS). In the Eastern Mediterranean CS, the total discard ratio of bottom trawls was quite high during the 1990s (~40%), but our review provides evidence that it has progressively decreased (to <25%). For trammel nets and purse seines, discards were generally low in all time periods. However, there doesn't seem to be enough progress in the lengths at discarding as explored in the bottom trawl fishery. In the Black Sea CS, the discard ratio for sprat (SPR) was found higher in the stationary uncovered pound nets (FPN) fishery compared to the midwater trawl, while in both cases the discard ratios seem to have progressively decreased.

The majority of studies have focused on bottom trawls where the increase in codend mesh size to 40mm introduced with the Regulation (EC) 1967/2006 seems to have contributed to this direction, while the synergistic effect of other factors (e.g., MCRS, spatio-temporal closures) cannot be easily assessed, at least quantitatively, since the different spatio-temporal scales and fisheries considered in individual studies do not allow deriving robust conclusions. Despite that their primal focus has not been the mitigation of discards, new MPAs have been progressively designated and enforced in the past decades - including in nursery grounds -

contributing to the avoidance of unwanted catches, while temporal bans take into account recruitment periods of the species when more undersized individuals are present in the catch. Furthermore, as discarding has gained much attention in the recent years, fishers and scientists have placed more effort on practices that seem to constitute important steps towards discards reduction, such as gear modifications, shifts to more selective gears, co-management and eco-certification. The Multi Criteria Decision Analysis (MCDA) revealed that measures on gear selectivity (mainly increase in codend mesh size) as well as spatial and/or temporal fishery closures are considered more effective for the mitigation of discards in the Mediterranean and Black Sea fisheries than MCRS and LO provisions. As for the effect of the LO provisions, there is very little scientific literature and it is too soon to evaluate their effect based only on the outcomes of the literature review. An explanation for the latter is the fact that the LO has been applied through a series of exemptions that cover most fisheries, at least in the Mediterranean Sea.

Based on the questionnaires results from scientists, the majority of these perceived that the LO has been partly applied and that there is only little effect on discards reduction. According to the respondents' replies, it seems that **substantial information has been additionally collected and has become available mainly through EU and National research and monitoring projects.** Most scientists perceived that their work related to discards may have been modified, but their workload has not increased. **From both the Review and the Interviews to assess the impact of the measures it is evident that, on the occasion of the LO, discarding became a hot topic of fisheries science in the Mediterranean and Black Sea region, that new information has been added and that new approaches and measures have been explored, which stakeholders and the management system could capitalize on.**

Fisheries information, i.e. discards and landings quantities and demographic structures from the MED&BS Data Call, was used to estimate discard ratios at different levels of aggregation, gear or fishery. In addition, for each species in each fishery, the size at which 50% of the individuals were discarded (L50) was estimated, split in three time periods (2012-15, 2016-17 and 2018-19). As examples selected from the bulk of results, we performed a more detailed presentation of the discard ratios in OTB fisheries for species subject to MCRS, sensitive species and species included in the Multiannual Management Plans or in GFCM Recommendations.

The discard ratios of the species included in the Western Mediterranean multiannual plan for demersal fisheries (Regulation (EU) 2019/1022) were generally very low or low (<0.02 or ranging between 0.02 and 0.07) in most Western Mediterranean GSAs, except for European hake and red mullet for which in some cases/years also higher values (>0.15) were observed. The L50 for these species were usually below MCRS, however improvements were observed in many cases, showing that there has been some progress in discarding patterns for the fisheries considered in this region. In the Adriatic Sea fisheries for small pelagics, very low ratios (<0.02) were observed for anchovy and sardine in PS (purse seine) fisheries, but they were in some cases/years higher (>0.15) in the PTM (pelagic trawler) fisheries; however, recent data were not available for PTM and the progress could not be assessed.

An improvement was observed also as concerns discard ratios in some regions (e.g., GSA 16), but this was accompanied by a slight decrease (around 10%) in the L50 for some species. On the contrary, **in the western Ionian Sea (GSA 19) and in the Adriatic (GSA 17-18), increased discard ratios were observed in the recent years,** which, as concerns the Adriatic, they still remained at low levels (<0.05) for most species despite the recent increase. In addition, **increased L50 values were estimated for most species in the Adriatic (but the opposite for GSA 19) in the most recent period and this may have contributed to the observed increasing**

trend in the discard ratios. In the Eastern Mediterranean trawler (OTB) and purse seine (PS) fisheries, the discard ratios were also low and <0.05 , with some exceptions, as for *Pagellus erythrinus*, for which the discard ratio was >0.15 in few years, but the trends could not be adequately assessed due to lack of time series in many cases. Finally, for Romanian OTM fisheries in the Black Sea, only few data points could be estimated, and only regarding the discard ratios.

Finally, according to the literature review of studies applying multi-species assessments and models to evaluate the effects of the LO and/or discards mitigation methods, it seems that adverse effects on specific scavenging groups - including some charismatic species - (e.g., seabirds, sea turtles) were predicted in the simulations, without substantial benefits for commercial stocks and fisheries. Simulating scenarios with and without landing obligation in an ecosystem model for the North-Eastern Adriatic Sea indicated that landings would increase by 13%, causing an increase in fishers' workload and a small decrease in fisheries revenue, while selling landed unwanted catches for fishmeal production would not compensate the economic losses. On the contrary, simulated improvements in the bottom trawl selectivity seemed to benefit fished stocks and the ecosystem in general.

Discards modelling through Generalized Additive Models (GAMs) was applied to discards per unit of effort (kg/h) of four species (HKE, DPS, MUT, and horse mackerel, HOM), using detailed data from onboard samplings. The analysis focused on discarding at the haul level in Italian and Greek bottom trawl fisheries (OTB) since 2010 to 2020. Twelve variables were considered with some variations depending on the data availability in each GSA: environmental (longitude, latitude, depth); temporal (year, month, quarter); catch related (catch of the species, total catch of all species in the haul, Lmean of the species); operational (vessel LOA, vessel age, haul duration).

Results highlight that **discards were positively related with the total catch of the species** (20/27 models) **and/or with the total catch of all species in the haul** (12/27 models). The relationship among landings and discards of the species is confirmed here, as in several other works. The effect of the total catch of all species in the haul shows that discards are affected by the catch composition in general and **when catches are satisfactorily high, the fishers' decision on what to discard may be more relaxed**. Additionally, an important variable affecting discards was also the length composition of the species considered; and the **discards of the species (especially for HKE) decreased as the mean length of the catch increased**.

Temporal patterns of discarding were also evident. Interannual effects were identified in 20/27 models **and seem related to the overall trends in species abundance, or** may be affected by annual differences in **recruitment success. Seasonal patterns were usually related to the recruitment period of the species** (e.g., 3rd or 4th quarter for HKE, 4th quarter for MUT in almost all GSAs). Additionally, in the Greek GSAs, where the 3rd quarter is closed for OTB in national waters, the increased discards during the 4th quarter for several species might be related to increased abundance due to this cease in the fishing operations.

Among the operational variables, the length (LOA) category of the vessel proved to be the one contributing most to the explanation of discard quantities. Larger vessels usually produced higher discards, probably because they catch larger quantities in general, but this pattern was not always constant in all species/GSAs. Vessel age had a significant contribution in some models (11/27), but there was no definite conclusion across all GSAs/species on whether younger or older vessels discard more. Finally, haul duration contributed significantly to a low number of models (8/27); this variable was often correlated with depth, which was more often included as it showed higher explanatory power. **The effect of duration was variable depending on the species/GSA, but in most cases longer durations were positively related with higher discards.**

The identification and evaluation of the measures, structures and resources adopted by

Member States' authorities to ensure control, enforcement and inspection of all activities relevant to the LO was based on interviews with representatives of MSs and relevant stakeholders and a thorough review of relevant documents issued by the MS Authorities or other institutional bodies, reporting control and monitoring activities. We used two types of questionnaires, one addressed to the control bodies and a second one to a wider group of stakeholders, including aquaculture and processing industry and the Market Advisory Council. Results from the interviews highlighted that **the implementation of the LO provisions depends by an effective system on control and inspection (at sea and at land), as well as by a system that allows to manage and possibly process the discards in the circuit "not for human consumption"**.

The results evidenced the presence of measures or infrastructures to ensure enforcement and inspection of LO compliance, as well as monitoring of catches/discards, but the information received was not very detailed. The process to report catches was noticed in all Member States; most of the stakeholders mentioned the electronic or manual logbooks, however specifications on discards registration was not always provided. The number of reported LO infringements by Member States was considered low. As concerns the possible use of discards for "not direct human consumption" the majority of the respondents reported that currently in their country there are no structures processing discards from fisheries (e.g. to produce fish meal). Some generic interest in processing or using discards was noticed from few respondents involved in fish meal/pet food industries and aquaculture/mariculture plants, also outside the areas of the case studies, though it is difficult to strictly associate this interest to the discards resulting only from the LO.

Similarly, the use of EMFF funds to support measures or infrastructures to enforce the LO provisions is very low and still limited to sporadic cases.

Most stakeholders, fishers in particular, declared their scepticism to the LO efficacy in reducing discards. **The main problems in implementing the LO seem due to the scarce knowledge of the fishers, the logistic difficulties to manage discards at sea and at land, the complexity of the rules, the difficulty to set up an efficient control activity, the need of specialised structures and regular volumes to process discards, the lack of financial motivation for fishers. Moreover, the "de minimis" exemptions allow, to a certain extent, to continue the previous operative fishing practices.**

In conclusion, a synthesis of the lesson learnt can consider the following aspects.

There is still the need of a continue work for increasing communication and raising awareness among the sector, involving the various stakeholders and actors, as well as researchers, administrations, consumers, industry and market organizations. The European Maritime, Fisheries and Aquaculture Fund (the 'EMFAF') can create opportunities aimed at continuing to inform, train, increase communication. The access to the funds and to the specific actions need to be promoted to ensure an effective implementation and use at regional, national and local levels. This type of actions can be promoted in the short terms.

There should be still room for improvements in gear selectivity, finding trade-offs that can mitigate the losses in the short terms, so making this kind of measure more acceptable by fishers. Therefore, the combination of the actions towards the selectivity improvements, the protection of the recruits of the main commercial species through area and season closures should be viewed as a major step towards the achievement of a more sustainable exploitation pattern. These type of actions might require a medium term time frame to be supported and implemented.

Localizing, in the Mediterranean and Black Sea, zones to be avoided given the potentially higher discard rate (nurseries of key species matching with high fishing footprint areas), selecting the more relevant for spatial management and spatial closures can be a step forward. This type of action can be promoted in the short terms.

Currently there are no structures processing discards (e.g. to produce fish meal). Incentives to identify innovative solutions at local level with the cooperation of the local administration and fisher associations can help in establishing new practices for the management of discards at the landing sites. There is, hence, the need to improve the utilization of the EMFAF funds in the near future and thus increase information and communication actions. This can be also promoted in the short and medium terms.

1 INTRODUCTION

The reformed Common Fisheries Policy (CFP) introduced in 2013 new elements for conservation such as the target of maximum sustainable yield (MSY) for all the stocks by 2020 at the latest, **the landing obligation and the regionalisation approach.**

The objective of the landing obligation (LO) is to reduce the wasteful practice of discarding by inciting fishers to fish more selectively and avoid unwanted catches and, ultimately, avoiding resource waste. Thus, it requires a behavioural change from the industry towards more selective practices in order to be successful in reducing discards and unwanted catches.

The landing obligation was introduced for all catches of species subject to catch limits and, in the Mediterranean, for catches of species subject to Minimum Conservation Reference Sizes (MCRS) (only bluefin tuna and swordfish are under Total Allowable Catches - TAC in this sea basin and are managed by the International Commission for the Conservation of Atlantic Tunas - ICCAT). It applies to all EU vessels fishing in Union waters and high seas. The LO came into force gradually, starting in 2015, with full implementation since January 2019.

The phasing-in period was meant to provide time for the fishing industry to adapt to the requirements of the LO as well as to provide Member States authorities time to devise the measures, structures and resources to ensure control.

The introduction of the LO by the reform of the CFP is a process that followed a specific schedule. First, in 2015, the pelagic fisheries and related target species started to be subjected to the LO in the Mediterranean. Then, only the demersal species that characterized the fisheries were taken into consideration for the LO and finally the demersal species subject to a MCRS, following the EU Regulations 1967/2006 and Article 31 of Regulation (EU) 1241/2019.

Since 2015, the LO concerns the sprat (*Sprattus sprattus*) fishery in the Black Sea. As far as the Black Sea is concerned, as from 1st January 2017, the LO is compulsory for turbot fisheries. The plan adopted for this fishery is based on a joint recommendation transmitted by Romania and Bulgaria and assessed by the STECF. It has a duration of three years and foresees a one-year survivability exemption for turbot caught with bottom set gillnets. Romania and Bulgaria had to provide additional data in the course of 2017, based on which the survivability exemption could be prolonged in the coming years.

Figures 1.1 and 1.2 schematise the timeline of the steps in the implementation of the LO and, consequently, in the delivery of Joint Recommendations and Discard Plans in the Mediterranean and the Black Sea, respectively. LO is in force for Mediterranean and Black Sea EU countries.

Collaboration between the stakeholders (industry, scientists, Member States, NGOs, Commission and the European Parliament) has intensified throughout the phasing-in period of the LO (2015 - 2019). Results from studies or reports (e.g. DiscardLess; Uhlmann, Ulrich, Kennelly, 2019; MINOUW project; <http://minouw-project.eu/>; and the project iSEAS¹ under the LIFE program) provide best-practice case studies on management measures to avoid discarding through technological changes, tactical

¹ http://lifeiseas.eu/?page_id=1692

changes, electronic monitoring, socioeconomic impact and the use of unwanted catches in the value chain, including the transformation into high added value products.

The details of the implementation of the LO shall be specified in multiannual plans (MAP) or, when no MAP is adopted, in the discard plans. The Member States - in consultation with the relevant Advisory Councils - can come forward with Joint Recommendations (JR) for these discard plans. Upon scientific assessment by the Scientific, Technological and Economic Committee for Fisheries (STECF), the Commission adopts these JRs as an EU delegated act.

In the Mediterranean, since the beginning, the regime of “de minimis exemption” has been requested for most fisheries on the basis of considerations on difficulties in increasing selectivity, and disproportionate costs for managing unwanted catches onboard and at landing sites. Moreover also high survival exemptions have been established. In the Black Sea the request of exemption were mainly based on high survival as regards turbot.

The last Joint Recommendations for the Mediterranean were reviewed by STECF EWG 20-04 (STECF 2020) and lastly by STECF 21-05 (STECF 2021a). Regarding the Black Sea, Commission Delegated Regulation (EU) 2017/87 established a discard plan for turbot fisheries in the Black Sea. This discard plan was valid until 31 December 2019 and included a high survivability exemption for turbot caught in bottom set gillnets. This exemption was granted for one year on the provision that the Member States concerned in the fishery should submit relevant data to the Commission to allow STECF to further assess the justifications for this exemption. No such data was forthcoming, so the exemption lapsed. Following discussions between Romania and Bulgaria a new Joint Recommendation for a discard plan for turbot fisheries in the Black Sea was submitted in 2021 and assessed by STECF 21-05 that highlighted the need of further scientific evidence to support such exemption.

Collaboration between member States’ experts and the European Fisheries Control Agency (EFCA) has resulted in the publication of Technical guidelines and specifications for the implementation of Remote Electronic Monitoring (REM) in EU fisheries (<https://www.efca.europa.eu/en/content/technical-guidelines-and-specifications-implementation-remote-electronic-monitoring-rem-eu>).

The importance of ensuring control for the successful implementation of the LO and the effectiveness of REM in doing so has been recognized by the European Commission. The Commission included a legal basis for the mandatory installation of continuously recording CCTV (closed-circuit television systems) incorporating data storage in the Union Fisheries Control System proposal (COM(2018) 368 final).

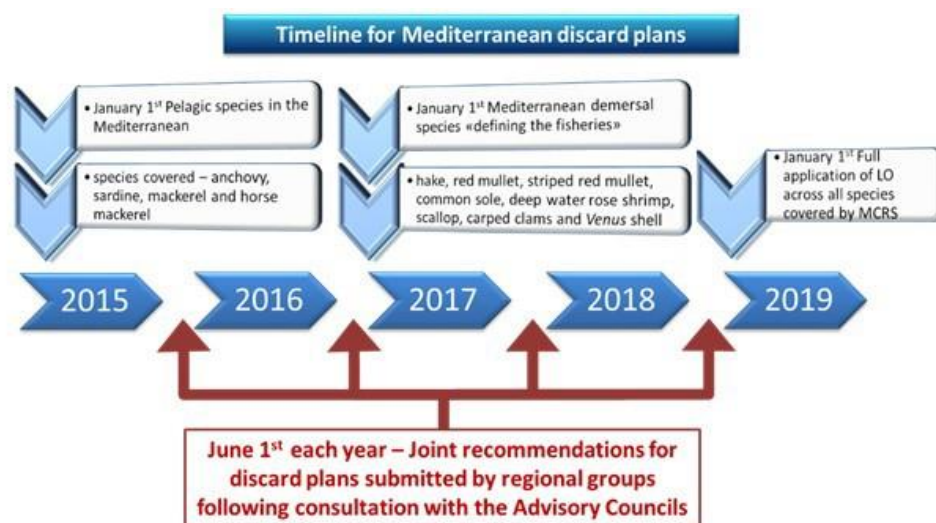


Figure 1.1. Timeline of the Landing Obligation implementation and Joint Recommendations for discard plans (Mediterranean).

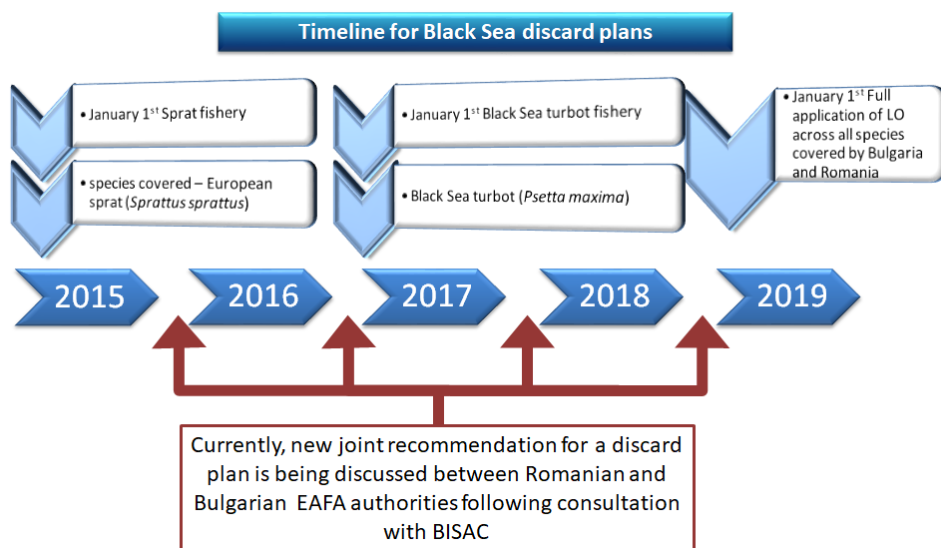


Figure 1.2: Timeline of the Landing Obligation implementation and Joint Recommendations for discard plans (Black Sea).

The European Maritime and Fisheries Fund (EMFF) (from 2021 to 2027 the European Maritime, Fisheries and Aquaculture Fund - EMFAF), supports innovation and investments that contribute to the implementation of the LO. This effort comprises investments that aim at improving fishing gears selectivity, fishing ports and vessel infrastructure, as well as the usage of unwanted catches "not for direct human consumption" (they can be the source of pet food, fish meal, fertilizers, and pharmaceuticals). The fund also provides support for the implementation of a Union control, inspection and enforcement system. In particular, this includes financial support for the installation of CCTV systems, which have been demonstrated as being highly effective in controlling the LO at sea.

The specific objectives of MedBLand project were:

- ✓ **contribute to an improved understanding of the implementation of the LO by mapping, assessing and evaluating the management measures put in place;**
- ✓ **build up knowledge on whether these measures were successful in reducing discards;**
- ✓ **assess the impact of the management measures on the development of the discard rates and on the length at which the probability to be discarded for a fish or shellfish is 0.5 (discard L50);**
- ✓ **modelling in some case studies the main causes of discarding in the current context;**
- ✓ **evaluate the measures, structures and resources adopted by Member States to ensure control, enforcement and inspection of all activities relevant to the LO.**

2 OVERALL METHODS IN BRIEF

The MedBLand study was organised in five tasks:

Task 0. Coordination;

Task 1. Overview of the management measures implemented to facilitate the implementation of the Landing Obligation

Task 2. Assess the impact (success) of the combination of measures implemented regarding the reduction of discards rates

Task 3. Identify and evaluate the measures, structures and resources adopted by Member States' authorities to ensure control, enforcement and inspection of all activities relevant to the landing obligation.

Task 4. Lesson learnt.

In addition, the project adopted a Case Study approach at a subregional level i.e. Western (Geographical Sub Area –GSAs- 1, 2, 5, 6, 7, 8, 9, 10 and 11; covering the national waters of Spain, France and Italy), **Central** (GSAs 15, 16, 17, 18 and 19; relevant for Malta, Italy, Croatia and Slovenia), **Eastern Mediterranean** (GSAs 20, 22, 23 and 25 relevant for Greece and Cyprus) **and Black Sea** (GSA29 covering the national waters of Bulgaria and Romania plus non-EU waters) to address specific fisheries, and to account for geographical differences in terms of ecosystems and productivity, compliance with the regulation, management of the European Maritime and Fisheries Fund (EMFF), which provides incentives for supporting different types of changes.

The review of relevant documents, mainly in the phasing-in period, combined with interviews to relevant stakeholders, the analysis and modelling of the discard data collected in the Data Collection Framework (DCF) was the integrated methodology applied along the MedBLand study.

Interviews were carried out through the involvement of stakeholders, administering questionnaires. Table 2.1 report the list of groups of stakeholders with the number of contact by each. The dissemination of the questionnaires took place both through the platform for the Stakeholders on the project SharePoint and using directly the links to the FORMS tool, used for the implementation of the questionnaires online in each mother language. The project MedBland was also presented at the MEDAC Meeting of the Working Group 1 (<http://en.med-ac.eu/events.php?id=178>) and the questionnaires relaunched through the MEDAC channels.

Table 2.1. Types of stakeholders and final number of contacts.

N.	Types of stakeholders	Final number of contacts
1	Member States' national Administrations, including the relevant Ministry and Executive Agencies dealing with the Common Fisheries Policy (implementing the landing obligation)	24
2	Representative of High-Level Groups (HLG)	3
3	Regional Coordination Group of the Mediterranean and Black Sea	3
4	The Advisory Councils (Industry and NGOs)	6
5	Regional Administrations delegated for the EMFF funds and incentives	23
6	Producers Organisations relevant for the production and marketing plans setup by the entailing details of the implementation of the landing obligation and the industries' effort	14
7	Fishers associations, cooperatives and Prud'Homies	60
8	FLAGS	67
9	NGOs	12
10	Fish processing, PET food and feeding companies; aquaculture companies/organizations	26
11	Fish trade platforms/organizations	19

12	Joint Research Center researchers	2
13	End-users, as STECF and GFCM	9
14	FAO Regional Projects	2
15	Research institutions, e.g. the scientists, working on DCF or other relevant projects for LO and discards at national or international levels	32 Institutes 125 Scientists
16	DGMARE representatives	2
17	The European Fisheries Control Agency	1
18	Control Bodies at National and Regional level	54

Data for the project were gathered from the European Data Collection Framework (DCF):

- data before and after 2015
 - Med&BS Data Call (<https://datacollection.jrc.ec.europa.eu/dc/medbs>) that includes information both on the discard volume and on the demographic structures (length, weight and biological parameters) of the whole catches since 2006 and to 2019. Realized with the support of DG MARE.
- data after 2015
 - FDI, data accessible at the link: <https://stecf.jrc.ec.europa.eu/dd/fdi>. This data could not allow the estimates of some metrics (e.g. reverse ogives).
- data made available by the project partners.

3. OVERVIEW OF THE MANAGEMENT MEASURES IMPLEMENTED TO FACILITATE THE IMPLEMENTATION OF THE LANDING OBLIGATION

3.1 INTRODUCTION

The LO came into force gradually, starting in 2015, with full implementation since January 2019.

The objective of the LO is to reduce the wasteful practice of discarding by inciting fishers to fish more selectively and avoid unwanted catches, and ultimately avoiding resource waste. With the introduction of the LO, the fishing opportunities proposed shall reflect the change from amount landed to amount caught. Discards may be very high in fisheries regulated by TACs and Quotas due to quota completion in mixed fisheries or high-grading for example. In these fisheries the LO represents a fundamental shift in the management approach to EU fisheries: a shift from landing-quota to catch-quota management, as all catches must now be accounted for against the relevant quotas which will produce a significant reduction of the fishing mortality.

The case of the Mediterranean Sea is different because discards of regulated species are relatively low and the destination of catches of fish under the MCRS is limited and exclude sale for human consumption. These differences explain that the implementation of LO in the Mediterranean has been done mainly using some flexibility instruments like the *de minimis* and high survival exemptions. In Black Sea the only species regulated by TAC is sprat (*Sprattus sprattus*).

This chapter aims at providing an overview of the management measures established and enforced so far per Member State, per fisheries and per sea basin to facilitate the implementation of the LO, including the ones implemented by the industry, if any. This should help to build up knowledge on whether these measures were successful in reducing discards. This overview has focused on the measures applied in the final year before the LO implementation, compared to the measures implemented from 2015 onwards.

3.2 METHODS

The methods applied combined reviews and interviews with experts and several stakeholders.

3.2.1 Review

The review focus was on the legislation and technical regulations applied by the different Member States, considering as a baseline the last year before the LO implementation. The review covers the period 2015-2020, mainly during the phasing-in period. The review structure followed a common format and included all the documents that may be relevant for LO implementation and discard reduction:

- 1) national legislation or other documented legal acts available in the last year before the LO implementation; BASELINE;
- 2) national legislation after 2015, including the implementation of “*de minimis*” exemption;
- 3) acts from the regional consultation process (joint recommendations);
- 4) STECF reports, Member States annual reports and other reports on implementation of LO;
- 5) pilot studies on selectivity, including the ones carried out in the projects MINOUW and DiscardLess;
- 6) other pilot studies and voluntary actions to reduce discards per case study/Member State;

7) scientific peer review literature and technical reports.

The review included the screening of the initiatives/measures according the following criteria:

- a) initiatives to improve selectivity;
- b) spatial and temporal measures to promote a better selectivity of the catches;
- c) measures to ensure control, including REM techniques, developments and global applications;
- d) initiatives to provide incentives to fishers to improve selectivity, improve compliance and to land and record all catches.

The review process started with the preparation of the review structure and the retrieving of the relevant documents. Each document has been assessed against expected impacts of the implemented measures for discarding mitigation and classified according to the criteria from a) to d) above reported.

The review has been structured by Case Study by Member State and fishery (pelagic and demersal).

3.2.2 Interview

Following the desk study, the necessary in-depth assessment of the measures implemented in the different geographical areas, species and fisheries has been achieved through the interactions with experts and several stakeholders by means of questionnaires and interviews. The gathered feedbacks contribute to complement the information on such measures as obtained from the review, gaining also perspectives from the different stakeholders. 219 entities have been contacted and a total of 78 questionnaires have been filled by the contacted stakeholders.

The stakeholders included Member States' national Administrations, the MEDAC and BISAC, Regional Administrations delegated for the EMFF funds and incentives, FLAGS, Community-Led Local Development (CLLDs), Producers Organizations, fishers associations, cooperatives and Prud'Homies², FAO Regional Projects and NGOs.

The questionnaire administered included an introductory section to gather basic information as the respondent's expertise, type of organization, country and geographical area so as to better categorize the answers. The specific contents of the questionnaire were organized in four sections:

- a. overview of the management measures established and enforced so far to facilitate the implementation of the LO;
- b. questions aimed at identifying the main problems (actual difficulties/obstacles) in implementing the LO;
- c. qualitative judgment on the effectiveness of the introduced new measures for discarding mitigation;
- d. additional information.

Each section was introduced by a small text to explain the issue and help in understanding the questions.

² Prud'homies are ancient systems of collective management of fishery resources still active along the Mediterranean coast of France.

3.3 RESULTS

3.3.1 Review

Landing obligation has been implemented in the Mediterranean and Black Sea mainly through Commission delegated Regulations. However, **a total of 225 documents/initiatives related to some extent with LO and discards reduction have been selected.** Most of them are legal acts from MS (96/225) and scientific literature (56/203), but also a relatively high number of pilot studies have been identified (31/225). A commented list of the retained documents with the classification of the type of initiatives is reported in the **ANNEX 1.**

Regarding case studies most of the documents are related with Western Mediterranean (127) followed by Central Mediterranean (66) and Eastern Mediterranean (60). The lowest number of documents was obtained for the Black Sea (32) (Figure 3.1).

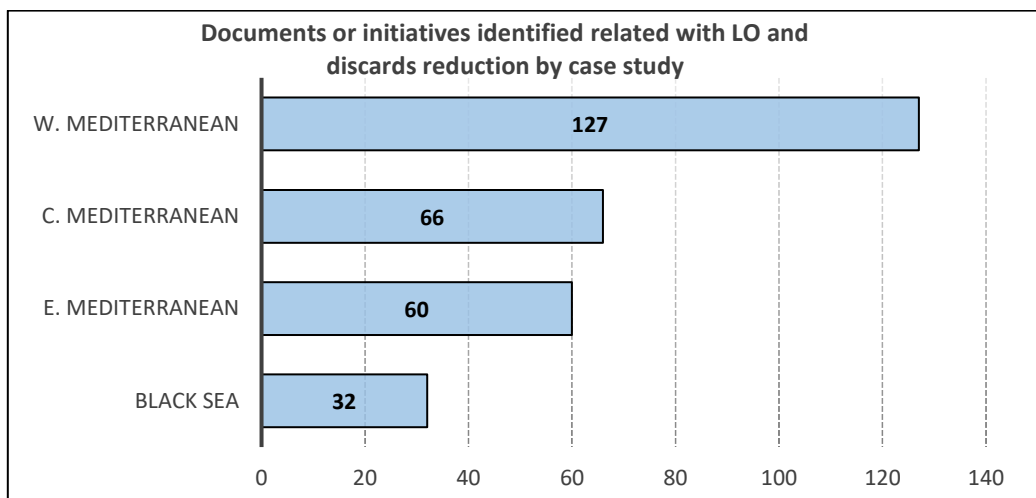


Figure 3.1: Number of identified documents/initiatives related with LO and discards reduction per Case Study (sea basin).

Results from the review show that regarding the qualitative assessment of the different initiatives identified, most of them are related with spatial and temporal measures to promote a better selectivity of the catches (105), followed by measures to facilitate control (76), initiatives to improve gear selectivity (74) and initiatives to provide incentives to fishers to improve selectivity, improve compliance and to land and record all catches (45) (Figure 3.2). From the selected documents, 36 do not contribute, from our point of view, to reduce discards although they are related with LO.

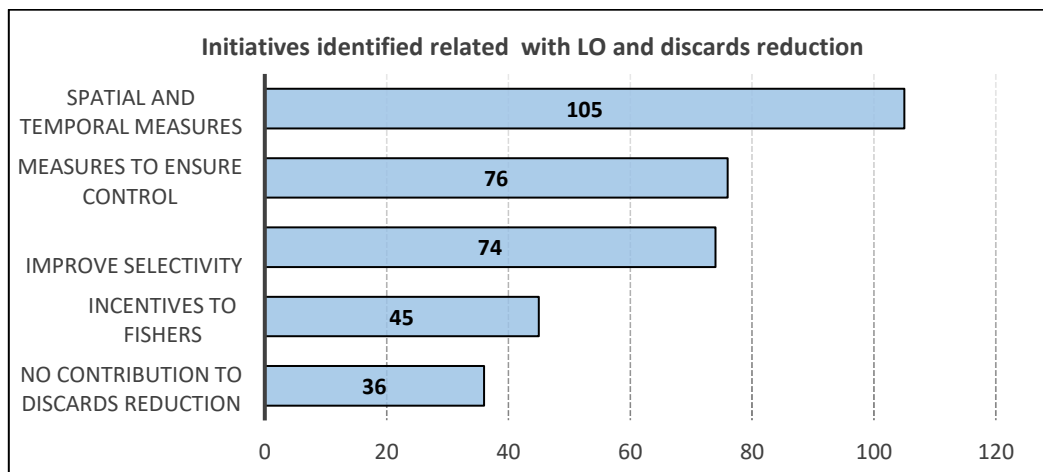


Figure 3.2: Qualitative assessment of the different initiatives identified

Some concrete examples of initiatives towards the implementation of the LO are the amendments to the national management plans of several Member States aimed at introducing additional measures, such as spatial and temporal closures, to protect nursery areas.

One of the main initiatives not designed specifically for the LO but expected to produce positive effects for reducing the discards of European hake and protect one of the main nursery of this species is the establishment of the fisheries restricted area (FRA) of the Pomo Pit in the Adriatic Sea, following the recommendation GFCM/41/2017/3 and related acts at national levels.

Likewise, several initiatives of area closures to protect the nursery of European hake have been undertaken by the Member States or are ongoing in the Western Mediterranean for the objectives of the Western Mediterranean Management Plan (MAP) (e.g. STECF, 2021b).

In Greece a temporal fishing ban to protect a hake nursery area in the North Aegean Sea was introduced (Ministerial Decision 1913/43489/20-04-2017 GGI 1444B' as corrected by the 1587B' /2017).

In Cyprus, a modification of the Fishing Law (Regulatory Administrative Acts 416/2019), sets obligation for vessels with length >12 m to have installed a VMS and foresees an increase of minimum mesh sizes for static nets (from 32 mm to 38 mm), measures which are expected to increase selectivity and improve control and compliance.

As for control and enforcement, some legal initiatives that are related, to some extent, to enforcement of LO are reported by several Member States, such as updating specifications for Vessel Monitoring System (VMS), complementing measures for the functioning of the Electronic Reporting System (ERS) and updating the sanction system for infringements. These are expected to have a positive impact on discards reduction by increasing compliance.

Several pilot studies were implemented in the framework of DiscardLess and MINOUW projects in the western, central and eastern Mediterranean Sea to provide the knowledge, tools and technologies as well as the involvement of the stakeholders to achieve the gradual elimination of discarding. However, very few initiatives are reported to actually implement the results of such pilot studies in current fishing practices. An attempt by the Spanish Ministry to introduce T90 mesh configuration on the basis of the results of MINOUW project was started, but new experimental evidences reached different results on this mesh configuration that was found to not increase selectivity

(Baro et al., 2019)³. An additional initiative was undertaken at local level in the harbour of Palamós for improving gear selectivity (45 mm square mesh size in the codend), but for the time being it applies to a very small number of vessels (16)

However, it is expected that new results will be gathered on gear selectivity in western Mediterranean and in the Adriatic Sea by the IMPEMED project⁴.

In the Galion project, catches and discards from the trawl fishery in the Gulf of Lion were mapped. The distribution maps of individuals under minimum conservation reference size (MCRS) were then used for the fisheries spatial planning. A large number of avoidance scenarios were generated to highlight strategic areas to avoid in order to protect undersized individuals.

Most of the reviewed initiatives and measures are the result of local pilot studies and have not been implemented and regulated on a larger scale. This might also explain the small percentage of stakeholders that have participated or have knowledge of some of these initiatives (around 30% in both cases; as from the results of the interviews in the following sub-chapter).

From the review it seems that discards of regulated species in the Mediterranean and the Black Seas is not a major issue. Catches in the sprat fishery in the Black Sea, the only fishery regulated by TACs that is submitted to LO, is reportedly well below the TAC. On the other hand, discards of species below MCRS are only a small proportion of total discards both in Mediterranean and Black Sea basins. However, if they were landed, discards will represent a low volume scattered in multiple landing sites that may generate management problems, given the inappropriate logistics (for instance the lack cold storage facilities at port), administrative issues (rules and procedures for the treatment of discards as special waste if no alternative use of discards is foreseen), coordination on drafting and disseminating the correct procedures among different actors (fishermen, managers of the Port Authorities, representatives of the fish markets and municipal authorities) and the lack of interest from the processing industry (i.e. Bellido et al 2014; García Rivera et al. 2015; Sarda et al. 2015; Sánchez Lizaso et al. 2018; Spedicato et al. 2018). These are the main reasons why the LO in the Mediterranean and Black Seas has been implemented mainly through Commission delegated Regulations considering *de minimis* exemption due to disproportionate costs. For some species the high survivability exemption has also been considered to avoid landing of fish that would otherwise have survived.

A detailed description of each measure and action identified during the review is reported in the **ANNEX 1**.

3.3.2 Interviews

All the EU Med&BS countries participated to the survey. The higher number of responses were from Italy (23) and Spain (14). The Western Mediterranean is the region with the higher coverage (29 respondents), followed by Central Mediterranean (21 respondents). Four questionnaires were received by stakeholders at supranational and regional level. Almost half of the respondents (36 out of 78) belong to National Institutions rather than regional, local or European. As regards affiliation, 21 questionnaires were answered by fisher associations, 14 by FLAGS (Fisheries Local Action Groups) and 10 by Member State representatives; 7 by regional government representatives and 6 by NGOs (Figure 3.3).

³ Baro et al 2019. Informe Técnico Campaña DESAL1219: Mejora de la selectividad mediante la modificación del arte en la pesquería de arrastre de fondo con puertas del caladero nacional Mediterráneo (mar de Alborán).

⁴ Specific Contract No 04: EASME/EMFF/2019/1.3.2.6/01/SI2.818717 "Improving the selectivity of trawl gears in the Mediterranean Sea to advance the sustainable exploitation pattern of trawl fisheries" - implementing Framework Contract No EASME/EMFF/2016/032.

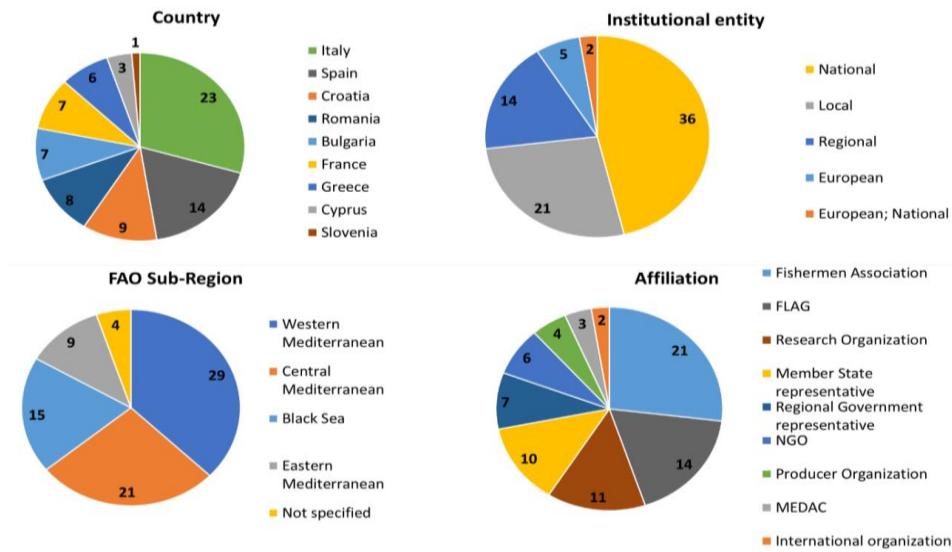


Figure 3.3: Geographic origin, entity of the Institution and affiliation of the respondents.

A considerable percentage of the stakeholders (47% overall and >60% in certain CS) were not aware of the specific implementation plans and measures related to the LO enforced (Figure 3.4). This is quite surprising considering that most of the respondents are involved in fisheries activities and their management. This could be related to the fact that the LO has been implemented in Mediterranean and Black Sea mainly through the “*de minimis*” and high survivability exemptions that actually allowed to continue the previous operative fishing practices.

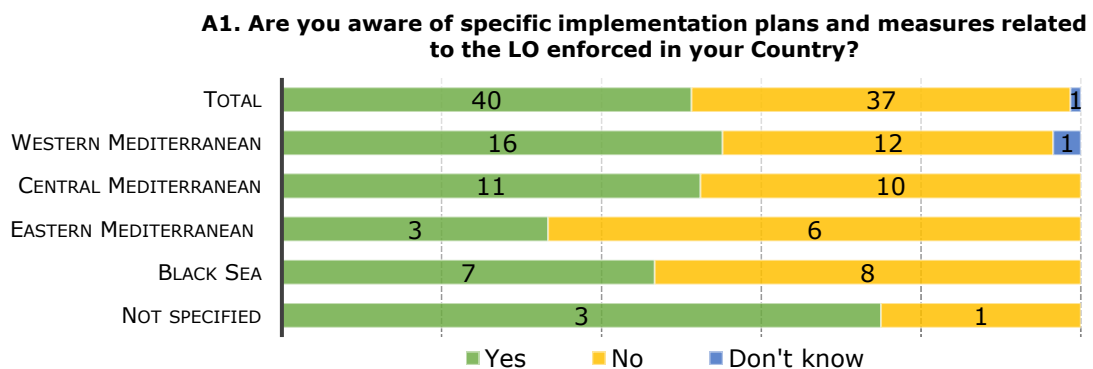


Figure 3.4: Responses (Total and by CS) to Question 1.

Only 29% participated to or supported studies for evaluating fishery discards, in relation to LO, in the period 2015-2019 (Figure 3.5). The types of studies and initiatives are rather heterogeneous, but they mainly refer to scientific projects at national or European level.

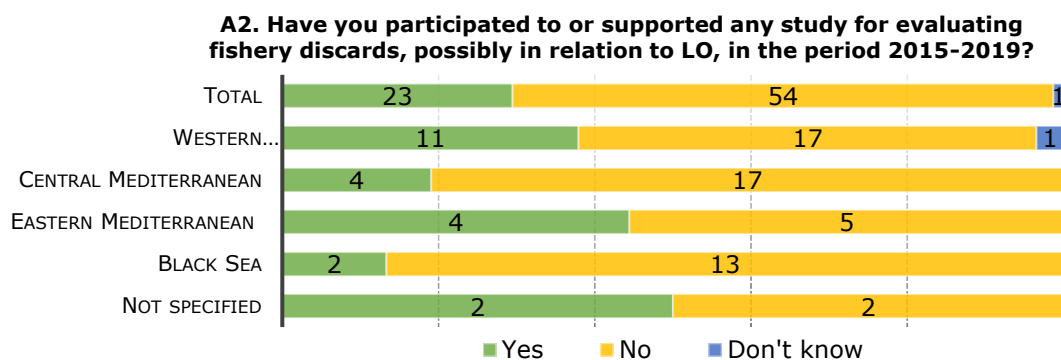


Figure 3.5: Responses (Total and by CS) to Question 2

With reference to additional technical measures or any other action aimed at mitigating unwanted catches, as foreseen under the LO implementation, only 31% of the respondents were involved in their implementation, directly or indirectly (Figure 3.6).

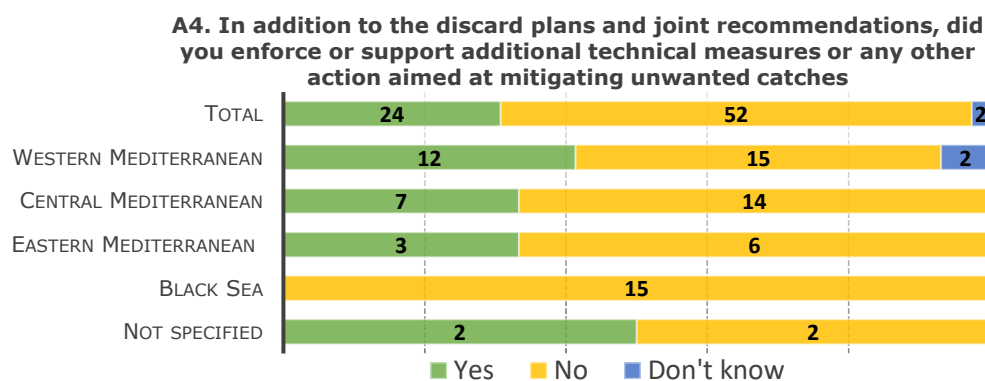


Figure 3.6: Responses (Total and by CS) to Question A4.

The more common initiatives reported by respondents are those related to streamline communication/dissemination actions, to inform and train the fishery sector on the measures adopted to reduce discards and to implement the LO. Also, several respondents referred to initiatives to provide incentives to fishers to monitor, land and record all catches and to closing specific areas or seasons to demersal fisheries to promote experimental studies on innovative gears and improving the selectivity of trawl gears of demersal fisheries (Table 3.1).

Table 3.1: Additional technical measures aimed at mitigating unwanted catches. No answer was obtained from Black Sea stakeholders (multiple answer allowed).

Type of initiative	Western Mediterr.	Central Mediterr.	Eastern Mediterr.	Total
a. improve the selectivity of trawl gears of demersal fishery through incentives/investments	8	2		10
b. improve the selectivity of passive gears targeting demersal resource through incentives/investments	1	4		5
c. regulate/mitigate the operations of small pelagic fisheries through specific measures (e.g. slipping methodology)	4	1	1	6

d.	regulate/mitigate the operations of demersal fisheries through specific measures related to the gears (e.g. number of gears used, multi rig trawling)	3			3
e.	banning demersal fisheries in specific seasons	2	4	1	7
f.	banning small pelagics fisheries in specific seasons	2	2	1	5
g.	closing specific areas to demersal fisheries	9	3	1	13
h.	closing specific areas to small pelagic fisheries	2	3	1	6
i.	initiatives to provide incentives to fishers to monitor, land and record all catches	4	9		13
l.	promoting investments on infrastructures at land to facilitate landing of unwanted	2	4		6
m.	promoting actions to foster commercial channels other than human consumption (e.g. feeding, pharmaceutical or pet food industry)	3	2		5
n.	promote experimental studies on innovative gears aimed at reducing unwanted catches	6	4	2	12
o.	streamline communication/dissemination actions, to inform and train the fishery sector on the measures adopted to reduce discards and to implement the LO	7	7	2	16
p.	Other (please specify)			2	2
q.	None	53	45	11	109

3.4 CONCLUSIONS

Our results are in accordance with other studies (STECF, 2018; STECF, 2020; STECF, 2021b) that indicates that the avoidance of unwanted catch through improved selectivity or other means should be the primary focus in implementing the LO, but probably the implementation of these initiatives is slow compared to the timing established in the phasing-in period. Only local pilot studies and one implemented FRA at a quite large spatial scale (Pomo Pit) have been identified.

Both the review and the interviews indicate that the main problems in implementing the LO are the inappropriate logistics and storage facilities at the landing points, logistic difficulties on board for the storage of discards and lack of interest of industrial companies in the processing of small and disperse quantities of discards that will produce a disproportionate costs for the management of catches subject to LO. Low compliance with fishing rules (technical measures, closing areas, etc.) low level of awareness and information by fishers. The need to improve enforce and control are also reported as relevant issues in all the CSs. Similar conclusions emerged also when the number of categories of interviewed stakeholders was expanded to processing industry and control bodies (see chapter 5). The utility of *de minimis* exemptions to mitigate all these problems have been stressed.

For the small pelagics fisheries, discard is not considered a relevant issue if slipping and *de minimis* are maintained. The multi-species nature of most of demersal fisheries is also reported, as well as a large number of artisanal or small-scale vessels. These facts, together with the difficulty of creating economies of scale that are profitable for the use

of the quantities subject to LO and the difficulties of operability at sea to separate the discard on board lead to problems of implementation and disproportionate costs for the management of catches subject to LO.

Keeping the "*de minimis*" for which discarding is allowed and increase the selectivity of trawling gear have been reported as the only way to allow the implementation of the LO for the regulated demersal species in the Mediterranean.

The assessment of the impact of the adopted measures in reducing discards for demersal fisheries has proven to be difficult. Most of the responses to interviews indicate that LO have not produced significant changes up to the moment towards the reduction of discards, but some of them indicate that has increased the awareness of fishers.

From the review and the questionnaires it may be concluded that LO probably has not produced significant changes towards the reduction of discards up to the moment, since most of the initiatives are local, but it may have increased the awareness of fishers and increased the number of studies that may contribute to a more effective implementation in the future.

4. ASSESS THE IMPACT (SUCCESS) OF THE COMBINATION OF MEASURES IMPLEMENTED REGARDING THE REDUCTION OF DISCARDS RATES

4.1 INTRODUCTION

Studies on discarding are numerous and have increased even more during the past years in response to the LO provisions (e.g. DISCATCH, MINOUW, DiscardLess); however, there is still little understanding on the quantitative effects of the measures adopted in terms of discards reduction.

Although discarding is mainly driven by market demand, a number of factors have a synergistic effect, which is sometimes difficult to disentangle and capture (Stithou et al., 2019). Understanding the drivers and the factors affecting discarding is fundamental for the reduction and the proper management of unwanted catches.

Discards vary locally, according to environmental variables such as depth, productivity, suitable habitats and other parameters that influence species composition, distribution and abundance (e.g., Feekings et al., 2012; Maina et al., 2018; Milisenda et al., 2021). Indicative of this is the fact that variability in discard rates across regions was greater than across fisheries, as highlighted in a multi-national European study (Uhlmann et al., 2016). The identification of discards hot-spots can be important for the designation of permanent Fisheries Restricted Areas (FRAs) (Despoti et al., 2020) or real-time closures (Little et al., 2015).

Inter-annual effects and seasonal patterns have been also identified in several fisheries worldwide (e.g., Rochet and Trenkel, 2005; Feekings et al., 2012) and in the Mediterranean as well (e.g., Tsagarakis et al., 2008; Damalas et al., 2018). Seasonal trends are mainly influenced by species biology (recruitment period, seasonal migrations).

In terms of quantities, the amount of discards is usually positively related with the amount of landings and as the catch increases so do discards (Rochet and Trenkel, 2005; Feekings et al., 2012). In addition, the length structure of the catch largely determines what is discarded, due to either market (low price) or legal (specimens below MCRS) reasons, even in the Mediterranean, where there is low compliance with MCRS regulations (Tsagarakis et al., 2017; Damalas et al., 2018). Furthermore, in the Mediterranean multi-species fisheries where fishers target species complexes, the overall quantity and composition of the catch may affect the discarding decision; when catches are low, by-catch species of low commercial value may provide a supplemental income to the fishers, while in the opposite case, these may be discarded (Tsagarakis et al., 2008). Finally, the effect of vessel characteristics such as age, size, engine power (e.g., Feekings et al., 2012; Carbonell et al., 2018) as well as of other operational factors like haul duration may influence discarding (Rochet and Trenkel, 2005; Feekings et al., 2012).

This chapter aims at assessing the impact (success) on the reduction of discards rates of a combination of measures implemented. The aim is also to evaluate which measures contributed to this reduction. This qualitative assessment is extended to the integration of these management measures in relation to the discards rates and to discard L50 (lengths at which 50% of the specimens are discarded), to ensure that an integral assessment and synthesis is achieved. The assessment also takes into account that the management measures should be aligned as much as possible with the policy measures mentioned in the CFP and should clarify the main causes of discarding per fishery in the current context.

4.2 METHODS

The methods applied combined desk work, collection of information through interviews/questionnaires and consequent data analysis, analysis of data from different sources and modelling.

4.2.1 Review

The review has been focused on studies examining various aspects of discarding with special focus on the ones that provide quantitative information on discard ratio, discard amounts and size at discarding. Specifically, we performed a search in the Scopus database using the following terms: TITLE-ABS-KEY ((mediterranean OR "Black Sea") AND (fish OR fisheries) AND discard*). The search returned 260 documents. After a first screening of the documents to exclude studies that were not geographically or thematically relevant, the list of papers was restricted to about 100. In addition, based on expert knowledge, we performed a search for grey literature, reports and technical documents produced at international and national levels. In total 1322 records from 78 retained studies with quantitative information were collected, which concerned discards metrics of the total catch, specific groups (e.g., bony fish, crustaceans, cephalopods), or species (either subject to the LO or not).

The information collected was analysed by Case Study, following the approach by Tsagarakis et al. (2017); the discard ratio and discard L50 of the main species subject to the LO were graphically presented for selected fishing gears, by using the information and data in the data base built from the review. The desk work related to the literature review took also into consideration the best available results from pilot studies and studies already carried out for discard assessment (e.g. MINOUW and DISCARDLESS).

The information listed in table 4.1 was collected for each identified study, while additional information on the period and other characteristics (e.g., gear selectivity) of the survey was recorded. Special focus was placed on 28 species subject to the LO, because subject to regulation on the MCRS (species listed in Annex III of the Regulation EC 1967/2006; now Annex IX of the Reg. EU 2019/1241). The information was split in different periods to examine the historical progress of discarding and to provide insights on the effectiveness of specific measures, when possible.

A qualitative assessment has been also conducted to evaluate the expectation of reduction against the type of measure and in terms of comparison of management measures, using an approach based on a simplified Analytical Hierarchy Process (AHP; Saaty, 1980) from Multi Criteria Decision Analysis techniques (MCDA; e.g., Belton and Stewart, 2002; Raykov and Bikarska, 2011; Kavadas et al., 2015; Rossetto et al., 2015; Lembo et al., 2017) on a selection of the papers analysed in the review and providing quantitative evidence, i.e. going beyond a descriptive approach to the discards issues. The aim was the ranking of four options, i.e. minimum conservation reference size and landing obligation, gear selectivity, establishing closed areas and seasons and a potential combination of these strategies, for their effectiveness in potential mitigation of discarding, using the discard ratio as an indicative criterion.

Table 4.1. List of information sought and common guidelines followed during the literature review.

Type of information	Content
CS	West/Central/East Mediterranean or Black Sea
Country	
GSA	
Region	if it was applied in a specific area, e.g. by a local fishers' organization, this should be also filled

Type of information	Content
Gear type	Mention the fishing technique, e.g. OTB, PS, OTM, etc...); if the detail of métier is available this level can also included
Fishery	demersal or pelagic
Species	mention the specific species, or "total catch" if the metrics are for the whole fishery, i.e. all species included
before/after	specify if the information mentioned in this row is before or after the implementation of the measure (or could be in relation to the control)
discard ratio	discards/total catch; for the specific species or for the whole fishery
discard rate	discards/landings
weight or number	specify if the metrics are calculated based on weight or numbers
L _{50%}	Size at which 50% of specimens are discarded; from a reverse ogive or other similar metrics
% of juveniles	% of juveniles or undersized specimens included in the catch
% survivability	% of specimens that survived (or estimated to survive based on vitality assessments)
other metric	IF other relevant quantitative information is available, it should be mentioned here and its value should be provided in the next column
value of other metric	value of the metric mentioned in the previous column (if any)
Reference	source of information
comments	provide comments here, or/and in the .doc table if needed

4.2.2 Interview

Information has been collected also through interviews and questionnaires, conducted by virtual tools, with scientists involved in the data collection and in discard estimates at the various laboratories in the geographical areas of the study. A target number of interviews close to 60-70 was initially expected, including "on board" scientists with recent field experience as well as high level experts.

This Activity collected information through questionnaire that included an introductory section to gather the respondent's expertise, type of institutional organization, country and geographical area to better categorize the answers. In the core questions the respondents were asked to choose from a limited number of answers (e.g., "yes", "no", "partly") and to provide additional comments in some cases. Questions were based on elements to gather by scientists: (i) their knowledge on discarding before and after the introduction of the LO regulation, (ii) their evaluation on the data quality and availability before and after the introduction of the LO, as well as (iii) their assessment on the efforts/needs to align their routinely work with the request of the LO provisions.

4.2.3 Discards metrics estimation

This activity performed an overview of the estimation, per fishery and split annually from 2012 to 2019, of the discard rates related to the species listed in Annex III of the Reg (EC) 1967/2006 (now Annex IX of the Reg. EU 2019/1241), which are subject to MCRS, including sensitive species and species which are target of the Multiannual Management Plans or of GFCM Recommendations; i.e. Regulation (EU) 2019/1022 on Western Mediterranean MAP, REC.CM_GFCM/42/2018/8-e for small pelagics in the Adriatic and REC.CM_GFCM/43/2019/5-e for demersal species in the Adriatic.

Data used have been gathered through the Med&BS Data Call. In addition, data updated to 2019 of FDI were available online (<https://stecf.jrc.ec.europa.eu/dd/fdi>) and were used also for checks.

In addition, an analysis of DCF data from MS Work Plans and Annual Report has been

implemented for an overview, in terms of coverage of species and métiers. The documents available through the European Commission Data Collection Framework web site (<https://datacollection.jrc.ec.europa.eu/wp-np-ar>) have been reviewed.

The assessment of the success of measures implemented included a review of multi-species assessments and models.

Different possibilities exist for the computation of discard rates (e.g., % discards of total catch for all species combined; only for regulated species; % unwanted catches for regulated species, i.e. including undersized and discards), however the discard rate methodology has been selected in agreement with the Contracting Authority before performing the overview. To this direction, Mediterranean and Black Sea EU Member States' data were analysed to provide estimates of the discard ratio (Ratio = Discards/Landings) by species and fishery as well as estimates of the size at which 50% of individuals were discarded (L50).

Two tools were produced, an excel Workbook and an *ad hoc* developed R script, to estimate discard ratios, with the flexibility to perform the analysis at different levels of aggregation (gear or fishery). In addition, for each species in each fishery, the L50 was estimated, split in three time periods (2012-15, 2016-17 and 2018-19) to better assess the progress in discarding after the implementation of the LO provisions.

A traffic light approach was applied to indicate the levels of discard ratios (very low: <0.02; low: 0.02-0.07; moderate: 0.07-0.15; high: >0.15) for each species in each GSA and gear, while the trend (decreasing, increasing or stable/fluctuating) was indicated with a symbol. When different levels of the discard ratios were observed in the period 2012-2019, the most frequent level was used, while when different levels were observed in equal frequency, the mean ratio for the whole period was used to assign a general level of the discard ratio. In cases that several fisheries operate in a GSA, the colours and symbols are based on the most important fishery in terms of volume of landings. Trends could not be adequately assessed due to lack of time series in many cases.

4.2.4 Discard modelling

The objective was to analyze discard data collected by the Institutes participating in the project with the goal to examine the effect of environmental, operational, temporal and catch-related variables on the discard quantities of selected species. Specifically, the data analyzed were collected by observers on board commercial trawlers in the framework of the National DCF programs during the period 2010-2020. The analysis focused on four species (*Merluccius merluccius*, European hake, HKE; *Parapenaeus longirostris*, deep-water rose shrimp, DPS; *Mullus barbatus*, red mullet, MUT; *Trachurus trachurus*, horse mackerel, HOM) discarded in Italian and Greek bottom trawl fisheries (OTB) since 2010 in seven GSAs (Western Mediterranean: GSAs 9, 10; Central Mediterranean: GSAs 18, 19; Eastern Mediterranean: GSAs 20, 22 (part), 23). In total, 4,620 hauls performed in the depth range 5-726 m were taken into consideration. The analysis was performed at the haul level in order to include more detailed information on the variability of the parameters considered (i.e., not averaged among hauls of the same fishing trip).

Generalized Additive Models (GAMs) were applied to model discards per unit of effort (kg/h) of each species in each GSA. Twelve variables were considered with some variations depending on the data availability in each GSA:

- environmental (*longitude, latitude, depth*)
- temporal (*year, month, quarter*)
- catch related (*catch of the species, total catch of all species in the haul, L_{mean} of the species*)
- operational (*vessel LOA, vessel age, haul duration*)

An exploratory analysis was conducted to assess the collinearity among the explanatory variables and a stepwise forward selection was followed to select the best model based on the improvement of appropriate criteria (e.g. GCV, AIC, explained deviance), the significance of the variables and the inspection of model diagnostics (e.g., QQ plots, distribution of residuals).

4.3 RESULTS

4.3.1 Review

In the Mediterranean Sea, it was evident that there has been some progress in discarding patterns since the 1990s, but these may be diverse or even contrasting among species, fisheries and CS.

In the Western Mediterranean, the L50 for deep-water rose shrimp (DPS), hake (HKE) and red mullet (MUT) in bottom trawl fisheries has increased but is still below the Minimum Conservation Reference Size (MCRS) (Figure 4.1). However, specifically for HKE, this is accompanied by a slight increase in its discard ratio.

In the Central Mediterranean CS, the percentage of discards in gillnets and trammel nets seems to have decreased in the last decade compared to the previous ones, while the opposite is shown for bottom trawls (but not for HKE) (Figure 4.2). The discard L50 for HKE and DPS in bottom trawls have progressively increased since the 1990s but remain still below the MCRS.

In the Eastern Mediterranean CS, the total discard ratio of bottom trawls was quite high during the 1990s, but our review provides evidence that it has progressively decreased. For trammel nets and purse seines, discards were generally low in all time periods. However, there doesn't seem to be enough progress in the lengths at discarding as explored in the bottom trawl fishery.

In the Black Sea CS, the discard ratio for sprat (SPR) was found higher in the stationary uncovered pound nets (FPN) fishery compared to the midwater trawl, while in both cases the discard ratios seem to have progressively decreased. Turbot (TUR) discards in gillnets were negligible, while around 19% was discarded in the rapana beam trawl (TBB) fishery.

However, the interpretation of results was treated with caution because the different spatio-temporal scales and fisheries considered in individual studies do not allow deriving robust conclusions. Still, based on the collected information and the findings of the original studies reviewed, some conclusion on the effectiveness of specific measures can be drawn. To this end, the Multiple Criteria Decision Analysis (MCDA) applied to a sub-selection of the reviewed papers highlighted that in the ranking preferences of management options, the measures based on gear selectivity devices (mainly increase in codend mesh size) and area and/or season closures seem to be considered more effective than the MCRS and the LO alone to mitigate discarding (Figure 4.3).

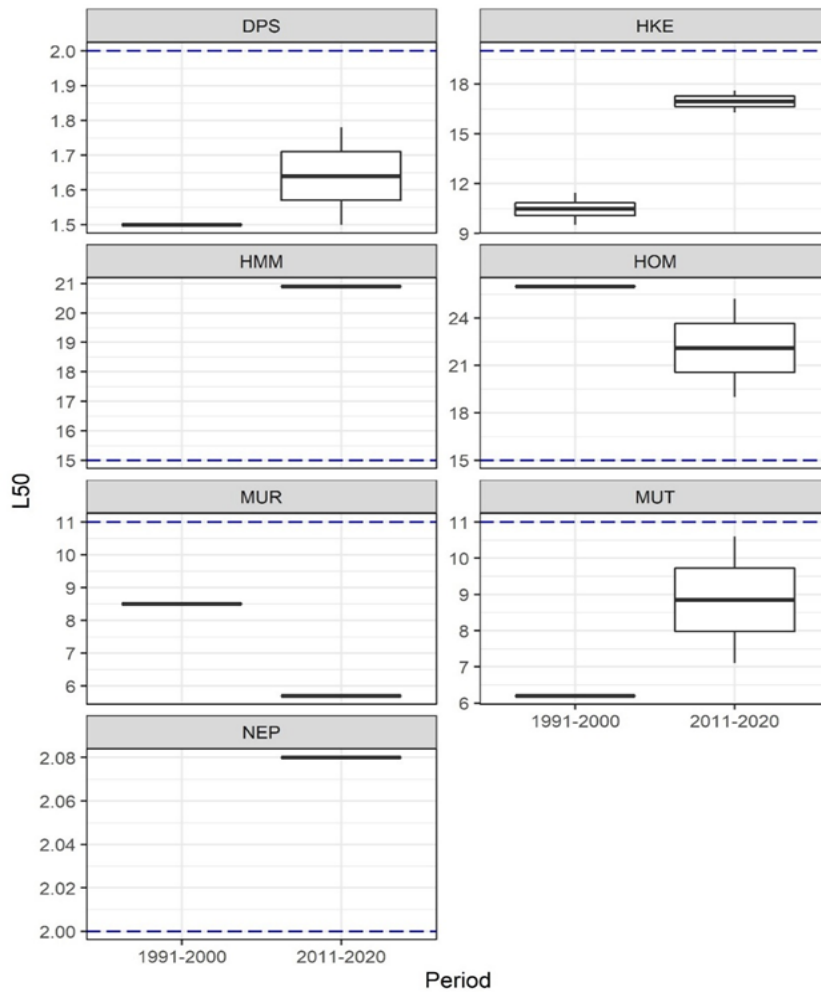


Figure 4.1: L50 of species with MCRS in the West Mediterranean bottom trawl fisheries, in two time periods (left panel) and in the Eastern Mediterranean (right panel). The dashed line corresponds to the MCRS of each species. Box range indicates 50% of observations; bold line inside the boxes indicates the median value. Vertical lines extend from the lower (or higher) quartile to the smallest (or higher) point.

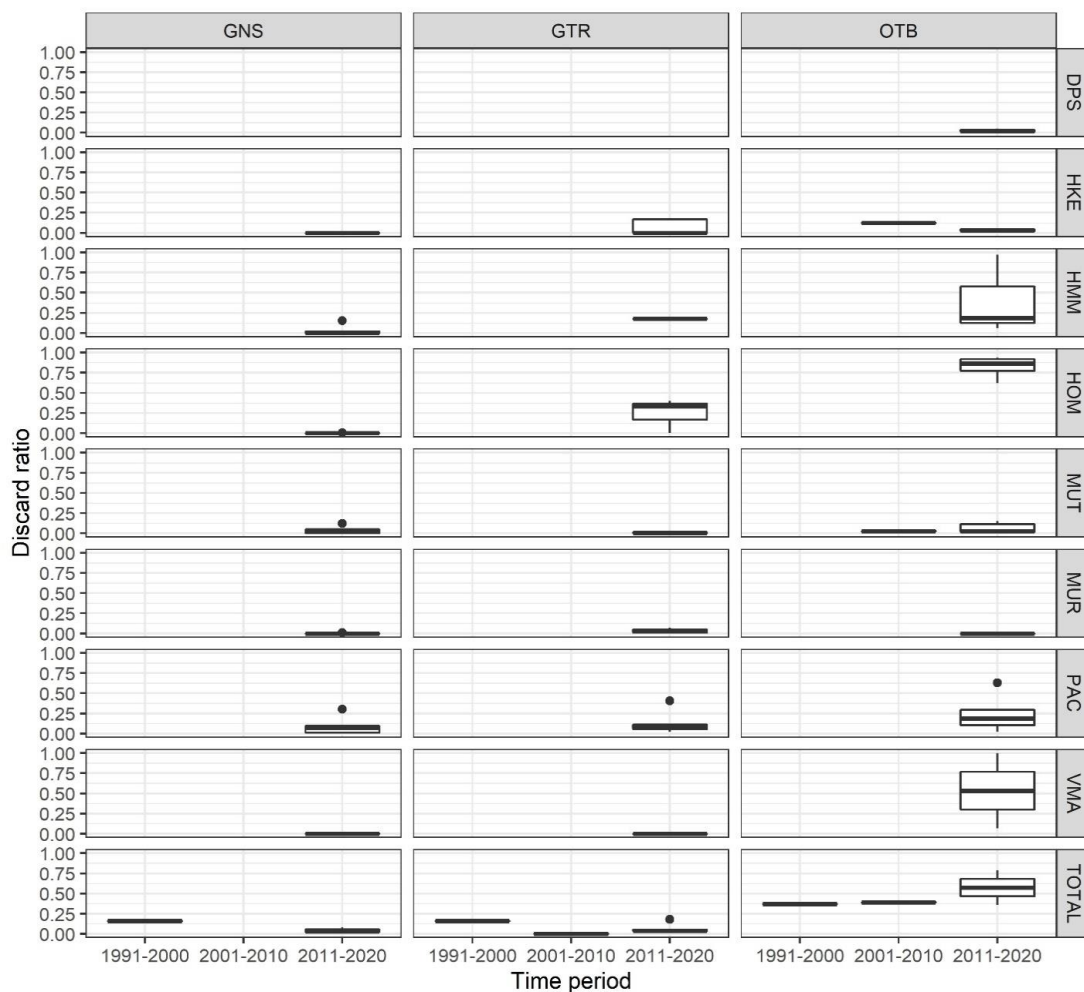


Figure 4.2: Discard ratios (in weight) of selected species and the Total Catch in Central Mediterranean fisheries in 10-year intervals. Box range indicates 50% of observations; bold line inside the boxes indicates the median value. Vertical lines extend from the lower (or higher) quartile to the smallest (or higher) point; points outside the boxes indicate outliers.

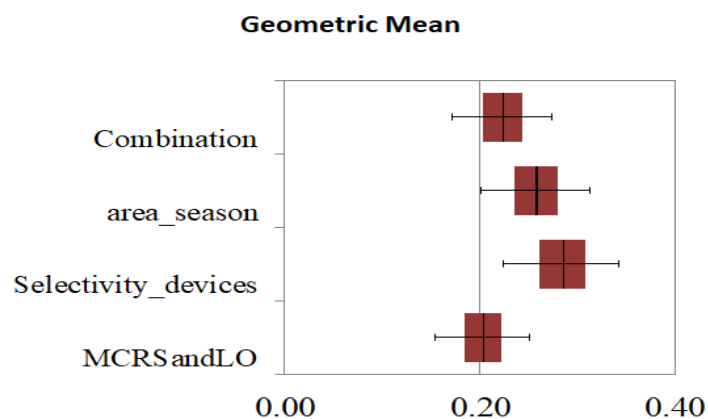


Figure 4.3: AHP (Ranking preferences). Ranking the objectives with uncertainty (box plot with median and percentile values: 0.05, 0.25, 0.75, and 0.95). Level 1, MCRS and LO (Minimum Conservation Reference Size and Landing Obligation), Selectivity devices (gear selectivity, mainly of the codend), area_season (closing areas and/or fishing season), combination (potential combinations of the measures).

Further details on the review are reported in the ANNEX2.

4.3.2 Interviews

In total, 68 scientists from almost all EU Mediterranean and Black Sea Member States provided a feedback replying to the questionnaires. The highest number of scientists was from Italy (15), followed by Spain and Croatia (11 each). The difference in the number of scientists among countries was reasonable due to differences in the magnitude of the fishing sectors among countries and the number of Research Institutions involved in the DCF. Most scientists (54/68) were affiliated in National Institutions rather than regional, local or European. The expertise of the scientists in relation to aspects of discards research and monitoring was quite balanced, while most of them stated that they are dealing with multiple aspects (Figure 4.4).

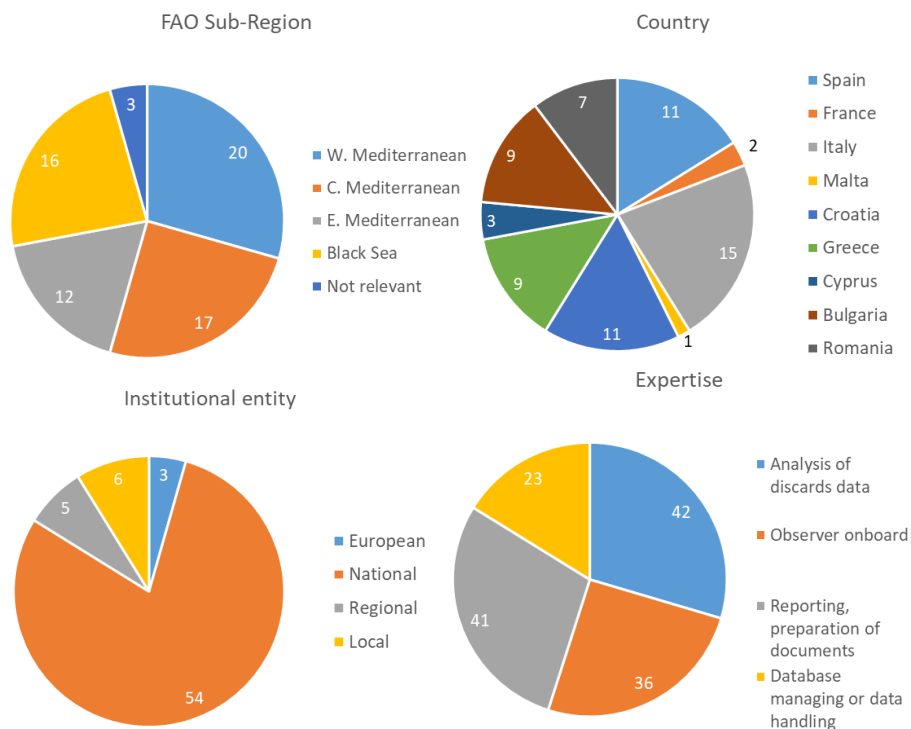


Figure 4.4: Geographic origin, entity of the Institution of affiliation and expertise of the respondents.

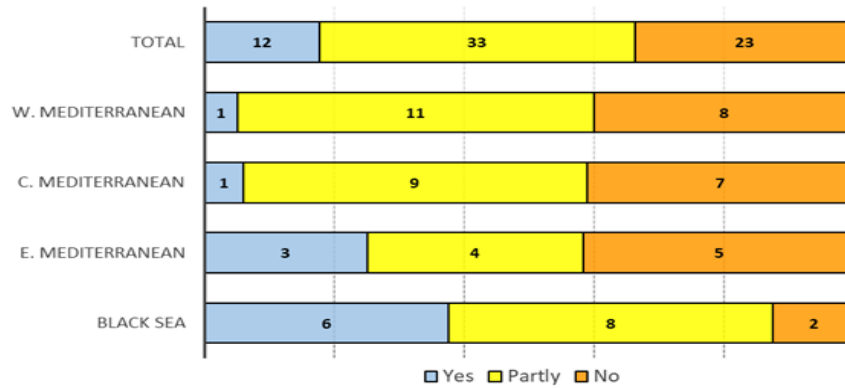
Despite that most scientists invited to respond to the questionnaire were involved in their National Data Collection programmes or are experts in issues related to fisheries discards, a considerable percentage (24% overall and >40% in certain CS) were only partly aware (few even unaware) of the LO and its provisions (Q1).

This could be related to the fact that the LO has been only partly implemented in practice in MS, at least as considered by the majority of respondents, especially in the Mediterranean CS, where more derogations from the LO have been granted (Q2) (Figure 4.5).

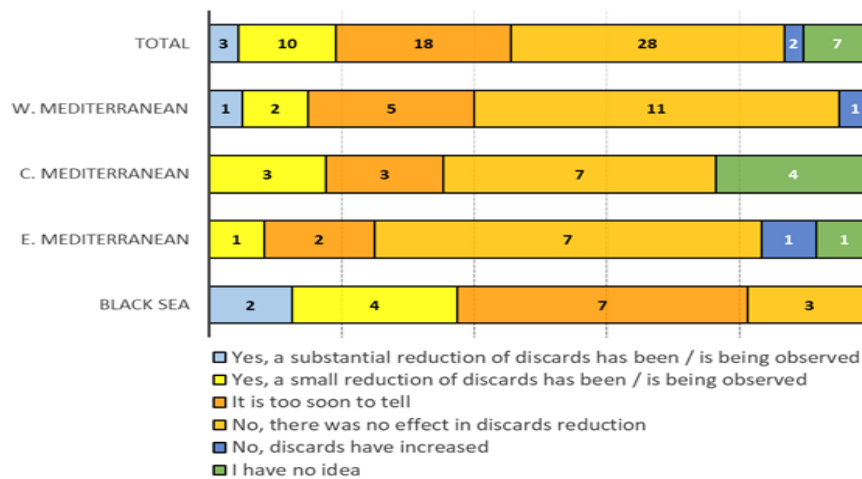
In the Black Sea, the percentage of respondents who believe that the LO has been adequately or partly implemented is higher than the other CS, which is interesting in combination to the perception of 40% of the respondents that discards have decreased in the Black Sea (Q3); this perception didn't exceed 18% in any of the Mediterranean CS. As for the coverage of discard data (Q4), most respondents in all CS answered that it has remained the same; however, in the Western Mediterranean, a high relative number of scientists (compared to the rest CS) thought that the coverage has increased.

In addition, in the Western Mediterranean, the availability of data (Q5) (Figure 4.5) is considered to have increased according to 70% of respondents, probably due to the inclusion of several pilot studies from the area in recent research projects (mainly MINOUW); this percentage is much lower (25-40%) for the other CS.

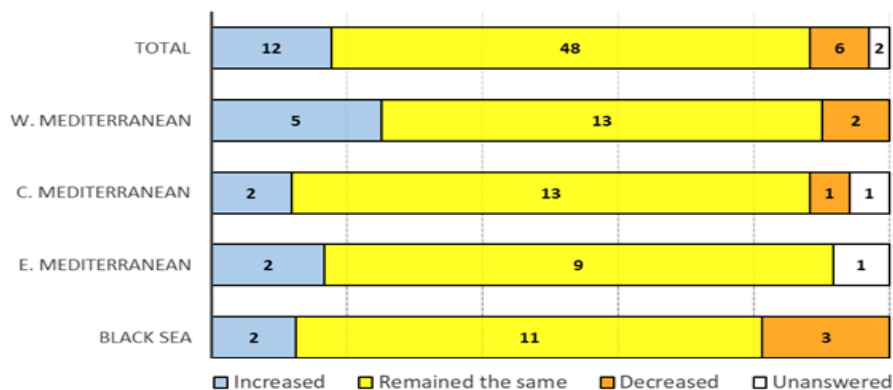
2. Has the LO been adequately implemented in practice in your country?



3. Do you think that the implementation of the LO and recent effort towards this direction was successful in reducing discards?



4. According to your perception, after the implementation of the LO, compared to the period before, the coverage (...) of discard data has:



5. According to your perception, after the implementation of the LO, compared to the period before, the availability of data from the Data Collection Framework or from specific projects (...), or from the scientific literature (grey or peer reviewed) has:

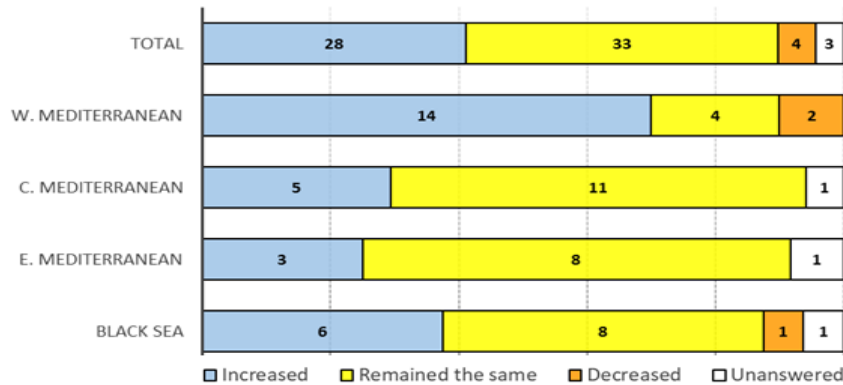


Figure 4.5: Responses (Total and by CS) of the scientists to selected Questions 2, 3, 4 and 5.

Overall, as well as across all CS, most scientists perceived that their workload hasn't increased due to the implementation of the LO and its provisions but it may have been altered (Q6). Those who stated that their work has changed (i.e., workload has increased or has remained the same but has been modified) provided several explanations for these changes, mainly that "requirements for reporting have increased", that there are "more metrics to estimate" and that "the volume of data has increased" (Q7).

Overall, according to the scientists' responses, there seems to be some progress in the implementation of the LO, in the coverage and availability of data as well as in the reduction of discards, however not to a satisfactory extent. More or less progress may have taken place in individual aspects in some Member States or Case studies, as implied by some of the responses.

4.3.3 Discard metrics

The discard ratios of the species included in the Western MAP for demersal fisheries (Regulation (EU) 2019/1022) were generally very low or low (<0.02 or ranging between 0.02 and 0.07) in most Western Mediterranean GSAs and in different bottom trawl (OTB) fisheries. NEP Norway lobster, ARA blue and red shrimp, and ARS giant red shrimp showed discard ratio values zero or close to zero in all cases with adequate information, while NEP had also L50 values above the Minimum Conservation Reference Size (MCRS). HKE European hake, DPS deep-water rose shrimp and MUT red mullet had also low discard ratios in most years and GSAs and there seems to be a further reduction in the recent years in some species; however, few exceptions with higher values (>0.15) throughout the period and/or increases in 2018 and 2019 were observed (e.g., HKE in OTB_DEMSP in GSAs 5 and 9) (Table 4.2).

The L50 (Table 4.3) for these species were usually below MCRS, however improvements were observed in many cases, showing that there has been some progress in discarding patterns for the fisheries considered in this region. Specifically, of the 18 species/fisheries combinations assessed, eight were above the MCRS in the most recent period with adequate data (usually 2018-19). In six more cases, increasing trends were observed, however, the values of L50 were still below MCRS. The L50 was lower than the MCRS and at the same time presented a decreasing trend in only two cases (MUT in GSA1 and HKE in GSA 9). Regarding the species considered, the L50 of NEP was above MCRS in both GSAs with adequate data, for DPS it was above MCRS in two out of three GSAs in which it could be estimated, while for HKE and MUT, it was above MCRS in two GSAs each.

In the Central Mediterranean bottom trawl fisheries, an improvement was observed also as concerns discard ratios in some regions (e.g., GSA 16) but this was accompanied by a slight decrease (around 10%) in the L50 for some species. On the contrary, in GSA 19 and the Adriatic (GSA 17- 18), increased discard ratios were observed in the recent years, which, as concerns the Adriatic, they still remained at low levels (<0.05) for most species despite the recent increase.

In addition, increased L50 values were estimated for most species in the Adriatic (but the opposite for GSA 19) in the most recent period and this may have contributed to the observed increasing trend in the discard ratios.

In the Eastern Mediterranean OTB (trawl) fisheries, the discard ratios were also low (<0.05, with some exceptions, as for *Pagellus erythrinus*, for which the discard ratio was >0.15 in few years), but the trends could not be adequately assessed due to lack of time series in many cases.

In the Adriatic Sea fisheries for small pelagics, where GFCM recommendations call for a multi-annual plan and emergency measures for small pelagic stocks (Recommendation GFCM/42/2018/8), very low ratios (<0.02) were observed for ANE anchovy and PIL sardine in PS fisheries (e.g., see Figure 4.6 for Croatian PS fisheries) but they were in some cases/years higher (>0.15) in the PTM (pelagic trawler) fisheries; however, recent data were not available for PTM and the progressed could not be assessed. For ANE, the L50 was estimated above MCRS (at 9.7 cm) in the Italian PTM fishery in 2012-15, while for sardine in the Slovenian PS fishery it was found below MCRS for the same period. No conclusion can be driven on the progress of the values in the whole period due to poor fit of the logistic functions. In the Eastern Mediterranean PS fisheries, discards of ANE and PIL were very low, with some exceptions in few years for the latter.

Table 4.2. Overview of discard ratios in Mediterranean bottom trawl fisheries (OTB) for selected species in each CS for the period 2012-2019.

CS	Country_GSA	DPS	HKE	MUT	NEP	ARA	ARS	HOM	PAC	MUR
Western Med	ESP_1	↘	↘	↘	↔	↘				
	ESP_5	↔	↗	↘	↘	↘	↔			
	ESP_6	↔	↘	↔	↘	↘				
	ESP_7	↘	↔	↔	↘	↘				
	FRA_7		↗	↔						
	ITA_9	↗	↗	↘	↔	↔	↔			
	ITA_10	↔	↘	↘		↔	↔			
ITA_11	↔	↗	↘	↔	↔	↔				
Central Med.	MLT_14									
	MLT_15	↘	↔	↗				↘		
	ITA_16	↘	↘	↘				↘		
	MLT_16									
	ITA_17		↗	↗						
	SVN_17		↗	↗						
	HRV_17	↗	↗	↗	↗					
	ITA_18	↗	↔	↗	↘					
	MLT_19									
ITA_19	↗	↗	↔				↔			
Eastern Med.	GRC_20									
	GRC_22		↗	↗					↘	↔
	GRC_23		↘							
	CYP_25		↘	↔					↔	↔

Key:	<0.02 (very low)	0.02-0.07 (low)	0.07-0.15 (moderate)	>0.15 (high)	Not considered	No data
	↘ (decreasing)	↗ (increasing)	↔ (stable or fluctuating)			

Table 4.3: Overview of discard L50 in Mediterranean bottom trawl fisheries (TBB for SOL and OTB for the remaining species) for selected species in each CS for the period 2012-2019.

CS	Country_GSA	DPS	HKE	MUT	NEP	HOM	SOL	PAC	MUR
Western Med.	ESP_1								
	ESP_5								
	ESP_6								
	FRA_7								
	ITA_9								
	ITA_10								
Central Med.	ITA_11								
	MLT_15								
	ITA_16								
	ITA_17								
	SVN_17								
	HRV_17								
Eastern Med.	ITA_18								
	ITA_19								
	GRC_20								
	GRC_22								
	GRC_23								
CYP_25									

Key:

Below MCRS, no time series	Below MCRS and decreasing	Below MCRS but increasing	Above MCRS	No data	Not considered
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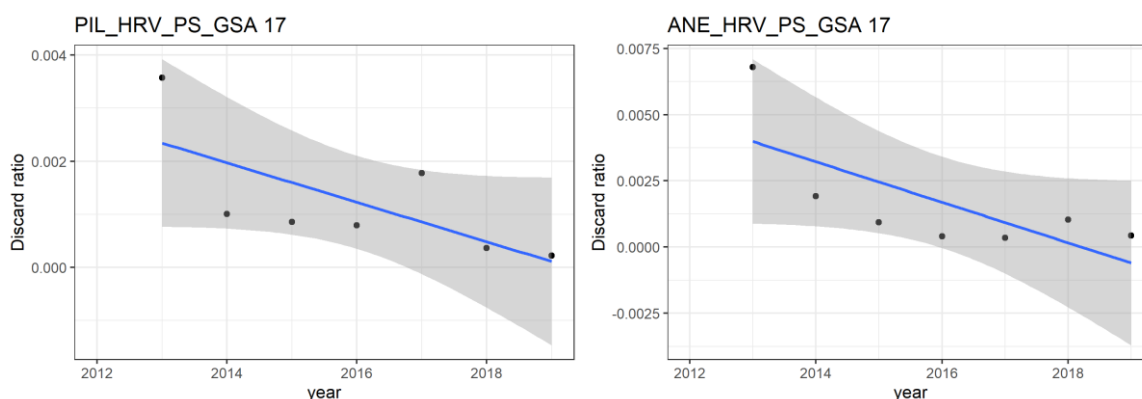


Figure 4.6: Discard ratios of sardine (PIL, left) and anchovy (ANE, right) in Croatian purse seine fisheries in the Adriatic Sea (GSA 17).

Finally, for Romanian OTM fisheries in the Black Sea, only few data points could be estimated, and only regarding the discard ratios; discards were high (>1) for all species considered (DGS Picked dogfish, HMM Mediterranean horse mackerel, and MUT red mullet), except SPR sprat in 2013.

In addition to the above, the inspection of the Member States' (MS) Work Plans (and Annual Reports as complementary source), with the aim to retrieve information on sampling coverage of species and métiers, confirmed that the selection of métiers included in the sampling plans of most MS is based on a ranking system that takes into account volume of landings, value and fishing effort, in line with Commission Decision 2010/93/EU and RCGMED&BS recommendations. The RCGMED&BS guidelines for the discard sampling programmes are also followed. In addition, in the most recent Work Plans of some countries additional efforts have been included to improve discards sampling (e.g. in France, in order to move effectively towards statistically sound

sampling schemes).

Finally, according to the literature review of studies applying multi-species assessments and models to evaluate the effects of the LO and/or discards mitigation methods, it seems that the implementation of the LO will have ecological consequences due to the change in the fate of discards which, under the new policy provisions, they should be landed instead of returned back to sea. Adverse effects on specific scavenging groups - including some charismatic species - (e.g., seabirds, sea turtles) were predicted in the simulations, without substantial benefits for commercial stocks and fisheries. Simulating scenarios with and without landing obligation in an ecosystem model for the North-Eastern Adriatic Sea indicated that landings would increase by 13%, causing an increase in fishers' workload and a small decrease in fisheries revenue, while selling landed unwanted catches for fishmeal production would not compensate the economic losses. An increase in fishers' workload and a small decrease in fisheries revenue was also foreseen. On the contrary, simulated improvements in the bottom trawl selectivity seemed to benefit fished stocks and the ecosystem in general.

More details on discard estimates are reported in the ANNEX 3.

4.3.4 Factors influencing discarding

Hauls with zero discards ranged from 5% to 68% depending on the species and GSA, while in the case of MUT in GSA 22 they reached 90% and no analysis was performed. In total, 27 models were applied successfully, explaining 21-96% of the deviance.

As an example from the Western Mediterranean CS, in the case of European hake in GSA 10, discards were distributed in the 18-536 m depth range with a peak of occurrence around 100m of depth. The higher CPUE values were observed in the 100-500m depth strata. The selection of the best model was conducted applying a logarithmic transformation to the response variable in a GAM model characterized by a quasi-poisson family distribution and a log-link function, which included the following variables:

$$kg_log \sim factor(LOA_cat) + te(depth, Y) + s(month, bs="cc") + s(catch_CPUE) + s(year, k=5) + s(vessel_age, k=6) + 0$$

The model, which explained 69.7% of the deviance, showed that the discards for European hake were variable in time: variations within the year were observed with peaks in September, April and July, but also along the time series in which a progressive reduction of the discard is shown (Figure 4.7). Vessel characteristics such as the vessel age and the vessel length show significant effects on the discard of the species. Discards are higher for vessel 30-40 years old and with LOA in the 18-24m range.

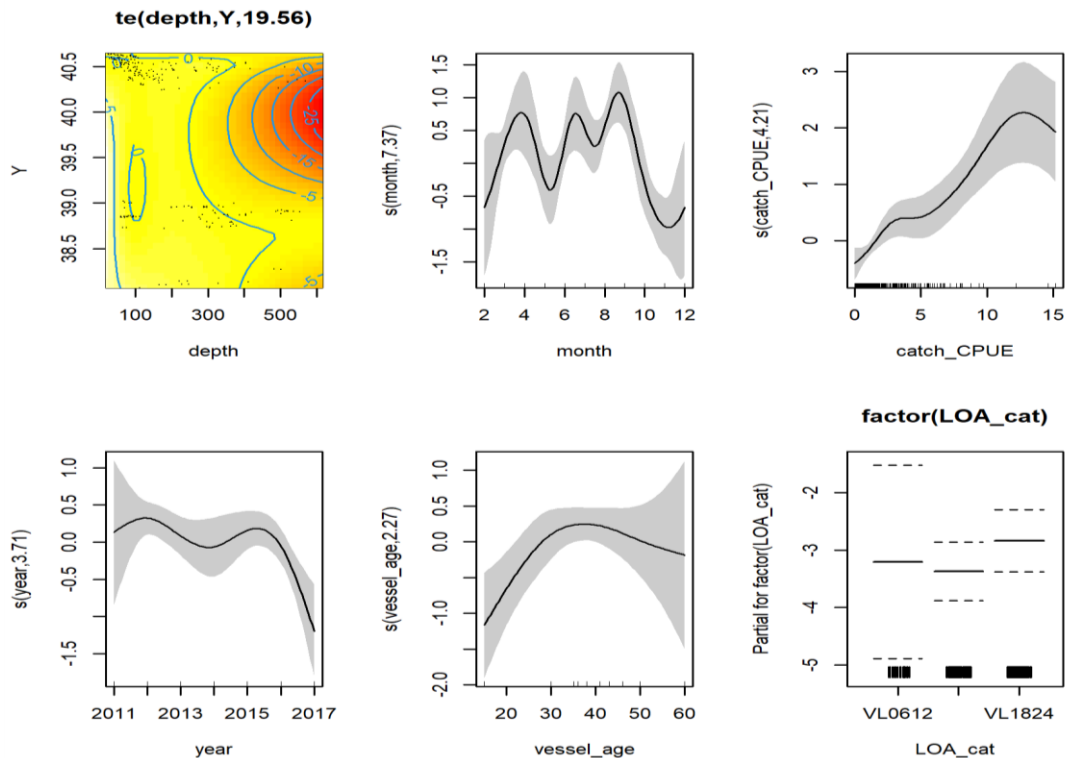


Figure 4.7: European hake in GSA 10: smoothers and step functions of the covariates estimated by the GAM model fitted. Y= latitude

In the Central Mediterranean CS, discards of red mullet in GSA 19 were distributed in the 6-602m depth range with a peak of occurrence around 50m of depth. The higher CPUE values were observed in the 0-50m depth strata. The best model included a quasi-poisson family distribution, and is the one here reported:

$$\text{kg_log} \sim \text{factor(quarter)} + \text{s(catch_CPUE)} + \text{s(duration,k=8)} + \text{s(Y,k=8)} + \text{s(year,k=8)} + \text{s(vessel_age)} + 0$$

The model explained 75.5% of the deviance with an $R^2=0.817$ and a $\text{GCV}=0.048$. According to the partial plots (Figure 4.8), discards for red mullet are variable in the time, with peaks in the first and fourth quarter of the year, and with a periodic oscillation along the time series. Red mullet discards seem to be influenced by the geographic position, increasing along the latitude. Discards are also influenced by the species' catch: the greater the species' catch the higher the discard. Vessel characteristics such as the vessel age show significant effects on the discard volume of the species.

As an example from the Eastern Mediterranean CS, the final model for deep-water rose shrimp in GSA 20 included a Tweedie distribution, explained 58.70% of the deviance and included the following variables:

$$\text{kg_log} \sim \text{factor(quarter)} + \text{s(catch_CPUE, k = 12)} + \text{s(year, k = 7)} + \text{s(total_CPUE)} + \text{s(X,Y)} + \text{s(depth)} + 0$$

Discards increased as the catch of the species increased up to ~ 5 kg/h but greatly fluctuated in higher catches (Figure 4.9). The effect of total catch of the haul was more straightforward and an increasing pattern was observed with increasing catches. Over the years, there were some fluctuations but an increasing trend after 2014 was apparent. Discards of DPS peaked at 100-200 m and during the 2nd quarter. Finally, the interaction of latitude with longitude contributed significantly in the final model.

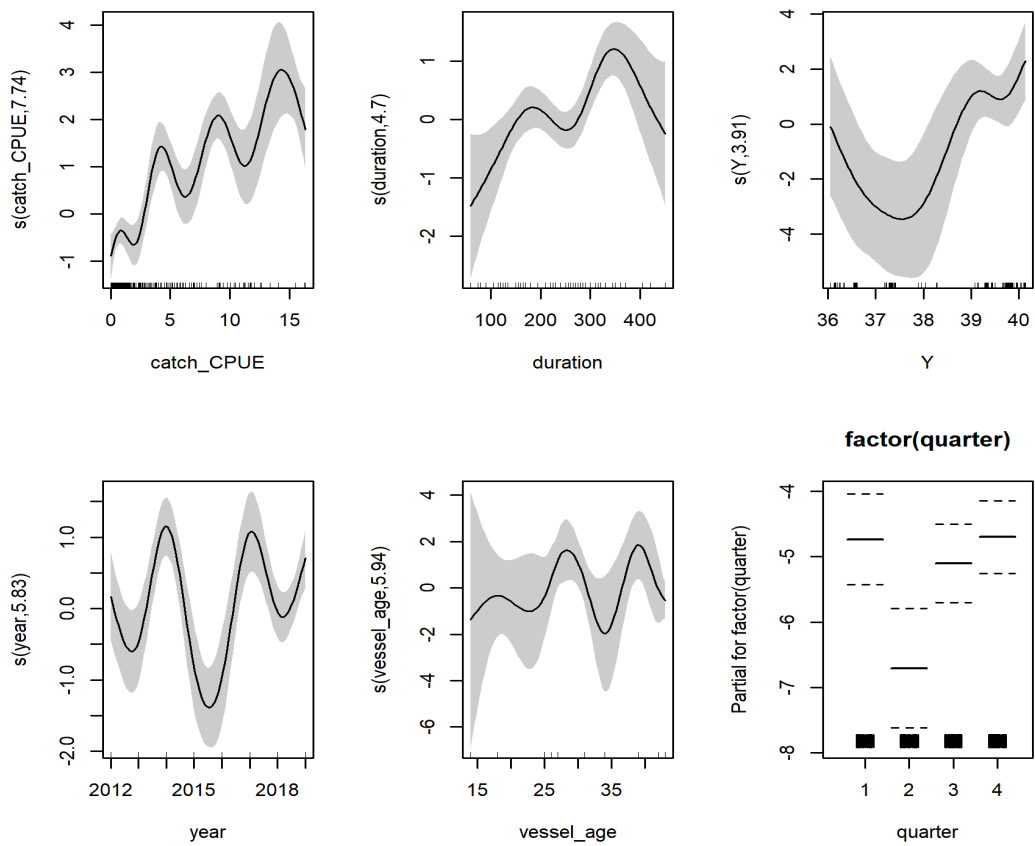


Figure 4.8: Red mullet in GSA 19: smoothers and step functions of the covariates estimated by the GAM model fitted.

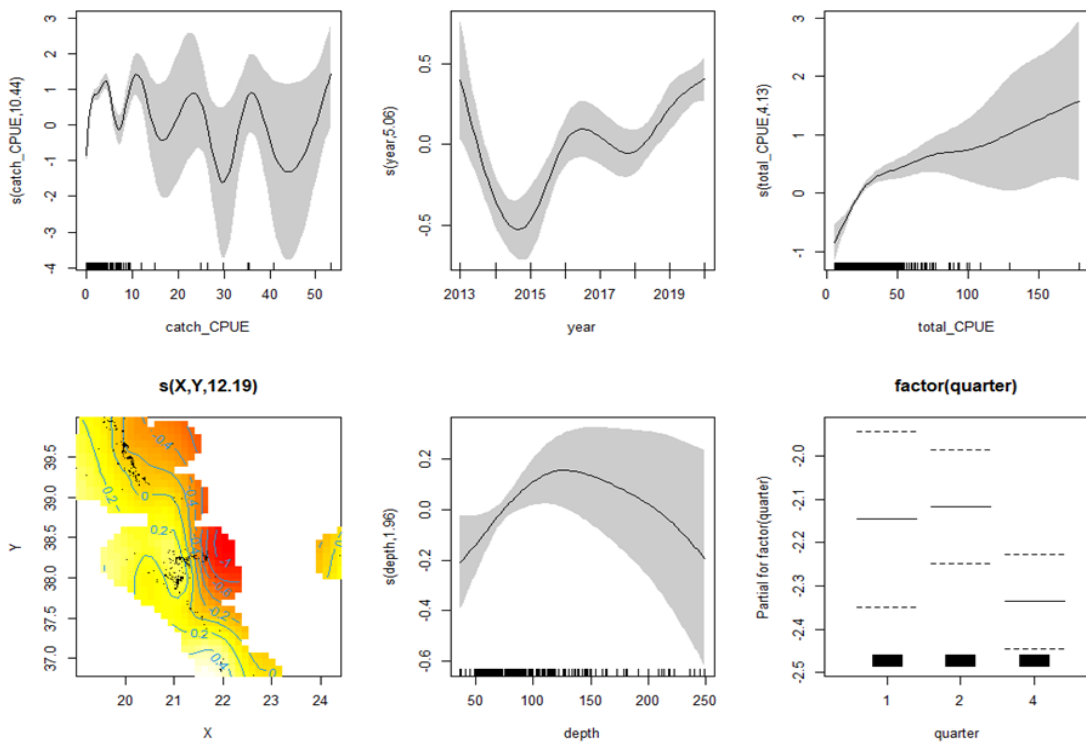


Figure 4.9: Deep-water rose shrimp in GSA 20: splines of the variables and partial terms for factors included in the best GAM. X = longitude, Y = latitude.

Table 4.4 summarizes the variables included, along with the number of observations (hauls) considered, the error distribution family chosen and the deviance explained in each of the 27 finally selected models. *Depth* was included as a significant covariate in 20 out of the 27 finally selected models, showing that discards are affected by the species' bathymetric preferences and/or their size-related distribution. **Discard rates were higher at the shelf break for HKE, DPS and HOM, while MUT discards occurred mainly in shallower waters. Geographic coordinates (*longitude, latitude* or their interaction) contributed in the majority of the models, reflecting local patterns in productivity** (where total catches and therefore discards may be high), **or possible existence of nursery grounds** (where discards may be high due to the small sizes of the species). Environmental drivers play a crucial role in the distribution of discards as shown in several studies (e.g., Feekings et al., 2012, Despoti et al., 2020). Especially for the Mediterranean, where fisheries are not managed through output control rules (e.g., quotas) and it is considered difficult to optimise codend selectivity for all species (Brčić et al., 2018), **spatial measures can be effective tools for discards mitigation by avoiding hot-spot areas.**

In the majority of models, **discards were positively related with the total catch of the species** (20/27 models) **and/or with the total catch of all species in the haul** (12/27 models). The relationship among landings and discards of the species is confirmed here, as in several other works, and is important in cases that the goal is to estimate discards from landings data. The effect of the total catch of all species in the haul shows that **discards are affected by the catch composition in general and when catches are satisfactorily high, the fishers' decision on what to discard may be more relaxed. Additionally, an important variable affecting discards was also the length composition of the species considered**; although the data availability didn't allow to explore this variable in all models, it was evident that **discards of the species (especially for HKE) decreased as the mean length increased.**

Temporal patterns were also evident. **Interannual effects were identified** in 20/27 models and seem to be related to the overall trends in species abundance (e.g., increase in DPS discards and abundance in GSA 9), or may be affected by annual differences in recruitment success.

Seasonal patterns, i.e., quarter of the year or month, were also included in almost all models (19/27 and 6/27 respectively, i.e., 25/27 in total) and were usually **related to the recruitment period of the species. Specifically, HKE discards peaked during the 3rd quarter in the Western and Central Mediterranean GSAs and during the 4th quarter in the Eastern Mediterranean (Greek) GSAs** (but the 3rd quarter is closed for trawl fishing in Greece). The high catches of undersized HKE in autumn is a common feature in Mediterranean fisheries and is attributed to a peak in the recruitment of the species (e.g. Mytilineou et al., 2020). **Similarly, common seasonal patterns are observed in every species considered here**: for DPS and MUT, discards in most GSAs maximized during the 2nd and 4th quarter respectively, while HOM showed the highest discard quantities mainly in the 3rd quarter in the Central and Eastern Mediterranean and in the 4th in the Western basin. Some variations in the timing of the peaks across GSAs may be related to latitudinal differences and other climatic factors that control the timing of the spawning (and therefore recruitment) peak in each region. Additionally, in the Greek GSAs, where the 3rd quarter is closed for OTB in national waters, the increased discards during the 4th quarter for several species might be related to increased abundance due to this cease in the fishing operations.

Among the operational variables, the length (LOA) category of the vessel proved to be the one contributing most to the explanation of discard quantities. Larger vessels usually produced higher discards, probably because they catch larger quantities in general, but this pattern was not always constant in all species/GSAs. **Vessel age had a significant contribution in some models** (11/27)

but there was no definite conclusion across all GSAs/species on whether younger or older vessels discard more; since the sampling design stratification does not take into account vessel age, the inclusion of this variable in the models seems relatively weak due to the unequal representativeness of different age classes. Finally, haul duration contributed significantly to a low number of models (8/27); this variable was often correlated with depth which was more often included as it showed higher explanatory power. **The effect of duration was variable depending on the species/GSA, but in most cases longer durations were positively related with higher discards.**

More details on the discard modelling are reported in the ANNEX 4.

Table 4.4. Summary of the variables included in the final selected models for each species and GSA. Grey cells indicate that these variables were not considered in the specific models. LOA: Length overall; Lon: longitude; Lat: latitude; catch_CPUE: catch (kg/h) of the species in the haul; total_CPUE: total catch (kg/h) of all species in the haul; Lmean: mean length of the landings; n: number of hauls considered in the model; Dev. expl.: deviance explained.

Species	GSA	Depth	Lon	Lat	Duration	Vessel age	Vessel LOA	catch_CPUE	total_CPUE	Lmean	Quarter	Month	Year	n	Dev.	family
HKE	9	X	X	X		X	X		X	X	X			346	37.50%	Gaussian
HKE	10	X		X		X	X	X				X	X	286	69.70%	Quasipoisson
HKE	18	X	X		X	X	X	X				X	X	917	62.70%	Gaussian
HKE	19	X		X		X			X		X		X	254	58.70%	Quasipoisson
HKE	20	X	X		X		X		X	X	X		X	722	30.00%	Tweedie
HKE	22	X	X	X			X	X	X	X			X	694	54.00%	Tweedie
HKE	23				X			X	X	X	X			169	53.30%	Tweedie
DPS	9	X	X	X			X			X	X		X	208	50.30%	Gaussian
DPS	10	X	X					X			X		X	289	54.50%	Quasipoisson
DPS	18	X		X	X	X	X	X				X	X	839	75.40%	Gaussian
DPS	19	X		X		X		X			X		X	320	69.70%	Quasipoisson
DPS	20	X	X	X				X	X		X		X	615	58.70%	Tweedie
DPS	22	X	X	X			X	X	X	X				517	37.70%	Tweedie
DPS	23								X		X			136	21.40%	Tweedie
MUT	9	X	X	X	X		X		X		X			375	53.80%	Gaussian
MUT	10	X		X		X	X	X					X	211	88.60%	Quasipoisson
MUT	18	X		X		X	X	X			X		X	786	72.40%	Quasipoisson
MUT	19			X	X	X		X			X		X	228	75.50%	Quasipoisson
MUT	20		X	X			X	X	X	X		X		744	38.70%	Tweedie
MUT	23							X	X		X		X	222	39.60%	Tweedie
HOM	9	X			X		X		X	X	X		X	233	64.90%	Gaussian
HOM	10	X	X				X	X				X	X	248	91.00%	Gaussian
HOM	18	X	X			X		X			X		X	656	72.70%	Quasipoisson
HOM	19	X		X	X		X	X				X	X	229	96.00%	Gaussian
HOM	20			X				X			X		X	499	78.40%	Tweedie
HOM	22	X				X		X		X	X		X	412	71.60%	Tweedie
HOM	23							X			X			90	69.60%	Tweedie
Count		20	12	16	8	11	15	20	12	8	19	6	20			

4.4 CONCLUSIONS

Based on the collected information and the findings of the original studies reviewed, some conclusion on the effectiveness of specific measures can be drawn.

- **MCRS:** it seems that in the Mediterranean there is no full compliance with MCRS, however, the measure (which has a long history of application in several Mediterranean Sea fisheries) probably **prevents fishers from targeting and landing large amounts of undersized fish.**
- **Technical measures:** Mediterranean fisheries are mainly managed by technical measures. Among them, the bottom trawl codend mesh size and shape configurations imposed by the Regulation (EU) 1967/2006 have been shown to be more effective in reducing discards either for regulated species or for the total catch compared to its precedent configurations. **The adoption of the new codend seems to have contributed towards the reduction of discards, at least for some fisheries,** as evidenced by the results of the review. **However, despite the progress, bottom trawls still catch undersized specimens** and unwanted catches in general, while it is considered doubtful whether trawl selectivity can be further increased without substantial economic losses, at least in the short term. **In the multi-species Mediterranean fisheries, to simultaneously improve the size selectivity of different species or catch categories, more sophisticated alternative of selective devices, such as grids or square-mesh panels,** could be explored and implemented in some Mediterranean fisheries (Sala et al., 2015). Concerning the small-scale fisheries, several studies have showed that simple modifications such as “guarding nets” in trammel net fisheries, can be considered promising.
- **Alternative gears: Some studies explored the transition to more environmentally friendly gears** which produce lower discards, such as the use of traps/pots instead of trammel nets, **however contrasting results** on the commercial amounts **were reported** from different areas.
- **Spatial measures:** Numerous spatial closures, especially in coastal areas, have been applied by Mediterranean Sea Member States. Furthermore, new MPAs have been progressively designated and enforced in the past decades. However, the primary objectives of their designation do not usually include discards mitigation. Conversely, **some closure areas have been established taking into account the spatial distribution of nursery of key species like European hake.** Implemented examples are the Jabuka/Pomo Pit FRA in the Adriatic Sea and the areas designated by Member States in the Western Mediterranean for the MAP objectives. **Despite such measures are not tailored to discard reduction a positive effects is expected by the avoidance of the unwanted catches of juveniles. In addition, a series of studies identified potential discards hotspot areas which could be considered for spatial solutions on the discard issue.**
- **Seasonal closures:** Seasonal closures are also frequent and are usually linked to the reproduction or recruitment periods of target species. **Seasonal effects in discarding have been demonstrated by several studies,** with higher discards during the recruitment period.
- **LO provisions:** Based on the collected information it seems that it is still soon to evaluate the effectiveness of the LO provisions as very few studies have been realized after the implementation of this new policy framework. **The collection of additional baseline information and the renewal of interest in field studies and discard data analysis during the years just before or during the gradual implementation of the LO is a positive effect. The increased demand (public, market, political) for discards reduction is expected to have positive effects towards the adoption of more selective practices,** even if the

majority of the Mediterranean fisheries have been granted exemptions from the LO provisions.

- **Other measures:** some more approaches towards the mitigation of discards have been identified during the review, especially in pilot studies. For example, **efforts for the eco-certification of some fisheries, co-management or development of new markets**, all provide incentives to fishers to improve selectivity and/or land all catches. However, there is **little quantitative information on the effectiveness of such actions**.

From both the Review and the Interviews it is evident that, on the occasion of the LO, discarding became a hot topic of fisheries science in the Mediterranean and Black Sea region, that new information has been added and that new approaches and measures have been explored, which stakeholders and the management system could capitalize on.

Overall, the results from modelling showed that discarding in Mediterranean OTB fisheries is affected by a large number of variables, including environmental patterns and processes (bathymetric preferences, local productivity, inter-annual recruitment), as well as operational factors and fishing tactics (vessel characteristics, haul duration), that should be taken into account for a more effective management of discarding.

5. IDENTIFY AND EVALUATE THE MEASURES, STRUCTURES AND RESOURCES ADOPTED BY MEMBER STATES' AUTHORITIES TO ENSURE CONTROL, ENFORCEMENT AND INSPECTION OF ALL ACTIVITIES RELEVANT TO THE LANDING OBLIGATION

5.1 INTRODUCTION

Collaboration among the stakeholders (industry, scientists, Member States, NGOs, European Commission and European Parliament) has intensified throughout the phasing-in period of the LO (2015-2019). This collaboration has contributed to a better understanding of the LO which implementation must be associated by an effective enforcement and control system adopted by Member States, to properly apply the various provisions and to deter and eliminate illegal discarding.

The main objective of this chapter was to identify and evaluate the measures, the infrastructures at ports and the regulatory framework, as well as the resources, adopted by Member States' Authorities to ensure control, enforcement and inspection of the activities relevant to the LO.

The objectives include also gathering information about the procedures to register the catches, as well as to identify eventual structures and measures in relation to the circuit "not for the human consumption".

5.2 METHODS

The methods applied comprised interviews/questionnaires with stakeholders, the review of the available information/reports, and the consequent analysis of these data collected.

5.2.1 Interviews

The collection of the relevant information was obtained mainly by means of questionnaires that were circulated among the MSs Authorities and other relevant stakeholders. Two different questionnaires have been prepared and circulated among 169 stakeholders.

Questionnaire 1: focused on aspects related to fishing control and monitoring. It was distributed to the following stakeholders:

- representatives of MSs, Local Governments/Administrations involved in fishery control;
- representatives of Maritime control bodies at local level (e.g., Coast Guard, etc.);
- representatives of the European and supranational Institutions.

The questions were structured to collect information on:

- measures, infrastructures, procedures to ensure control and enforcement of LO in each MS;
- the use of EMFF funds for the above measures/infrastructures;
- procedures of control (e.g. last haul method);
- information about non-compliance/infringements and the possible reasons;
- the recording of data on fishing activity and catches;
- issued related to *de minimis* exemption;
- the perception and the reasons on the efficacy or the inefficacy of the LO measures.

Questionnaire 2: focused on the use of the unwanted catches, by means of the circuit "not for the direct human consumption". It was distributed to the following main stakeholders:

- representatives of fish meal/pet food Industries, aquaculture/mariculture Plants;

- representatives of fish markets/Producers Associations;
- representatives of Fishers Associations;
- representatives of NGOs, and Advisory Councils.

The questions were structured to collect information on:

- the presence, in a MS or a Region, of structures for the processing of discards to produce pet food, fish meal, or any other product;
- the potential interest in producing/using fish meal or other products derived from discards;
- the use of European funds (e.g., EMFF) for investments to processing discards;
- the perception and the reasons on the efficacy or not of the LO measures.

Semi-structured questionnaires were used, because they ensured that stakeholders provided information on key topics, allowing at the same time that they could expand on the most important items for them.

5.2.2 Review

A review was carried out of the available documents issued by the MS Authorities or other institutional bodies, reporting control and monitoring activities. Different typologies of documents were gathered, although they resulted rather scattered as concerns the temporal coverage and the detail of information, as well as for the typology of information reports and the MS concerned. In general, these documents report information on the control system and the inspections enforced by the MSs to implement the LO provisions, as well as data on infringements to the rules of LO.

MS Annual Activity Reports for France, Italy, Greece, Bulgaria and Romania were reviewed, as well as the Annual Activity Reports of EFCA (European Fishery Control Agency). These documents report data and statistics on fishery controls and infringements for each MS. Other information from reports of the European Parliament, STECF, NGOs or other entities, or from studies was collected as well. In addition, a few information about the possible use of discards for the circuit "not for direct human consumption" was gathered, as the advices of MAC (Market Advisory Council).

5.3 RESULTS

5.3.1 Interviews

A total of 63 questionnaires (25 for Questionnaire 1 and 38 for Questionnaire 2) were received, corresponding overall to 37% of replies (34% for questionnaire 1; 40% for Questionnaire 2). All the EU Med & BS countries participated to the survey (except Slovenia and Malta); the higher numbers of responses were from Italy (20), Greece (8) and Spain (7). The subdivision of the respondents, according to FAO sub-regions, affiliation and type of questionnaire is shown in Fig. 5.1.

A synthesis of the main outcomes obtained from the questionnaires highlighted the following points.

- The majority of respondents to the Questionnaire 1 (control bodies) provided some information on the implementation of measures or infrastructures to ensure enforcement, inspection of LO at sea and at land (Fig. 5.2).
- As concerns the use of EMFF funds, to support/implement measures or infrastructures to enforce the LO provisions, the majority of respondents replied "no" or "don't know", both for control and inspection activities and for handling or processing the unwanted catches. No specific comments about the limitations of EMFF funds or suggestions about possible ways to increase the utilisation of such funds in the future were received from the stakeholders interviewed.

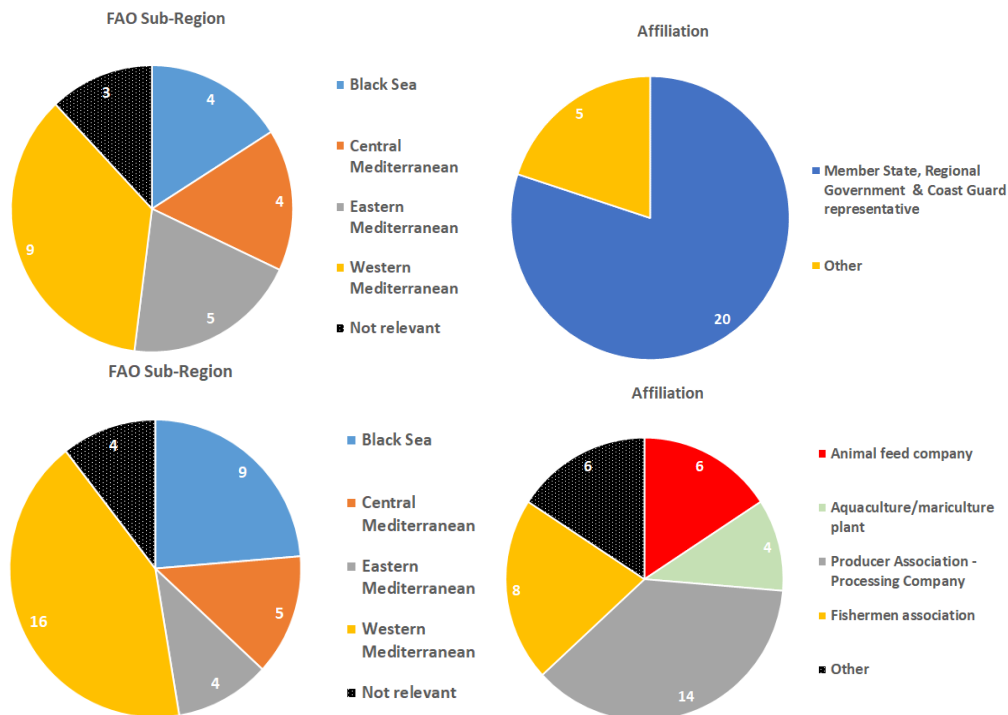


Figure 5.1. Geographic origin (FAO sub-Region) and affiliation of the respondents. Questionnaire 1 (left), Questionnaire 2 (right).

- The process to report catches was noticed in all Member States; most of the stakeholders mentioned the electronic or manual logbooks, however specifications on discards registration was not always provided.
- Half of respondents (12/25) to Questionnaire 1 reported that estimations on infringements due to landings or sale of undersized specimens are available, but the number of reported infringements in relation to the LO by Member States was very low. Only one third of them answered that specific measures have been taken to ensure that discards under the *de minimis* exemption does not exceed the permitted volume in the Delegated Acts. It was reported that controls are performed through the electronic logbook and, additionally, there is some validation system.
- The feedback to the question about the “last observed haul (LH)” approach to monitor the implementation of the LO highlighted some uncertainty in the majority the respondents. In some cases, alternative approaches to LH were mentioned, as the development of aerial and maritime surveys or preventive checks on the basis of the catch communicated through logbooks. Moreover, it was reported that the COVID_19 restrictions hampered the inspections on board and at land in 2020 and 2021.
- The majority of respondents of Questionnaire 1 revealed some scepticism in the utility of the LO in reducing discards. The main reasons reported are: the difficulty to set up logistics and infrastructures, the complexity of the rules; the difficulty to set up the control activity; the lack of financial motivation for fishers. The stakeholders also reported that application of LO for trawl fisheries in more complicated than for small pelagic fisheries, mainly due to the multispecies catch of trawling.

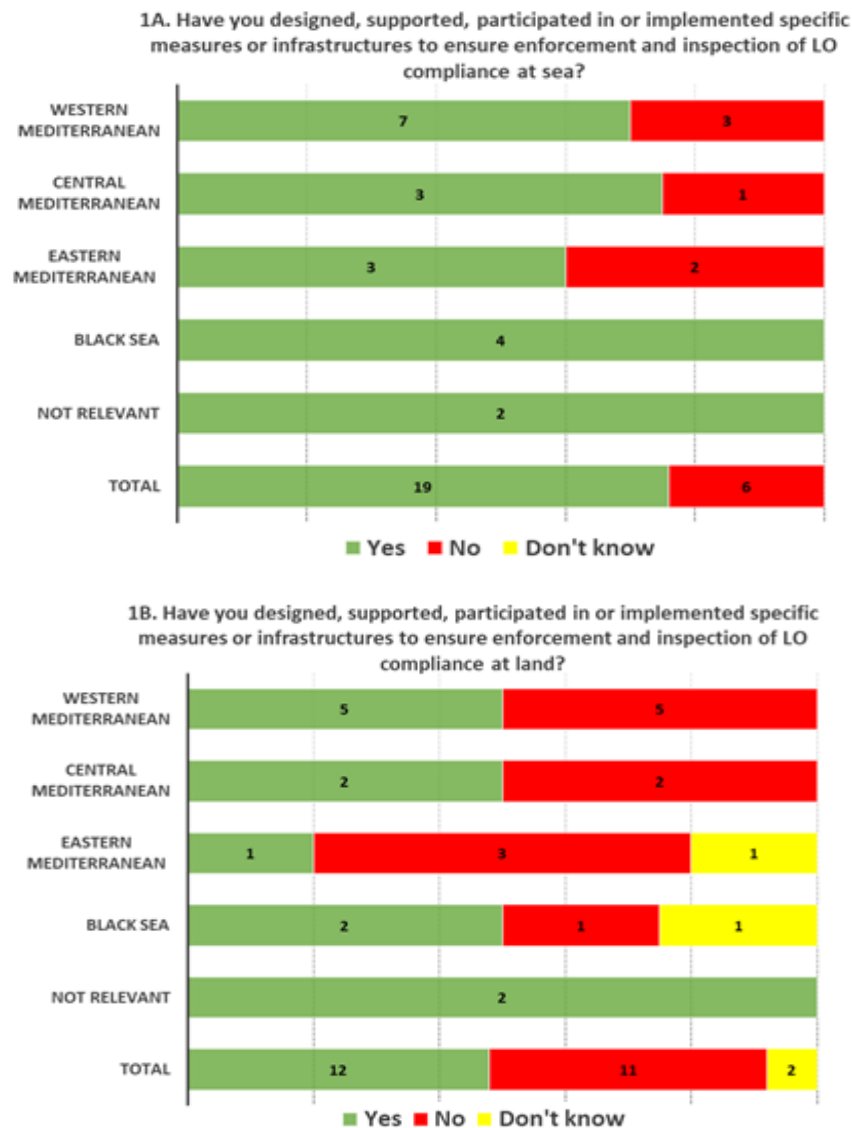


Figure 5.2. Responses to the Questions 1A (upper panel) and 1B (lower panel) of the Questionnaire 1.

- As concerns the possible use of discards for “not direct human consumption” (Questionnaire 2) the majority of the respondents reported that currently in their Country there are no structures processing discards from fisheries. The presence of Plants processing fish discards seems to be limited to sporadic cases, to the production of fertilisers, fish meal (mainly for aquaculture), fish oils, but currently these Plants utilise by catch species or fish sub-products and not products coming from LO fishery discards.
- In some cases, it was reported that EMFF funds were assigned for Projects on the use of discards for pharmaceutical and animal feed industry, but currently these initiative concerns the use of by catch or low commercial value species, not the use of discards from LO.
- In the case of the Questionnaire 2, some generic interest of respondents from fish meal/pet food industries and aquaculture/mariculture plants in producing or using products from fish discards was noticed (Fig. 5.3). These stakeholders reported that discards can represent a source of feed for aquaculture or pet food and that this process can be framed in a form of circular economy. However, it is difficult to strictly connect this interest with the management/processing of discards resulting only from the LO.



Figure 5.3. Responses to the Question 1B of the Questionnaire 2.

- The reply to the question “In your opinion, which could be the main factors making LO more subject to non-compliance?” highlighted, among main factors: *the overall scarce knowledge of the LO provisions from the fishers and the difficulties (especially in terms of manpower) to do a correct sorting in the trawl fishery* (Table 5.1).
- On the other hand, the stakeholders noticed that there are still many problems that prevent the implementation of this process, as the lack of efficient structures and of a capillary organisation throughout the territory for the disposal, storage and processing of discards, as well as the need of regular and sufficient volumes of discards and the fragmentation of the fleets in dozens of landing points.
- The reply to the question “What are the main problems in implementing the LO provisions related to the usage of unwanted catches by means of the circuit “not for direct human consumption” highlighted by far among the main factors: *The lack of structures and facilities on board and at land* (Table 5.2).

Table 5.1: Responses by CS to Question 2C, Questionnaire 1 (WM, Western Mediterranean; CM, Central Mediterranean; EM, Eastern Mediterranean; BS, Black Sea).

<i>In your opinion, which could be the main factors making the LO more subject to non-compliance?</i>	WM	CM	EM	BS	Total
The overall scarce knowledge of the LO provisions from the fishers.	4	1	1	2	8
The skepticism versus the results and the long-term benefits of the LO	3	1	1	2	7
The difficulty for the inspectors to verify, in real time, the actions made by the crew of sorting, discard, and registration of the catch	3	2	1		6
Especially for trawl fishery, it is difficult and expensive (especially in terms of manpower) to do a correct sorting	3	3		2	8
The complex provisions, the lack of clear guidelines	2	1			3
The lack of a proper communication among fishers, Control Bodies and Administrations	1		1	2	4
The lack of a culture of compliance	1		1		2
The lack of regular inspections			1		1

The lack of financial motivation for fishers				1	1
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Table 5.2: Responses by CS to Question 1C, Questionnaire 2 (WM, Western Mediterranean; CM, Central Mediterranean; EM, Eastern Mediterranean; BS, Black Sea).

<i>What are the main problems in implementing the LO provisions related to the usage of unwanted catches by means of the circuit "not for direct human consumption"?</i>	WM	CM	EM	BS	Total
The lack of structures and facilities on board and at land	8	3	2	4	17
The lack of guidelines to manage the unwanted landings	2				2
The volume of discards is too low.	2	1			3
The costs are huge and not sustainable by the fishers.	2	1		1	4
Landings occurs at many and sparse landing sites often at unpredictable times of the day, not compatible with a regular collection	4	1			5
The need of increasing and facilitating investments, especially with benefits to the Companies	3	1	1	1	6
The lack of information and awareness among the fishers	2		1	3	6
Others	2				2

5.3.2 Review

The critical review of the gathered information produced a similar picture to that obtained from the interviews with the stakeholders. The main outcomes were:

- MSs apply protocols for control and monitoring the LO provisions, including the risk-based approach and the last-haul analysis, but the level of enforcement is currently low. This emerges also from the very low number of infringements that have been reported; they mainly concern illegal selling of fish below the MCRS for human consumption.
- Landings of fish below MCRS reported by MSs seem generally low if compared to the overall catches, although not all MSs have provided quantitative information, so the picture is incomplete.
- The use of EMFF funds to support LO is currently limited, both to improve the infrastructures of ports as well for modifications on board fishing vessels. Furthermore, the use of EMFF funds is currently limited, both for the infrastructures to process discards or to handle them and for experimental Projects.

Further details on the list of documents are reported in the ANNEX 5.

5.4 CONCLUSIONS

The majority of respondents to the questionnaires provided useful indications for the purposes of this study. On the other hand, several responses were rather vague or very concise. In general, more detailed information was received from some Control Bodies and the Institutional representatives. An explanation can be found in the rather low interest or awareness or probably of knowledge of the main issues of LO; this aspect was noticed especially in the case of representatives of fishers association and producers. They also reported some scepticism towards the effectiveness of the LO measures in reducing the problem of discarding.

The overall impression from the stakeholders replies to Questionnaire 1,

targeted to control bodies, is that for the moment the level of enforcement of control and data registering is rather low: very likely it is the effect of the “*de minimis*” mainly for the disproportionate cost exemptions to the LO still in place, that actually allowed to continue the previous operative fishing practices. Criticisms emerged on the inertia of Member States and the fishing sector to implement and enforce efficient tools for ensuring control as REM.

In the case of the processing of discards, about 50% of the respondents reported an interest in producing or using products from fish discards. About 60% of them reported that LO provisions can have a positive effect in reducing discards. They reported that discards can represent a source of food for aquaculture or pet food and that can be framed in a form of circular economy. On the other hand, they reported that **there are still many problems that prevent the implementation of this process, such as the lack of efficient structures and capillary organisation throughout the territory for the disposal, storage and processing of discards, as well as the need of regular and sufficient volumes and the fragmentation of the fleets in dozens of landing points.**

As concerns the possible use of discards for “not direct human consumption”, the majority of the respondents reported that currently in their own countries there are no structures processing discards from fisheries. The presence of plants processing fish sub-products (producing fertilisers, fish meal, fish oils) were reported, but this was limited to sporadic cases, and they use mainly by catch species and trimmings, not discards from LO.

6. LESSON LEARNT

This chapter aims at taking the main results and messages from the different thematic areas of the study, making also some proposals for further developments to improve the implementation of the LO.

6.1 OVERVIEW OF THE MANAGEMENT MEASURES IMPLEMENTED TO FACILITATE THE IMPLEMENTATION OF THE LANDING OBLIGATION

The qualitative assessment from the review in the 2015-2020 period, i.e. mainly in the LO phasing-in, highlighted most initiatives related with spatial and temporal measures to promote a better selectivity of the catches (105), followed by initiatives to improve gear selectivity (74), measures to facilitate control (76) and initiatives to provide incentives to fishers to improve selectivity, improve compliance and to land and record all catches (45) (Infographic 1, Annex 6).

The more common reported initiatives aimed at mitigating unwanted catches are communication and dissemination actions, to inform and train the fishery sector on the measures adopted to reduce discards and to implement the LO. Also, some initiatives are reported to provide incentives to fishers to monitor, land and record all catches and to closing specific areas or seasons to demersal fisheries, to promote experimental studies on innovative gears and improving the selectivity of trawl gears of demersal fisheries.

In-depth assessment from stakeholders highlighted that, although most of the respondents are involved in fisheries activities and their management, many (47% overall and >60% in certain basins) were not aware of the specific implementation plans and measures related to the LO enforced. This could be related to the fact that the LO has been implemented in Mediterranean and Black Sea mainly through the “*de minimis*” and high survivability exemptions that actually allowed to continue the previous operative fishing practices. Only 29% participated to or supported studies for evaluating fishery discards, in relation to LO, in the period 2015-2019. The types of studies mainly refer to scientific projects at national or European level. The survey also demonstrated that 65% of the respondents, but percentages vary by basin, are not much aware of any other study for evaluating fishery discards, also in relation to LO, in the period 2015-2019 (Infographic 2, Annex 6).

Discards of species below MCRS is considered a small proportion of total discards both in Mediterranean and Black Sea basins. Discards, if landed, will represent a low volume scattered in multiple landing sites with inappropriate logistics to manage these volumes that may generate different problems. Lack of interest of industrial companies in the processing small and disperse quantities of discards and, in addition, logistic difficulties on board for the storage of discards will produce disproportionate costs for the management of catches subject to LO. That is the main reason why the LO in the Mediterranean and Black Seas has been implemented essentially through Commission delegated Regulations considering *de minimis* due to disproportionate costs and high survivability exemptions.

Low compliance with fishing rules (technical measures, closing areas, etc.) low level of awareness and information by fishers and the need to improve enforce and control are also reported as relevant issues. Thus, there is the need of a continue work for increasing communication and awareness among the sector, involving the various stakeholders and consumers.

As an example of the complexity of the discards issues, Stithou et al. (2019) provides a review of measures applied for discard reduction (e.g., selectivity, spatio-temporal effort allocation, creation of incentives, new markets, co-management and other behavioural changes). The study argues that although discarding is mainly driven by market demand, a number of factors have a synergistic effect, which is sometimes difficult to disentangle and capture. Regarding measures, evidence from involved stakeholders (marine scientists and fishers) shows that economic incentives but also “social

measures” such as more involvement of the industry and raising awareness, are offering common ground. However, specific concerns have been also expressed on measures applicability. Reducing discards is a complex issue and solutions should involve a combination of management measures designed for specific fleets and regions.

In 2017 the General Fisheries Commission for the Mediterranean (GFCM) adopted the recommendation GFCM/41/2017/3 on the establishment in the Adriatic Sea of the Jabuka/Pomo Pit FRA. This action was supported also by Italian and Croatian fishers. The Jabuka/Pomo Pit is a nursery for both European hake and Norway lobster. Therefore, the establishment of a FRA is expected to improve the exploitation pattern of both stocks. In addition, the Pomo Pit FRA is likely to determine a strong increase of SSB of the Norway lobster. The GFCM Sub Regional Committee of the Adriatic Sea in the 2021 session pointed out that, three years after the establishment of the Jabuka/Pomo Pit FRA (which surface presents 2-3% of the Adriatic Sea) and the establishment of the no-take zone (1% of the Adriatic Sea surface), significant recovery of resources were estimated.

This presents a meaningful case-study model for the protection of other areas. In the last session a new Recommendation GFCM/44/2021/2 was adopted for the Jabuka/Pomo pit FRA.

A series of scientific publications focus on the identification of hotspot areas where high quantities of juvenile fish are present (e.g. results from MEDISEH project) and are potentially caught and so high discards may occur (Despoti et al. 2020; Milisenda et al. 2021). Exploiting and expanding this approach at Mediterranean and Black Sea basins, using the different fishery independent and dependent information from DCF and DCRF, may provide the basis for establishing new FRAs tailored to the avoidance of unwanted catches. Different types of coordinated actions can be promoted in the short term.

In addition, the MED_UNITS project⁵ has analysed and mapped the fishing grounds at Mediterranean scale, using integrated approaches and data sources (i.e. VMS, AIS and MCDA for the vessels not tracked by remote control systems). These outputs can be used and the approach also extended to the Black Sea basin. This type of action could be promoted in the short terms.

1. Highlights

- Initiatives such as management measures and pilot projects have been identified mainly related with spatial and temporal measures to reduce discards (e.g. closed season and areas), and to a lesser extent to improve selectivity and to facilitate control. **Several initiatives of closure areas are ongoing in the western Mediterranean in the MAP framework. The Jabuka/Pomo Pit Fisheries Restricted Area (FRA) in the Adriatic is a good example of a spatio-temporal measure not specifically tailored on the LO, but that can produce positive effects on the European hake stocks, as a relevant nursery area of this species is located in this area.** Thus, it is expected that catches of undersized European hake individuals are reduced and hence the discards, improving the exploitation patterns. Positive effects on the state of resources have been recently documented and a new Recommendation GFCM/44/2021/2 on this FRA, amending the previous Recommendation GFCM/41/2017/3, has been issued in the 2021 GFCM session.
- In Mediterranean nursery areas of demersal species are widespread with hot spots of the different species geographically localized and fishing effort hot spots identifiable (if not already identified) as well. **Localizing zones to be avoided given**

⁵ Specific Contract No. 03EASME/EMFF/2017/1.3.2.3/01/ SI2.793201 -SC03” – MED_UNITS.

the potentially higher discard rate (nurseries of key species matching with high fishing footprint areas), selecting the more relevant for spatial management can help in improving the fishing pattern, and in turn to facilitate LO compliance, contributing twofold to the CFP objectives: moving towards MSY and reducing the wasteful practice of discarding. This type of action could be promoted in the short terms.

- LO has been implemented in Mediterranean and Black Sea mainly through the “*de minimis*” and high survivability exemptions that actually allowed to continue the previous operative fishing practices. This is possibly the reason why a rather low level of awareness of LO emerged.
- There is thus **the need of a continue work for increasing communication and awareness among the sector, involving the various stakeholders and actors, as researchers, administrations, consumers, industry and market organizations. The European Maritime, Fisheries and Aquaculture Fund (the ‘EMFAF’) can provide opportunities aimed at continuing to inform, train, increase communication.** The access to the funds and to the specific actions need to be promoted to ensure an effective implementation and use at regional, national and local levels. **This type of actions can be promoted in the short terms.**
- LO probably has not produced significant changes towards the reduction of discards up to the moment, since most of the initiatives are local, but it may have increased the awareness of fishers. At local scale, interesting initiatives related to bottom trawl fishery are reported in the western Mediterranean by fishers in Cataluña that have adopted more selective gears (larger mesh size in the codend) on a voluntary basis, and by fishers association that are experimenting a certification process for the deep-water rose shrimp fishery in the south Adriatic sea. **Supporting the industry for certification of sustainable fishing can be an incentive for a more selective fishing practices that can be implemented through EMFAF funds. This type of actions can be promoted in the short and medium terms.**

6.2 ASSESS THE IMPACT (SUCCESS) OF THE COMBINATION OF MEASURES IMPLEMENTED REGARDING THE REDUCTION OF DISCARDS RATES

From a meta-analysis on 78 studies going back to the 1990s, it seems that the discard ratio has decreased and the L50 has increased for some species. The increase in codend mesh size introduced with the Regulation (EC) 1967/2006 might have contributed to this direction, while the synergistic effect of other factors, such as MCRS and spatio-temporal closures, cannot be easily assessed. An insight from 28 quantitative studies according to a MultiCriteria approach (Belton and Stewart, 2002; Lembo et al., 2017) revealed that measures on gear selectivity as well as spatio-temporal approaches are considered more effective for the mitigation of discards in the Mediterranean and Black Sea fisheries, then MCRS and LO alone.

The majority of 68 scientists respondent to a survey perceived that the LO has been partly applied with little effect on discards reduction. However, according to the respondents’ replies it seems that substantial information has been additionally collected and has become available mainly through EU and National research and monitoring projects. Nevertheless, most scientists perceived that their work related to discards may have been modified, but their workload has not increased. In addition, it is worth to highlight that in the Western Mediterranean, the availability of data is considered to have increased according to 70% of respondents, probably due to the inclusion of several pilot studies from the area in recent research projects (mainly MINOUW). The

role of studies and pilot project seems thus to play a key role in increasing awareness and communication channels among different actors (Infographic 3, Annex 6).

Analyses of data from Data Collection Framework in the Mediterranean and Black Sea provided estimates of the annual discard ratio (Ratio = Discards/Landings) by species and fishery, as well as estimates of the size at which 50% of individuals were discarded (L50), the latter by three time periods (2012-15, 2016-17 and 2018-19), to better assess the progress in discarding after the implementation of the LO provisions.

The discard ratios of the species included in the Western Mediterranean MAP for demersal fisheries (Regulation (EU) 2019/1022) were generally very low or low in most Western Mediterranean GSAs and in different bottom trawl (OTB) fisheries. A further reduction seems to occur in the recent years for some species; however, few exceptions with higher values (>0.15) throughout the period and/or increases in 2018 and 2019 were observed (e.g., HKE in OTB_DEMSP). The L50 in the western basin were usually below MCRS, with improvements observed in many cases. In the Adriatic Sea fisheries for small pelagics, very low ratios (<0.02) were observed for anchovy and sardine in PS fisheries, but they were in some cases/years higher (>0.15) in the PTM (pelagic trawler) fisheries. An improvement was observed also as concerns discard ratios in some regions (e.g., GSA 16), but this was accompanied by a slight decrease (around 10%) in the L50 for some species. On the contrary, in GSA 19 and the Adriatic (GSA 17-18), increased discard ratios were observed in the recent years, but discards in the Adriatic still remained at low levels for most species, while L50 increased (the opposite for GSA 19) in the most recent period that may have contributed to the increasing trend in the discard ratios. In the Eastern Mediterranean OTB (trawl) and PS fisheries, the discard ratios were also low (with some exceptions, as for *Pagellus erythrinus*), but the trends could not be adequately assessed due to lack of time series in many cases. Finally, for Romanian OTM fisheries in the Black Sea, only few data points could be estimated, and only regarding the discard ratios (Infographics 4 and 5, Annex 6).

All these signals would testify that, though slowly, increase of mesh size introduced in 2011 according to the Regulation (EC) 1967/2006 and MCRS contributed towards the reduction of unwanted catches, as highlighted by Damalas et al. (2018) that provided a baseline description of the discarded catch in the Aegean Sea bottom trawl fishery.

The modelling of discard variations using GAMs and detailed data at haul level from observations onboard in the period 2010-2020, highlighted that discards were positively related with the total catch of the species and/or with the total catch of all species. When catches are satisfactorily high, the fishers' decision on what to discard may be more relaxed. An important variable affecting discards was also the length composition of the species considered; it was rather evident that discards of the species (especially for HKE) decreased as the mean length of catch increased.

Temporal patterns were also evident that seem related to the overall trends in species abundance, or may be affected by annual differences in recruitment success. Seasonal patterns were also included in almost all models and were usually related to the recruitment period of the species (e.g., 3rd or 4th quarter for HKE, 4th quarter for MUT in almost all GSAs). Additionally, in the Greek GSAs, where the 3rd quarter is closed for OTB in national waters, the increased discards during the 4th quarter for several species might be related to increased abundance due to this cease in the fishing operations.

Among the operational variables, the length (LOA) category of the vessel most contributed to the explanation of discard quantities. Larger vessels usually produced higher discards, probably because they catch larger quantities in general, but this pattern was not always constant in all species/GSAs. Vessel age had a significant contribution in some models, but there was no definite conclusion across all GSAs/species. The effect of haul duration was variable, but in most cases longer durations were positively related with higher discards (Infographic 6, Annex 6)

From the analyses of discard ratio and discard length L50 on one side and the modelling

from observations onboard on the other, it appears that the implementation of different management measures, regarding both gear selectivity and fleet behaviour associated to the resources distribution and abundance on the fishing grounds, can be reasonable.

However, the mixed nature of the demersal trawl fisheries, especially in the Mediterranean, poses problems when technical measures related to the codend mesh size opening are taken into account. STECF 21-13 (2021b) analysed the issue of the gear selectivity in terms of mesh size opening, highlighting that a 50 mm square-mesh in the codend would imply an increased size at first capture of European hake, reaching about 18-19 cm, and thus getting close but still not reaching the MCRS for this species. On the other side, the size at first capture of red mullet would be well above the size at first maturity and so the capture losses of this species would be remarkable and likely not compensated by the expected increase in biomass in the medium term. Similar considerations hold for deep water rose shrimp, which captures co-occur with the ones of European hake in several areas.

Increasing in the mesh size of the codend may have a positive ecological effect on various species, also considering that these effects are beneficial not only for the target ones, but this type of measure for certain fisheries or depth ranges may be economically unsustainable. Simultaneously improving the size selectivity of fish and shrimp species can be difficult due to large differences in their morphological characteristics and so such improvements can be achieved only through the simultaneous modification of multiple trawl features (STECF, 2021b).

Some results are expected by the IMPEMED project regarding mesh configurations and the use of grids to avoid the capture of undersized individuals. However, it is worth to consider the possibility to expand such studies, in terms of spatial coverage, sea trials and types of technological solutions, as the results might also depends on specific geographic and fisheries characteristics.

2. Highlights

- On the occasion of the LO, discarding became a hot topic of fisheries science in the Mediterranean and Black Sea region. **LO has remarkably contributed to increase the number of studies that may support a more effective implementation of the LO in the near future. European Projects like DISCATCH, MINOUW, DiscardLess, GALION, IMPEMED are good examples. New information has been added and new approaches and measures explored, which stakeholders and the management system could capitalize on.**
- There are clear **signs of improvement in the West Mediterranean**: discard ratios are decreasing and **L50s are increasing for species included in the Western Mediterranean MAP**. Although there are some signs of improvement in other areas as well, the trends are not always so clear.
- Since 1990' scientific literature points at measures on gear selectivity as well as at spatio-temporal approaches as more effective tools for the mitigation of discards in the Mediterranean and Black Sea fisheries. **Avoidance of unwanted catch through improved selectivity, gear technology, fleet fishing tactics should be the primary focus**. However, in the project study areas, especially in the Mediterranean, **trawl fisheries are mainly mixed**. This is an intrinsic operational factor that increases the difficulties of the LO implementation, for optimising the size at first capture of several species in a way that is also economically sustainable. **Given this characteristic a combination of measures, accounting for technical measures and fishing tactics can be more effective.**
- **The modelling of discard variations confirmed that discarding is affected by a variety of factors, including environmental patterns and processes** (bathymetric preferences, local productivity, inter-annual recruitment), as well as

operational factors and fishing tactics, **that should be taken into account for a more effective management of discarding.**

- There should be still room for improvements in gear selectivity, finding a trade-off that can mitigate the losses in the short terms, so making this kind of measure more acceptable by fishers. Therefore, **the combination of the actions towards the selectivity improvements, the protection of the recruits of the main commercial species through area and season closures should be viewed as a major step towards the achievement of a more sustainable exploitation pattern (e.g. Suuronen and Gilman, 2020). These type of actions might require a medium term time frame to be supported and then implemented.**
- **Management by hot spots or by area limitations can be beneficial also to avoiding the catch of non-commercial species, mainly invertebrates, thus reducing the impact on certain areas and preventing the deterioration of benthic communities.**
- Monitoring and **data gathering through direct sampling techniques on-board fishing vessels is pivotal for collecting meaningful information on discarding practices. Increase mutual cooperation between fishers and researchers by collaborative research, can contribute to identifying solutions and best practices.**

6.3 IDENTIFY AND EVALUATE THE MEASURES, STRUCTURES AND RESOURCES ADOPTED BY MEMBER STATES' AUTHORITIES TO ENSURE CONTROL, ENFORCEMENT AND INSPECTION OF ALL ACTIVITIES RELEVANT TO THE LO

The implementation of the LO provisions depends on an effective system of control and inspection (at sea and at land), as well as on a system to manage and, possibly, process the discards in the circuit "not for human consumption". MedBLand followed two approaches to identify and evaluate the measures and infrastructures adopted by Member States to ensure control, enforcement and inspection of the LO: the collection of information by means of questionnaires distributed among the relevant stakeholders and the revision of the documents issued by the MS Authorities, reporting control and monitoring activities.

The results evidenced the presence of measures or infrastructures to ensure enforcement and inspection of LO compliance, as well as monitoring of catches/discards, but the information received was not very detailed. The number of reported LO infringements by Member States was low. Among the main factors that can make the LO more subject to non-compliance, the following were principally mentioned:

- *The overall scarce knowledge of the LO provisions from the fishers;*
- *Especially for trawl fishery, it is difficult and expensive (especially in terms of manpower) to do a correct sorting;*
- *The difficulty for the inspectors to verify, in real time, the actions made by the crew of sorting, discard, and registration of the catch.*

(Infographic 7, Annex 6).

Further, the majority of the respondents noticed that currently there are no structures processing discards (e.g. to produce fish meal or fish oil). Few respondents involved in fish meal/pet food industries and aquaculture/mariculture plants expressed some generic interest in processing or using discards, but it is difficult to strictly link this

interest to the discards resulting only from the LO. It should be noted that if for some reason the situation would change and an increased interest to the discards from LO should arise from the processing/aquaculture industries, then the remuneration of this product might create incentives to catch undersized fish. This risk has been discussed in several papers (e.g. Bellido et al., 2014).

The use of EMFF funds to support measures or infrastructures to enforce the LO provisions is still limited to sporadic cases. As concerns the use of such funds, to support/implement measures or infrastructures to enforce the LO provisions, the majority of respondents replied "no" or "don't know", both for control and inspection activities and for handling or processing the unwanted catches. There is hence the need to improve the utilization of the EMFAF funds in the near future and, hence, increase information and communication actions. This can be also promoted in the short and medium terms.

Most stakeholders, fishers in particular, declared their scepticism towards the LO efficacy in reducing discards. The main problems in implementing the LO seem due to the scarce knowledge and awareness of the fishers and the logistic difficulties to manage discards at sea. This is an important point because the LO in the Mediterranean is based on regulated species under MCRS and sorting small individuals by species in the discards after the sorting of the landing is a time consuming activity, even though the total amount of discard of regulated species is small. Thus, technical solutions to assist the selection processes onboard can be useful, but it is up to the fishers to evaluate, in practice, if this type of solutions is useful and therefore undertake operational initiatives in this direction.

On the other hand, the presence of the "*de minimis*" exemptions, that actually allowed to continue the previous operative fishing practices, may have not prompted the motivation to innovative solutions. Also, managing the discards once at land has logistic problems because there are no suitable infrastructures to collect and manage such material at the landing sites. Other issues are related to the complexity of the rules, the difficulty to set up an efficient control activity, the lack of financial motivation for fishers. (Infographic 8, Annex 6)

It can be noted that in other areas, as in United States, there are donation programs of discards and by catches to hunger relief organizations (Watson et al. 2020). This program simultaneously provides food and reduces waste, while avoiding inadvertent incentives for catching prohibited species or sizes. Currently, this might be an option also for the Mediterranean and Black Sea.

It is also worth noting that the recent approval by GFCM of the following Resolutions: GFCM/44/2021/2 on the definition of a minimum conservation reference size for priority stocks in the Mediterranean Sea; GFCM/44/2021/8 on the implementation of a vessel monitoring system; GFCM/44/2021/9 on the implementation of an electronic logbook is providing a framework of rules shared at whole basin level.

3. Highlights

- **A certain criticism emerged from the interviews pointing at some inertia of the Member States as well as of the fishery sector to effectively implement a system of enforcement and control for LO.** Enforcement and compliance cannot be disjoined, and compliance cannot be disjoined by increased awareness. Avoidance of unwanted catches can be incentivized through information sharing towards selectivity improvements and closures of specific areas and/or seasons when and where recruits of regulated species occur. **Promoting bottom up processes and increasing awareness also at local level, within small groups of fishers, should be a priority prompted by the use of EMFAF funds. This can be promoted both in the short and medium terms.**
- In future and where implemented, the management of discard hot spots would

require a special effort to control the fleet displacement. However, **if measures are tailored to each particular fishery, or even to species within a fishery, combined with programs for increasing awareness among fishers, it can be expected a better compliance, as it has been observed in the Jabuka/Pomopit FRA management.**

- Vessels are dispersed in many ports and landing sites that is a limit for the management of discards at a larger scale, especially for reaching critical volumes needed for the use other than human consumption.
- **The stakeholders highlighted the difficulties in implementing the LO for reasons linked to the lack of suitable infrastructures onboard and on the land**, as well as to the deficiency of interest from the processing industry given the low volume of discards. Incentives to identify innovative solutions at local level with the cooperation of the local administration and fishers' associations can help in establishing new practices for the management of discards at the landing sites. **There is, hence, the need to improve the utilization of the EMFAF funds in the near future and therefore increase information and communication actions. This can be also promoted in the short and medium terms.**
- There is also the need to **increase the awareness of consumers towards products that are fished sustainably**. There could be consumers' premium price for a sustainable and selective fishery incentivized by the LO.

All the infographics are reported in the ANNEX 6.

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LIST OF ELECTRONIC ANNEXES TO THE MEDBLAND FINAL REPORT

The following electronic Annexes are also available at: www.coispa.it

ANNEX 1 - SYNTHESIS FROM THE PROJECT RESULTS IN TASK 1 (DELIVERABLE 1.1) REVIEW OF THE MANAGEMENT MEASURES IMPLEMENTED TO FACILITATE THE IMPLEMENTATION OF THE LANDING OBLIGATION.

ANNEX 2 – SYNTHESIS FROM THE PROJECT RESULTS OF TASK 2 - ASSESS THE IMPACT (SUCCESS) OF THE COMBINATION OF MEASURES IMPLEMENTED REGARDING THE REDUCTION OF DISCARDS RATES - DELIVERABLE 2.1 REVIEW.

ANNEX 3 - ASSESS THE IMPACT (SUCCESS) OF THE COMBINATION OF MEASURES IMPLEMENTED REGARDING THE REDUCTION OF DISCARDS RATES. OVERVIEW OF THE ESTIMATION OF THE DISCARD RATES AND LENGTHS AT DISCARDING.

ANNEX 4 – PROJECT TASK 2 - ASSESS THE IMPACT (SUCCESS) OF THE COMBINATION OF MEASURES IMPLEMENTED REGARDING THE REDUCTION OF DISCARDS RATES. DELIVERABLE 2.3: REPORT ON THE DISCARD MODELLING.

ANNEX 5 - LIST OF THE DOCUMENTS REVIEWED IN THE PROJECT TASK 3: IDENTIFY AND EVALUATE THE MEASURES, STRUCTURES AND RESOURCES ADOPTED BY MEMBER STATES' AUTHORITIES TO ENSURE CONTROL, ENFORCEMENT AND INSPECTION OF ALL ACTIVITIES RELEVANT TO THE LANDING OBLIGATION.

ANNEX 6 – INFOGRAPHICS.

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