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Case Study Report, Task 7.3

Synthesis and recommendations for Discard Mitigation Strategies by case study

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1 What has been going on in this area during the last 12 months?

1.1 Important changes in stock development, discard data and ecosystem

The western Mediterranean case study focuses on two contrasting areas in terms of the ecosystem productivity, exploitation pattern, and types and rates of discards: the French and Spanish Gulf of Lions-Catalan coast and the Balearic Archipelago. These areas encompass three different geographical subareas (GSAs), established by the General Fisheries Commission for the Mediterranean (GFCM; www.gfcm.org) for the assessment and management of Mediterranean stocks: 1) Balearic Islands (GSA 5); 2) Northern Spain (GSA 6); and 3) Gulf of Lions (GSA 7). The Gulf of Lions is the most productive area in the western Mediterranean owing to the winter upwelling and the discharges of rivers, whereas the Balearic Islands constitute an especially oligotrophic area within the general oligotrophy of the Mediterranean (Estrada, 1996).

The Gulf of Lions may not correspond to a complete stock unit. Indeed, hydrological exchanges between the Gulf of Lions and the Catalan Sea for instance are well known, which should at least affect larval transport (Ospina-Alvarez et al., 2013) and then recruitment of juvenile fish in both areas. Similarly, part of the young recruited in the Gulf of Lions may come through larval transport from spawners of the Ligurian Sea. Preliminary genetic analyses have shown no differences between Spanish and French stocks of small pelagics in the northwestern Mediterranean (GFCM, 2014a). Investigations have also been conducted combining French and Spanish landing data in order to see whether the disappearance of large individuals of sardine or anchovy from the Gulf of Lions might result from a migration towards Spanish waters. As this did not seem to be the case, GSAs 6 and 7 are still assessed separately (GFCM, 2014a).

Several decades ago the Balearic Islands were defined as an individualized fishing area in the western Mediterranean (Massutí, 1991). More recently, a comprehensive comparison including different aspects such as geomorphology, habitats, fisheries and exploitation state of resources and ecosystems between the Balearic Islands and the adjacent coast of the Iberian Peninsula, concluded that the Archipelago should be maintained as an independent unit for assessment and management purposes in the western Mediterranean, at least for demersal stocks and fisheries (Quetglas et al., 2012).

The main fishery management organization in the Mediterranean is the General Fisheries Commission for the Mediterranean (GFCM; www.gfcm.org). Apart from the GFCM, the European Union, through its Scientific, Technical and Economic Committee for Fisheries (STECF; https://stecf.jrc.ec.europa.eu/home), established in 2008 a working group specifically addressed to the assessment of Mediterranean and Black Sea stocks (known as SG-MED up to 2011). Each year, the GFCM and the STECF assess the exploitation status of the main target stocks and the results of these assessments (both inputs and outputs) are publicly available on their websides: i) GFCM

(http://www.fao.org/gfcm/reports/statutory-meetings/en/); and ii) STECF (https://stecf.jrc.ec.europa.eu/reports/medbs).

The table below compiles the total number of stocks exploited by the bottom trawl fishery from the Gulf of Lions and the Balearic Islands assessed up to now. In the Gulf of Lions, hake shows very high fishing mortality rates with F_c=12.8·$F_{0.1}$, the red mullet is also overexploited but at lower levels (F_c=3·$F_{0.1}$). Regarding the four target species of the bottom trawl fleet from the Balearic Islands (striped red mullet, hake, Norway lobster and red shrimp), hake shows the worst stock status, with current fishing mortality being near eight times the biological reference point ($F_{0.1}$). The striped red mullet is at an intermediate stock status, with F_c=3.8·$F_{0.1}$, whereas the Norway lobster is comparatively in better status, with F_c=1.7·$F_{0.1}$. The red shrimp is currently exploited at $F_{0.1}$.

	Stock	Fc	$F_{0.1}$	Fc/$F_{0.1}$	Source
Gulf of Lions	European hake *(Merluccius merluccius*)	1.92	0.15	12.8	GFCM, 2016
	Red mullet (*Mullus barbatus*)	1.13	0.35	3.2	GFCM, 2016
Balearic Islands	Black-bellied angler (*Lophius budegassa*)	0.84	0.08	10.5	STECF, 2014
	European hake *(Merluccius merluccius*)	1.34	0.17	7.9	GFCM, 2016
	Red mullet (M*ullus barbatus*)	0.93	0.15	6.2	GFCM, 2014b
	Striped red mullet (*Mullus surmuletus*)	0.50	0.13	3.8	GFCM, 2016
	Red shrimp (*Aristeus antennatus*)	0.32	0.31	1.0	GFCM, 2016
	Norway lobster (*Neprhrops norvegicus*)	0.29	0.17	1.7	STECF, 2014b
	Common octopus (*Octopus vulgaris*)	0.37	0.31	1.2	Quetglas et al., 2015
	Deep-water pink shrimp (*Parapenaeus longirostris*)	0.77	0.62	1.2	STECF, 2013a
	Cuttlefish (*Sepia officinalis*)	0.44	0.41	1.1	Quetglas et al., 2015

Data obtained from the French and Spanish Data Collection Framework were analysed to provide information on themain species discarded by fishery in both study areas. The average discard rates for the French bottom otter trawl (OTB) and mid-water otter trawl (OTM) fleets in the Gulf of Lions during 2011-2014 were about 25% and 15% respectively. The average percentage of discards per species is shown in the Figure 1.1.1. The discard rate of the bottom trawl fleet targeting demersal resources (OTB_DEF) varies with the different species, being very high for small pelagics such as *Engraulis encrasicolus* (ANE) and *Sardina pilchardus* (PIL), but very low for high-value species such as *M. merluccius* (HKE) and *Sparus aurata* (SBG).

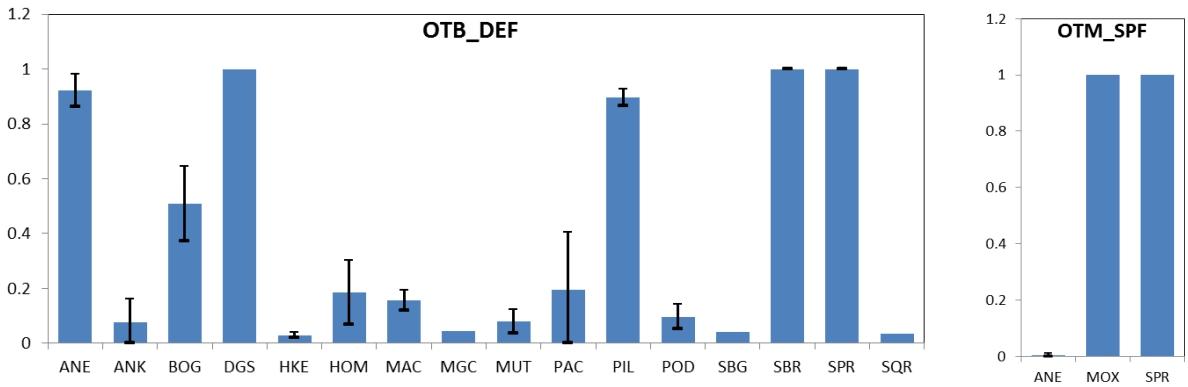
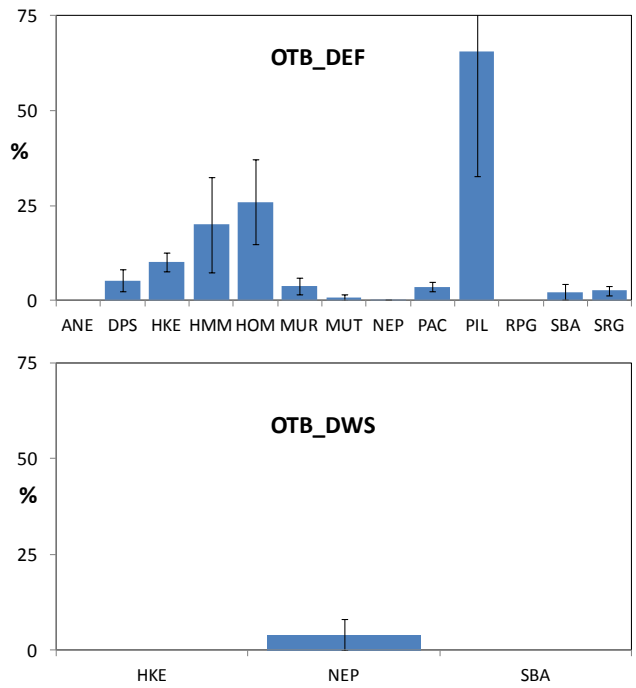


Fig. 1.1.1. *Average percentage of biomass discards of the French OTB and OTM fleets in the Gulf of Lions (2011-2014) by metier and species. Error bars indicate standard deviation. Species under the minimum landing size (MLS) European Regulation (EC, 1967/2006) are indicated in bold.* ***ANE****: Engraulis encrasicolus; ANK: Lophius budegassa; BOG: Boops boops, DGS: Squalus acanthias,* ***HKE****: Merluccius merluccius;* ***HOM:*** *Trachurus trachurus;* ***MAC****: Scomber scombrus; MGC: Liza ramada; MOX: Mola mola;* ***MUT****: Mullus barbatus;* ***PAC****: Pagellus erythrinus;* ***PIL****: Sardina pilchardus; POD: Trisopterus minutus;* ***SBG****: Sparus aurata;* ***SBR****: Pagellus bogaraveo; SPR: Sprattus sprattus; SQR: Loligo vulgaris.*

The 2012-2014 average discard biomass rates for the Balearic Islands are shown in the figure 1.1.2. The average percentage of discards is in general lower than 10% for most of the species subjected to the Landing Obligation (LO), except for three species *Trachurus trachurus* (HOM) and *S. pilchardus* (PIL) in OTB_DEF and *Trachurus mediterraneus* (HMM) in OTB_MDD (mixed demersal and deep water species). Small pelagic species are bycatch species for the bottom trawl fleet in this area and their importance is highly variable, both in terms of catches (their catchability shows important oscillations) and in terms of their final destination (they are landed or discarded depending on different factors, including market interest).



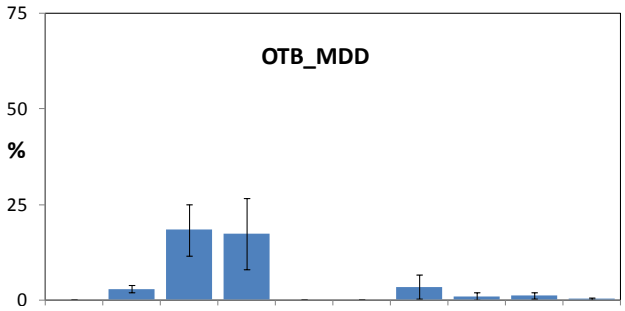


Fig. 1.1.2. *Average percentage of discards, by biomass, for the Balearic Islands (2012-2013) by metier and species. Error bars indicate standard errors. ANE: Engraulis encrasicolus; DPS: Parapenaeus longirostris; HKE: Merluccius merluccius; HMM: Trachurus mediterraneus; HOM: T. trachurus; MAZ: Scomber* spp.*; MUR: Mullus surmuletus; MUT: M. barbatus; NEP: Nephrops norvegicus; PAC: Pagellus erythrinus; SBA: P. acarne; SBR: P. bogaraveo; PIL: Sardina pilchardus; RPG: Pagrus pagrus; SBG: Sparus aurata; SRG: Diplodus* spp.

1.2 Important changes in terms of fisheries and stakeholders perception

Our second annual meetings with stakeholders hold in both study areas revealed that their perception about the LO has not changed at all in comparison with the first year meeting held in Bilbao (April 2015). Most stakeholders still consider the LO a wrong regulation for the Mediterranean, that no one believes in, neither the fishing industry nor the administration. Also in agreement with the last year meeting, stakeholders insist in the danger of bringing discards to land, which could promote a black market and stimulate, rather than decrease, taking discards. This measure goes against the efforts done during the last decades to reduce the commercialization of small-sized fish, so it is considered ecologically and ethically wrong. Moreover, Mediterranean vessels are not prepared for sorting and storing discards on board. However, problems are compounded onland, because there is not a single fish processing industry in the western Mediterranean. The LO is not feasible in some small, fragmented areas such as the Balearic Islands, where small quantities of discards of regulated species (mainly hake) are caught.

After the first two years of implementation to small-pelagic fisheries, there have not been major consequences for the Mediterranean fishers, mainly because of the use of the "slipping" and the "de minimis" exemptions. Although it is still too early to talk about the effects on demersal fisheries, stakeholders do not forsee important consequences, either due to the low number of species affected (mainly hake and red mullets) and the low threshold established (25% total landings) for vessels to be committed to the LO.

In view of the Delegated Regulations approved so far (see table below), Oceana considers that the LO has turned into a mere request for exemptions for the Mediterranean bottom trawl and purse seine fisheries. According to Oceana, the Delegated Regulation fails to identify a fishing strategy to reduce unwanted catches, such as the incentive to use more selective gears and the establishment of stock recovery areas to reduce catches of undersized individuals.

1.3 Important changes in management

The Catania High-level Seminar, held the 9-10th February 2016 (http://ec.europa.eu/fisheries/high-level-seminar-state-stocks-mediterranean-and-cfp-approach_en), represented a turning point for the fisheries management in the Mediterranean since a new process involving all relevant stakeholders, scientists, the National Administrations and the European institutions started there. After Catania, three different High Level Groups were established: 1) Western basin (PESCAMED), including Spain, France and Italy; 2) Adriatic Sea (ADRIATICA), Italy, Slovenia and Croatia; and 3) Eastern basin (SUDESTMED), Italy, Greece, Cyprus and Malta. Negotiations for the adoption of the different discard plans for the Mediterranean take place according to these three different geographical areas.

The figure and table below summarize the timeline for the LO implementation in the Mediterranean and the different discard plans adopted so far, respectively.

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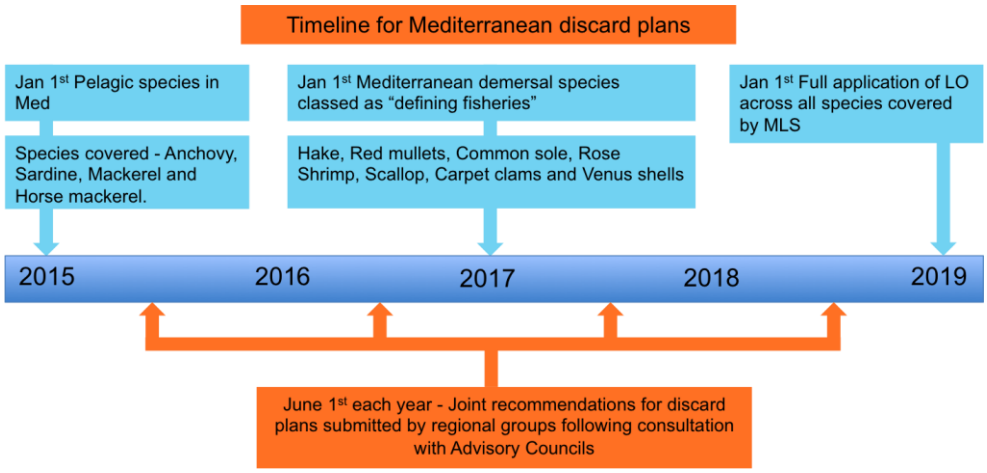


	Western Med	Adriatic	Eastern Med	Pelagics
Regulation	86/2017, 2376/2016			1392/2014
	All cover species subject to minimum sizes			
Years covered	2017, 2018, 2019			2015, 2016, 2017
Spatial coverage	GFCM Sub-Areas 1, 2, 5, 6, 7, 8, 9, 10 and 11	GFCM Sub-Areas 17 and 18	GFCM Sub-Areas 15, 16, 19, 20, 22, 23 and 25	Mediterranean Sea
Countries	France, Italy, Spain	Croatia, Italy, Slovenia	Cyprus, Greece, Italy, Malta	Greece, Spain, France, Croatia, Italy, Malta, Slovenia
Species	Hake, red-mullet, scallop, carpet clams and Venus shells.	Hake, red-mullet and common sole	Hake, red-mullet and deep water rose shrimp	Anchovy, sardine, mackerel and horse mackerel.
High Survival exemptions (under certain conditions)	Scallop, carpet clams and Venus shells caught with dredges in GSAs 1, 2, 5 & 6 (valid for 2017 only)	Common sole caught with rapido (beam trawl) (valid for 2017 only)	None	slipping
	2376/2016 covers Venus fisheries in Italian waters only and a derogation based on high survivability of this species covers 2017-2019			
***De minimis* exemptions** (under certain conditions)	Hake & red-mullet on the basis of disproportionate costs of handling unwanted catches	Hake, Red Mullet & Sole on the basis of disproportionate costs of handling unwanted catches	Hake, Red Mullet & rose shrimp on the basis of disproportionate costs of handling unwanted catches	Between 3 and 7% of total annual catches of small pelagics in purse seine and mid-water trawl fisheries.
Other points: See Regulations 1392 of 2014 (pelagic) and 86 of 2017 (demersal) for details relating to exemptions.				

A. Large pelagic fisheries

No changes in the management of these fisheries during the last year. On the 1st January 2015, the LO for small and large pelagic fisheries was enforced in the Mediterranean. In practice, concerning large pelagic fish the European Commission (EC) adopted the delegated Regulation 98/2015 which establishes derogations from the LO for the purpose of implementing Union's international obligations under the International Commission for the Conservation of Atlantic Tunas (ICCAT) and the Convention on Future Multilateral Cooperation in the Northwest Atlantic Fisheries. As a result, large pelagic fisheries managed by ICCAT are no longer concerned by the landing obligation and ICCAT regulations should apply instead.

B. Small-pelagic fisheries

Concerning small pelagic fisheries (anchovy/sardine/mackerels/horse mackerels), the EC adopted the delegated Regulation 1392/2014 establishing a discard management plan for small pelagic fisheries in the Mediterranean. In the western Mediterranean area, the "de minimis" exception to the LO is applied whenever the discards are <5% of yearly catches. This exception is generally met since there are very low discards of those species in small pelagic fisheries (seiners or pelagic trawlers).

C. Demersal fisheries

The LO applies to Mediterranean demersal fisheries from January 1st 2017. For this purpose, the Commission Delegated Regulation (EU) 2017/86 established a discard plan for certain demersal fisheries in the Mediterranean, which will apply from 1 January 2017 to 31 December 2019. This Delegated Regulation states that the LO will apply to hake and red mullets only whenever these species represent more than 25% of the total landing per vessel in 2014 and 2015. The Regulation also stablishes how the survivability and the de minimis exemptions will be applied.

According to the Delegated Regultion, by 31 December 2016, the Member States concerned shall submit to the Commission and to the other Member States, using the secure Union control website, the lists of all vessels targeting hake, red mullet, common sole and deep-water rose shrimp. Member States shall keep those lists updated.

The Commission approved this Delegated Regulation after reviewing the Joint Recomendations sent by the MEDAC and the three HLGs. The MEDAC sent the report *Joint Reccomandations on Discards Management Plans for Species Defining the Fisheries* (MEDAC JR-LO-demersal) to the EU in June 2016, which was reviewed by the STECF EWG 16-06 (STECF 16-10). EWG 16-06 noted that this document was not yet approved by the relevant Member States. Therefore, it was treated as a working document and not considered as a formal joint recommendation for demersal fisheries in the Mediterranean as it did not emanate from the Member States in the region.

About a month later, the PESCAMED HLG sent a proposal of the *Joint Recommendation Discard Plan for Demersal Fisheries in the Western Mediterranean,* shared by Italy, France and Spain. This JR was also reviewed by the STECF which noted that, apart from the de minimis exemption proposed by MEDAC,

an additional high survivability exemption was requested for bivalves (i.e. *Pecten jacobaeus, Venerupis* spp. and *Venus* spp.) in GSAs 1, 2, 5 and 6 caught with mechanised dredges.

2 The Year behind us (2016-2017): What has DiscardLess produced in this case study during the last 12 months?

2.1 Impact assessment

2.1.1 Ecosystem scale

1. Size spectra (SS) modelling was used to analyse the likely effects of management measures directed to reduce discards on western Mediterranean demersal ecosystems by means of investigating the size-structure of their fish megafaunal communities. The bottom trawl fishery targeting the European hake (*M. merluccius*) on deep shelf grounds (100-200 m) were used as a case study for two main reasons. Firstly, because of the key role played by hake and the remaining megafaunal by-catch species on those demersal ecosystems. Secondly, hake is one of the main species affected by the Landing Obligation in the Mediterranean (included in Annex III of Council Regulation (EC) Nº 1967/2006) since it shows significant discard rates in the bottom trawl fishery.

The analyses directed to investigate the ecosystem effects of discard ban policies were focused on the Balearic Islands, but we also used two nearby areas (the Mediterranean Iberian Peninsula and the Alboran Sea) to investigate whether the results might be extrapolated to other western Mediterranean ecosystems. Data came from the bottom trawl research surveys MEDITS, carried out in the western Mediterranean: Balearic Islands (2002-2013) and Iberian Peninsula and Alboran Sea (1994-2013).

The ecological consequences of the three scenarios defined within the DiscardLess project were explored: i) Baseline: biomass of all the commercial species above their corresponding mean selectivity value for a 40 mm square mesh codend; ii) Partial implementation: biomass of all the commercial species independently of the size; and iii) Full implementation: biomass of all the fish species of the community.

For each scenario, the mean size spectra, its inter-annual variation and the slope-intercept relationships standardized to the mean values were calculated.

Figure 2.1.1 shows the observed mean size spectra (SS) and their corresponding mean parameters (intercept and slope) of the three study areas. The following conclusions can be drawn from this figure:

- Community biomass and/or productivity were higher in the Balearic Islands than in the Iberian Peninsula and Alboran Sea.

- There was a higher contribution of small and medium-sized individuals to the community in the Balearic Islands compared to the Iberian Peninsula and the Alboran Sea.
- There was a higher variability in the contribution of smaller individuals and the exploitation pattern in the Alboran Sea, which could make balanced harvest difficult.

A comparison of the standardized slope-intercept relationships did not show significant differences among the three areas (Fig. 2.1.2).

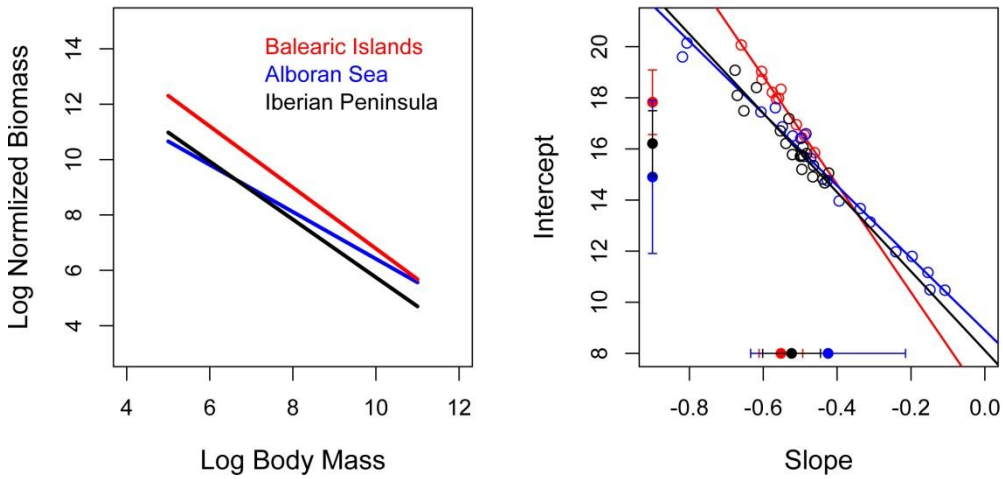


Fig. 2.1.1. Mean size spectra (SS; left) and slope-intercept relationships (right; each dot represents a mean SS of a given year) for European hake grounds (100-200 m depth) for the three western Mediterranean study areas.

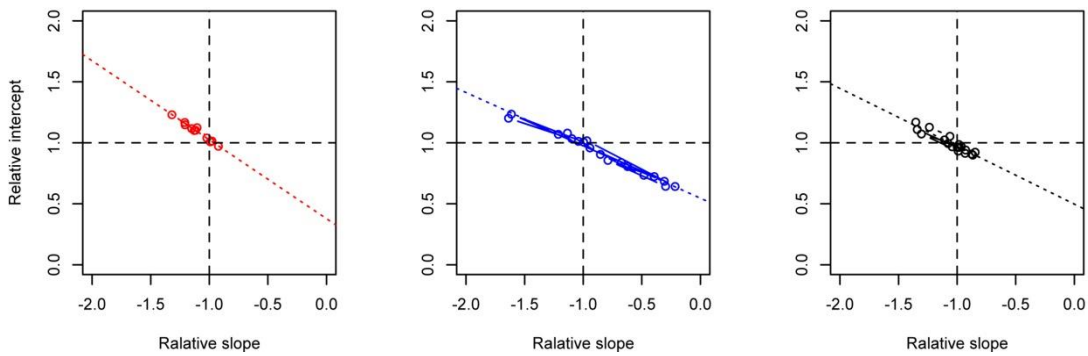


Fig. 2.1.2. Slope-intercept relationships standardized to the mean values to allow comparisons among the three study areas (red: Balearic Islands; blue: Alboran Sea; black: Iberian Peninsula).

Results revealed no significant differences among the different scenarios for the Balearic Islands ecosystems (Fig. 2.1.3). Although there were some small differences during the three first years of the time series, the mean SS did not vary at all (Fig. 2.1.4). This would be due to the fact that Mediterranean bottom trawl catches are mainly constituted by juveniles and small-sized species with a very low contribution of large individuals. This would make difficult finding significant differences at the community level using the different scenarios tested.

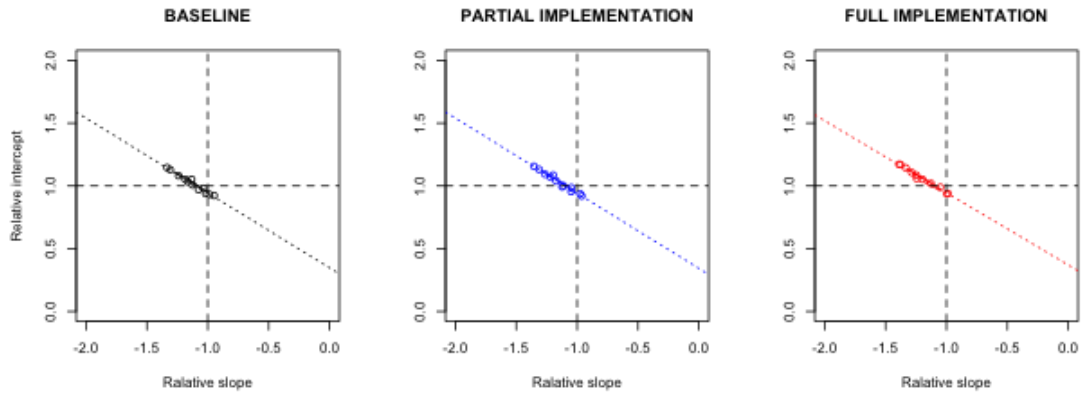


Fig. 2.1.3. Slope-intercept relationships standardized to the mean for the three implementation scenarios in the Balearic Islands ecosystems.

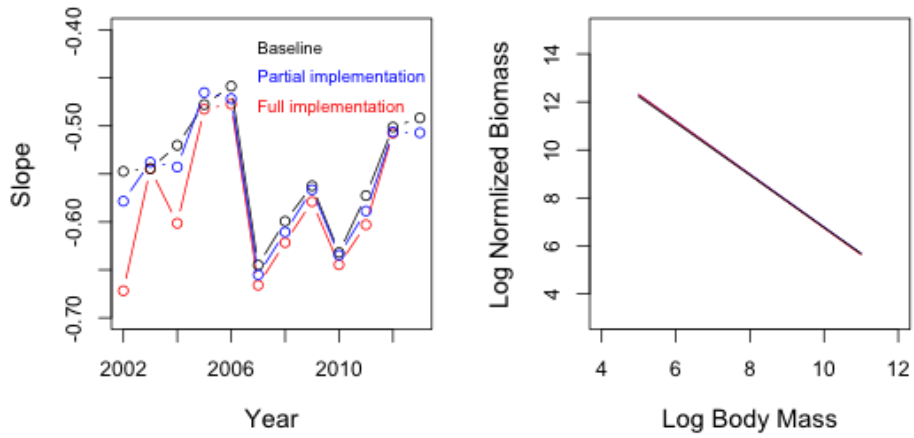


Fig. 2.1.4. Inter-annual variation (2002-2013; left) and mean size spectra (right) of the slope from the Balearic Islands ecosystems according to the three implementation scenarios.

2. In the Gulf of Lions, various environmental descriptors of sediments, currents, hydrology and food availability were processed in order to produce a risk map of the benthic sensitivity to trawling. In parallel, a trawl disturbance index was produced on the basis of in situ observations of the macro-benthic fauna, to illustrate the distribution of sensitive assemblages (Fig. 2.1.5). The two approaches were compared and the bottom contacting fishery effort distribution was tested to explain these differences.

This work had shown that the distribution of vulnerable benthic species in the Gulf of Lions was not coherent with that of their prefered environment but could be linked to their vulnerability to trawling. Most sensitive bentic species are generally found in areas where fishing effort is low, which could reflect the fact that fishery has impacted and restructured seabeds some time ago by inducing local depletion where fishing intensity is high. An underwater video survey of the benthic fauna was

realized in September 2016 and another in April 2017 to complete and verify the results of these two approaches (http://campagnes.flotteoceanographique.fr/series/238/).

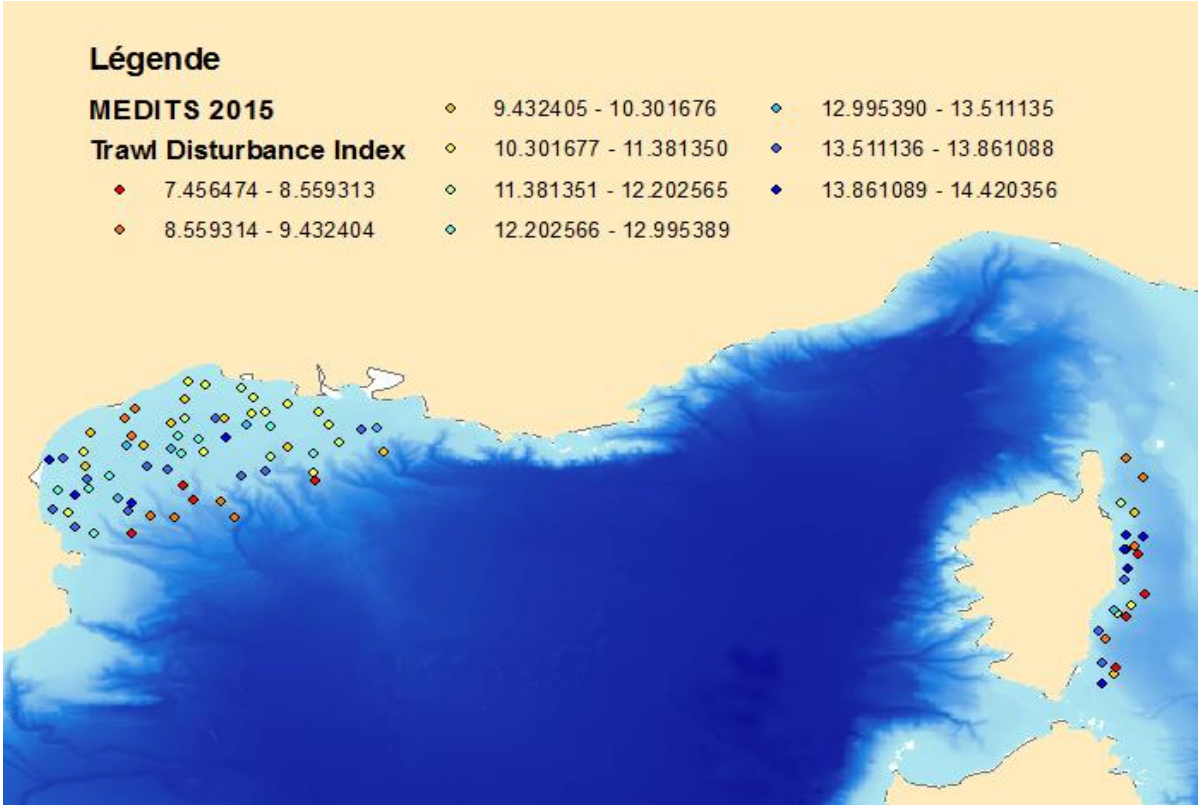


Fig. 2.1.5. Trawl disturbance index in the Gulf of Lions (Ifremer).

2.1.2 Fishery scale

1. The socioeconomic effects of the LO for the bottom trawl fishery from the Balearic Islands were analysed using the bioeconomic model MEFISTO (Mediterranean Fisheries Simulation Tools; http://mefisto.info/). This analysis was focused on the European hake (*Merluccius merluccius*) since it is the only target species that shows significant discards in the bottom trawl fishery. The following five scenarios were modelled:

Sce1-Business as usual (BAU): applying the current fishing mortality levels per age class.

Sce2-Full Implementation (FI): considering a 10% increase of daily variable costs and increase of one crew member as a result of sorting and storing individuals under MLS on board.

3-Use of avoidance strategies: modelling the use of avoidance strategies by means of changing the current age-selectivity parameters.

Sce3.1-Removing the fishing mortality at age 0 (F_0=0).

Sce3.2-Fishing mortality for individuals under the minimum landing size (MLS=20 cm) was set at 0 (F_0 =0 and 10% decrease in F_1).

Sce3.3-Modification of current age-selectivity parameters to avoid fishing mortality for immature individuals (TL=30 cm).

The results of this modelling showed that the use of avoidance strategies was the scenario providing the most significant differences in the outputs, both biological and economic (Fig. 2.2.1). It significantly decreased fishing mortality, as a result of the new selectivity parameters, and increased SSB, Yield, Income from Landings, Average crew wage per day and Profits with and without subsidies. Nevertheless, it caused a reduction of some of the biological and economic indicators in the first year of the implementation.

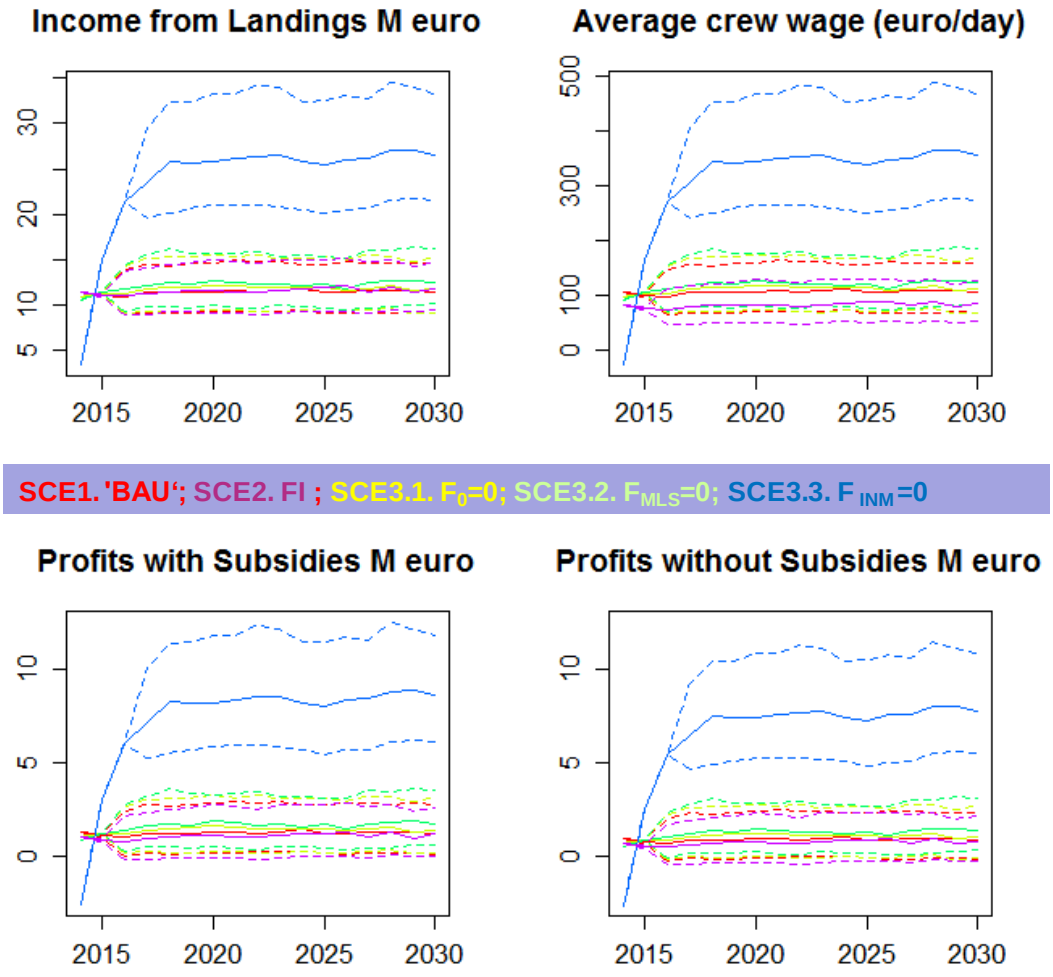


Fig. 2.2.1. Comparison of the Economic outputs of the different scenarios.

The results of this bioeconomic modeling, together with the ecosystem modeling using size-spectra shown above, were presented at the ICES Annual Science Conference (2016) held in Riga (Latvia) as the following oral presentation (CM Code: Q:504): *Ecological and bio-economic inplications of the Landing Obligation on balanced harvesting in Mediterranean fisheries by Rueda L., Hidalgo M., Maynou F., Guijarro B., Massutí E. and Quetglas A.*

2. Changes in stakeholders perception about the Landing Obligation were followed by annual meetings after the first one held during the kick-off meeting of the project held in Bilbao (April 2015). During 2016, a total of three meetings were organized according to the three main areas involved: 1) Gulf of Lions (IFREMER), April 8th in Sète; 2) Catalan Sea (IEO), June 14th in Barcelona; and 3) Balearic Sea (IEO), July 11th in Palma de Mallorca.

2.2 Avoiding unwanted catch

2.2.1 gear technology

1. An oral presentation entitled "Selectivity in a Mediterranean bottom trawl fishery: is the Council Regulation (EC) Nº1967/2006 enough for fulfilling the Landing Obligation?" by Zapata M.A., Ordines F. and Guijarro B. was presented at the 41th CIESM Congress (CIESM.org) held in Kiel, Germany (CIESM Congress 2016 Kiel article 0523.pdf). This study has resulted in a manuscript, entitled "*Selectivity in a Mediterranean bottom trawl fishery: It is justified and enough the implementation of the Council Regulation (EC) Nº1967/2006?*", which will be submitted for publicaction. This work aims at comparing catches and size composition, both from landings and discards, obtained by two different mesh types in the codend of bottom trawlers in the Balearic Islands (western Mediterranean), under commercial conditions and using data from the on board scientific monitoring of the commercial fishing fleet, within the Data Collection Framework. The specific objectives were: i) to analyze if the selectivity of the 40 mm square mesh and 50 mm diamond mesh in the cod-end are equivalent; and ii) to assess the usefulness of these "new" meshes for the LO regulation. The results suggested that the 40 mm square mesh cod-end is more selective than the 50 mm diamond mesh cod-end (Fig. 2.3.1). According to that, the current exemption of using 50 mm diamond mesh codend is not justified. Although this study reflects the potential benefits of the implementation of 40 mm square mesh in the cod-end, with a reduction of the discarded catches and an improvement of the exploitation pattern of the species, this improvement does not affect equally to all of them. In fact, most target species still have a length of first capture lower than their length of first maturity and some of them even have a length of first capture lower than their minimum landing size. Thus, additional measures should be implemented.

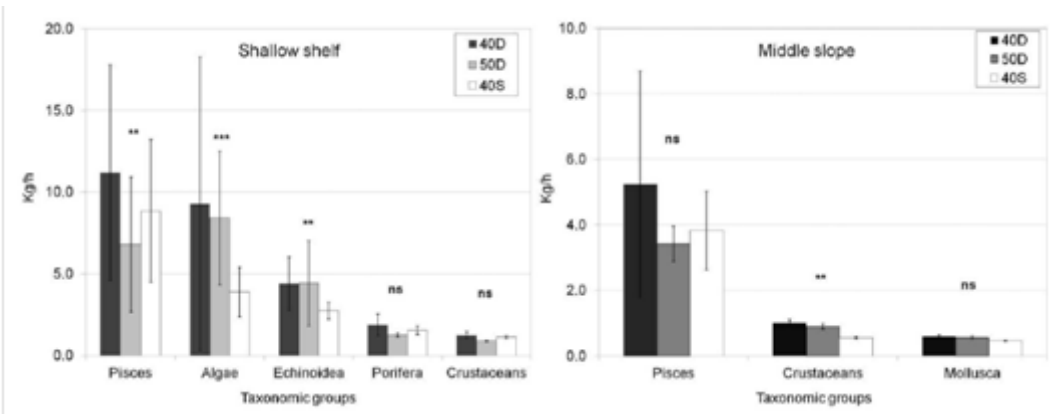
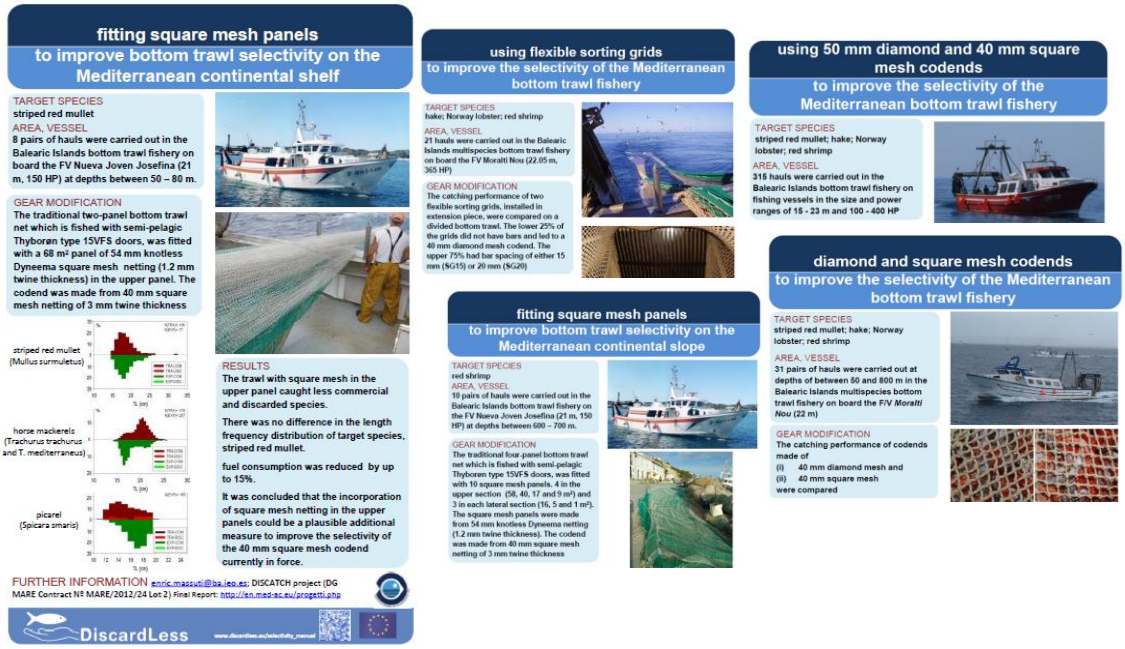


Fig. 2.3.1. Yields of standardized biomass for the main taxonomic groups of the discarded fraction for the shallow shelf and for the middle slope from the Balearic Islands. 40D: 40 mm diamond mesh; 50D: 50 mm diamond mesh; 40S: 40 mm square mesh; ns: not significant; * p<0.05; ** p<0.01; *** p<0.001.

2. A manuscript entitled "*Improving the ecological efficiency of the bottom trawl fishery in the western Mediterranean: It's about time!*" has been published in the scientific journal *Marine Policy (Guijarro B., Ordines F., Massutí E., 2017, 83: 204-2014.* http://dx.doi.org/10.1016/j.marpol.2017.06.007). This work analyzes different measures to mitigate the direct and indirect impact of the bottom trawl fishery in the western Mediterranean, through three experiments and different technical measures: i) changing vessel operation routine and the mesh shape in the cod-end; ii) using more hydrodynamic bottom-doors, lighter gear and 40 mm square mesh in the cod-end; and iii) using mid-water doors not contacting the seabed and 40 mm square mesh in the cod-end. Results showed that these measures can reduce the direct impact of bottom trawling on the seabed and its indirect impact on the ecosystems, through reducing discards and even the emission of CO_2 into the atmosphere. These outcomes, which allow improving the ecological efficiency of this fishery, have other direct positive consequences in the short term, as the reduction of its operation costs and hence the improvement of the economic efficiency. Reductions in the weekly activity would also improve the life conditions of the crew, an important aspect taking into account the difficulties of the fishing sector to offer attractive jobs for young people in coastal communities during the last decade, a key objective of the future Common Fisheries Policy. It is concluded that after years of studies focused on improving the sustainability of the Meditrraenan bottom trawl fishery, it's about time to turn this improvement into reality.

3. After the WP3 meeting held at DTU-Aqua (Copenhagen) the 7th and 8th June 2016, a total of five different factsheets on selectivity were prepared by the IEO for the DiscardLess selectivity catalogue (http://www.discardless.eu/selectivity_manual). These factsheets provide a brief description of catch comparison and selectivity trials that have been carried out by our scientific team in the western Mediterranean. The factsheets, which can be downloaded as a pdf from the link above, were: 1) Diamond and square mesh codends to improve the selectivity of the Mediterranean bottom trawl fishery; 2) Fitting square mesh panels to improve bottom trawl selectivity on the Mediterranean continental shelf; 3) Fitting square mesh panels to improve bottom trawl selectivity on the Mediterranean continental slope; 4) Using 50 mm diamond and 40 mm square mesh codends to improve the selectivity of the Mediterranean bottom trawl fishery; and 5) Using flexible sorting grids to improve the selectivity of the Mediterranean bottom trawl fishery.



4. It has also collaborated in the review of the manual entitled "Selectivity in Trawl Fishing Gears", by F.G. O'Neill and K. Mutch (Scottish Marine and Freshwater Science, Vol. 8, Nº 1, 16 pp, http://www.discardless.eu/media/publications/00513830.pdf). This manual contains the sheets mentioned above and it is aimed to review how different parts of the trawl gear influence selectivity, with the objective to show fishermen, net makers and fisheries managers which modifications can be made to improve trawl selectivity.

2.2.2 fishing strategies

1. Both the IEO and IFREMER attended the Workshop on WP4 held in Dublin between the 27th and 29th September 2016. This Workshop was focused on Task 4.1-The Fishers story, Task 4.3-The Scientitsts story and Task 4.4 The managers story. Progresses done on all these three tasks in the western Mediterranean CS were presented and discussed in this Workshop. A synthesis of these progresses is given below.

The Fishers story: To document the suggested discard reduction fishing practices from the Balearic Islands, a total of 7 interviews (3 bottom trawl fleet, 4 small-scale fleet) were performed in Mallorca. To take into account differences in local perceptions, the interviews were carried out at different ports situated along the island's coast. As the answers were similar in all cases, it was decided not doing more interviews. Interviews included both the bottom trawl (BTF) and small-scale (SSF) fisheries. There was a general claim in both fisheries: Traditionally, the small-sized fish was not a problem for fishermen, neither from the BTF nor the SSF, which were only interested in catching as much fish as possible. However, this situation changed with the implementation of Minimum Landing Sizes (MLS) and the corresponding inspection of catches.

According to fishermen, the main problem of small-sized fish is restricted to hake (*Merluccius merluccius*). Some fishers report that, unlike other species (e.g. red mullets), hake recruitment does not seem to have a clear seasonality and large quantities of recruits can be captured almost all year round at some specific continental shelf areas and depths. These areas were not exploited routinely; they were only used when the bad weather conditions prevented working at deeper depths where the fleet targets high value decapod crustaceans. Other fishers report that these hake recruits were only taken during some specific periods (February-March, May-June). After the implementation of the MLS, fishermen do not use these areas and periods in order to avoid catching small-sized hake.

Bottom trawl fishers did not use gear modifications to avoid catching small-sized individuals because this is a highly multispecific fishery and the problem was reduced to hake. For fishers, increasing the mesh size to reduce hake recruits would entail reducing the catches of small-sized species with important commercial value (e.g. picarel). Currently, with the implementation of the 40 mm square mesh cod-end this problem has been diminished because it reduces considerably the capture of individuals under the MLS.

The SSF is clearly seasonal, being adapted to the life cycles of the different species (Quetglas et al., 2016). Fishers change the target species and the gear used with the seasons. The strategies used by fishers to reduce discards depend on the target species.

2. The Scientists *story (IEO)*: Fisheries independent and dependent data were gathered to create maps showing zones of high discard likelihood in space and time from the Balearic Islands. Regarding the independent data, information from the MEDITS surveys carried out around the Balearic Islands between 2003 and 2016 is being used. During the MEDITS surveys, a total of 50 fixed sampling stations are sampled annually around Mallorca and Menorca islands, between 50 and 800 m depth. These stations have been used to produce maps of densities and to determine the persistence of hotspots for the most important demersal resources. The figure 2.4.1 shows these two parameters (density and hotspot persistence) for juveniles (<MLS) and adults (>MLS) of European hake around the Balearic Islands. The maps showed that, in most cases, the main density areas of juveniles and adults do not overlap, which would allow defining specific areas to avoid catching hake individuals below the MLS (20 cm).

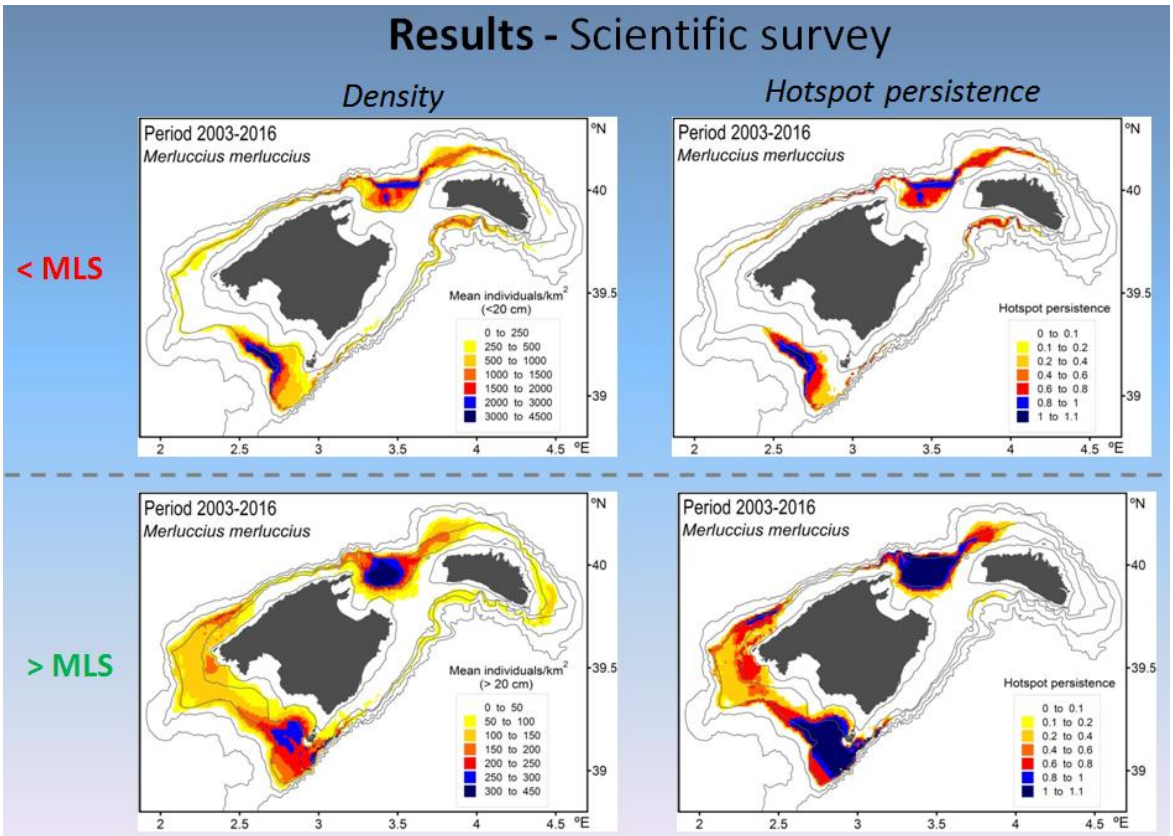


Fig. 2.4.1. Density and hotspot persistence of hake individuals under and over the minimum landing size (MLS) in waters around the Balearic Islands.

Data from MEDITS surveys has also been used to determine the persistence of hotspots of young of the year and the species richness for some of the main demersal species, as well as their total abundance and biomass, along the Mediterranean coast of the Iberian Peninsula and around the Balearic Islands. The species analysed have been the elasmobranches *Galeus melastomus* and *Scyliorhinus canicula* and 4 teleosts *M. merluccius, Helicolenus dactylopterus, Phycis blennoides* and *Lepidorhombus boscii*, which represent 39 and 40% in abundance and biomass, respectively of the commercial demersal fish species in the area and 15 and 27% in abundance and biomass, respectively of the demersal fish assemblages in the area. The overlap between persistent hotspots of young of the year species and persistent hotspots of demersal fish abundance/biomass and species richness is mainly located along a narrow band along the Spanish Mediterranean coast, offshore Mar Menor and around the Balearic Islands (Figure 2.4.2). The areas offshore the Iberian Peninsula almost disappear when we focus at the higher rates of persistence (i.e. 80% persistence).

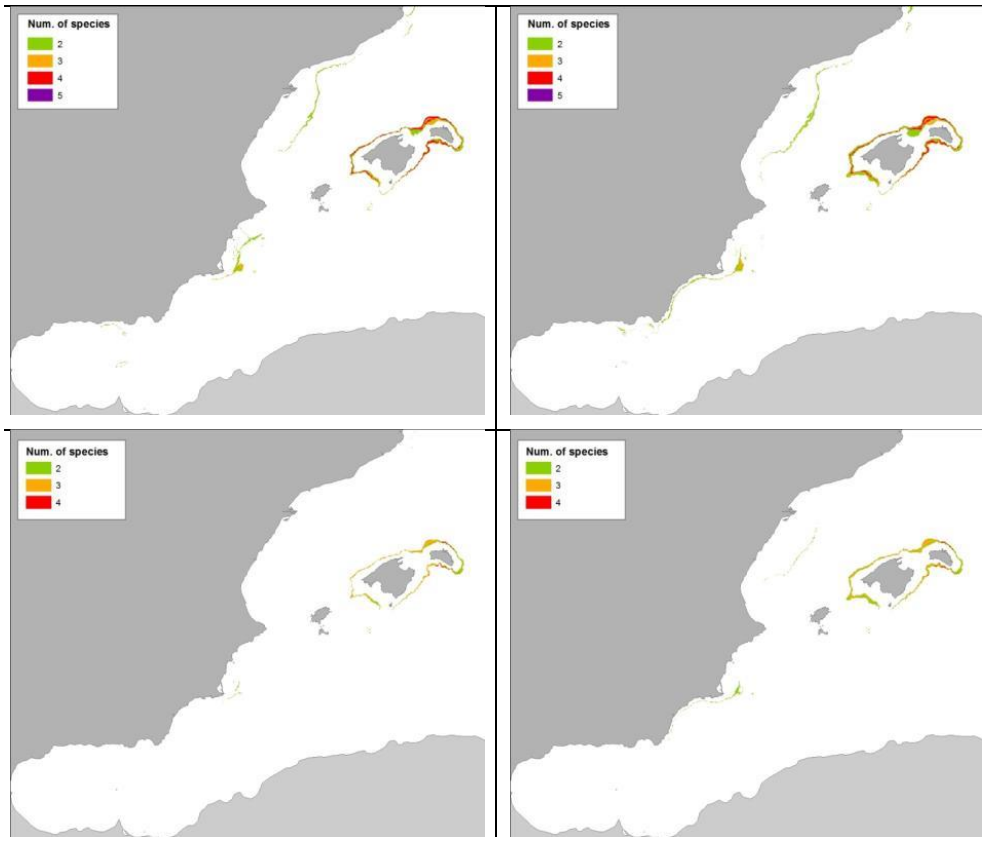


Figure 2.4.2. Spatial overlap between overlapping persistent hotspots of young of the year and i) the persistent hotspots of abundance of demersal fish species (left) and ii) the persistent hotspots of demersal fish species richness (right) and for two levels of persistence: 60% (upper) and 80% (lower).

In the case of dependent data, information from sampling onboard commercial bottom trawlers during the same time period is also being used (a total of 1456 fishing sets). In contrast to the scientific surveys, the commercial sampling does not follow a regular sampling grid whereby a fishing ground approach is being used in this case. However, and also in contrast with the snapshot given by the scientific surveys, the commercial sampling takes place all the year round, which allows following seasonal variations of spatial distribution of fishing resources densities. The figure 2.4.3 shows the seasonal variations of the standardized hake abundance, both the discarded and commercial fraction, for the most important fishing grounds around Mallorca (37, 71, 72 and 75). As above, the graphs would help fishermen to choose the best season and fishing ground in order to avoid taking fish under the MLS.

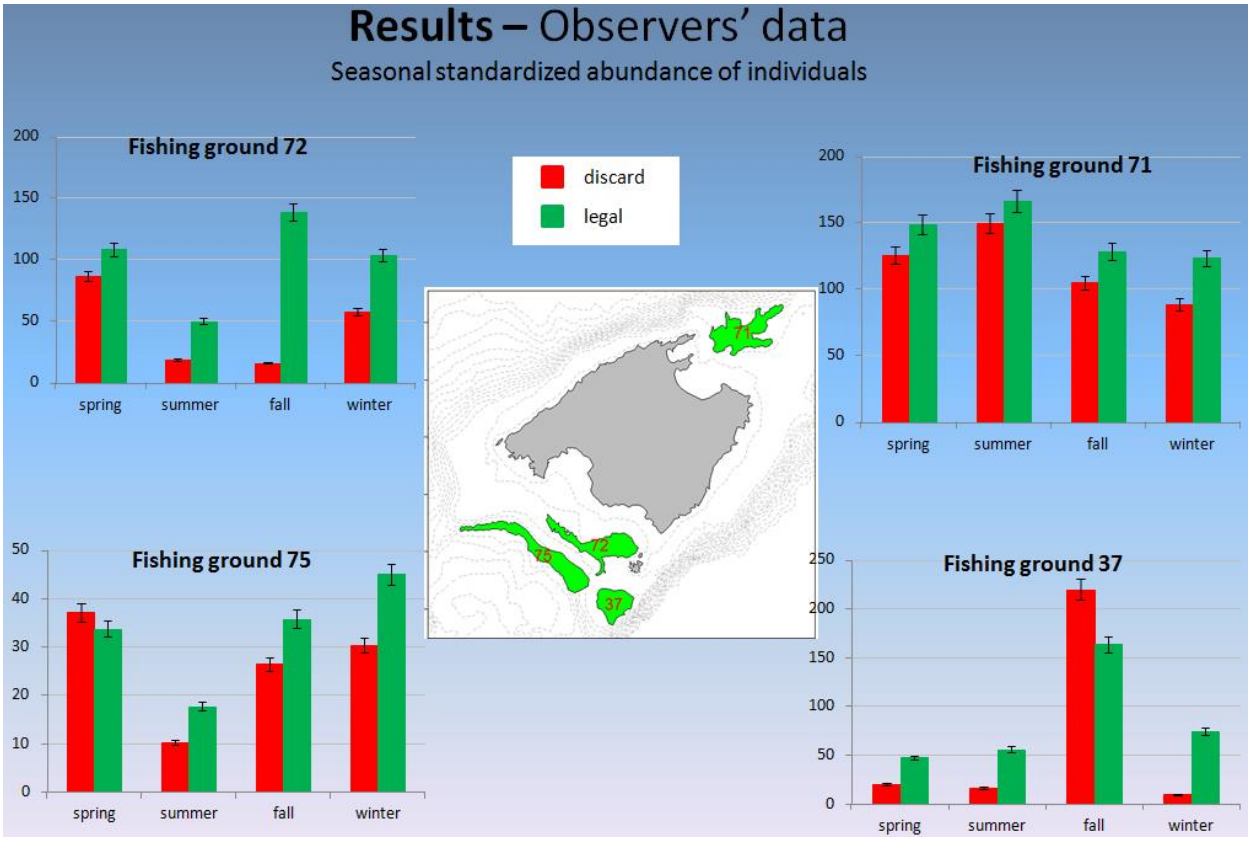


Fig. 2.4.2. Abundance of hake individuals under (discard; red) and over (legal; green) the minimum landing size in the main fishing grounds of this species in the Balearic Islands.

3. In the Gulf of Lions a study was undertaken to map the captures and the undersized species distribution of trawl fisheries. Thus, observation at sea data and scientific surveys MEDITS and PELMED were geostatistically analized and interpolated with kriging method. Distribution maps of undersized commercial species were then used to undertake a spatial planification exercise aiming at proposing spatial strategies to avoid discard at seasonal scale (Fig. 2.4.3). Many avoidance scenarios were produced in order to identify strategic zones that need to be avoided to protect undersized commercial species. For every scenario, three protection degrees of trawl fishery were considered to maintain this activity. This study showed that the coastal zone was the most important one for both trawl fisheries and undersized specied protection, and thus underlined the necessity to find a management compromise in this area. Seasonal scenarios of spatial planification represent an interesting baseline for discussion between scientists and fishermen and then could help to elaborate management plans.

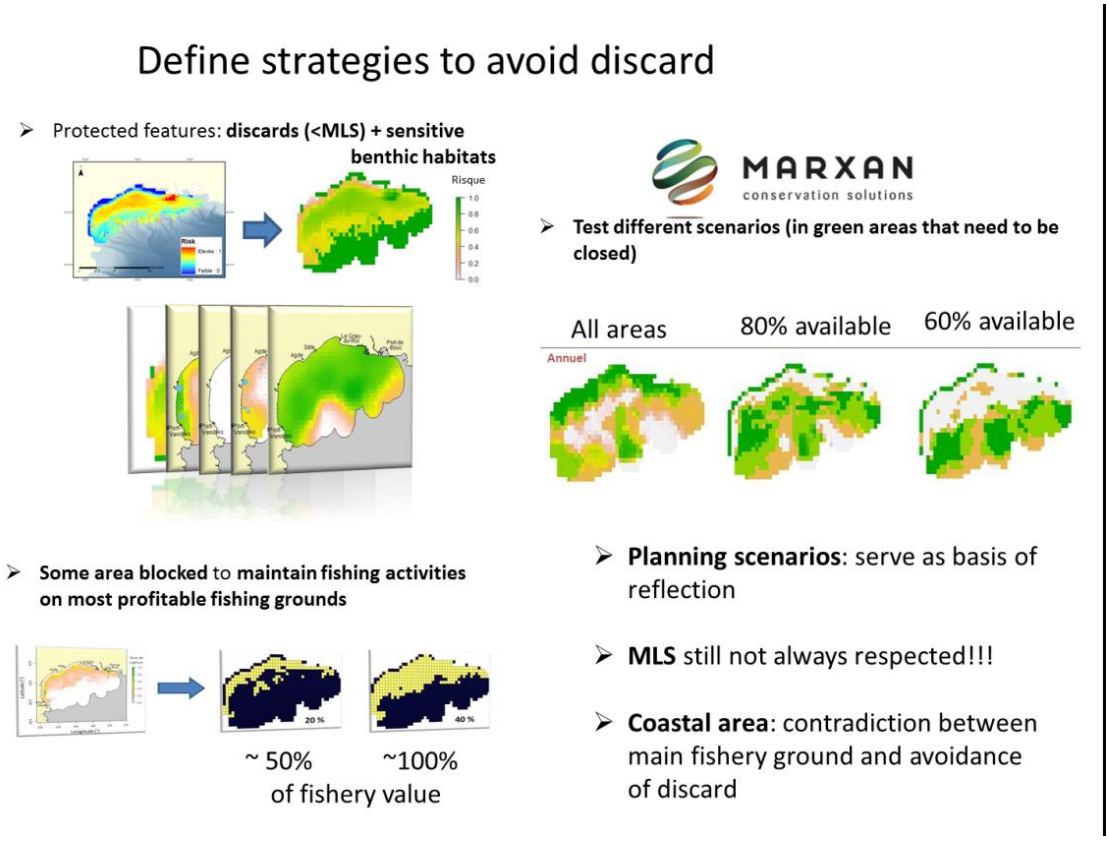


Fig. 2.4.3. Spatial planning of avoidance strategies in the Gulf of Lions using MARXAN.

2.3 Policy Outreach

2.3.1 meetings

1. To produce guidelines for the implementation of the discard policy in the CFP and regional polices, different meetings were held at both national and regional level:

i) Spanish Ministry of Fisheries, Madrid, November 3rd 2016.

The Ministry agrees with the fundamental principle of the LO, which is considered a necessary measure since it cannot be continued with the current levels of discard and the food waste of catches with high protein value that this implies. Given the difficulties of its implementation within the current management framework, the tight timetable set and the diversity of the fleet to which it is addressed, more flexibility would be welcome for its implementation.

The Ministry has participated in the implementation process and in the elaboration of discard plans, at the moment it is part of 3 technical groups of discards. These groups pass the technical recommendations to the High-Level Group (HLG), made up of the General Directors of Fisheries, who actually make the decisions and guide the work of the technical groups, agreeing on the terms in which the Joint Recommendations are written.

At the national level, the Ministry has created an information and coordination tool called the State Bureau for the Elimination of Discards (MEED, in its Spanish acronym). In order to be more operational, several working groups have been organized including a specific working group for the Mediterranean, in which the Autonomous Communities, the fishing sector, NGOs and scientists are represented.

ii) Mediterranean Advisory Council (MEDAC), Rome, November 29th 2016.

During the first negotiations of the Green Paper previous to the adoption of the CFP Reform, including the LO, all members of the MEDAC Executive Committee, with the exception of Oceana and the European Anglers Alliance (EAA), were against the LO because they thought it would increase the black market of small-sized fish and asked for a derogation for the Mediterranean Sea due to its specificities of highly mixed fisheries (e.g. target species varies not only in composition but also in size). However, once the Basic Regulation was published on the EC Official Journal, the MEDAC did its best to implement the LO provisions properly and managed to find a way to propose useful elements to draft the Joint Recommendations (JR), although many members of the professional sector have expressed their opposition to implement the LO.

During the first years of the LO implementation (2013), most member states (MMSS) did not have data on the undersized fish fraction of the species defined in the Annex III of the Mediterranean Regulation; they only counted with general information on discards (e.g. total, main taxonomical groups). The MEDAC proposed an adaptive approach in order to see what the real situation was and then decide how to proceed accordingly. That's why the MEDAC proposed to the relevant MMSS the development of pilot projects during the first two years (2015-2016) in order to collect specific discard data to know the percentages of those species listed in the Annex III.

According to MEDAC, Mediterranean fishermen should no longer see EU regulations as tailored only to Atlantic fisheries. They have already started to change their minds and to be constructive, proposing useful elements, such as the MEDAC advice on the Strait of Sicily. MEDAC managed to draft the JR for some demersal species, giving priority to measures aimed at minimizing or eliminating the capture of undersized specimens of the target species identified, both by means of increased selectivity and by avoiding fishing activities on sensitive areas where juveniles of these species concentrate seasonally.

iii) Environmental NGO Oceana, January 30th 2016.

A discard regulation in Europe was really needed. However, the final version of the LO has changed substantially compared to how it was initially designed. That's why Oceana published a leaflet summarizing its main concerns to the LO in June 2012.

According to Oceana, the LO contains both good and bad things. Article 15 (Landing obligation) of Regulation 1380/2013 lacks specific measures and incentives aimed at minimizing unwanted catches in the Mediterranean. In this sense, the LO is much less ambitious in the Mediterranean than in the

Atlantic where reductions of discards are incentivized through counting unwanted catches against quota. In the Mediterranean there is no an incentive system in place to ensure reduction of discards, i.e. incentives to improve the exploitation pattern as to minimize unwanted catches. There should be a framework to reduce unwanted catches based on Articles 7 (Type of conservation measures) – and in particular identifying mechanisms to prioritize access to fishing grounds to more selective fisheries - and Art. 8 (Establishment of fish recovery areas).

Overall, Oceana considers that the Delegated Regulation, both for small pelagics and demersal stocks, are not based on scientific criteria. It results that the LO has turned into a mere request for exemption for the Mediterranean bottom trawling fleet. The Delegated Regulation fails to identify a fishing strategy to reduce unwanted catches, such as the incentive to use more selective gears and the establishment of stock recovery areas to reduce catches of undersized individuals.

2. Several skype meetings have taken place during this year to produce the Mediterranean Policy Brief that will be presented at the next DiscardLess Annual Meeting to be held in Rome in March 2017. This Policy Brief aims at providing an overview of the current status and initial experiences, barriers, and opportunities with regard to applying the LO in the Mediterranean. The Policy Briefs produced withing DiscardLess are written for policy makers, the fishing industry, NGO's and citizens with an interest in fisheries management and are based on policy documents, stakeholder interviews, meetings and literature.

2.3.2 communications

1. Different information sources (e.g. STECF and GFCM reports) have been provided to feed the western Mediterranean case study of the ATLAS (Atlas-WestMed). Data gathered under different scientific projects (e.g. MEDISEH, DISCATCH) will also be provided.

2. Oral presentation at the ICES Annual Science Conference (2016) held in Riga (Latvia) (CM Code: Q:504): Ecological and bio-economic inplications of the Landing Obligation on balanced harvesting in Mediterranean fisheries by Rueda L., Hidalgo M., Maynou F., Guijarro B., Massutí E. and Quetglas A.

3. Oral presentation at the 41th CIESM Congress held in Kiel (Germany): Selectivity in a Mediterranean bottom trawl fishery: is the Council Regulation (EC) Nº1967/2006 enough for fulfilling the Landing Obligation? by Zapata M.A., Ordines F. and Guijarro B. (CIESM_Congress_2016_Kiel_article_0523.pdf).

4. Selectivity factsheets providing a brief description of selectivity trials carried out in the western Mediterranean by the IEO are available at http://www.discardless.eu/selectivity_manual.

5. Annual meetings with local stakeholders to monitor changes in their perception of the Landing Obligation: i) Gulf of Lions (IFREMER), April 8th in Sète; ii) Catalan Sea (IEO), June 14th in Barcelona; and iii) Balearic Sea (IEO), July 11th in Palma de Mallorca.

6. Interviews with national stakeholders (IEO): Spanish Ministry of Fisheries, Madrid, November 3rd 2016.

7. Interviews with regional stakeholders (IEO): i) Mediterranean Advisory Council (MEDAC), Rome, November 29th 2016; ii) environmental NGO Oceana, January 30th 2017.

2.4 Summary:

The ecosystem and socioeconomic impacts of the LO have been modelled by means of size-spectra and bioeconomic modelling, respectively. In both cases, results showed that the LO will not have important effects in the western Mediterranean. Size-spectra analyses did not reveal significant changes as a result of the implementation of discard reduction strategies, which could be due to the fact that Mediterranean fisheries depend mainly on small-sized fish whereby it is difficult to notice further effects on mean population sizes. In case the LO would require contracting a new crew member per boat to help with sorting out and storing discards on board, there would be a reduction in the average daily crew wage given that benefits are not expected to increase because at present there is no an alternative market to commercialize individuals under MLS.

Progresses were done in our objective of helping western Mediterranean fishers to avoid unwanted catches. Regarding the adaptation of gear technology, different selectivity trials carried out in the study area were provided as factsheets (http://www.discardless.eu/selectivity_manual) that might be useful to reduce the volume of discards in the bottom trawl fishery. Apart from gear modifications, preliminary results regarding the adaptation of fishing strategies indicate that mapping the spatio-temporal distribution of the main resource could also be used as a tool to help fishers choosing the best season and fishing ground in order to avoid taking fish under the MLS. In the Balearic Islands, for instance, the main density areas of juveniles and adults of European hake do not overlap, which would allow defining specific areas to avoid catching individuals below the MLS (20 cm). Such maps were presented to French fishers who generally favors spatial closures rather than change in gear selectivity but demanded a balanced effort for the fleets of every harbours (closed areas should be distributed equally over all the GSA).

Stakeholders perception about the LO has not changed at all with respect to the first year meeting held in Bilbao (April 2015). After the first two years of implementation to small-pelagic fisheries there have not been major consequences for the Mediterranean fishers, mainly because of the use of the "slipping" and the "de minimis" exemptions. Although it is still too early to talk about the effects on demersal fisheries, stakeholders do not forsee important consequences either due to the low number of species affected (mainly hake and red mullets) and the low threshold established (25% total landings) for vessels to be committed to the LO.

3 The Year ahead of us (2017-20118): What do we expect for the next year?

1. Progresses on the calibration of the Ecopath and ISISFISH models used in the case study. Simulations of the different scenarios are foreseen for month 36 (WP1).

2. Analysis and maps of sensitive benthic habitats distribution in the Gulf of Lions, based on environmental predictors and species functional traits. Two independent strategies to evaluate potential and observed benthic sensitivity will be used to produced risk maps where trawling pressure should not be increased (WP1).

3. Update stakeholders perception of the LO from meetings with both for French and Spanish stakeholders (WP2).

4. Further analyses of economic impacts on the Balearic Islands trawl fishery by means of the bio-economic model MEFISTO (WP2).

5. Translation of the selectivity manual and factsheets to the three languages used in the area (French, Spanish and Catalan) (WP3).

6. Preparation of a manuscript comparing fishing yields, selectivity and quality of catches in the trawl fishery developed off Mediterranean Iberian Peninsula (GFCM GSA 1: Northern Alboran; GFCM GSA 6: Northern Spain), using 40 mm square mesh cod-end with two different twine thickness: i) 3 mm, which is established by the Council Regulation (EC) Nº1967/2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean; and ii) 5 mm. This information has been compiled during the project "*Mejora de la selectividad de los artes de arrastre en el Mediterráneo español*" (TORZAL), funded by Fundación Biodiversidad (reference: 20124302) and carried out by the IEO and the Spanish Fishing Confederation (CEPESCA) during 2014.

7. Preparation of a manuscript assessing the bottom trawl selectivity through the introduction of panels of un-knotted *Dyneema* 54 mm square mesh and 1.2 mm twine thickness attached to the extension piece of the nets: i) a single trapezoidal panel (7.4x4.0x12.0 m) of approximately 68.4 m^2 in the two-panels net used in the continental shelf (targeting fish and cephalopods); and ii) ten panels in the four-panels net used in the middle slope (targeting decapod crustaceans), four panels of 6.7x8.7, 6.6x6.0, 4.4x4.0 and 3.3x2.7 m (~124.69 m^2) in the upper plan, and three panels of 6.7x2.4, 6.x0.8 and 1.7x0.4 m (~43.9 m^2) in both lateral plans. This information has been compiled during the "*Pilot Project on catch and discard composition including solutions for limitation and posible elimination of unwanted by-catches in trawl net fisheries in the Mediterranean*" (DISCATCH), funded by the DG MARE European Commission (Contract Nº MARE/2012/24 Lot 2) and developed during 2014 (WP3).

8. Spatiotemporal distribution of juveniles hotspots from the main demersal stocks using both scientific data (MEDITS surveys) and on board commercial sampling. Two different approaches will be used: i) a general map at broad scale covering the entire study area (GSAs 1, 5, 6 and 7); and ii) maps at short spatial scales for each focused area (Gulf of Lions and Balearic Islands). These last maps are intended to be used for fishermen as tools to avoid areas with high abundance of recruits in order to reduce discards (WP4).

9. Preparation of a manuscript on hotspots of demersal fish resources along the western Mediterranean, with data from MEDITS survey developed off Mediterranean Iberian Peninsula (GFCM GSA 1: Northern Alboran; GFCM GSA 6: Northern Spain) and Balearic Islands (GFCM GSA 5). Data was compiled and revised, and analysed in a preliminary way, during the project MEDISEH (Mediterranean Halieutic Resources Evaluation and Advice: Compilation and mappins of environmental and fisheries related information in the Mediterranean Sea by means of Geographical Information Systems, funded by DG MARE European Commission (Contract Nº MARE/2009/05) and developed between 2011 and 2012.

10. Check and update the information currently available in the ATLAS from both the French and Spanish side (WP7).

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