ECOSAFIMED

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CROSS-BORDER COOPERATION IN THE MEDITERRANEAN

Towards Ecosystem Conservation and Sustainable Artisanal Fisheries in the Mediterranean basin

Final report

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CONTENT

1. EXECUTIVE REPORT

Towards Ecosystem Conservation and Sustainable Artisanal Fisheries in the Mediterranean basin – ECOSAFIMED

The project "Ecosystem conservation and sustainable artisanal fisheries in the Mediterranean basin (ECOSAFIMED)" has been coordinated by Biodiversity Foundation, from the Spanish Ministry of Agriculture, Food and Environment, and its partners have been the Institute of Marine Sciences of CSIC, the National Institute of Marine Sciences and Technologies in Tunisia and the University of Genoa.

The project, carried out in Spain, Italy and Tunisia, aimed to promote sustainable artisanal fisheries practices in a compatible manner with the conservation of the marine biodiversity in the Mediterranean Basin. For this purpose, an evaluation of the status of the benthic communities and a study related to the impact of some fishing métiers were conducted in cooperation with fishermen and other national and international organizations. As a result of this evaluation, several recommendations have been developed for reducing the impact of the artisanal fishing and achieving the preservation of the habitats, with the purpose of being implemented by fishermen and other stakeholders. The study also has provided an opportunity to identify areas of high ecological value that may be object of some special protection.

In order to understand how we achieved the goals of the project we try briefly to detail the procedure carried out during the entire grant. The specific objectives of the project were the same for the three countries, although sometimes the procedures developed have been different. For example, the evaluation of the trawling areas, the VMS data were used in Spain and in Italy and Tunis interviews to the fishermen were the source of information, but both methods gave us the same information and were very useful for the next steps. Afterwards the degree of artisanal activity was selected according to high, medium and low impact artisanal activity, and at the same time the characterization of the fleet was done. Different gears were selected in each country due to the capability to make onboard surveys, because the objective was to quantify and determinate the structural benthic species captured (as a consequence, impacted) by the artisanal fishery, depending of the effort degree previously identified.

The last step was to complete the ROV surveys in the study areas; in that case the objective was to characterize the benthic communities and the actual healthy status of these communities. At the same time, the procedure during the fishing activity was analyzed and some experiments were carried out to improve the survival of the bycatch during the fishing operation. Finally, one of the keystones of the project has been the permanent dissemination of the results to the main stakeholders. All these actions were developed and based in scientific procedures and, as a result, the main capitalization of the ECOSAFIMED project, and achieved for the first time in Spain and Italy, has been the marine stewardship agreements signed by stakeholders according to the proposed guidelines (see below). These agreements encompass approximately more than 400 artisanal fishermen.

As a result of all of these activities during the two years of the project two main results directly derived of the ECOSAFIMED actions has been achieved, 1) 10 guidelines to reduce the impact of artisanal fisheries on the Mediterranean seabed were offered to fishermen and 2) several sites were selected as potential areas for protection, due to the present healthy status and high ecological value that, at this moment, is considered as exceptional in the Mediterranean.

Two main aspects must be highlighted:

- Application of new methodologies and technologies recently developed in the Northern Mediterranean basin for the exploration of the sea beds, which have allowed the acquisition of valuable information of the biological richness of our Mediterranean sea and an important amount of good quality images that can be used now for scientific and communication purposes.
- Close cooperation with artisanal fishermen, who have become actors in the exploration of the sea beds and the evaluation of the impact of their fishing activity with the aim to improve its sustainability.

In summary, the project has combined, beyond the scientific aspects and the expected results, a good twinning among the different partners, and with the different stakeholders. The transfer of knowledge from northern countries to southern partners has been a total success. The presence of fishermen in many of the actions proposed in the project has given meaning to all the effort made by the partners to carry out the objectives successfully. Actually this project can be seen as an example of cross order cooperation between scientists, managers and fishermen in the Mediterranean region.

2. INTRODUCTION

The destruction of marine habitats has been perceived during the last decades as one of the main threats to the marine environment. Commercial fisheries expanded across the world have been a major cause in the reduction of fishing landings, as they use non species-specific gears, mostly benthic beam and otter trawls. Nevertheless, there are also other kinds of fisheries working in most areas, which probably explain the existence of exploited habitats with well-preserved marine communities.

The main aim of the ECOSAFIMED project is to promote sustainable artisanal fisheries and the conservation of the Mediterranean seabed. After two years of study in six different maritime areas of Spain, Italy and Tunisia, the project offers, as one of its main results, a set of guidelines to make artisanal fisheries activity more sustainable. These results have been reached after analysing the data from oceanographic surveys, where the seabed has been filmed, and from direct observation during on-board surveys with fishermen. In this regard, the impact of selected métiers (trammel nets, longlines and gillnets) over benthic communities has been assessed. Finally 10 recommendations are proposed to fishermen, public Administration and scientific bodies to reduce the impact of artisanal fisheries on the seabed.

3. METHODOLOGY AND MATERIALS

a. SELECTION OF STUDY AREAS AND FISHING METIERS

3.1.1 Study areas

The ECOSAFIMED project has been carried out in three Mediterranean countries: Spain, Italy and Tunisia and namely in the following marine areas:

- Spain: Cataluña (Cap of Creus) and Balearic Islands (Minorca channel)
- Italy: Sicily (gulf of Patti) and Lazio (Pontine archipelago)
- Tunisia: Bizerte, Jendouba, Nabeul, Ariana and Tunis (La Galite Archipelago and Esquerquis Bank)

The first objective of the ECOSAFIMED project was to select study areas between 60 and 120 meters depth that were simultaneously a) trawl-free and b) used by artisanal fisheries, as the first step for the assessment of the impact of artisanal fisheries in the Mediterranean basin. In this areas bottom trawlers are absent, mainly due to the seabed morphology and geology, although artisanal fisheries using species-specific gears are not equally excluded.

The methodology employed to designate the study areas has laid in the use of three main tools: Vessel Monitoring System (VMS) data in those places where it was available (this has been only possible in the case of Spain), contact with local fishermen and field interviews in order to gather information about local knowledge concerning trawling and artisanal activity, and bibliographical research for comparison and redefinition of results.

a) VMS data: taking into account that knowing the spatial effort of the different fleets has always been a major challenge to fisheries management, this technology provides direct information at all times of the position of each fishing ship, its course, the time spent in each position and its current speed. This system is basically used to monitor the commercial fishing fleet making possible to assign changes of habitat and benthic communities to the fishing effort at spatial scale that allows to measure disturbance gradient; the data obtained must be proposed as an essential tool to quantify and manage the alterations produced in the ecosystem by the commercial fleet.

The objective of this preliminary analysis was to determine the areas covered by bottom trawlers in order to propose which areas can be considered free of trawling. With this kind of analysis, we could understand the potential spatial limits where artisanal activities happen exclusively. The processing of the VMS data is strictly descriptive: data was selected according to the average speed at which trawlers work (2 to 5 knots) and the average time of trawling (approximately more than twenty minutes) for each vessel, which has been identified by a code. This work pretends to provide a better distribution model of the presence of trawlers in the fishing ground.

VMS is now available in many countries in all fishing vessels over 24 meters in length, and also on those ships over 12 meters long fishing in foreign waters. The information produced is sent to a data center that is active 24 hours a day, 7 days a week.

b) Grid interviews: interviews to the fishermen can be employed to gather useful information relative to the dislocation of the fishing grounds over large areas as well as important data on the typology of the gears used by large fleets. A simple 1x1km grid has been overlapped on the map of each study area. This paper has been presented to the artisanal fishermen of the involved harbors so that each one was able to draw, mark or color the cells where his fishing vessel commonly works for each selected gear. Additional information was obtained by asking to define whether in each fishing ground the activity effort was high, medium or low, intended as how much time is spent over the all season in this area. The computer overlap of these data was used to create a single map for each study area indicating the no-trawl area boundaries as well as the specific dislocation of the fishing grounds.

   Moreover, another traditional method to understand the spatial effort of the fleet is through personal interviews to fishermen. During the interviews they were asked about the frequency of fishing in each area, as well as about the technical characteristics of the gears used and the different métiers. But similarly to the grid interviews method, there was a subjective component to the answers given and the data quality was not always entirely acceptable.

c) Bibliography: bibliographic research aimed at collecting information relative to previous fishing surveys carried out in the study areas, oceanographic and topographic data, maps, bycatch data, as well as to previous bionomic characterizations of the sea bottoms, in order to be able to delimitate smaller suitable trawl-free grounds where to concentrate the field surveys. The references of the collected material have been organized in a bibliographic list with a common formatting specific for each country and each study area.

For the project ECOSAFIMED the three techniques have been used differently by the three partners based on the different availability of previous data. In Spain, the selection of suitable areas accomplishing the ECOSAFIMED criteria of trawl-free and artisanal fishing ground was made thanks to the large dataset of multibeam and VMS data obtained in previous surveys; as a result, two maps have been produced, one for Cap de Creus and one for the Minorca Channel. In Italy and Tunisia, this material was not available; therefore, the maps were obtained based on bibliographic data as well as grid interviews.

3.1.2 Fishing *métiers*

The artisanal fishery, as opposed to the industrial one, implies a relative small financial investment, the use of several types of gears and the exploitation of different target species, with each type of fishing carried out with particular gears, specific technical characteristics, in specific seasons. Thus, it has many different characteristics in each country, and not only within the country, probably in

each area: one of the special features of the artisanal fisheries in the Mediterranean is that they are multi-gears and multispecies.

Preliminary tasks for the scientists involved in the ECOSAFIMED project included the evaluation of the impact of the local artisanal fishing activities in the seabed of the study areas through the identification of the artisanal fleets in first place, followed by the determination of their selected métiers, meaning the activity practiced on board a given type of boat, which is characterized by one catching gear and one or more group of target species, operating in a given area during a given season, within which each boat's effort exerts a similar exploitation pattern on a particular species or group of species.

Due to the high number of métiers used by the Mediterranean artisanal fishery, a selection was made based on the most common used gears (trammel nets, gillnets and longlines) and fisheries (targeted species like red spiny lobster or groupers) characterizing each study area. These gears were selected specially on the basis of their potential impact over the benthic communities, since they mainly operate on the bottom or in its proximity. The selection was operated also in consideration of both the work window for the three partners (summer for all three partners) and the necessity to act a common data elaboration.

Finally, three priority gears were identified in the three countries, such that all experimental fishing surveys foreseen in the project (60 for Spain, 70 for Tunisia and 60 for Italy) would focus on *métiers* using these gears. In Spain, only trammel nets have been evaluated due to the use of this *métier* during the season when the surveys were taking place (long lines and gillnets are used in autumn and winter) and because this is probably the most impacting *métier*. For the same criteria, retained gears in Tunisia are trammel nets and longlines. On the other hand, trammel nets gillnets and longlines were assessed in Italy.

Therefore, in order to have the possibility to partially compare the results, it was impelling the accomplishment of a single strategy based on a common fishery, trammel net and two other gears (gillnets and longlines).

In regards to the gears,

a) European spiny lobster trammel net: the european spiny lobster (*Palinurus elephas*) is widely distributed and exploited in the NE Atlantic and Mediterranean waters where it lives on rocky, coralligenous and maërl substrates from close inshore to depths of 200 m where micro-caves, crevices and natural holes are available. In recent decades, the most productive Mediterranean lobster fisheries appear to occur around islands, where there are suitable isolated rocky substrates that have provided refuge to exploited populations, as in the Eastern Adriatic, Corsica, Sardinia, Sicily, Balearic Islands, and off northern Tunisia; a great productivity is also noted in high rocky bank area as Esquerquis bank in Tunisian water. In concrete, in the western Mediterranean Sea the spiny lobster commands high prices and its fisheries, which are very much regulated, have great socio-economic importance, supporting a large number of small-scale artisanal vessels.
   It is traditionally targeted by artisanal fisheries, but the change in fishing strategy (from traps to trammel nets) that took place between the 1960s and the 1970s has severely impacted lobster populations, having declined its catches in most of the distribution range during recent decades.

b) Longlines: artisanal longline rigs consist of a monofilament mainline which is currently made of synthetic materials such as nylon, perlon, polyamide, polyester, etc. This line can vary in size, but it is always the thickest and most resistant of the rig; hanging from it, attached with

swivels, there are secondary lines, called branch lines, with 0.5 to 1.2 mm diameter monofilament of variable length (0.7–2 m) spaced 1.5–7 m apart (features may vary depending on the target species), with hooks on their ends. There are several types and sizes of hooks but those who normally are used by the fleets operating in the Mediterranean Sea are the French type VMC aluminum hooks and Mustad brand steel hooks numbering from 1/0 to 5/0.
It is practiced all over the Mediterranean coast on board small boats, <15 m long, on short trips rarely lasting 12 h, and, although there is a wide variety of longlines, the most common one is the bottom longline, where the line is set lying in the sea bottom, weighted at both ends with a rock or lead weight attached to a buoy. Timing of fishing and duration of soak time depends on the target species, area, depth and bait used.
Target species are principally groupers (*Epinephelus marginatus* and *E. costae*) and high value sea breams (*Sparidae* species). In some sandy places there is a specific longline métier targeting European seabass (*Dicentrarchus labrax*). In deeper waters (100-600 m) longlines are targeting European hake (*Merluccius merluccius*).

c) Gillnets: are passive fishing gears composed by several pieces of nets tied together to form a rectangular single ply set upright in the water perpendicular to the fish direction. Gillnets are made of monofilament or multimonofilaments or multifilament nylon. These gears are widely used in small-scale fisheries due to their simplicity, little investment and easy manipulation. Gillnets gears are very size selective and tend to catch fish of a specified size range only, excluding capture of small and large specimen. Gillnets are mainly used to target demersal bony fish (e.g. red mullet, hake, S*paridae*) but also to target cephalopods and crustaceans. In Mediterranean Sea, several mesh sizes are used according to the local traditions, the year period, the depth and targeted stocks.

Concerning the métiers used by area:

a) Spain:

➢ Spiny lobsters with trammel nets: spiny lobster fishery has a properly regulation in the Balearic Islands that includes the prohibition of using different gears at the same time, which has led to the use of the most profitable gear instead of sharing the effort in two gears, one of them less impacting. The first regulation in 1987 laid out relevant issues as for instance the definition of the season, the minimum landing size and the gears with which you can capture, being these only trammel nets and pots: the trammel have a minimum dimension of the inner mesh net that is 133 mm and 400 mm from the outer mesh net, the maximum height cannot exceed 2 meters and may deploy a total of 2000 meters of net per crew, up to maximum of 5000 m per boat.

The vessels for the spiny lobster's fishing may not exceed 160 hp. or 10 tonnes GT and the maximum soak time is 48 hours. The net used is multimonofilament of 8 to 12 fine lines, the thinner lines are twisted in one line. The fishing season is from April 1st to August 31st and in 2007 the landing size changed from 24 total length to 90 mm CL, which includes a modification of the parameter from total length to carapace that improves the evaluation of the regulation and allows comparing the results in all the countries.

In Cap of Creus the spiny lobster fishery is quite similar to the one in Balearic Islands, although there is not such a good regulation that defines issues like the lobster fishing season for the area, and many of the existing legislation is not enforced. The boats, the type and material of gears are basically the same than Balearic Islands, with two differences: first, due to the proximity of the big canyon of Cap of Creus, where most of the fishermen try to fish in the shallower part, if the gears are set deeper than 100 meters it is possible to leave them several

days in order to increase the capture; and second, the minimum landing size, the same for the European community (90 mm CL), is not met in Cap of Creus.

b) Italy:

In the Italian selected areas, Ponza and Patti, a total of five different *métier*, exploiting the three selected gears, have been identified and monitored during the field activities:

- Spiny lobsters fishing with trammel nets: it is widely practiced on the Italian territory, being one of the most profitable. In regards to the project, this fishing is mainly practiced on the rocky sea bottoms of Ponza, while in Patti, being the gulf almost entirely muddy, this species is only an occasional target, especially when the fishing ground is around the rocky capes of the gulf.

In Ponza, this *métier* is carried out with low trammel nets, 1.5 m high, with 210/9 and 210/12 nets which are robust enough to work directly on the rocky shoals. This type of fishing needs longer soak time (72 hours) due to the fact that the nets need to first entrap fish, which, by dying, represent the true bait for the lobster. The lobster, attracted by the baits, crawl on the nets and remain entrapped. The depth at which these nets are set may vary between 60 and 120 m depth.

In Patti, the length of the trammel net is about 1000-2000m with a height of 1.2-2m. Because the mesh of this gear is larger than usual (200mm the external and 45-60mm the internal) it is usually referred to as “tramaglione”, large trammel net, and is set around 60-110m depth especially in spring-summer.

The fishing of spiny lobsters is ruled by a strict national regulation. The minimum size of the captures is 90 mm of carapace length and 30 cm of total length. The fishery is closed from the 1st of January to the 30th of April (covering only part of the breeding season) and is always forbidden the collection of mature females with eggs below the abdomen.

- Fish fishing with trammel nets: trammel nets are widely used also to fish mullets, as monitored in the area of Patti, where the main target species of this métier are represented by two species belonging to the *Mullidae* family, *Mullus surmuletus* and *M. barbatus*; both are present from the coast to 500 m depth and are fished all the year round. When the trammel is addressed to mullets the internal net has a mesh of 45 mm. The minimum size following the CE Regulation is 11 cm total length.

- Groupers fishing with longlines: the groupers (*Epinephelus* spp.) are large demersal fish belonging to the family Serranidae that live from the rocky shores to various hundreds of meter and occasionally they may be found on detritic bottoms bordering *Posidonia* meadows. They are relatively common in the Mediterranean Sea and in the Eastern Atlantic Ocean; they are present in all Italian seas were they live usually as solitary individuals in caves or clefts. This *métier* is carried out in the Gulf of Patti targeting the species *Epinephelus marginatus* and *E. aeneus*. The longline targeting groupers is a demersal one, usually 1200m long, armed with 200-500 hooks, 10 Mustad size, triggered with sardines. The minimum size following the CE Regulation is 45 cm total length.

- Pelagic fish fishing with longlines: this *métier* is carried out mainly in the area of Ponza targeting snappers (*Dentex dentex* and *Pagrus pagrus*) or seabreams (*Spondyliosoma cantharus* and *Diplodus vulgaris*), all of them belonging to the Family *Sparidae*. This *métier* is

not common among the artisanal fishery of Ponza (that mainly work with pelagic longlines targeting swordfish) and this type of fishing is mainly carried out by recreational fishermen.
The fishing targeting snappers uses longlines with filament and hooks of larger size with respect to the one used for the other two sparids and are usually set at 60-90 m depth, while those targeting seabreams are set at 45-60 m depth. The soak time is approximately 2-4 hours. The minimum sizes following the CE Regulation are 15, 18, 15, and 18 cm total length, respectively for *D. dentex*, *P. pagrus*, *S. cantharus* and *D. vulgaris*.

- Fish fishing with gillnets: gillnets are widely used to fish mullets and hakes, as monitored in both the areas of Ponza and Patti.

During the fishing targeting mullets, carried out at about 60-90 m depth, it is important to identify groups of shoals where to set the net. The direction of the net is therefore less straight with respect to the one for hakes otherwise the recovery would take a large amount of time on a rough bottom with a higher risk to remain entangled. The set is made before dawn and the hauling is carried out just after the sunrise. Mullets move exactly during this period of light changing and do not tolerate long soak time otherwise are immediately attacked by other organisms directly on the nets.

The hake (*Merluccius merluccius*) is a demersal fish belonging to the family *Gadidae* with a size commonly comprehended between 30 and 40 cm, although it can reach 90 cm of length and 12 kg of weight. This species is uniformly distributed in the Mediterranean Sea, Black Sea and Atlantic Ocean and is very common in the South Tyrrhenian Sea; lives on muddy bottoms (sometimes mixed with sparse rocks) from 30 to 400 m depth. The hake fishing is practiced with trawlers, longlines, gillnets and trammel nets. It is one of the principal target species of both the Ponza and Sicilian artisanal fisheries all the year round. The minimum size allowed by the CE Regulation is 20 total length.

In Ponza the hake gillnets are used on muddy bottoms or mixed bottoms (mud and rocks) starting from 100 m to 500 m depth. This métier is practiced all the year round whether the most productive period is late autumn and winter. In summer, some vessels continue this métier but with lighter nets than those used in winter time. The summer gillnet targeting hake is typically made of a monofilament net 0.25 mm in diameter, 3.2 m high and with a stretched mesh of 56 mm. The winter version is a monofilament net in nylon 0.35 mm in diameter, 4.2 m high and with a stretched mesh of 72-80 mm. The direction of the nets for hakes is usually more straight than for mullets, because they are set on sandy or muddy bottoms showing less entanglements. The nets are set before dawn and the soak time is up to one or two hours after sunrise. In Patti, typically, the gillnet used for hakes is made by one or more meshes of polyamide net, with 3 to 4 m height and a mesh size of around 50 mm. The net is usually set between 90 and 300 m depth.

c) Tunisia: in Tunisia three *métiers* are represented by the following gears:

- Spiny lobster (*Palinurus elephas*) trammel nets: spiny lobster fishing is practiced exclusively in the north region of Tunisia and in particular Langoustier in Tunisian ECOSAFIMED study areas (Esquerquis Bank and Galite Archipelago). The fishing activity occurs between 1 March and 15 September of each year. This species is targeted by artisanal vessels called “langoustier” using trammel nets gangs characterized by 300 to 1000 m length (each gang is composed by 6 to 20 net pieces of 50 m), 2.5 to 2.75 m of height and with a mesh size of generally 140 to 160 mm and in some cases 200 mm.

- Fish trammel net: fishermen targeting red spiny lobster use also fish trammel net to target red mullet *M. surmuletus*, *Scorpeana* sp. and various *sparidea*. This net has a length of about 1000m and mesh size around 60-80mm. Fish trammel nets are made with multifilament polyamide thread and they are generally used during spring and summer. The depths of setting fish trammel nets are around 50 m.

- Longlines: several types of lines and long lines are used in the study area to catch demersal species (drop lines and bottom long lines) or pelagic species (troll lines, surface long lines: drifting or fixed): drop lines or troll lines have only one hook for most, and bottom long lines used in the study area are generally small in size, while the surface long lines are of great length (7-10 km). Bottom long lines are used in shallow waters for fishing the following species: the red porgy (*Pagrus pagrus*), the common dentex (*Dentex dentex*), the red scorpionfish (*Scorpaena scrofa*) and little *sparidae*. The hooks used in shallow depths range from size 7 to 16. At great depths larger hooks (No. 1, 4, 5, 6) are used to catch groupers, rays, sea sharks, big red porgy, big *Dentex* and scorpion fishes. The bait attached to the hooks is chosen according to the target species but also its availability, its strength and its cost.

3.2ON BOARD SURVEYS WITH FISHERMEN

In order to achieve the goal of the ECOSAFIMED project of analyzing the local artisanal fisheries in the selected areas, scientific observers conducted onboard surveys in the artisanal boats; by means of these surveys they have been able to obtain a detailed quantification of the species composition of the catches, with special attention to structural species (number of benthic organisms or fragments and identification of captured species), as well as a characterization of the artisanal fleets themselves that included boats technical information, seasonal patterns and type of gears.

As a first step, a common content was prepared in order to standardize the onboard surveys, namely:

- In relation to the characterization of the artisanal fleet (interviews), the information required includes:
  - Boat technical information: name, ID and year of construction of the vessel, length, material, plotter, if appropriate, gross tonnage, horse power and crew number.
  - Seasonal pattern: name of the gear and the target species, the code or name of the zone where each métier is done and an indication of the month in which each métier is operating.
  - Technical characteristics of gears:
    - For nets (trammelnet, gillnet, others: specify the name): species for which is conducted the fishery, the stretched mesh size in millimeters, net height, total length in meters, the number of panels that make up each set, the standard quantity of sets hauls each day, material of the net and type and code of filament.
    - For longline: total length in meters of the main line set, total number of hooks present in the line, the commercial size of the hook or length and gap of the hook, diameter of the main line in millimeters, diameter of the branch line in millimeters, length of the branch line measured from the main line to the hook and the distance branch to branch or hook to hook.
  - General comments: comments or extra information.

- Regarding the onboard samplings (onboard observer datasheet), for each fishing set an observer datasheet must be completed and afterwards rewritten and checked at lab in a new datasheet;

pictures and benthos samples must be archived or store properly. The following data must be provided:

- General information: region to which the area belongs to, the number or name of each zone, the name that fishermen use for this ground, the date when the onboard sampling is done, the name of the boat sampled, name of the harbour to which the vessel belongs, the climatic conditions and any other additional comments.
- Haul information: the number of each set, the geographical coordinates of the position of the buoy at the start and at the end of the set (latitude and longitude), depth in meters of the buoys at the start and at the end of the set, date and time of the set, geographical coordinates of the position of the buoy at the start and at the end of haul (latitude and longitude), depth of the haul, date and time of the haul, type of bottom, the approximate weight of the substrate present in the haul, an indication of the presence (or not) of benthic species and any comments about haul information.
- Gear information:
    - For nets (trammelnet, gillnet, others: specify the name): length of net set in meters, the stretched mesh size in millimeters, material of the net and type of filament.
    - For longline: total length in meters of the main line set, total number of hooks present in the haul, the commercial size and total length of the hook, the gap or gape size of the hook, diameter of the main line in millimeters, diameter of the branch line in millimeters, species for which is conducted the fishery.
    - In the case of using pots data on length of fishing set (m), mesh size of the square, material, number of traps, diameter of main line (mm) and diameter of branch line (mm) must be filled.
- Commercial catch species (including fishes, crustaceans and cephalopods): scientific name of the species and size of each individual caught.
- Discarded species (including fishes, crustaceans and cephalopods): scientific name of the species, size of each individual caught and status of discarded species according to the legend of the datasheet (combination of categories is allowed).
- Benthic species (mainly of them non-commercial): number for the main group of species with the letter for the subgroups, scientific name of the species, real number if can be counted or category if they are uncountable due to their great abundance, status of the returned benthic species according to the legend of the datasheet (combination of categories is allowed) and the code of the pictures.
- Litter: this section must contain information about the litter: quantity of plastic bags, bottles, cans, lost nets, etc.

This sample collection has the following objectives:

- Get information on the specific composition of the exploited community: species, number or volume of individuals and its size.
- Get data from the demographic structure of species of commercial interest: number of individuals captured by size class.
- Obtain information to estimate the impact of fisheries on exploited ecosystems: quantify the fraction retained and discarded by obtaining the number and size by species of all individuals retained and discarded and quantify species composition and relative abundance of non-commercial benthic species in the catch.

Some results emerged as an outcome of the onboard observations made in all the study areas of the project:

	SPAIN		ITALY		TUNISIA	
	MINORCA CHANNEL	**CAP DE CREUS**	**PONTINE ARCHIPELAGO**	**PATTI**	**GALITE**	**ESQUERQUIS**
HAULS/ SURVEYS	29 hauls carried out, soak time 24-72 hours 3-5 hauls per day in a depth range of 53.7- 89.0 m	28 hauls carried out, soak time 48-192 hours 1-7 hauls per day in a depth range of 88.5- 2780 m	30 hauls carried out between a minimum of 50m and a maximum of 200m depth (considering double hauls[1] 41 fishing operations)	30 hauls carried out between a minimum of 50m and a maximum of 110 m depth	2 fishing surveys (April and October 2015) 88 hauls in depth range between 30 and 110 m Soak time 24 hours (trammel nets) and about 2 to 5 hours for bottom long lines	2 fishing surveys (between 30 May and 3 June 2015) 59 hauls in depth range between 30 and 140 m
MÉTIERS/ GEARS	3 types of trammel net: • polyamide-monofilament (PMF) 2.5 mesh, • multi-monofilament-4 (MMF-4) 3.3 mesh • multi-monofilament-8 (MMF-8) 2.75 mesh	Trammel net: polyamide-monofilament (PMF) 2.5 mesh 15200 meters of trammel nets were set, averaging 600 m per haul	3 different gears: • 10 hauls with trammel nets[1] • 16 hauls with gillnets (imbrocco), • 4 hauls with bottom long lines	3 different gears: • 16 hauls with trammel nets • 10 hauls with gillnets (schette) • 4 hauls with bottom long lines	3 different gears: • Lobster trammel nets (62 sets) • Fish trammel nets (16 sets) • Bottom long lines (11 sets)	3 different gears: • Lobster trammel nets (30 sets) • Fish trammel nets (10 sets) • Bottom long lines (9 sets)
VESSELS	1 commercial vessel licensed to use selected gear	1 commercial vessel licensed to use selected equipment	1 commercial vessel licensed to use selected gear	3 commercial vessel licensed to use selected gear	2 artisanal fishing boats	2 artisanal fishing boats
GROUNDS/ EFFORT AREAS	Two high-effort areas	Hauls made in no trawling grounds with three artisanal fishing efforts: high, low and no data	8 fishing grounds identified in the no trawl area Additional fishing ground FGdeep to assess biodiversity by means of ROV Based on the interviews, an estimation of the effort of fishing is given for each area, calculated as an average of how much time of the year or fishing season the interviewed fishermen work in a specific area	6 fishing grounds identified in the no trawl area, high, low and medium effort Additional fishing ground, subjected to trawling, to assess biodiversity by means of ROV Based on the interviews, an estimation of the effort of fishing is given for each area, calculated as an average of how much time of the year or fishing season the interviewed fishermen work in a specific area	All hauls made in no or low trawling grounds Two effort areas: high (40 hauls) and low (48 hauls)	All hauls made in no or low trawling grounds Two effort areas: high (30 hauls) and low (29 hauls)
SPECIMENS CAUGHT	2455 (85 benthic bycatch specimens)	6278 (74 benthic bycatch specimens)			<u>APRIL 2015</u> - 10976 specimens with trammel net lobster - 1313 specimens with trammel net fish - 107 specimens with long lines	- Trammel net lobster: 19344 specimens. Lobster represents 27,8% of total catches (not taking into account invertebrates) - Trammel net fish: 2008 specimens. - Bottom long lines: 358 individuals

TARGET SPECIES CAUGHT	264 individuals of European spiny lobster (51% of the catches excluding invertebrate)	86 spiny lobsters (1,4% of total, 29,1% of catches without considering invertebrate bycatch)			APRIL 2015 - 132 individual of spiny lobster with trammel net lobster, 12 of which were discarded OCTOBER 2015 - 7126 specimens	- Trammel net lobster: 74 individuals of spiny lobster, 11% of which was discarded
COMMERCIAL BYCATCH	108 individuals (4,4% of the total) from 17 commercial species 20,8% of catches correspond to commercial landings	139 individuals (2,2% of total) from 19 species 34,8% of catches correspond to commercial landings	1909 specimens collected, 33 commercial species including fish, cephalopods and crustaceans: - 6 species (mainly target) with trammel net - 44 species with gillnets - 11 species with longlines	2258 specimens caught, 57 commercial species including fish, cephalopods and crustaceans: - 50 species (mainly target) with trammel net - 31 species with gillnets - 5 species with longlines	APRIL 2015 - 58 individuals (0,53% of total) captured with trammel net lobster, distributed in 22 species - 186 individuals (14,2% of total catch) caught with trammel net fish, distributed in 32 species - 73 specimens (68,2% of total) captured with long lines, distributed in 11 species OCTOBER 2015 - 106 specimens distributed in 22 species	- Trammel net lobster: 112 individuals (0,92% of total) distributed in 22 commercial species. Lobster represents 36,8% of commercial catches. Commercial bycatch represents 61,5% of total landings. - Trammel net fish: 231 individuals, 11,5% of total catch, distributed in 26 species. Commercial catches represent 81,73% of total landings (not taking into account invertebrates). - Bottom long lines: 174 specimens (48,6% of total) distributed in 14 species. Commercial catches represent 98,9% of total landings.
DISCARDED CATCHES	146 individuals (5,9% of total) from 27 species that represented 20,8% of catches excluding invertebrates 72,6% of total were dead	174 individuals (2,7% of total) from 27 species that represented 43,6% of catches excluding invertebrates 63,8% of total were dead	347 discarded catches Present in 75% of the operations, represents 15% of total catches and covers 17 species Longline produced 21% of discarded specimens (1 species), gillnets 13% (26 species) and trammel nets 4% (11 species) 58% of the discard of trammel nets and 45% from gillnets are dead	416 discarded catches Present in 75% of the operations, represents 16% of total catches and covers 36 species Longline produced 33% of discarded specimens (35 species), gillnets 10% (11 species) and trammel nets 19% (1 species) 95% of the discard of trammel nets and 99% from gillnets are dead	APRIL 2015 - 34 individuals (0,53% of total) captured with trammel net lobster, divided in 15 species, 3 of which are not commercial - 68 individuals (5,18% of total), caught with trammel net fish divided into 21 species, 4 of which are nor commercial, - In the catches with long lines only 3 specimens were discarded because of their small size. OCTOBER 2015 - 128 specimens distributed in 29 species	- Trammel net lobster: 85 specimens, divided in 22 species, 4 of which are not commercial. Discarded species represent 38,5% of catches. - Trammel net fish: 36 individuals (1,8% of total), divided in 18 species, 4 of which are no commercial. Discarded species represents 22% of total catches. - Bottom long lines: 2 individuals.

BENTHIC SPECIES CAUGHT	1937 individuals (78,9 % of total) from 41 species	5965 individuals (93,7 % of total) from 44 species	6411 specimens covering 89 taxa: – Gillnets: 53 taxa and 300 specimens per fishing set – Longlines: 21 taxa and 22 specimens per fishing set – Trammel nets: 50 taxa and 8 specimens per fishing set Composition: dominated by the algal component (brown and red algae), followed by echinoderms	2963 specimens covering 160 taxa: – Gillnets: 56 taxa and 37 specimens per fishing set – Longlines: 19 taxa and 21 specimens per fishing set – Trammel nets: 133 taxa and 157 specimens per fishing set Composition: dominated by the cnidarian component (hydroids and anthozoans), followed by echinoderms, bryozoans, molluscs and crustaceans.	<u>APRIL 2015</u> - 10764 individuals (98% of total) captured with trammel net lobster, distributed in 79 species - 1059 individuals (80,65% of total) caught with trammel net fish, distributed in 50 species - 31 individuals (29% of total) captured with long lines, divided in 7 species <u>OCTOBER 2015</u> - 6892 specimens distributed in 73 species	- Trammel net lobster: 19081 individuals (98,65% of total) distributed in 62 species. - Trammel net fish: 1741 (86,7%) distributed in 43 species. - Bottom long lines: 182 individuals (50,8% of total) distributed in 24 species.
ADDITIONAL INFORMATION			Another source of impact reported in Ponza is represented by the collection of large quantities of coralligenous substrate, on average 30kg each fishing set (with a maximum of 150 kg). Together with the catches, there is also a significant amount of litter that is hauled onboard (present in 10% of the operations) including general litter and lost gears. [1] Due to the fact that for certain fishing typologies or some fishing grounds it is more productive to divide the gear into two distinct parts and set them in different areas of the fishing ground, some of them are indicated twice with a 'bis' code. This situation occurred one for gillnets and always for all the operated lobster trammels.	Another source of impact reported in Patti is represented by the collection of large quantities of marine litter (present in 73% of the operations) including general litter and lost gears.		

3.3. ROV CAMPAIGNS

The observation of the richness, biodiversity and structure of the benthic communities has been possible due to the use of Remotely Operated Vehicle (ROV) during the oceanographic surveys in Spain, Italy and Tunisia, thus facilitating the evaluation of the impact of the artisanal fisheries in the study areas selected.

In order to prepare this ROV surveys, some useful guidelines were given so as to optimize the equipment, plan ROV transects in each area and anticipate the field work to be developed during surveys.

3.3.1 Selection of sampling location

Prior to the ROV surveys, a preliminary selection of trawling free areas and the consecutive determination of high and low artisanal fishing pressure locations were conducted; 3 ROV transects minimum were performed in each of this locations.

3.3.2 ROV transects

For the sake of an optimal comparability of the data resulting from the different study areas, ROV transects had to be designed and performed under common guides:

In relation to *the installation of ROV equipment*, it has to be installed in a dry room accessible from the deck of the vessel, being necessary to have the possibility of connecting the tracking system to the GPS system of the vessel.

Regarding the *deployment of the ROV* to the water, it follows a particular routine depending on the vessel characteristics: if the vessel is equipped with an extensible crane, it is of much help to use it; if the vessel is equipped with dynamic positioning, it also helps to maintain the boat in a standstill position when deploying the ROV. Sea conditions are as well important, so the ROV pilot decides whether these are safe enough when deploying.

In regards to the *performance of ROV transects*, it was agreed that they last one hour over the seabed, which means that, including the up and down of the ROV from seabed, the effective time in each transect is two hours. The optimal number of transects will be around 3 or 4 per day, depending on the navigation time between sampling points.

It is important to take into account the following recommendations:

- Keep the ROV's distance from the seabed as constant as possible.
- Keep the ROV's track as straight as possible, avoiding going back or driving in circles.
- Maintain the ROV speed around 0,3-0,4 knots
- Keep the laser pointers always visible, in the middle part of the picture.
- All transects should be done in the same common depth range (70-120m) for the 3 surveys
- Depth blocked in each transect (10-15 m range)
- When ROV is on the bottom, the video recorder should always be on, even if the visibility is poor or the ROV is away from the bottom (TURN ON when reaching the bottom; TURN OFF when starting the ascent).
- When ROV stops (e.g. sampling organisms or taking still images), write "TRANSECT PAUSE" in the ROV log together with the time; when ROV begins to move again, write "PAUSE END" in the ROV log together with the time and NEVER stop recording. When moving again, ROV should keep the same course it had before the stop. During a pause, the camera can be

moved (e.g. to zoom in) and laser pointers do not have to be visible. Before moving again, relocate the camera in the same position it had before the stop.
- Every time ROV collects a sample, it should be noted on the ROV log.
- The video camera, ROV, the bridge and the Track-link System must be set exactly with the same time.
- Write all observations on the field log, mainly the type of community and the depth every 3-4 minutes.
- Spending some time before and after each transect obtaining close ups of the species present in the area, especially those hard to identify, is crucial to properly identify the more species as possible.

3.3.3 Materials and recommendations

- It is useful to have some maps printed in large sizes to help to determine how to proceed during the cruise, as well as a list of potential transects with start and end coordinates (lat/long).

- Logbooks: all the activities carried out during the cruise should be noted down in a survey logbook, and every dive has its own record in the ROV logbook that includes:

    - The position of the ROV every two minutes, along with the substrate type and benthic community, noted by the person in charge of the logbook
    - Time & position of ROV deployment
    - Time & position of landing at the seabed
    - Time & position of “Transect start”
    - Time & position of sample collection & sample information
    - Time & position of “Transect end”
    - Time & position of surfacing
    - Any other incident that should be remarked

- Sample collection: some samples may be taken in order to identify some species; all of them must be stored in either alcohol or formalin and properly labelled.

3.3.4 ROV surveys

ROV operations were achieved in all the study areas of the ECOSAFIMED project in Italy, Tunisia and Spain; they have become a priority in the field of oceanographic surveys, although weather conditions have been a difficulty when it comes to comply with the expected number of footage hours. Around 2 to 5 ROV dives per day were the minimum goal set, while, experimental design considered zones with high and low fishing pressure to compare the ecological status of the bottom in both selected grounds. Scientists from the Institute of Marine Sciences (ICM-CSIC) assisted the University of Genoa and the National Institute of Marine Sciences and Technologies when carrying out ROV surveys in Italy and Tunisia respectively.

The majority of ROV surveys were carried out during 2014 to ensure time enough for data analysis.

The following table summarizes the objectives and results of the ROV surveys carried out in the study areas:

	SPAIN		ITALY		TUNISIA	
	MINORCA CHANNEL	**CAP DE CREUS**	**PONTINE ARCHIPELAGO**	**PATTI**	**GALITE**	**ESQUERQUIS**
DURATION	➢ SURVEY 23-26 JULY 2014 ➢ SURVEY 15-18 AUGUST 2015	➢ SURVEY 12-16 DECEMBER 2014 ➢ SURVEY 14-18 JANUARY 2015	20-27 AUGUST 2014	4-11 OCTOBER 2014	➢ SURVEY 8-13 OCTOBER 2014 ➢ SURVEY 30 APRIL- 6 MAY 2015 ➢ SURVEY 13-16 OCTOBER 2015	➢ SURVEY 22 SEPTEMBER – 7 OCTOBER 2014 ➢ SURVEY 22-26 AUGUST 2015
ORGANIZER	ICM- CSIC	ICM- CSIC	Università degli Studi di Genova	Università degli Studi di Genova	National Institute of Marine Sciences and Technologies (INSTM)	National Institute of Marine Sciences and Technologies (INSTM)
PARTNERS INVOLVED	ICM- CSIC	ICM- CSIC	Università degli Studi di Genova ICM- CSIC	Università degli Studi di Genova ICM- CSIC	➢ SURVEY OCTOBER 2014 INSTM, ICM- CSIC ➢ SURVEY 30 APRIL- 6 MAY 2015 INSTM ➢ SURVEY 13-16 OCTOBER 2015 INSTM	➢ SURVEY SEPTEMBER-OCTOBER 2014 INSTM, ICM- CSIC ➢ SURVEY 22-26 AUGUST 2015 INSTM
NUMBER OF PARTICIPANTS	5 scientists from ICM- CSIC 1 ROV pilot 2 fishermen 1 boat's crew member	7 scientists from ICM- CSIC	2 scientists from UNIGE 1 scientists from ICM- CSIC 1 fisherman 3 crew members	2 scientists from UNIGE 1 scientists from ICM- CSIC 3 fishermen 3 crew members	➢ SURVEY OCTOBER 2014 11 scientists from INSTM 2 scientists from ICM- CSIC 1 ROV pilot 8 boat's crew members ➢ SURVEY 30 APRIL- 6 MAY 2015 3 scientists from INSTM 1 ROV manipulator 3 boat's crew members ➢ SURVEY 13-16 OCTOBER 2015 3 scientists from INSTM 5 boat's crew members	➢ SURVEY SEPTEMBER-OCTOBER 2014 11 scientists from INSTM 2 scientists from ICM- CSIC 1 ROV pilot 8 boat's crew members ➢ SURVEY 22-26 AUGUST 2015 3 scientists from INSTM 1 ROV manipulator 3 boat's crew members

SPECIFIC OBJECTIVES	• 2 high impact artisanal fishery grounds and 3 low impact artisanal fishery grounds with similar bottom features were selected. • ROV dives were planned to be 30-60 minutes long in each area between 60 and 120 m depth. • 5 ROV transects per day in areas with different fishing effort. • Video images recorded with a HD camera with two parallel lasers as a reference for species measurement and for the establishment of the area to be analyzed. • For the experimental surveys, a maximum of 20 trammel nets were set during the 4 alternating days with the collaboration of professional fishermen. • Involve the local fishermen and community in scientific investigation and discuss the objectives and activities with them.	• 4 high impact artisanal fishery grounds and 2 low impact artisanal fishery grounds with different bottom features were selected. • ROV dives were planned to be 30-60 minutes long in each area between 60 and 120 m depth. Video camera recorded the track visualizing two lasers as a reference for species measure. • 2 ROV transects per area of different fishing effort per day • Involve the local fishermen and community in scientific investigation and discuss the objectives and activities with them.	• 2 ROV transects planned in each area between 50 and 200 m depth of different fishing effort, based on the fishing ground identified in the interviews (7) and the localization od the experimental fishing hauls made. HD video camera with two lasers and HD photographs. • Three-dimensional multiBeam mapping of the sub-areas identified in each fishing ground near fishing hauls. • Involve the local fishermen and community in scientific investigation and discuss the objectives and activities with them.	• 2 ROV transects planned in each area between 50 and 200 m depth of different fishing effort, based on the fishing ground identified in the interviews (6) and the localization od the experimental fishing hauls made. HD video camera with two lasers and HD photographs. • Three-dimensional multiBeam mapping of the sub-areas identified in each fishing ground near fishing hauls. • Involve the local fishermen and community in scientific investigation and discuss the objectives and activities with them. • Collect and preserve living specimens of the rare soft-bottom gorgonian S. klavareni (target species).	➢ <u>SURVEY OCTOBER 2014</u> Two/three sectors were identified: one with a high artisanal fishing effort, the second with medium artisanal fishing effort and the last with low artisanal fishing effort. Within each sector we established a transect design for ROV footage covering depths between 50 and 200m. Transects were arranged in the same manner that fishermen put their fishing gear at sea. In addition to the ROV footage and in the case of unidentified species appear, dredging and diving can take place to collect samples of macro fauna and flora for species identification. The first survey also aimed the training of Tunisian team on the field of collecting and analyzing data of ROV campaigns. ➢ <u>SURVEY 30 APRIL- 6 MAY 2015</u> The program was firstly to continue ROV dives on transects planned and not carried out in the previous ROV survey. And secondly to find the limits of trawling activity and specific gorgonian area. ➢ <u>SURVEY 13-16 OCTOBER 2015</u> This survey represented a continuation of previous ROV and fishing surveys, with the possibility of involving local fishermen in scientific investigation. Another aim was the elaboration of ROV dives in the same transects before and after fishing operation.	➢ <u>SURVEY SEPTEMBER-OCTOBER 2014</u> Two/three sectors were identified: one with a high artisanal fishing effort, the second with medium artisanal fishing effort and the last with low artisanal fishing effort. Within each sector we established a transect design for ROV footage covering depths between 50 and 200m. Transects were arranged in the same manner that fishermen put their fishing gear at sea. In addition to the ROV footage and in the case of unidentified species appear, dredging and diving can take place to collect samples of macro fauna and flora for species identification. The first survey also aimed the training of Tunisian team on the field of collecting and analyzing data of ROV campaigns. ➢ <u>SURVEY 22-26 AUGUST 2015</u> The program was to continue ROV dives on transects planned and not carried out in the previous ROV survey. In order to collect as much data as possible in relation to the study area, the ROV dive time, originally scheduled for one hour, was adjusted according to the seascape importance and the required details.

CONCRETE RESULTS	• During the first part of the survey: - 9 Benthic Ripper transects, in 8 dives, were carried out during the first part of the survey (6.5 hours of video and 270 high-resolution pictures), at depths between 40 and 110 m, corresponding to over 9600 m of linear ground. At least two transects were performed on previously selected areas. Thirty-three gorgonian and sponge samples were sampled. The GPS position of each transects was registered. - 14 trammel nets hauls to capture target species European Spiny Lobster, on board of local artisanal boat. 8 were carried out over ROV tracks from previous surveys. 20 samples stored. - 2 Martin Rauschert sledges were carried out, one on a low effort ground and another on a close to high effort ground. • During the second part of the survey: - 15 ROV transects in depths between 65 and 123 m, covering a sampling distance of 8615 m (11 hours of filming and 1470 medium resolution pictures); 8 of them on low impact fishing effort grounds, 2 on high effort grounds (and 5 with ND). - 1 Martin Rauschert sledge was carried out on a close to high effort ground. - Thirty-three gorgonian and sponge samples were sampled.	• During the first part of the survey: - 3 ROV dives on the southern high impact fishing ground. • During the second part of the survey: - 12 ROV dives were carried out: 8 dives on northern low impact fishing ground and 4 dives on the high impact ground of the middle. - 3 Martin Rauschert sledges on a high effort ground to sample gorgonian facies, 10 minutes each. • Transects took place at depths that ranged 70 to 133 m, covering a sample distance of 9910m, which corresponded to almost 15 hours of filming and 300 low resolution pictures. • Two types of continental shelf habitats were filmed in the ROV: (1) muddy detritic bottoms dominated by alcyonaceans (*Alcyonium palmatum*), sea pens (*Pennatula rubra*) and crinoids (*Leptometra* sp) and (2) rocky beds dominated by gorgonians (*Eunicella cavolinii*).	• 20 dives covering all fishing grounds. • 21 transects (13000 m of linear ground explored), 2 per fishing ground, each transect with duration between 30 and 60 minutes (linear distance of about 500 m). • 25:30 hours of video and 2080 high resolution photographs. • 9 multiBeam maps (1 for each fishing ground, one for FG5 and one for the extra dive in the east coast). • 2 additional extra sites in the east and south coast of Ponza. • Some very interesting coral communities were reported in this survey (for example important black coral forests and sponge grounds) as well as important traces of fishing impact, attributable not only to professional gears but also to recreational ones. Among the most dominant species, various black coral species, gorgonians, hydroids and sponges will be selected as target species for the following data analysis.	• 15 dives covering all 6 fishing grounds. • 1 additional extra site outside the gulf (Brolo). • 15 transects (12000 m of linear ground explored), 2 per fishing ground, each transect with duration around 60 minutes (linear distance of about 500 to 1000 m). • 17 hours of video and 1419 high resolution photographs. • 10 multiBeam maps (1 or 2 for each fishing ground, and one for Brolo). • Some very interesting coral communities were reported in this survey (for example rich forests of *S. klavareni* and *L. myriophyllum*) as well as important traces of fishing impact, attributable not only to professional gears but also to recreational ones. Among the most dominant species, soft bottom gorgonians and sea pens, hydroids, black corals and the scleractinian *Dendrophyllia ramea*. • 10 colonies of *S. klavareni* were collected and kept alive in the aquarium of the vessel and were successively transported to the Institute of Marine Sciences of Barcelona for specific analyses.	➢ <u>SURVEY OCTOBER 2014</u> • 23 ROV dives (18:28 hours of video): - 22 dives on transect (15:33 hours of video) in depth range 52-108 m, 11 in high fishing effort sector (8:01 hours) and 11 in low fishing sector (7:32 hours) - 1 dive in depth of 51,9 m • 4 drags in depth of 57-89,3 m, 1 in high and 2 in low fishing effort sector (1 ND) • Around 90 samples taken were sorted, photographed and preserved, either in alcohol, formalin or dried. **CONCLUSION**: the area seems to be richer in terms of biodiversity (gorgons, luminaria, algae, sponges, etc..). Only three times have seen lost fishing gear. ➢ <u>SURVEY 30 APRIL- 6 MAY 2015</u> • 3 ROV dives during the testing of the equipment (two days) in Bizerte coastal area • 20 ROV dives (12:42 hours of video) in depth range 56,5-98 m: - 11 dives in high and medium fishing effort sector (8:17 hours) - 8 dives in low fishing effort sector The samples taken are mainly gorgons and sponges. Only two times have seen lost fishing gear (longline). ➢ <u>SURVEY 13-16 OCTOBER 2015</u> 10 ROV dives (4:33 hours of video) in depth range 49,7-101 m : - 4 dives in high fishing effort sector (2:14 hours) - 4 dives in low fishing effort sector (2:01 hours) - 2 dives aborted, only 8 dives on transect were valid (4:15	➢ <u>SURVEY SEPTEMBER-OCTOBER 2014</u> • 14 ROV dives (11:40 hours of video): • 11 dives on transect (9:08 hours of video) in depth range 55,7-93 m: - 7 in high fishing effort sector (7:48 hours) - 2 in low fishing sector (1:20 hours) - 2 aborted dives, one in high and one in low fishing effort • 1 dive in depth of 47 m in high fishing effort sector • 1 dive in depth of 41 m in high fishing effort sector • 1 dive depth 121 m in high fishing effort sector • 12 drags in depth range 61-112 m , 3 of them in high fishing effort sector and 6 in low fishing effort sector (3 ND) • Around 80 samples taken, most of them gorgons and sponges, were sorted, photographed and preserved, either in alcohol, formalin or dried. **CONCLUSION**: the area seems to be poor in terms of biodiversity (gorgons, luminaria, algae, sponges, etc.) compared to Galite Island. The sea bed is composed specially by maërl. Only three times have seen lost fishing gear. ➢ <u>SURVEY 22-26 AUGUST 2015</u> 14 ROV dives (8:21 hours of video) in depth range 68 -116 m: - 7 dives in high fishing effort sector (3:36 hours) - 7 dives in low fishing effort sector (4:45 hours)

ADDITIONAL INFORMATION	The survey was divided in two parts due to the unavailability of the ROV.	The surveys were achieved in two parts due to the weather conditions, and still it was not possible to accomplish the expected ten days nor, in consequence, to sample all the grounds or complete the minimum 20 hours that were planned.			ROV: Used boats (N/E Amilcar, Sultana TG613) have not a DP system. Consequently, it is impossible to maintain a steady course and a speed of 1 knot. Thus, we adjusted the transect directions depending to the surface drift direction and the investigation is made engine stopped. During the first survey onboard N/E Amilcar we had lost many days because of ROV loss at the bottom and its reparation (10 days). As consequence we had reduced in cases where the seascape is considered monotonous the duration of ROV transects and we have also increased the number of work hours/day; we start at 6am until dark. Dredging: The duration of the dredging is 2 minutes from the time the drag reaches the seabed and the boat is stopped. In the case where the sample is large, an under sample is systematically taken (0.05 m3). The recovered samples will be sorted, photographed and preserved either in alcohol or formalin (algae, gorgons, sponges, and macro fauna) or dried (bryozoans). Diving: For areas with a rich fauna and if conditions are favorable (weather, currents, depth) some dives are expected. The collected samples are treated in the same manner as for dredging.

4. RESULTS

4.1 State of benthic communities

Marine ecosystems are threaten and in constant degradation, most of the time due to the human pressure, which implies the destruction of habitats and the consequent loss of biodiversity. Today there are several tools and assessment methods that enable their recovery and allow deeper studies of ecosystems in all their complexity, but the first step to achieve this restoration is to know the state in which they are.

The characterization of these communities by means of direct methods is based partly on the use of the Remote Operated Vehicles (ROV), Towed Video System (TOV) or Underwater Manned Vehicle (MUV). Taking into account that the objective is to obtain a reference point of the status of the community, among all these methods, ROV has several advantages: it is the one which cost is the lowest, has a high quality images and a high capacity of movement, and provides a very accurate tracking system for precise geographic reference of recorded images.

All the analysis has been developed in all the study areas with the same technical procedures; thus, the methodology used is based in the ROV surveys, video analysis and data analysis.

- ROV surveys: video transects were recorded with ROVs equipped with an HD camera, a grabber and two parallel laser beams which provided a scale to define a fixed width of the transects (0.3 m) for the subsequent video analyses. All transects were selected to cover low and high fishing effort and recorded in digital format. Positioning of the ROV was achieved through a tracking system and the transponder. ROVs moved at a constant speed of approximately 0.3 knots when possible, and transect lengths ranged between 300 and 1000 m, over depths ranging from 40 to 150 m. Specimens of benthic species observed during the transects were collected; colonies were fixed and preserved in 10% formalin for taxonomical studies and 100% ethanol for genetic studies.
- Video analysis: pauses in the movement of the ROVs were removed from the footage, in order to correctly estimate the length in each transect. Sequences with poor image quality or too far away from the seafloor were considered unsuitable for analysis. Every organism, lost fishing gear or debris observed within the width of 0.3 m along each video transect was identified with a time reference derived from the time elapsed since the beginning of the video transect to the crossing of the laser beams with the base of the organism. This time reference was posteriorly converted into position along the transect according to the known velocity of the underwater vehicle. A similar procedure was used to characterize seabed substrate types and slopes along every transect, within the same width of 0.3 m. The firsts were classified into different categories according to the internal variability of each surveyed area, and seabed slope was classified into three categories: horizontal (0º–30º), sloping (30º–80º) and vertical (80º–90º). Slope was estimated from the video images by looking at the two parallel laser beams and the depth sensor.

  To study population size structure, the maximum height of each observed gorgonian and antipatharian colony was measured using the Macnification 2.0.1 software (Orbicule, Inc.) on still images extracted from the recorded footage. The distance from the two lasers beams was used to calibrate the images. Measurements were done on still images in which the colony base was in the same plane as the laser beams, while the colony lied perpendicular to the video (Gori et al., 2011b). This methodological constraint entails that only a subsample of observed organisms could be measured for the study of population size structure.
- Data analysis:
  - Benthic community composition: for the quantification and examination of the benthic communities, each transect was divided into a string of 4.5 m2 sampling units (0.3 m wide

and 15 m long); each sampling unit was characterized by the number of organisms of each benthic species, as well as by its depth and percentage of cover for each substrate and slope type. Benthic community composition was assessed with a non-metric multidimensional scaling ordination (nMDS) of the sampling units, with square root transformed data on species abundances, and based on an ordination by a Bray-Curtis similarity matrix. Pairwise permutation multivariate analysis of variance using Bray-Curtis distances was used to test for significant differences in benthic communities based on the environmental features. Additionally, a similarity percentage procedure analysis (SIMPER; Clarke and Warwick, 1994) was performed to identify which benthic species contributed the most to the different assemblages considering the previously mentioned environmental features. Finally, benthic community analysis results derived in the sorting of habitats according to the EUNIS classification.

- Size frequency distribution of key forming species: to study population size structure, the maximum height of each individual of key forming species, such as gorgonians or antipatharians, was measured using the Macnification 2.0.1 software on still images extracted from recorded footage. The distance from the two lasers beams was used to calibrate the images. Measurements were done on still images in which the colony base was in the same plane as the laser beams, while the colony lied perpendicular to the video. This methodological constraint entails that only a subsample of observed organisms could be measured for the study of population size structure.
- Spatial structure: the spatial distribution of the most relevant habitat constructing/bioengineering species was analyzed along the most representative transects. Abundance of each gorgonian species along the transects was displayed in density plots, obtained by transforming each transect into a string of contiguous quadrats (1 x 0.3 m) and counting the number of colonies of each species inside each quadrat.
- Index of biodiversity: species diversity in the different areas surveyed was calculated using 4 different indices: Shannon-Wiener (H), exponential of Shannon (exp-H), Gini-Simpson and the Inverse of Simpson. All these indices consider the number of species present in an area as well as their representativeness; this is the relative abundance of each of the individuals belonging to each of the species considered.

The results of this methodological analysis per areas are the following:

	SPAIN		ITALY		TUNISIA	
	MINORCA CHANNEL	**CAP DE CREUS**	**PONTINE ARCHIPELAGO**	**PATTI**	**LA GALITE**	**ESQUERQUIS BANK**
ROV SURVEY	• From 14 to 18 of August 2014. • Performed in 2 high-impact and 3 low-impact artisanal fishery grounds with similar bottoms, 2 dives minimum in each. • 14 video transects covering 6401 m, each with a length between 82 and 702 m, over a depth range between 63 and 114 m. • HD pictures. • 2 ROV transects were performed following the track of two trammel nets in order to evaluate the net impact over benthic communities. • 3 trammel nets hauls on board of artisanal boats (by-catch species monitored over 4 hours). Scuba diving experiment.	• From 12 to 16 of December 2014, and from 14 to 18 January 2015. • Performed in 4 high-impact grounds (8 dives) and 2 low-impact artisanal fishery grounds (4 dives in the north and 3 in the south). • 15 ROV tracks, performed at depths that ranged between 80 and 120 m, covering a sampling distance of 10 km that corresponds to 15 hours of video filming.	• From 20 to 27 of August 2014 • 20 video transects covering 19097 m. Of these 20 transects, 5 were made in high effort areas, 10 in medium effort areas and 4 low effort fishing grounds. • Transect length ranged between 520 and 1649 m, over a depth range between 50 and 350 m depth.	• From 4 to 11 October 2014 • 15 video transects covering a total distance of 12,148m, 6 were made in high effort areas, 5 in medium effort areas and 2 low effort • Transect length ranged between 500 and 1351 m over a depth range between 40 and 185 m depth	• 3 ROV surveys in September 2014, May 2015 and October 2015. • 30 video transects covering a total distance of 18,390 m with an average of 613 m per transect, 15 of them in high effort areas and 15 in low effort areas. • Transect length ranged over 242 to 1773 m, over a depth from 44 to 114 m +. • Substrate dominated by maërl (77%). • 77 trammel net hauls from 2 artisanal fishing boats, 31 of them following the ROV tracks.	• 2 ROV surveys in September 2014 and August 2015. • 24 video transects covering a total distance of 17,715 m with an average of 738 m per transect, 15 of them in high effort areas and 9 in low effort areas. • Transect length ranged over 94 to 1809 m, over a depth from 36 to 122 m. • Substrate dominated by maërl. • 50 trammel net hauls from 2 artisanal fishing boats, 19 of them following the ROV tracks.
MEGAFAUNAL DIVERSITY	• Both low and high effort fishing grounds presented a high diversity of megafauna. • 156 species identified in low effort fishing grounds and 106 on high effort fishing grounds. The group *Porifera* presented the highest diversities, followed by *Ascidia*, *Echinodermata* and *Octocorallia*.	• 9335 individuals or colonies, belonging to more than 100 morpho-species, were identified in video images. • The most abundant species was the sea pen *Pteroeides spinosum*, with over 1800 colonies registered, and densities over 12 col./m2 in some transects. • The most common species was *Alcyonium palmatum*, a soft coral present in all ROV transects, where its highest densities reached 8 col./m2. • The most diverse taxa observed was *Porifera*, with 35 morpho-species identified, and *Cnidaria*, represented with 26 different species. Higher numbers of *cnidarian* species in low effort transects, while *polychaete* and sponge groups were more represented in high effort areas.	• 107 species identified in low effort fishing grounds • 123 species on high effort areas • Sponges presented the highest diversities followed by anthozoan, hexacorallians and octocorallians	• 55 species in low effort areas, mainly octocorallia, hexacorallia and porifera • 114 species on medium effort areas mainly octocorallia, hexacoralllia and porifera • 53 species on high effort areas octocorallia, hexacoralllia, porifera and bryozoa	• 123 taxa in low effort fishing grounds, mainly poriferas, octocoralia and echinoderma. • 117 taxa in high effort areas, mainly porifera, octocorallia and bryozoa	• 32 taxa in low effort fishing grounds, mainly Echinodermata and porifera. • 119 taxa in high effort areas, mainly algae, porifera and bryozoa.

	SPAIN		ITALY		TUNISIA	
	MINORCA CHANNEL	**CAP DE CREUS**	**PONTINE ARCHIPELAGO**	**PATTI**	**LA GALITE**	**ESQUERQUIS BANK**
STRUCTURAL SPECIES	Density and occurrence: - Gorgonians: • *Eunicella singularis*, mostly found on coralligenous grounds, and *Paramuricea macrospina*, found in maërl beds, with densities of 7 col/m-2 (3 ± 2.3 col/m-2 (mean ± SD)) and 8 col/m-2 (7.5 ± 3 col/m-2 (mean ± SD))). • High frequency of occurrences over large areas of the evaluated fishing grounds. • Asymmetrical populations composed by small size colonies (1-10 cm) regardless the fishing effort. This indicates that the studied grounds are particularly suitable for these populations but due to the joint effect of habitat instability (for populations located on maërl) and fishing pressure these populations can develop into a mature stage. • Population health: in both high effort and low effort fishing grounds the majority of observed colonies where in a healthy state (~80%); partially necrotic and epiphyted colonies were slightly higher in low effort than in high effort fishing grounds, being 14% and 11% of observed colonies respectively; and dead colonies presented the lowest frequencies representing 7% and 4% of observed colonies in both high and low effort fishing grounds respectively. - Sponges: *Halicona elegans* y *Aplysina cavernícola* with densities of 27 ind/m-2 (4 ± 3 ind/m-2 (mean ± SD)) and 25 ind/m-2 (4.5± 4 ind/m-2 (mean±SD)).	Density and occurrence: • Gorgonian *Eunicella cavolinii* on the northern side of the cape, mostly over rocky outcrops but also on very coarse biogenic sediments formed by a mixture of sands and large shells. The most important densities were found in transect T5, where a very dense patch of up to 23 col./m2 could be recorded. • Sponge *Suberites syringella*, which creates patches of up to 10 ind./m2. It was mainly found in transect T5, in the same area where the gorgonians develop. • Soft sediment areas: - Sea pen *Pteroeides spinosum*, forming some dense patches of up to 5 col./m2 in various areas - Soft coral *Alcyonium palmatum,* found in every single ROV track, with a few patches of 2-3 col./m2 in certain transects. Gorgonian population size structure: • *Eunicella cavolinii:* only found in high effort fishing grounds, the population was composed mainly by small sized colonies, showing a rapid decrease towards larger sizes. Gorgonian population health state: • Gorgonian health assessed from video images. In all transects, around 90% of gorgonians showed good health status of the population. There were no colonies that could be considered dead.	Density and occurrence: - Sponge *Haliclona* sp. reach very high densities, up to 29 individuals m-2 (1.4 ± 3.7 colonies m-2 (mean ± SD). In the same habitat type, also *Corallium rubrum* and *Paramuricea clavata* could reach considerable densities, up to 22 colonies m-2 (0.2 ± 1.2 colonies m-2 (mean ± SD) and 20 colonies m-2 (0.7 ± 1.9 colonies m-2 (mean ± SD), respectively. -Black coral *Parantipathes larix* reach maximum densities of up to 5 colonies m-2 (0.4 ± 0.9 colonies m-2 (mean ± SD) and Antipathella subpinnata reach maximum densities of up to 9 colonies m-2 (0.1 ± 0.7 colonies m-2 (mean ± SD). Population size structure: *Parantipathes larix* in low effort fishing grounds was 60-90 cm mainly while in high effort fishing grounds was 90-120 cm Health state: Overall, independently from the fishing effort, the majority of the observed colonies was in a healthy state (90%).	Density and occurrence: Soft bottom species: *Spinimuricea klavereni* with a maximum density of 13 colonies/m2 (1.0 ± 1.8 colonies m-2 (mean ± SD)). *Lytocarpia myriophyllum* and *Alcyonium* spp. could reach considerable densities, up to 25 colonies m-2 (1.0 ± 3.4 colonies m-2 (mean ± SD) and 7 colonies m-2 (0.7 ± 1.1 colonies m-2 (mean ± SD), respectively Hard bottom species: *Paramuricea clavata* reaching maximum densities of up to 33 colonies m-2 (0.7 ± 2.9 colonies m-2 (mean ± SD)). Health state: Overall, independently from the fishing effort, the majority of the observed colonies was in a healthy state.	Density and occurrence: • Sponges in maërl beds: - *Haliclona sp*, with a maximum density that could reach 69 ind/m² (5.6 ± 9.2 ind/m2 (mean ± SD)). - *Pseudosuberites hyalinus*, showing a density of 3.55 ind/m² with a mean of 1±0.96 ind/m² (SD). • Gorgonians, in maërl beds (high density, small sized colonies) and rock substrate (lower density larger colonies): - *Paramuricea* sp, with density of colonies that could reach 49.33 col/m² with a mean of 10.36 ± 11.34 col/m² (SD). - *Eunicella sp*, with a maximum density of 5 col/m² and a mean of 1±0.99 col/m² (SD) Population size structure: • *Haliclona sp* and most gorgonians were symmetrical and composed mainly by small colonies for gorgonians (0-10 cm) and small individuals for Haliclona sp (0-4cm), regardless the fishing effort. • Population's size of gorgonians could be related to the nature of the substrate (mainly maërl). • Presence of small specimen, which could mean many young colonies and individuals. Health state • For both taxa, sponges and gorgonians, the specimen presented a healthy state about 99% of the populations regardless the fishing effort.	Density and occurrence: • Sponges in maërl beds: - *Haliclona sp*, with a maximum density of 6 ind/m² and a mean of 4.22 ± 1.88 ind/m2 (SD). High frequency of occurrences (95%). Found in maërl beds. - *Axinella sp*, showing a density of 1.1 ind/m² with a mean of 0.88 ± 0.12 ind/m² (SD). Low frequency of occurrences (28%). Found on rocky grounds. • Gorgonians: - *Paramuricea* sp, with a mean density of 2.44 ± 0.0 col/m². Frequency of occurrences (51%). Found on rocky grounds. Population size structure: • Most *Haliclona sp* populations were symmetrical and composed mainly by small individuals for *Haliclona sp* (0-4 cm) regardless the fishing effort. • Population's size of *Haliclona sp* could be related to the nature of the substrate (mainly maerl), not large colonies due to instability of maerl. • Presence of small specimen in sponges, which could mean many young colonies and individuals. Health state: observed populations were in a healthy state.

		SPAIN		ITALY		TUNISIA	
		MINORCA CHANNEL	**CAP DE CREUS**	**PONTINE ARCHIPELAGO**	**PATTI**	**LA GALITE**	**ESQUERQUIS BANK**
ENTHIC COMMUNITIES	**STATISTICAL ANALYSIS**	• 3 major groups identified in the nMDS: - Sample units on maërl located between 60 and 90 m depth. - Coralligenous outcrops located between 90 and 120 m depth. - Biogenic sands located between 60 and 70 m depth, occasionally extending to 110 m. • SIMPER analysis: the number of species contributing up to 90% of the similarity in the first two groups varied between 17 and 12; on the third group only 4 species.	• 441 sampling units of 4.5 m2 used for the analysis of a total area of 2000 m2 during 13 ROV tracks. • 9935 organisms registered in the video images, belonging to 189 species • 4 major groups according to the Bray-Curtis similarity index representing 90% of the samples and distributed taking into account the substrate : - Group b was restricted to areas dominated by very fine sediments, such as muds and fine sands. - Groups d and a were mostly found in coarser sediments, such as medium sands and fine gravels. - Group c is a lot more common in very coarse sediments, such as gravels and pebbles, as well as over rocky outcrops.	• 7 major groups identified in the nMDS: - Sub-outcropping rocks between 80 and 120 m depth - Mixed assemblage dominated by *Paramuricea clavata*, *Leptopsammia pruvoti*, echinoderms and bryozoans - Assemblage dominated by the ascidian *Halocynthia papillosa* at 60-100 m depth - Forests of *Antipathella subpinnata* from 60 to 120 m depth - Coralligenous rock dominated by the *Myriapora truncata* assemblage - Deep sponge grounds at around 250 m depth - Bathyal rocks dominated by the shrimp *Plesionika narval* below 300 m - Cerianthid *Arachnanthus oligopodus* on volcanic detritic slopes between 60-80 m depth • SIMPER analysis: the number of species contributing up to 100% of the similarity in all the groups varied between 1 and 15.	• Seven major groups could be identified in the nMDS: - Sample units located on compact muds, located between 40 and 80 m depth and hosting *Spinimuricea klavereni* and *Alcyonium* spp - *Funiculina quadrangularis* and *Pennatula* spp. assemblage thriving on compact muds, around 100-120 m - *Lytocarpia myriophyllum* on the shallow muds and detritic sands. - *Parapenaeus longirostris* below 150 m depth - Coralligenous outcrops host mixed assemblages: one of which dominated by *Paramuricea clavata*, *Eunicella cavolinii*, *Leptopsammia pruvoti* and hydroids and another one by *Hacelia attenuata* and *Halocynthia papillosa* • SIMPER analysis: the number of species contributing up to 90% of the similarity in all the groups varied between 1 and 5. In all the identified groups cnidarians (mainly gorgonians and hydrozoans) played a key role.	• 3 major groups identified in the nMDS: - Sample units on maërl, coralligenous rock and medium sand, located between 60 and 90 m depth and ocassionally 110m. Sponges, gorgonians and annelida. - Coralligenous rock and maërl, located between 60 and 80 m depth. *Laminaria sp*, Sponge and bryozoa. - Maërl substrate located between 70 and 90 m depth, occasionally at 60 m. Cidaridae • Stress stimation of 0.1, SIMPER analysis: the number of species contributing up to 90% of the similarity is respectively 3 in the first group, 4 in the second group and only 1 species in the third group.	• 3 major groups identified in the nMDS: - Sample units on shallow maërl ground with coralligenous outcrop and few medium sand, located between 30 and 70 m depth and ocassionally 80 m.Algae *(Laminaria sp* and *Schoretta sp*), Briozoa and *Paramuricea sp*. - Maërl land with few medium sand, located between 70 and 90 m depth. *Laminaria sp*, *Cidaridae.* - Maërl substrate with medium sand and cobbles and pebbles located between 80 and 120 m depth. *Haliclona sp.* • Stress stimation of 0.07, • SIMPER analysis: the number of species contributing up to 90% of the similarity is respectively 8 in the first group, 2 in the second group and only 1 species in the third group.

		SPAIN		ITALY		TUNISIA	
		MINORCA CHANNEL	CAP DE CREUS	PONTINE ARCHIPELAGO	PATTI	LA GALITE	ESQUERQUIS BANK
	DESCRIPTION	• Shallow rhodolite (maërl) beds: - Brown algae Laminaria rodriguezii is more abundant than in coralligenous banks. - Sponges *H. elegans, Axinella sp.* and the gorgonian *P. macrospina* were the most abundant engineering organisms. The two first ones formed facies restricted to smaller areas, while *P. microspina* formed facies that could extend along very large areas. - Myriapora Truncta is the most frequent structural species in corallingenous outcrops. - Isolated colonies and individuals of the gorgonian *Eunciella verrucosa*, the hydrozoan *Lythocarpia myriophyllum* and the *Laminaria rodrguezii*. • Deep rhodolite (maërl) beds: - Sponges H. elegans and A. cavernicola were the most abundant engineering organisms. - *Hamacantha sp., Halyclona pachastrelloides* and *Poecillastra compressa* colonies were occasionally encountered. - Gorgonian *Eunicella cavolinii*, the soft coral *Daniela sp,* the sponges *H. elegans*, and *H. pachastrelloides* were the main engineering organisms. All of them formed facies excep *H. pachastrelloides.* - Sponge *Hamacantha sp*, the gorgonian *P. macrospina,* the hydrozoan *Lythocarpia myriophyllum*, the antipahtarian *Antipahtella subpinnata, E. cavolinii* and *Daniela sp*. densities were higher on exposed cliff edges than inner flatter areas. *H. pachalestroides* presented different morphologies depending on the substrate inclination, on flat areas it would appear forming fanlike structures while in vertical walls it would appear as an incrusting sponge. • Detritic sand: this community usually occupies small areas, but in few occasions it stretched along vast areas. - Substrates constituted by a matrix of biogenic coarse sands,	Based on the 4 major groups a SIMPER analysis showed the species of each assemblages: • Group a- Pennatulacean assemblage, located in central part of the continental shelf and dominated mainly by octocorallian species - Sea *pens Pteroeides spinosum,* with an average densities ranged between 0.5 col/m2 in the less abundant tracks to more than 4 col/m2 in the most abundant, (T3, sd=2,9; Max density=13,33 col/m2). - *Cavernularia pusilla* - *Pennatula rubra,* - *Alcyonium palmatem.* , with densities above 2-3 col./m2 in certain regions of transect T3 and T10. • Group b– Lanice conchilega / Sabella pavonina assemblage, mainly found in areas with very fine sediments, mostly sand and muds between 80 and 90 m depth, with 2 polychaete species: - *Lanice conchilega* - *Sabella pavonina*. • Group c– Eunicella cavolinii assemblage, located in areas of the continental shelf and dominated mainly by: - *The* gorgonian *Eunicella cavolinii*, which created some sense patches in certain locations. - The sponge *Suberites syringellawas*. - The alcyonaceans *Alcyonium palmatum* and *Paralcyonium spinulosum*. - The zoantharid *Epizoanthus* sp. - The bryozoan *Smittina cervicornis*. - The hydrozoan Sertularella gayi. • Group d– Leptometra phalangiumassemblage, mainly found in areas where the substrate is largely dominated by sands, sometimes with a small fraction of broken shells and small stones. Is characterized by the presence of: - The crinoid *Leptometra phalangium*, whose abundance can be very high in some areas, reaching densities of up to 15 ind./m2. - *L. phalangium*.	•10 main communities: - Cidarid beds and *Parantipathes larix* forest on coralligenous rocks and maërl beds between 60-80 m depth - Coralligenous assemblages dominated by gorgonians between 40-100 m depth - *Halocynthia papillosa* population on coralligenous rocks between 60 and 100m depth - *Myriapora truncata* assemblage with *Caulerpa racemose* and *Udotea petiolate* together with colonies of *Eunicella singularis* and various sponge species - *Lytocarpia myriophyllum* forests on sandy slopes between 40 and 80 m depth - Sabellid grounds on sand at 60-80 m depth dominated by various species of *sabellids* - Volcanic detritus with *Arachnanthus oligopodus* between 60-80 m depth - Antipathella subpinnata forests between 80-100 m depth - Deep sponge hardgrounds between 240 and 360 m depth - Bathyal anthozoan forests below 300 m depth	• 8 main communities: - Pennatulacean assemblage on compact mud with *Funiculina quadrangularis* and *Pennatula rubra* - *Spinimuricea klavereni* forest starting from 36 m depth down to about 70 m depth. - *Lytocarpia myriophyllum* forests on detritic sands - Deep muds with *Parapenaeus longirostris* below 150 m and with the bathyal fish *Gadiculus argenteus*. - Gorgonian forest on coralligenous outcrops dominated by *P. clavata* and *E. cavollini* between 40 and 70 m depth. - *Dendropphyllia ramea* on deep sub-outcropping rocks on the deep circa-littoral rocks at about 80-90 m depth. - Rocky bottoms with *Hacelia attenuate* and *Halocynthia papillosa* betwwen 70-80 m depth. - Black coral forest dominated by *Anthipatella subpinnata* between 70-80 m depth.	• 3 main communities: - Maërl rhodolite beds, coralligenous outcrops and detritic sand: *Haliclona sp1* and *Paramuricea sp* could form very dense facies that could extend to very large areas especially on high maërl density for *Paramuricea sp* and medium maërl density for *Haliclona sp1*. pecimens of crinoids *Leptometra phalangium* and *Antedon mediterranea* occurred mainly on large specimens of *Haliclona Sp1. Sabella sp* also formed facies but were restricted to smaller areas. Isolated individuals of *Myriapora truncata* and *Pentapora fascialis* were observed too. Corallineous outcrop: *Paramuricea sp, Eunicella cavolini* and *Eunicella singularis* especially on exposed cliff edges. *Haliclona sp1* was less frequently isolated. Detritic sand: *Haliclona sp2* formed facies but were restricted to smaller areas. Isolated individuals of *Pseudosuberites hyalinus, Clathria sp* and *Cidaridae* were observed. - Shallow rhodolite maërl beds and coralligenous outcrop: dominated by the brown algae Laminaria sp which forms very dense facies that could extend to very large areas as well as on rhodolite (maërl) beds and coralligenous outcrop. The substratum free from algae was colonized by *Myriapora truncata, Eunicella singularis* and *Paramuricea sp.* - Rhodolite maerl beds with medium density: *cidaridae* formed facies in small areas and isolated individuals of *Halicliona sp* and *Myriapora truncate*.	• 3 main communities: - Shallow maërl ground mixed with medium sand and coralligenous outcrops: Laminaria *sp* and *Pentapor fascialis and Paramuricea sp.* On shallow maërl rhodolite mixed with medium sand algae Laminaria sp was abundant. It could form dense facies especially on high maërl density. *Myriapora truncata* and *Pentapora fascialis* were restricted to smaller areas. Isolated individuals of *Ascidiacea*. Corallineous outcrop: dominated by algae *Laminaria sp*. many species of gorgonians, specially Paramuricea sp that could form small facies restricted to smaller areas. - Maërl rhodolite beds with medium sand located at medium depth: *cidaridae* could form very dense facies, found once large facies of *Centrostephanus longispinus*. - Rhodolite maërl beds with medium sand and cobbles and pebbles: dominated by *Halicliona sp*. *cidaridae* and *ascidiacea* were observed too.

		SPAIN		ITALY		TUNISIA	
		MINORCA CHANNEL	CAP DE CREUS	PONTINE ARCHIPELAGO	PATTI	LA GALITE	ESQUERQUIS BANK
	EQUIVALENCE TO EUNIS	• Both deep and shallow rhodolite beds would fall in the category A5.51 Maërl beds. • Coralligenous outcrops within the category A4.32 (Mediterranean coralligenous communities sheltered from hydrodynamic action). • Coralligenous patches with high densities of the gorgonian E. singularis and E. cavolinii would receive the codes A4.26A and A4.269 respectively. Detritic sand would fall within the category A.5.44, which corresponds to the habitat type circalittoral mixed sediments.	• Pennatulacean assemblage (group a) can be considered part of the "Mediterranean communities of shelf-edge detritic bottoms" (Code A5.47), in which the crinoid assemblage (group d) is a facies, so it can be included under the next level of classification "Facies with [Leptometra phalangium]" (Code A5.472). • Gorgonian assemblage (group c) can be included under the group "Mediterranean coralligenous communities moderately exposed to hydrodynamic action", into its next level of classification "Facies with [Eunicella cavolinii]" (Code A4.269). Polychaete assemblage (group b) may fall under the group "Mediterranean communities of muddy detritic bottoms" (Code A5.38).	• Cidarid beds and *Parantipathes larix* forest: category A4 Circalittoral rock and other hard substrata • Coralligenous assemblages dominated by gorgonians and *Myriapora truncata* assemblage: category A4.26 Mediterranean coralligenous communities moderately exposed to hydrodynamic action • *Halocynthia papillosa* population: category A4.21 Echinoderms and crustose communities on circalittoral Rock • *Lytocarpia myriophyllum* forests on sandy slopes: category A5.44 Circalittoral mixed sediments • Sabellid grounds on sand: category A5.435 Oyster beds on shallow sublittoral muddy mixed sediment • *Hyalinoecia tubicola* field on sand: category A5.45 Deep circalittoral mixed sediments • Volcanic detritus with *Arachnanthus oligopodus*: A5.44 Circalittoral mixed sediments • *Antipathella subpinnata* forests: A4 Circalittoral rock and other hard substrata • Deep sponge hardgrounds and Bathyal anthozoan forests: category A6.11 Deep-sea bedrock	• Pennatulaceans assemblage on compact muds: category A5.36 Circalittoral fine mud • Spinimuricea klavereni forests on mud to fine sands: category A5.39 Mediterranean communities of coastal terrigenous muds • Deep muds with Parapenaeus longirostris: category A5.36 Circalittoral fine mud and A6.51 Mediterranean communities of bathyal muds. • Lytocarpia myriophyllum forests on detritic sands: category A5.35 Circalittoral sandy mud. • Gorgonian forests on coralligenous outcrops: category A4.26 Mediterranean coralligenous communities moderately exposed to hydrodynamic action. • Dendrophyllia ramea on deep sub-outcropping rocks: category A4.26 Mediterranean coralligenous communities moderately exposed to hydrodynamic action. • Rocky bottoms with Hacelia attenuata and Halocynthia papillosa: category A4.21 Echinoderms and crustose communities on circalittoral rock. • Black coral forest: category A4.26 Mediterranean coralligenous communities moderately exposed to hydrodynamic action.	• Maërl rhodolite beds would fall in the category A5.51 Maërl beds. • Shallow rhodolite maërl beds supporting forest of Laminaria sp corresponds to the category A5.52L which is characterised by the abundance of the brown alga Laminaria sp. • Coralligenous outcrops within the category A4.26 that correspond to Mediterranean coralligenous communities moderately exposed to hydrodynamic action. • Coralligenous patches with high densities of the gorgonian Paramuricea sp would receive the codes A4.26B. • Detritic sand would fall within the category A.5.44, which corresponds to the habitat type circalittoral mixed sediments.	• Deep, medium and shallow rhodolite beds would fall in the category A5.51 Maërl beds. • Shallow rhodolite maërl beds with high density of *Laminaria sp* corresponds to the category A5.52L which is characterised by the abundance of the brown alga Laminaria sp . • Coralligenous outcrops fall in the category A4.32 that corresponds to Mediterranean coralligenous communities sheltered from hydrodynamic action.

		SPAIN		ITALY		TUNISIA	
		MINORCA CHANNEL	CAP DE CREUS	PONTINE ARCHIPELAGO	PATTI	LA GALITE	ESQUERQUIS BANK
	SPATIAL DISTRIBUTION	• Shallow rhodolite (maërl) beds were widely distributed along the study area. • Deep rhodolite beds were mainly located in the north western part of the study area. Along rhodolite beds both coralligenous and detritic sands intercalated in small patches.	• Pennatulacean and crinoid assemblages were mainly observed in the middle part of the continental shelf of Cap de Creus, on the northern side of the cape, where sediments tend to be soft and composed mainly of sands with a small portion of gravels. • Gorgonian populations were mostly found closer to shore, at depths of 80-90, still at the northern side of the cap. Polychaete assemblage was found on the southern part of the cape, where sediments tend to be finer.	• Coralligenous assemblages widely distributed in the study area, being the shallow waters of the Archipelago mainly represented by rocky hardgrounds from the shore to 150m depth. • Sub-outcropping rocks represented down to the 500m depth bathymetry. • Sandy and detritic bottoms, and the communities they host restricted in the areas surrounding the rocky shoals	• Soft bottom communities, mainly the forests of *S. klavereni* and the pennatulacean assemblages, are widely distributed in the study area • Coralligenous assemblages and the other communities thriving on hardgrounds were mainly found on the shallow water rocky capes or on the rocky shoals • Nearby these habitats are found the communities of detritic sands.	• Rhodolite (maërl) beds were widely distributed along the La Galite area. • Shallow rhodolite (maërl) beds were mainly located in the north part of the study area. • Along rhodolite beds both coralligenous outcrop and detritic sands intercalated in small patches.	• Rhodolite (maërl) beds were widely distributed along the Esquerquis benches, • Shallow rhodolite beds were mainly located in the middle part of the study area. • Coralligenous outcrops were intercalated in small patches within maërl beds.

	SPAIN		ITALY		TUNISIA	
	MINORCA CHANNEL	**CAP DE CREUS**	**PONTINE ARCHIPELAGO**	**PATTI**	**LA GALITE**	**ESQUERQUIS BANK**
DESCRIPTORS OF MARINE STRATEGY DIRECTIVE	• Diversity: analysis revealed that low effort grounds were more diverse with 142 species than high effort grounds, with 104 species; Porifera was the most diverse group in both cases with 66 species in low effort and 41 in high effort grounds. • Mean maximum size of key forming species: - In low effort grounds, 4 species of gorgonians: E. singularis, E. cavolinii, E. verrucosa, P. macrospina, 1 species of antipatharian A. subpinnata, and one species of large hydrozoan L. myriophyllum. - In high effort grounds, 2 gorgonian species: E. singularis (with populations slightly smaller than on low effort) and P. macrospina. • Habitat percentage of area occupied by biogenic substrate: - In low effort grounds 73% of sampling units were mostly covered by biogenic substrates, about 8% by coralligenous and 65% by rhodolite beds. - In high effort grounds 63% of sampling units were mainly covered (>50% of the sampling unit surface) by biogenic substrates, about 8.4% were covered by coralligenous outcrops and 54.6% by rhodolite beds. • Percentage of marine litter: density of 0.0005 debris/m in the explored area; during the 15 ROV transects only 2 lost fishing lines and 1 glass bottle were found.	• Diversity: in 3 out of the 4 indices used, high-impact areas were slightly more diverse and with further species richness than low impact areas, with 75 species identified from the ROV footage compared to 58 in low impact grounds. • Mean maximum size of key forming species: only the gorgonian *E. cavolinii* was measured from the ROV footage in this area, it was abundant in 2 transects, and appeared in reasonable numbers in another 2. Maximum size of the colonies relates with gorgonian density, and the tallest individuals were registered in the two transects where densities were high. Values in all areas ranged between 4.5 and 6 cm. • Percentage of marine litter: very low percentage of human impacts was detected.	• Diversity: low effort fishing grounds were the areas showing the greater diversity of the megabenthic fauna. Sponges represented the most diverse group, with 28, 43 and 30 species in the three effort areas, respectively, followed by anthozoans • Mean maximum size of key forming species: *Parantipathes larix* is the species considered as it was found in both low and high effort fishing grounds with a considerable number of colonies. No remarkable differences were observed between populations. • Habitat percentage of area occupied by biogenic substrate: 25% coralligenous rocks, 6,5% of muds to fine sands, 31,6% sands to gravel, 6% maërl and 30,9% sub-outcropping rocks • Percentage of marine litter: overall average density of 0.009 debris/m.	• Diversity: Species diversity analysis revealed that medium effort fishing grounds were the areas showing the greater diversity of the megabenthic fauna. In high and low effort fishing grounds we encountered 53 and 54 species, respectively, while in medium effort fishing grounds 114. • Mean maximum size of key forming species: In high/medium effort fishing ground we measured two different species of gorgonians (*S. klavereni*, *P. clavata*), and the large hydrozoan *L. myriophyllum*. In low effort fishing grounds we measured two gorgonian species, *E. cavolinii* and *P. clavata* and again the large hydrozoan *L. myriophyllum*. No remarkable differences were observed between populations	• Diversity: - Low effort fishing grounds: 123 species; 16 species of porifera and 14 of octocorallia; total abundance (N) was higher in low effort fishing grounds; Shannon–Wiener index1 (H') was 0,73; and Simpson index was 0,33. - High effort fishing grounds: 117 species; 23 species of porfiera and 12 of octocorallia; Shannon–Wiener index (H') was 1,09; and Simpson index was 0,17. • Mean maximum size of key forming species: - *Haliclona sp* (porifera): the larger individual was found in low effort areas. - *Paramuricea sp* (gorgonian): the largest colony was found on high effort areas, in concrete in outcrop coralligenous substrate. • Habitat percentage of area occupied by biogenic substrate: biogenic substrate of maërl was the major substrate found; on high effort fishing grounds about 86% of sampling units were mainly covered by maërl and only 14% were by rocks. On low effort fishing grounds, 70% of the sampling units were mostly covered by maërl, and about 12% were covered by medium sand. Cobbles and roks covered about 9% of sampling units. • Percentage of marine litter: within the 54 ROV transects performed, three lost fishing long lines were found, two lost ballasts, 11 ropes, one glass bottle and a piece of plastic. So the density of marine litter in La Galite area is about 1.96 10-7debris/m2.	• Diversity: - Low effort fishing grounds: 32 species; porifera was the most diverse with 10 species and 4 of *Echinodermata*; total abundance (N) was 7887; Shannon–Wiener index (H') was 0,82; and Simpson index was 0,0004. - High effort fishing grounds: 119 species; 23 species of *Echinodermata*; total abundance (N) was 1043; Shannon–Wiener index (H') was 1,32; and Simpson index was 0,039. • Mean maximum size of key forming species: - Porifera represented by *Haliclona sp*: there isn't a great difference for the size structure between low and high effort fishing grounds. However, the larger individual (14,84) was found in high effort fishing grounds. - Gorgonians represented by *Paramuricea sp:* the mean size is more important in high effort fishing grounds than in low effort fishing grounds. The most larger colony (17,93) was found in high effort fishing grounds in coralligenous outcrop. • Habitat percentage of area occupied by biogenic substrate: - Biogenic substrate of maerl was the major substrate found; on high effort fishing grounds about 74% of sampling units were mainly covered by maërl. - Medium sand have the second range (14%). - Roks covered about 8% of the area. - On low effort fishing grounds 70% of sampling units were covered by maerl. About 14% were covered by Cobbles and pebbles and medium sand • Percentage of marine litter: within the 24 ROV transects performed, we found 8

[1] *permits to describe the distribution of the individuals into the various species*

5. CONCLUSIONS

After two years of study, the ECOSAFIMED project can offers, a set of guidelines to make artisanal fisheries activity more sustainable. These results have been reached after analysing the data from the oceanographic surveys, where the seabed has been filmed, and from direct observation during on-board surveys with fishermen. In this regard, the impact of selected *métiers* over benthic communities has been assessed. These are the 10 recommendations addressed to fishermen, public Administration and scientific bodies to reduce the impact of artisanal fisheries on the seabed:

1. Avoid fishing in areas where fragile communities have been detected
Black corals and gorgonians represent the most important habitat- forming benthic species of the Mediterranean Sea. Due to their longevity, slow growth rates, limited dispersal ability, and possibility to enhance biodiversity levels of the benthic community, they are considered fragile and vulnerable species. When they are detected, due to the capture of large benthic species or huge quantities of habitat-forming species, scientific experts should be informed and fishing gears no longer deployed along the same track and in the nearby area. This is particularly relevant when exploring new fishing grounds. Furthermore scientists should be supported to map the extent of such important habitats in order to provide the spatial information to fishermen.

2. Promote the inclusion of fishermen's knowledge in scientific studies and monitoring activities
The long experience of fishermen is a source of information of enormous value. Their reporting on extraordinary captures, occurrence of rare species and large animal forests and species of considerable size helps to increase our limited knowledge on the seabed, as well as to identify high valuable sites where to establish Marine Protected Areas. Experts may provide the fishermen with photographic charts of the most common and valuable species occurring in the bycatch to be used on-board for a first identification. This information also represents a way to transform the fishing activity into an opportunity for collaboration. Networks of fishermen-cooperatives-experts-managers should be established to keep trace of valuable discard species.

3. Return in water the benthic discard in less than 30 minutes and avoid as much as possible discard
Experimental evidences (targeting the gorgonian *Paramuricea macrospina*) highlight that the survival of accidental captures increases up to 85% if the colonies are returned to the sea in less than 30 minutes. For the same reason, it is important to avoid damaging and crushing of branched or three-dimensional organisms (such as bryozoans, sea urchins, gorgonians, sponges...) during the cleaning operations to reduce their fragmentation and enhance their recovery. Particular attention should be posed to the gorgonians coming onboard with their own support (such as a rock): experimental data suggest that, when returned to the water, the probability to fall on the sea bottom in the upright position is 90%, reducing the possibility to be covered by sediment and enhancing their chance of survival. It may be concluded that the survival of accidental captures of benthic species increases if they are returned as soon as possible to the sea so as to reduce their exposure to air and heat.

4. Return the benthic discard in the same location where the gear has been hauled

Complex marine benthic communities are heterogeneously distributed on the sea bottom according to environmental conditions. Gorgonians and black corals, representing the most important habitat-forming benthic species in the Mediterranean Sea at a depth of 50-200m, are known for their slow growth rates as well as their limited dispersal ability and tendency to form aggregations on the sea bottoms. Returning the benthic discard species in approximately the same area of collection increases the probability that they fall back in their original area of distribution, where environmental conditions are optimal for their growth, therefore enhancing their survival rate.

5. Pursue the establishment of Marine Protected Areas or fishing restriction zones to protect the identified valuable ecosystems

The most efficient way to guarantee the protection of valuable and fragile benthic identified ecosystems is their declaration as Marine Protected Areas with specific regulations to curb negative impacts on these ecosystems or areas with some level of restriction for fishing activities. These are not necessarily widely geographically extended as they may only enclose specific populations of important species. In case the explored areas are already protected or their designation is in progress, data coming from the ECOSAFIMED experience should be included in the decision making.

6. Promote the use of more selective gears and more efficient materials

Experiments show that the type of gear plays an important role in the magnitude of the impact. The selection of more efficient materials, such as multi-monofilament trammel nets (MMF) over polyamide ones, carefully used over maërl bottoms, reduces by 64% the capture of substrate. It is very important to promote studies to develop more selective and less impacting gears and then encourage fishermen to use them.

7. Decrease the fishing impact by reducing the number of sets of nets in the same site over a single season

The impact of fishing nets is accumulated in each fishing operation if the gear is deployed in exactly the same place repetitively, for the entire fishing season. A good practice is to reduce the number of fishing operations in the same place. The maximum number of repeated operations in the same fishing track conducted on maërl bottom with trammel nets should be defined depending on the gear, the site and its conservation status, and a significant reduction is always suggested.

8. Decrease the fishing effort by reducing the length of the fishing sets of nets

The most productive habitats (coralligenous outcrops, rocky areas and maërl habitats) show a typical patchy distribution over limited rocky areas surrounded by sandy bottoms. Remotely Operated Vehicles (ROV) surveys showed that the length of a trammel net for decreasing the impact should be between 500 and 800 meters length to make fisheries activity and seabed conservation compatible. This minimizes the undesirable impact on habitats and the possibility for the portions of the nets exceeding this length to remain entangled. Adaptations of this "optimal length" should be made depending on the gear and the site, and a significant reduction is always suggested.

9. Promote the regular mending of fishing nets

One of the factors that increases the contact surface between the seafloor and demersal fishing nets like trammel nets, is the loss of the buoys line, that weigh the gear and keep the net anchored in an upright position on the sea bed. The loss of the line enhances the possibility for the net to fall on the rocks hence to entangle the benthic organisms. Also, lost pieces of nets easily remain entangled on arborescent organisms, as demonstrated by ROV footage. Avoiding the presence of damages in the nets reduces the probability for the gear to come in contact with the benthic species.

10. Promote best fishing practices with easy, straight-forward and good quality video footage

An image is better than thousands of words" This captures the essence of this recommendation. Straight-forward video footage, visually showing the scientific backgrounds to some statements (such as the occurrence of lost gears, the survival of discarded species, the status of the returned organisms in the water), obtain a much higher attention and a much more positive response that any technical report or graph. Video footage therefore should be considered as a priority communication tool and a key element to propose recommendations.