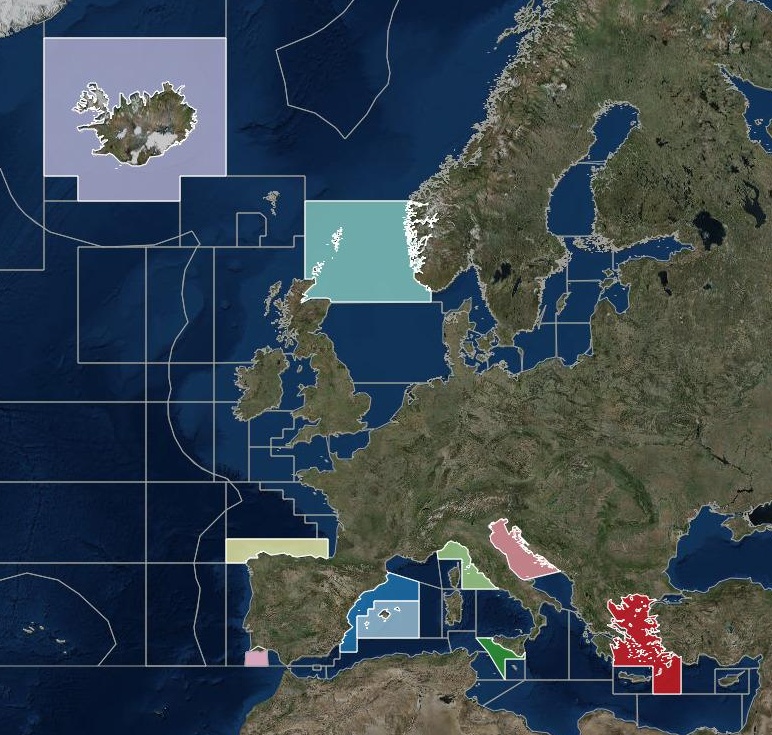
## Description of MINOUW Case Studies (CS)

*Fig. 1. General map of the case study areas in the MINOUW Action (colored marine areas). Lines demarcating areas in the sea correspond to ICES areas in the Atlantic Ocean or Geographical SubAreas (GSA) in the Mediterranean sea.*



*Table 1. Summary table with CS identification and Beneficiary responsible.*

|  |  |
| --- | --- |
| Case Study | Beneficiary number and acronym |
| CS1.1 Icelandic bottom trawl fishery | 3. UI |
| CS1.2 Algarve deep-water trawl fishery | 6. CCMAR |
| CS1.3 North and South Iberian hake stocks | 10. UPV/EHU |
| CS1.4 Catalan sea bottom trawl fishery | 1. CSIC + 4. WWF |
| CS1.5 Bottom trawl crustacean fisheries in Sicily (*Parapenaeus*) | 2. CNR + 4.WWF |
| CS1.6 – 1.8 North Ligurian and N. Tyrrhenian Sea bottom trawl fishery | 8. CIBM |
| CS1.7. Aegean sea bottom trawl fishery | 9. HCMR |
| CS2.1 Adriatic pelagic trawl | 4. WWF + 2. CNR |
| CS2.2 Algarve purse seine | 6. CCMAR |
| CS2.3 North Aegean Sea purse seine (Kavala) | 4.WWF |
| CS3.1 Algarve set nets, bivalve dredges and traps | 6. CCMAR |
| CS3.2 Mallorcan set nets (red mullet and lobster nets) | 1. CSIC + 5. DGMRM |
| CS3.3 Mallorcan boat seine fishery | 1. CSIC + 5. DGMRM |
| CS3.4 Small scale fishing in Catalan coast | 1. CSIC + 4. WWF |
| CS3.5 Trammel net fisheries in North Tyrrhenian sea | 8. CIBM |
| CS3.6 Longline swordfish fisheries in Aegean sea | 9. HCMR |
| CS3.7 Norway pots | 7. IMR |

### CS 1.1 Icelandic bottom trawl fishery

Discarding in Iceland did most likely not start until at the end of the 19th century when fishing with trawlers began. In the beginning of the 20th century there were no rules relevant to unwanted catches in Icelandic fisheries, but in 1937 a law of minimum length of landed fish and minimum mesh size was implemented (Pálsson, 2002). In the beginning the minimum length of cod and haddock was 24 cm and the minimum mesh size was 70 mm. These regulations were changed over the years and in 1977 the minimum size for cod and haddock was 50 and 45 cm, respectively and the mesh size increased to 155 mm. These regulations probably led to increased discards of fish smaller than the minimum size. In 1977 discards of cod and haddock and four other demersal species was prohibited and fish smaller than the minimum size was confiscated by the Ministry of Fisheries.

In 1984 a catch-quota system was implemented and the previous laws regarding minimum size were canceled, so that fish under minimum size was not counted towards the quota (Pálsson, 2002). In 1986 it was mandatory to land all caught fish that had quota and this was confirmed with laws in 1996 with few exceptions (Pálsson, 2002, *Lög um umgengni um nytjastofna sjávar* nr. 57/1997). It is allowed to discard intestines and heads of some species that are processed onboard. The minister can authorize to discard viable fish and this has been done for the Atlantic halibut which is not targeted because of low stock size but is caught as a by-catch in other fisheries (*Reglugerð um nýtingu afla og aukaafurða* nr. 468/2013, *Reglugerð um veiðar á lúðu* nr. 470/2012).

Actions have been taken to reduce discards when the quotas run out with so-called “Catch-quota balancing” regulations (Woods et al., 2015). If quota for one species is exceeded, quota for another species can be transformed into a quota for that species. This rule has exceptions and limits, quota cannot be transformed into quota for cod and a maximum of 5% of a species quota (in cod equivalents based on market value) can be transformed and no more than 1.5 % into a single species. The quota can also be transferred between years. Up to 15% of a species quota that was unused the previous year can be transferred to the present year and up to 5% of species quota can be borrowed from the next year. If all these “Catch-quota balancing” options have been used, 5% over the quota can be landed but only 20% of the value is kept and 80% goes to the Directorate of Fisheries. If the landings exceed this 5% all of the landings are confiscated by the Directorate of Fisheries.

Monitoring of discards did not begin until 2001 and only discards of cod and haddock are monitored but in some years discarding of saithe, golden redfish and plaice have also be monitored (Pálsson et al., 2012). Discarding of undersized cod has been estimated to be 0.9% of the total catch from 2001 to 2010 and 2.02% for haddock for the same period (Pálsson et al., 2012).

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Reglugerð um veiðar á lúðu nr. 470/2012. <http://www.reglugerd.is/reglugerdir/eftir-raduneytum/atvinnuvega--og-nyskopunarraduneyti/nr/18302>

Woods, P.J., et al (2015). Catch-quota balancing mechanisms in the Icelandic multi-species demersal fishery: Are all species equal? Marine Policy 55, 1-10.

### CS 1.2 Algarve deep-water trawl fishery

The Portuguese crustacean trawl fishery involves 26 trawlers (20-29 m, 90-150 GRT) plus 5 Spanish licenses under a bilateral agreement. The fleet operates at the edge of the continental shelf and slope in the SW and S of Portuguese continental waters (ICES Div IXa), all year round, at depths higher than 150 m. Landings take place in fishing ports along the Southwest and South coasts, but are sold only in Vila Real de Santo António, near the Spanish border, the main market for Portuguese crustaceans. Information on individual vessels catches comes from fishing logbooks and auction tickets, while spatial activity can be derived from the vessel monitoring system (VMS). The fishery is also monitored within the scope of the Portuguese DCF (scientific surveys, on board or at-auction landings/catches, and discard sampling). Control and enforcement is carried out by the National Fisheries Administration (DGRM).

The main target species are the rose shrimp, *Parapenaeus longirostris*, and the Norway lobster, *Nephrops norvegicus*. The amount of by-catch can largely exceed the catch of target species. In 2005-2007 the total landed weight in tonnes, comprising crustaceans and commercial by-catch, was estimated to be around 1000 t per year (landings database, DGRM). The fleet directs the fishing effort towards one or the other of the target species, according to their abundance, resulting in the existence of two distinct landing (and discarding) profiles, each characterized by different composition of target and by-catch species (Campos et al., 2007), and discards. With regards to the latter, tows directed at the rose shrimp may lead to significant discarding of small-spotted catshark *Scyliorhinus canicula*, conger eel, *Conger conger*, European hake *Merluccius merluccius*, horse mackerel *Trachurus trachurus*, boarfish, *Capros aper* (Borges et al., 2001), while those aiming at Norway lobster result in discarding mostly of deepwater fishes, e.g. silvery pout *Gadiculus argenteus*, roughtip grenadier *Nezumia sclerorhynchus*, Mediterranean slimehead *Hoplostetus mediterraneus* (Monteiro et al., 2001). The blue whiting *Micromesistius poutassou* is a ubiquitous species in both discard profiles, but particularly abundant in deeper waters. Discards ratios may vary considerable, ranging from an average minimum of 37% (Monteiro et al., 2001) to a maximum of 70% (Borges et al., 2001). Survival of discards has been assessed for *Nephrops* (Castro et al., 2003) with the objective to examine if a policy of releasing could be used to protect the *Nephrops* population off the South coast of Portugal.

Rose shrimp has not been subject to any assessment, but catch limits are fixed through TACs and quotas for *Nephrops* and for a number of commercially valuable fish by-catch species including horse mackerel, hake, and blue whiting. The fishery is regulated by two different cod-end mesh sizes, 55 mm for rose shrimp and 70 mm for *Nephrops* directed hauls. Minimum landing sizes (MLS) are set in national legislation and by-catch restrictions apply when using 55 mm cod-ends. Mismatches between maturation sizes, MLS and codend minimum mesh sizes, and by-catch limits were evidenced in selectivity studies (Campos et al., 2002, 2003; Fonseca et al., 2007), constituting relevant causes of discarding or misreporting of commercial by-catch. Gear based options (BRD systems) were developed to mitigate by-catch and reduce discards (Campos et al., 2004; Fonseca et al., 2005, 2007). Up to the present, the legal dispositions applied to this fishery have not encouraged fishermen to adopt these options or develop new ones to reduce by-catches. The discard ban introduced by the CFP, entailing a transformation to a policy where all fish caught count on the TAC/quotas, should be an incentive to avoid unwanted catches both through improvements in trawl selectivity and the development of low impact fishing techniques such as traps.

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### CS 1.3 North and South Iberian hake stocks

The Iberian hake (*Merluccius merluccius*) stock corresponds to ICES area VIIIc (northern Iberian peninsula, Cantabrian Sea) and IXa (western Iberian peninsula). The stock is also known as the Southern Stock of Hake (SHS). This stock is managed by TAC, effort control and technical measures. The agreed TAC for Southern Hake in 2012 was 12 299 t and 14 144 t in 2013. Hake is caught in a mixed fishery by the Spanish and Portuguese fleets (trawls, gillnetters, longliners and artisanal fleets). Spain accounts for most of the landings. The ICES advised, on the basis of the transition to the MSY approach, that landings for SHS in 2013 should be no more than 10 600 t. Nevertheless, the agreed TAC for SHS in 2013 was 14 144 t. A Recovery Plan for SHS was enacted in 2006 (CE 2166/2005). This plan aims to rebuild the stock to within safe biological limits by decreasing fishing mortality a maximum of 10% per year with a TAC constrain of 15%. SSB target (35 000 t) is not considered suitable under the new assessment model. This regulation includes effort management in addition to TAC measures, set in Reg. EU Council 39/2013 (annex II-b). Since 2006, a 10% annual reduction of fishing days at sea was applied to all vessels, although with some exclusions. In 2012, vessels that landed less than 5 tones of hake in 2009 or 2010 are excluded. The effort from fishing trips which retain <3% hake are excluded from the regulation. Technical measures applied to this stock include: (i) minimum landing size of 27 cm, (ii) protected areas, and (iii) minimum mesh size. These measures are set depending on areas and gears by several national regulations. According to the Spanish Regulations in 2012 and 2013 the fishing options have been shared by quarters and individual trawlers (ARM/3158/2011 and Res. 28-12-2012 SGMAR). The Portuguese regulations also established a closure for trawling off the southwest coast of Portugal between December and February. With respect to discards, a Spanish Discard Sampling Programme is being carried out in this stock since 1993. The series provide information on discarded catch in weight and number and length distributions for southern hake. Spanish sampling was carried out in 1994, 1997, 1999-2000 and 2003 onwards. The number of trips sampled by the Spanish program was distributed by three trawl fleets: Baca otter trawl, Pair trawl and HVO (High Vertical Opening) trawl. Total discards were estimated raising sampling with effort. This series was revised and computed by quarter from 2004 onwards. The Portuguese Discard Sampling Programme started in 2003 (second semester) and is based on a quasi-random sampling of co-operative commercial vessels. Two trawl fleets are sampled in this programme: Crustacean Trawl and Fish Trawl fleets. The discards estimation method was revised to take into account fishing hours as auxiliary variable and include outlier analysis.

### CS 1.4 Catalan sea bottom trawl fishery

Catalonia is an Autonomous Community of Spain where demersal fisheries represent 41% of the total landings and 70% of the value (in 2014), while the remaining fisheries yield correspond to small pelagics captured by the purse seining fleet. Demersal fisheries are carried out mainly by fleets using bottom trawl, set nets (trammel nets and gillnets) and longlines. The bottom trawl fleet (256 units in 2014 corresponding to fleet segments OTB1218, OTB1824 and OTB2440) produces 35% of the total landings in weight and 54% of the total landings in value. As in other Mediterranean fisheries, it shows a high rate of unwanted catches, both of species under minimum size regulation and marine organisms in general, that are discarded at sea (Lleonart, 2015; Tsagarakis et al. 2014). Bottom trawl exploits over 100 demersal and benthic species of finfish, crustaceans, and mollusks, but the main commercial species in the landings are: hake (*Merluccius merluccius*), red mullets (*Mullus* spp), red shrimp (*Aristeus antennatus*), Norwegian lobster (*Nephrops norvegicus)*, octopus (*Octopus vulgaris*), anglerfishes (*Lophius* spp), blue whiting (*Micromesisteus poutassou*), Sparidae and several species of squid. Two broad bottom trawl fisheries can be differentiated in Catalonia, a continental-shelf fishery targeting hake, red mullets and octopus, and a deepwater fishery targeting the highly prized crustaceans (red shrimp and Norway lobster). All vessels can and do fish along the entire depth range, although smaller trawlers (OTB VL1218) tend to restrict their activity to coastal waters. The management of the trawl fisheries is based on effort control and technical measures such minimum landing sizes, which are not always observed. Trawling is forbidden in waters less than 50 m depth (or 3 miles from the coastline). Trawl fishing is carried out on soft bottoms and fishing is limited to daily trips from Monday to Friday of approx. 6 hours of effective fishing time. The fishing grounds and the target species vary according season.

Several projects funded at national or EU level have investigated the problem of discards in the study area, notably the projects “DISCARDS I” (1995-1996) and “DISCARDS II” (2001). Other projects with relevant information were also reviewed for the MINOUW project. The results of these projects show that discard rates of species subject to the Landings Obligation are high (up to 30% of catches in number) for hake and red mullet during their recruitment season (spring and autumn, respectively). Other regulated species, such as mackerel and horse mackerel, have also very high discard rates year round. Deepwater fisheries targeting crustaceans have comparatively low discard rates. The total amount of discards in the trawl fishery is very important and is broadly related to depth and recruitment season of the target species. For instance, in fishing grounds located at depths less than 300 m overall discards are approx. 50% of the total catch, while discards are approx. 20% in deeper waters. An important part of the discarded biomass (30-50%) is composed of species of commercial interest (small sized or damaged specimens) and the rest are species with low or no economic value.

The data obtained during these projects have been compiled and re-analysed for the MINOUW RIA, with the main findings reported in the Results section below.

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### CS 1.5 Bottom trawl crustacean fisheries in Sicily (*Parapenaeus*)

These fisheries are the most important for catch and values of the demersal fisheries in the Mediterranean. The deep water rose shrimp, *Parapenaeus longirostris* (DPS) is the first target species of bottom trawlers operating on the outer continental shelf and upper slope of the south-central Mediterranean in terms of catch (mean landings of 5790 t in 2012-2014) and values of landings (about 30 million € in 2014). The second target species is the giant red shrimp (*Aristaeomorpha foliacea*, ARS), caught on the epi- and meso-bathyal fishing grounds with a yield amounting to a mean of 1620 t in 2012-2014 and a value of 24 million € in 2014. The main commercial by-catch of the deep water crustacean fisheries is the European hake, *Merluccius merluccius* (HKE), which yield amount to a mean of 1440 t in 2012-2014 and a value of 8 million € in 2014. Other important deep water crustacean by-catch are the Norway lobster, *Nephrops norvegicu*s (355 t and a value of 5 million € in the same period) and violet shrimp, *Aristeus antennatus* (95 t and a value of 2 million €). Although a fraction of catch of DPS is due to Tunisian trawlers (about 20%), most of the yield of DPS and almost the total of ARA is caught by Sicilian trawlers.

Sicilian (Italy) trawlers between 12 and 24 m LOA targeting deep water rose shrimp are based in seven harbours along the southern coasts of Sicily. These trawlers operate mainly on short-distance fishing trips, which range from 1 to 2 days at sea, and fishing taking place on the outer shelf and upper slope. In recent years, the dynamic of this fleet component evolved resulting in a shift of fishing grounds to deeper waters. Italian trawlers being over 24 m LOA have longer fishing trips, which may have a duration of up to 4 weeks and are mostly based in Mazara del Vallo (south-west Sicily). These vessels operate offshore, in both Italian and international waters of the south-central Mediterranean Sea at depth generally ranging from 200 to 400 m.

On the basis of their target Sicilian trawlers are distinguished in three main métiers:

Considering the Bottom otter trawl targeting to demersal species (OTB\_DEMSP), the species which cumulative percentage in terms of value of landings accounts for 75% are the deep water pink shrimp, *Parapenaeus longirostris* (DPS, 60 %) and the European hake, *Merluccius merluccius* (HKE, 15 %). According to the most recent DCF data, in the period 2012-2014, 147 vessels, on average, were involved in this fishery. This fleet was mostly composed by the segments VL2440 (44 %) and VL1824 (39 %). In the period 2012-2014, this fleet performed, on average, 2,347,237 GT\*days at sea per year.

Regarding the Bottom otter trawl targeting to deep water species (OTB\_DWSP) the red giant shrimp, *Aristaeomorpha foliacea* (ARS), is clearly the only target species of this fishery, accounting for about 75 % both in terms of the total value and landings. This fishery is performed on the muddy bathyal bottoms, from 300 to 800 m depth. Traditionally the Sicilian bottom trawlers fishing on deep water shrimps operate mainly in GSAs 12, 13, 14, 15, 16, and 21. Some trawlers targeted to Red shrimps, registered in Mazara del Vallo harbor, exploit also fishing grounds in GSAs 22, 23 and 24. According to the most recent DCF data, in the period 2012-2014, 49 vessels, on average, were involved in this fishery. This fleet was mainly composed by the segment VL2440 (74 %), followed by VL 1824 (18 %). In the period 2012-2014, this fleet performed, on average, 1,860,114 GT\*days at sea.

As the Bottom otter trawl targeting to mixed demersal and deep water species (OTB\_MDDWSP) concerns, the species which cumulative percentage in terms of value of landings accounts for 75% are the deep water pink shrimp (DPS, 32 %), the red giant shrimp (ARS, 29 %), and the European hake (HKE, 14 %). In terms of volume of landing, the same species mentioned above account for higher fraction of the landed biomass, although Hake landings in tons are higher than the giant red shrimp ones. This fishery is performed by trawlers based on GSA 16 but operating the muddy bottoms of continental outer shelf and upper slope of the GSAs 12, 13, 14, 15 and 16. According to the most recent DCF data, in the period 2012-2014, 60 vessels, on average, were involved in this fishery. This fleet was mostly composed by the segments VL2440 (72 %) and, in lesser extension, VL1824 (23 %). In the period 2012-2014, this fleet performed, on average, 1,200,003 GT\*days at sea per year.

The stock of DPS is routinely assessed with the support of the regional FAO project MEDSUDMED with XSA using the length structure of catch of Italy, Tunisia and Malta converted in age tuned by MEDITS trawl surveys data. According to the last assessment the stock is in overfishing with intermediate level of relative biomass. The current Fishing mortality (Fc), calculated as mean of the last three years (2012-2014) was 1.12. To reach the F0.1 (0.84-0.93) reference point a reduction of fishing mortality between 20 and 30% of the Fc should be pursued. This reduction could be reached both decreasing the fishing effort and also closing the main nurseries (Russo et al., 2014).

Although the deep water rose shrimp is clearly the target species of trawling in the Strait of Sicily, hake represent an important commercial by-catch, amount to about the 15% of catch and value both in OTB\_DEMSP and OTB\_MDDWSP. Other by-catch species are Norway lobster (*Nephrops norvegicus*), scorpionfish (*Helicolenus dactylopterus*), greater forkbeard (*Phycis blennoides*), red Pandora (*Pagellus bogaraveo*), common Pandora (*Pagellus erythrinus*), monkfish *(Lophius* spp.), and horse mackerel (*Trachurus* spp).

According to the different fishing grounds discard ranged between 25 and 40% of the total catch. The main discarded fraction, vary along with areas, being horse mackerel and greater forkbeard the most relevant in abundance. Other important discards are due to undersized hake and deep water rose shrimps. Hake, deep water rose shrimps and horse mackerel have a minimum catch size in the Reg. CE 1967/2006 and are subject to the discard ban according to the Reg. UE 1380/2013.

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### CS 1.6 – 1.8 North Ligurian and N. Tyrrhenian Sea bottom trawl fishery

The Ligurian and northern Tyrrhenian Seas (FAO division 37.1.3, Geographical Sub-Area 9, GSA09) cover an area of 42,410 km2 and include 1,245 km of coastline. The trawl fleet operating in GSA09 is characterized by different “métiers” according to the resources exploited. The trawl fleet in the investigated area (2012) consists of 330 boats, with an overall tonnage of approximately 13,000 GT, representing about 70% of the fishing capacity employed in the area. The landings volume produced by trawlers was about 8,000 t. This production features a high proportion of fish (58%), followed by molluscs (27%) and crustaceans (15%). The most important species in terms of landings are European hake, red mullet and horned octopus; the crustaceans Norway lobster, deep-water pink shrimp, and giant red shrimps also play an important role thanks to their high economic value. Almost all the trawlers in GSA 9 usually carry out one day fishing trips, with the exception of certain fleets, such as that of Porto Santo Stefano, where it is common to make trips of two and, occasionally, three days, particularly in summer. The Ligurian and Tyrrhenian bottom otter trawl fisheries are characterised by the problems affecting most of the Mediterranean fisheries: multi-specific composition of the catch and presence of a large number of juveniles of many commercial species subjected to minimum legal size (Caddy, 1993).

Sartor et al. (2003) showed that the by catch of deep sea trawl fisheries in the Ligurian and northern Tyrrhenian Seas accounts for about 80% of the total annual average catch, while the remaining fraction is represented by target species. Even though the exploitation is devoted to the target species, the economic value of the landings is also enhanced by species belonging to the retained by catch. Furthermore, on many fishing grounds catches are dominated by small sized species and specimens, which form the bulk of the rejected by catch. The fisheries targeting crustaceans produce a significant amount of discards, representing about 20% of the total catch (Sartor et al., 2003).

Discards of commercial species are mostly constituted by individuals under the minimum landing size of species belonging to the retained by catch. Discards are particularly abundant in cases of low commercial value species, such as blackmouth catshark, *Galeus melastomus*, and greater forkbeard, *Phycis blennoides*.

These characteristics affect the discard practice, and discards may represent a high percentage of the total catch in some periods of the year and in some areas. In particular, the investigated area is characterized by important nurseries of hake, *Merluccius merluccius*, where the concentration of juveniles is among the highest of the whole Mediterranean (Orsi Relini et al., 2002; Colloca et al., 2004). The introduction of 40 mm square mesh (or 50 mm diamond mesh Council Regulation (CE) No 1967/2006), although contributing to reduce the unwanted catch fraction, cannot solve the problem by itself due to the characteristics of the fisheries and the benthic/demersal communities in the area.

In recent years, thanks to the available information, the areas of greatest concentration of juveniles (“nurseries”) for many of the target species of trawling have been identified. In the last National Management Plan for GSA09, it is reported that more than 20% of hake juveniles are concentrated in specific nurseries, even though those areas represent about 1% of the surface of the entire GSA. The possibility to introduce regulations to manage the fishing activities in these areas seems to be the best tool in order to reduce unwanted catches of hake and other valuable species.

The case study is aimed at assessing the impact of using artificial lights on crustaceans catching efficiency and unwanted catches (mainly juvenile European hake) by means of comparing catch rates of target species (crustaceans) and unwanted catches in bottom trawling with and without lights.

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### CS 1.7. Aegean sea bottom trawl fishery

The Greek Aegean bottom trawl fishery is multi-specific in its nature and is managed by technical measures such as: (i) a summer closure of 4 months (Jun-Sep), (ii) spatial closures (within a 1.5 mile coastal zone, several closed gulfs) and minimum landing sizes (national & EU). The main target species on which the fishery is based are: European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), striped red mullet (*Mullus surmuletus*), Picarel (*Spicara smaris*), Bogue (*Boops boops*), Anglerfish (*Lophius budegassa*), Deep water rose shrimp (*Parapenaeus longirostris*), Norway lobster (*Nephrops norvegicus*), Caramote prawn (*Penaeus kerathurus*) and European squid (*Loligo vulgaris*).

However the group of species targeted is closely related to season, depth and substrate. The Aegean Sea is characterized by generally deep waters and a very narrow continental shelf, with the exception of the northern Aegean region. This results in the north Aegean Sea being one of the major fishing areas. The exploited fishing depths are in the range of 50 to 800 m, however the bulk of effort is exerted in the depth stratum between 100 and 350 m.

During the past decade, around 250 vessels were putting forth their effort in the area (excluding Turkish and Italian trawlers visiting the area, the impact of which is currently unknown). Effort is estimated to more than 6,000,000 GT x fishing days, with the most intensive period being October to January. According to the most recent figures (DCF, 2014) the Aegean bottom trawl fishery is responsible for 25% of total Greek catches summing up to around 13,000 tons. These are considerable values taking into account that just the 2% of the Greek fleet (~16,000 vessels) is landing a quarter of the total landings. More than 50% of bottom trawl landings consist of deep water rose shrimp (*Parapenaeus longirostris* 2325 t), European hake (*Merluccius merluccius* 1540 t), red mullet (*Mullus barbatus* 854 t), various cephalopods (1200 t) and horse mackerels (Trachurus spp. 506 t).

Regarding unwanted catches, the main discarded taxa include: *Parapenaeus longirostris*, *Trachurus trachurus*, *Liocarcinus depurator*, *Merluccius merluccius*, *Scyliorhinus canicula*, *Illex coindetii*, *Lepidopus caudatus*, *Gadiculus argenteus argenteus*, *Sardina pilchardus* and various other invertebrates. Market demand and regulation restrictions (e.g. MLS) are dictating discarding; important commercial species may be frequently considered 'unwanted' by the fishers. Total discard rates are rarely below 25% and can go up to 45% in some years/seasons. It has been identified that at least 46 fish, 3 crustaceans and 10 cephalopod species are consistently marketed, in comparison to 82 fish, 52 crustaceans and 8 cephalopod species that are discarded in all cases.

Although a study has identified six potential metiers in the Aegean bottom trawl fishery, such a classification was deemed inapplicable in the Data Collection Framework and currently all bottom trawlers are categorized under a single metier (DEMSP = targeting demersal species assemblages).

Finally, stock status of Aegean demersal resources has not been assessed since 2007 due to the lack of a data collection scheme during 2009-2013. According to these outdated assessments, only *Boops boops* was considered sustainably exploited in 2007. All other species (*Merluccius merluccius*, *Mullus barbatus*, *Mullus surmuletus*, *Nephrops norvegicus*, *Spicara flexuosa*, *Spicara smaris*) were classified as overexploited.

### CS 2.1 Adriatic pelagic trawl

Based on the Seventeenth session of the GFCM - Scientific Advisory Committee (held in FAO HQ, Rome, 24-27 March 2015), Small pelagic fisheries in the Adriatic Sea (in GSA 17) are assessed to be overfished, with exploitation rates higher than the reference points. The GFCM advice is an immediate reduction of fishing mortality. In particular, a timeframe for the implementation of reduction measures have to be established for the implementation of the multi-annual management plan. According to GFCM recommendation and EC adoption, a multi-annual management plan for the fisheries exploiting the small pelagic stocks in GFCM-GSA 17 "Northern Adriatic" must be developed and be coherent with the precautionary approach and designed (1) to provide high long-term yields consistent with the maximum sustainable yield and to guarantee a low risk of stocks collapse while maintaining sustainable and relatively stable fisheries. Within the framework of the GFCM-GSA 17 "Northern Adriatic" small pelagic stocks multi-annual management plan, objectives and related actions have to be taken into account (2) to reduce discards. Members of GFCM whose vessels have been actively fishing for the small pelagic stocks including, inter alia, sardine, anchovy in GFCM GSA 17 agree to implement such a multi-annual management plan for the fisheries concerned and in accordance with the general and specific objectives and measures set by this recommendation.

### CS 2.2 Algarve purse seine

The purse seine is the fishing gear responsible for more than 50% of the fish caught in weight and in value in Portugal, and represents around 41% of the catches and 44% of the revenues in the Algarve (2012-2014, Datapescas, 2015). These values are up to 40% less than usual, because of the recent sardine fishery decline. Generally, the purse seine is the most efficient gear for catching large and small pelagic species that are schooling. Fishing is usually close to the home port, on short daily trips where the net is set once or twice, usually around dawn. A large part of a typical fishing trip is spent searching with the fish-finding equipment (echo-sounder and sonar) for dense fish marks. Once schools of pelagic fish have been detected, large nets (Portugal/Algarve: 300-800 m long and 60-150 m deep with a 16-18 mm mesh size), are set rapidly with the help of an auxiliary vessel, and hauled involving all members of the crew, 5–20 persons, depending on the size of the fishing vessel. In 2014, there were 176 active fishing vessels off the Portuguese mainland, with purse seine licences. Of these, 46 licences were from the Algarve, belonging to vessels with an overall length of 8-24m and an average engine power of 160 hp (CFFR, 2015). Practically all of these vessels belong to POs and are based in Portimão and Olhão (Gonçalves et al., 2015).

Being the main fishing gear in the Algarve and in Portugal, the purse seine is targeting mainly sardines (European pilchard, *Sardina pilchardus*), but also other small pelagic fish such as horse mackerel (*Trachurus trachurus*), anchovy (*Engraulis encrasicolus*), Atlantic mackerel (*Scomber scombrus*), Atlantic chub mackerel (*Scomber colias*) and other jack mackerels (*Trachurus* spp.). The sardines are the major target species, but depending on the season and on the market demand any other commercial by-catch species such as the above can be the target of specific tows as well. Apart from the above species other pelagic ones such as bogue (*Boops boops*), spotted mackerel (*Scomberomorus* spp.), Atlantic bonito (*Sarda sarda*), triggerfish (*Balistes* spp.), garfish (*Belone belone*), mullets (*Mugil* spp., *Liza* spp., *Chelon* spp.) and bluefish (*Pomatomus saltatrix*) can be caught legally.

The purse seine fishery is highly regulated, including measures such as: 1) the fisheries comply with the statutory regulations on minimum mesh size (16 mm) and minimum landing sizes for the target species (e.g. *S. pilchardus*, 11 cm; *Trachurus* spp.; *S. colias*, 20 cm ); 2) purse seining is not allowed within ¼ mile from the coast and at depths of less than 20 m between ¼ mile and 1 mile from shore; 3) fishing is not allowed in the Algarve (Costa Vicentina) between 37º 50´N and 37º 00´ and from December to February; 4) fishing is forbidden during the weekend and the annual number of fishing days is limited to 180; 5) there are specific rules for the use of light attraction and for the use of live bait for the capture of tuna fish; 6) Vessel Monitoring System (VMS) and AIS - Automatic Identification System (AIS) are obligatory for all vessels larger than 15 m; 7) log books should provide a daily register of landings for all vessels longer than 10 m, and 8) all landings must be sold through auction and supported by DOCAPESCA sales notes.

The sardine purse seine fishery has been certified by the MSC from 2008 till 2012, when the sardine fishery collapsed. As the certification has implied some directives, with the decline of the sardine stock the associated measures are even stricter and are based on the setting and allocation of annual quotas mainly to the POs. In general these quotas are allocated to the POs and after that to the POs members based on their historical catch records and are used by the POs to set a daily quota.

Concerning the by-catch and discards issues, in Portugal the purse seine fishery is legally limited to a demersal by-catch of 20% of total landings, in order to avoid the capture of valuable by-catch species, such as seabass and seabreams. Borges et al. (2001) reported an average discard rate in weight of 20% and 27% for the demersal purse seines and pelagic purse seines, respectively. *B. boops*, *S. colias*, *B. belone* and *S. pilchardus* being the main discarded species. Gonçalves et al. (2008) reported 46 species caught by demersal purse seine, of which 32 are discarded, with an overall discard rate in weight of 51%, again largely consisting of small pelagic fish such as chub mackerel, bogue and sardine. In both studies the variability associated with discard ratios was very high. Following the above mentioned authors, discards in the purse seine fisheries in Portugal and in the Algarve may happen for several reasons: (1) the capture of schools with a mix of species with low commercial value; (2) undersized fish and (3) the catch of fish in amounts and/or sizes that are too small for the market. At least since 2001, in the Occidental coast of Portugal and more recently in the Algarve, there is a fourth strong reason for discarding: a catch of sardines above the daily vessel quota (Stratoudakis & Marçalo, 2002).

Gonçalves et al. (2008) tested a By-catch Reducing Device (BRD) in the demersal purse seining which consisted in the use of a panel of diamond-shaped mesh netting of 70 mm stretched mesh in the posterior part of the purse seine, that successfully reduced the amounts of by-catch (>60%).

The effect of capture and subsequent release of sardine from a purse seine has been studied by Marçalo et al. (2006), who reported the likelihood of stress related mortality. Experimental work carried out by Marçalo et al. (2008) indicated the possibility of a high survival for sardine slipped from a purse seine, provided that this is done soon after the seine has been lightly pursed. Further experimental work suggests that mortality of escapees after fishing events is always present at different levels, that depend on the severity and extent of certain factors (e.g. time, density and temperature) (e.g. Marçalo et al., 2013).

In addition to by-catch and discards of fish and invertebrates, purse seiners are also responsible for by-catch related mortality of sea birds and marine mammals (Gonçalves et al., 2008, Oliveira et al., 2015). The scenario for marine bird and mammals by-catch in Portuguese waters remains under evaluation (MARPRO, 2015). However, vessel skippers usually engage in actions to avoid the catch of these animals and when captured, try to release them by several methods, such as by lowering the floatline or by opening the net. At least for the common dolphins by-catch in purse seiners is below the PBR Potential Biological Removal (PBR), and the same is assumed for Minke whales and Bottlenose dolphins (Hough et al., 2009). On the other hand a large number of marine birds follow purse seiners to feed on discards or accidentally slipped fish, namely Atlantic Gannets (*Morus bassanus*), Shearwaters (*Calonectris diomedea*, *Puffinus mauretanicus*), and Seagulls (*Larus michahellis*).

The impact of purse seine activity on habitats is limited as they only operate in open water and the increment of nutrients in the water column during the pursing of the net is considered localised in time and space (Stratoudakis et al., 2003). When fishing takes place in illegal areas, demersal species are also caught and gear can be lost accidently by fouling on hard bottom. Gear loss can also be caused by excessively large catches, particularly if small fish (e.g. sardines) are caught or due to technical problems during the fishery, but the net is usually recovered later because of its high value.

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### CS 2.3 North Aegean Sea purse seine (Kavala)

The Case Study will focus on a fleet representative of Greek fisheries: the purse seine fleet of Kavala in the Aegean Sea (GSA 22) in Northern Greece – a large fleet (for Greek standards) of 18 vessels, targeting small pelagic species such as sardines (*Sardina pilchardus*) and anchovies (*Engraulis encrasicolus*). Kavala is one of the two most important landing ports for sardines and anchovies in Greece. The Kavala purse seine fleet is part of the Kavala Fisheries Improvement Project (FIP). The KavalaFIP is a multi-stakeholder partnership between WWF Greece, one of the biggest super market chains of the country “AB Vassilopoulos” (member of the Delhaize Group), local purse seiners and the national Fisheries Research Institute. The discards ratio (discards/total catch by weight) for purse seiners in the Aegean Sea (GSA 22), at the northern part of which the Kavala fleet operates is 4.6% according to Tsagarakis *et al*. (2012). Discarding is a process decided on board based on the size of the catch, market prices of species and length composition, weather conditions, economic pressure, alternative fishing strategies, previously gathered information and personal skills and takes into account legal, technical and environmental constraints. The main driver for discarding in purse seines in the Aegean Sea is the Minimum Landing Size (MLS) and the length of fish caught. It should be noted that low legislation compliance results to the sale of undersized individuals (Tsagarakis *et al*. 2012). Another driver is market value with regards to species of very low value such as *Sardinella aurita* which can be discarded*.* Current management measures include: MLS for species that are set by the Mediterranean Regulation (Council Regulation 1967/2006), minimum distance from shore of 300 m and minimum depth of 50 m, a closed season for 2.5 months in winter (15 December – 28 February), which applies only in Greek territorial waters (out to 6 nautical miles - the vessels regularly fish in international waters, i.e. outside 6 miles) and a minimum mesh size of 16 mm for night purse seines targeting sardine and anchovies. Finally, the relevant small pelagics management plan states that a reference point has been set as a maximum exploitation rate (E) for each stock. The exploitation rate is defined in the management plan as the fishing mortality as a proportion of the total mortality and the maximum rate has been set at 0.4 for both stocks (i.e. F/Z = 0.4 or F/(F+M) = 0.4; i.e. fishing mortality F is not more than two thirds of natural mortality M) (Anon. 2009).

### CS 3.1 Algarve set nets, bivalve dredges and traps

A) TRAMMEL NETS

Fixed nets (trammel nets and gillnets) are widely used in Portugal, second only to longlines in number of licenses. In 2014 a total of 6291 licenses for gillnets and trammel nets were issued, with 5504 for vessels of less than 9 m in total length. In the Algarve (Southern Portugal), 1443 licenses for fixed nets were issued, with 927 for the “local” category fleet (less than 9 m vessels) and 313 for the larger vessel “coastal” category fleet. Trammel net licenses accounted for approximately 60 and 45% respectively of the fixed net licenses for the local and coastal category fleets.

Trammel nets regulations stipulate a maximum length of a set net of 5,000 m and a minimum distance between nets of at least ¼ of a mile. The maximum total length of trammel nets fished by a vessel depends on the size of the vessel, ranging from 4,000 m to 20,000 m, and with maximum height of 5 m. The minimum ratio allowed between the inner panel mesh size and the outer panel mesh size is 1 to 4. Inner panel mesh sizes range from 80 to 99 mm stretched mesh for mixed species *métiers* targeting cuttlefish (*Sepia officinalis*), sea bass (*Dicentrarchus labrax*), sea breams (Sparidae), flatfishes (*Solea* spp.) and rays (*Raja* spp.) to inner mesh sizes greater than 220 mm for angler fish (*Lophius* spp.). In the Algarve (Southern Portugal) a questionnaire survey within the framework of a study on trammel net selectivity revealed the existence of 4 main trammel net *métiers*: 1) a main *métier* targeting cuttlefish (*Sepia officinalis*), 2) a sole (*Solea senegalensis*, *Solea vulgaris, Microchirus azevia*) *métier*, 3) a large sea bream (*Pagrus* spp., *Dentex* spp.) *métier*, and 4) a monkfish (*Lophius piscatorius*) *métier* (Erzini et al., 2001, 2006).

Fishing vessels less than 9 m in total length cannot fish within ¼ of a mile from the coast, while larger vessels are restricted to fishing grounds beyond 1 mile from the coast. Beyond 20 miles from the coast only trammel nets with inner panel mesh sizes greater than 220 mm can be used. The maximum soak time is 24 hours but trammel nets of greater than 100 mm inner panel mesh size set at depths greater than 300m can fish for up to 72 hours. Some spatial and temporal restrictions exist: no trammel netting is allowed from December to February between 37º50’N and 37º00’N, and year round between 7º31’W and 7º47’W.

Several studies of by-catch and discards of trammel nets have been carried out in Portugal over the past 15 years. Borges et al. (2001) reported an average discard rate of 13%, with chub mackerel (*Scomber japonicus*) and sardine (*Sardina pilchardus*) accounting for 58 and 11% of the total fish discards. Also from the same area (Algarve) Gonçalves et al. (2007) reported 105 discarded species, with an overall discard rate in numbers of 49%, again largely consisting of small pelagics such as chub mackerel and sardine. Fifty-five non-commercial discarded invertebrates were also discarded, accounting for almost 65% of the total discards in numbers (Gonçalves et al., 2008). However, these results are from experimental nets from a trammel net selectivity study. Batista et al. (2009) reported 98 discarded species, accounting for 22% of the total catches in weight for trammel nets fished in the vicinity of the ports of Sesimbra and Setúbal, and estimated that 45 trammel netters discarded a total of 17 mt *per* year, with *S. japonicus* the main discard species. Elasmobranchs, some with conservation status, constitute a significant part of trammel net catches and discards in Portugal (Erzini et al., 2002, Coelho et al., 2004, Batista et al., 2009, Baeta et al., 2010).

In addition to by-catch and discards of fish and invertebrates, trammel nets are also responsible for by-catch related mortality of sea birds and marine mammals and reptiles (Erzini et al., 2001, Oliveira et al., 2015). Furthermore, unlike active gears such as purse seines, trawls and dredges, trammel nets can continue to fish after being lost. The reasons for trammel net loss and the phenomenon of "ghost fishing" have been the focus of several studies in Portugal (Erzini et al., 1997, Santos et al., 2003, Baeta et al., 2009). In relatively shallow water, lost trammel nets effective fishing lifetime is less than a year. However, although there is no information from deeper waters, it is likely that ghost fishing may continue for much longer under conditions of limited light and low turbulence (Erzini et al., 1997).

To date there have been no studies on mitigation of by-catch and discards in Portuguese trammel net fisheries. However the maximum soak time legislation is aimed at reducing discarding due to catches deteriorating in the net if soak time is too long. Trammel and gill netters targeting spiny lobster will often deliberately and illegally leave old nets fishing for much longer than the legal soak time in order to attract lobsters to the rotting fish in the nets. There have also not been any studies on the survival of any trammel net discards species. With regards stock assessment, the vast majority of the trammel net discard species can be considered "data poor", with no stock assessment of any kind.

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B) BIVALVE DREDGES

Bivalve dredging is one of the most important small-scale fisheries conducted along the Portuguese South coast (Algarve). At present, the dredge fleet comprises 53 Portuguese vessels and 25 Spanish vessels, 4 – 15 m overall length, with engines of 17 – 150 HP and a crew of 1 to 5 fishers. This fleet directs fishing effort towards the clams *Spisula solida*, *Donax trunculus,* C*hamelea gallina* and the razor clam *Ensis siliqua*. These species inhabit sandy bottoms, forming extensive and dense beds, sometimes several kilometres in length. In this fishery, only mechanical dredges are allowed. This fishing gear is composed of a rigid iron structure with a toothed lower bar and a metallic grid where the catch is retained. Dredges are dragged across the seafloor and are designed to dig clams and razor clams out of the sediment (up to 60 cm depth). The low selectivity of many dredging gears inevitability results in some level of unintended catch and not all individuals captured will be landed. Although we succeeded in developing a more efficient and selective dredge in this fishery, the amount of by-catch is still high in this fishery (Gaspar et al., 2001, 2003). In some periods (late spring, early summer), it was observed that the quantity of by-catch could surpass the catch of the target species (Gaspar & Chícharo, 2007). Discarding of by-catch by commercial dredge fishing vessels is a common practice, but should not be a major problem if the discarded individuals survive. However, survival probability decreases if sorting times are long and/or conditions on deck are unfavourable, if the damage suffered during the tow is high and depends on the size of the specimens discarded and their susceptibility to predation after discarding (e.g. Medcof & Bourne, 1964; Fonds, 1994; Fonds et al., 1998; Kaiser & Spencer, 1995; Broadhurst et al., 2006). Although in the Portuguese dredge fishery most discarded species are invertebrates (bivalves, gastropods and echinoderms), most catches are only sorted at the end of the fishing day which may decrease the survival of discarded individuals (Gaspar & Monteiro, 1999; Gaspar et al., 2003). Therefore, efforts to reduce the by-catch in Portuguese dredge fisheries must be carried out, which will involve the development of modifications to the grid dredge to further improve selectivity and minimise by-catch (Gaspar & Chícharo, 2007). We believe that the amount of unwanted catch can be significantly reduced by the introduction of By-catch Reduction Devices (BRDs) in dredges as observed in trawls (see Broadhurst, 2000 for a review), so studies to evaluate their effectiveness in dredge fisheries should be conducted. In the present project, in order to reduce by-catch, a prototype dredge frame will be designed and tested. This frame will be incorporated, in the middle of the collecting system, an oblique metallic grid terminating at an escape exit at the top of the cage. Thus, individuals larger than the openings could be expected to be guided upwards to the escape exit, while smaller individuals should pass through the openings of the cage.

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### CS 3.2 Mallorcan set nets (red mullet and lobster nets)

Small scale fisheries in Mallorca include a large number of vessels (260 licensed vessels in 2015), usually less than 10 m length, operated by a crew of one or two, rarely three, using trammel nets to catch a variety of demersal resources. The main target species vary seasonally, with 70% of the fleet rotating fishing gears depending on resources availability and practicing 7 main métiers: for instance, in winter and spring the cuttlefish (*Sepia officinalis*) is the target species, while in summer and autumn the target species switches to striped red mullet (*Mullus surmuletus*), and the fleet targets the spiny lobster (*Palinurus elephas*) from April to August. The fishing activity is carried out close to port, with daily fishing trips of less than 6 h (Reglero et al. 2008), except when targeting spiny lobster, where the trammel net is set for more than 24 h. The production of small scale fishery represents 25% of the fish consumed in the island, but unit fish prices are high due to their high quality and freshness. Trammel nets are made of 50-m pieces, for a total length of 1500-2000 m, with a vertical hanging of 2-3 m.

Unwanted by catch is relatively low in these highly selective fisheries, but in the case of trammel nets targeting spiny lobster it can be as high as 42% of the catch in weight (Quetglas et al. 2004), with long soaking time (24 h or more) and mesh sizes of 120 to 160 mm. The discarded fraction may contain species under regulation, such as hake, red scorpionfish, striped red mullet or mackerel that must be discarded because of their poor condition. Additionally, lobster trammelnets may impact sensitive habitats (maërl and *Posidonia* beds).

The objectives of this case study are to compare the use of trammelnets of different material (mono-filament polyethylene twine vs multi-filament polyamide twine) in the lobster trammelnet fishery, to reduce unwanted catches. Comparing traditional nets and nets mounted with “selvedge” will also be made. In the cuttlefish metier, two mesh sizes will be compared (conventional 67 mm vs 80 mm meshes). In the striped red mullet metier, the comparison will be made in terms of trammel net vs gillnet, using the same mesh size of 50 mm.

### CS 3.3 Mallorcan boat seine fishery

The Mallorcan boat seine fishery is a small scale fishery targeting the transparent gobies under the local name of *jonquillo* (comprising mainly *Aphia minuta* but also 3 species more), using a fishing gear similar to a small purse seine. The fleet is composed of 30 authorized vessels, all smaller than 10 m length, employing 2 persons on board. Fishing trips are 6 hours or less per day, with daily return to port. The fishing grounds are located on sandy bottoms 20 to 40 m depth. The target species, *jonquillo*, are highly prized (ca. 30 €/kg at first sale) and each vessel has a daily quota of 20 kg. The unwanted catch consists of juveniles (less than 10 cm TL) of coastal sparid or labrid species, but usually the entire catch is released before bringing the net on board if the amount of unwanted by catch is high. Among the unwanted catches, the highly diverse by-catch includes seven taxa under regulation (*Diplodus annularis, Diplodus vulgaris, Mullus surmuletus, Pagellus acarne, Pagellus eythrinus, Pagrus pagrus* and *Trachurus* spp.)

The main objective of the case study is the experimental assessment of survival of the unwanted by-catch, as well as the target species when slipped.

### CS 3.4 small scale fishing in Catalan coast

Small scale fisheries in Catalonia are carried out by a large number of vessels (ca. 700 licensed units in 2015), usually in length classes 12 and 18 m (50-100 HP), operated by a crew of one or two using trammel nets, bottom longlines and other types of set gear to catch a variety of demersal resources. The fleet rotates the metiers practiced along the year, depending on the availability of main target species. In the case of trammel nets, the metiers are defined by the target species: for instance, in autumn and winter trammelnetters target sole, while in winter and spring the cuttlefish (*Sepia officinalis*) is the target species, moving to the caramote prawn (*Penaeus kerathurus*) in summer and to striped red mullet (*Mullus surmuletus*) in summer and autumn. The fishing activity is carried out close to port, with daily fishing trips of less than 12 h. Trammel nets are made of 50-m pieces, for a total length of 1500-2000 m, with a vertical hanging of 2-3 m. Unwanted by catch is relatively low in these highly selective fisheries.

The objectives of this case study are to compare the use of trammelnets of different material (mono-filament polyethylene twine vs multi-filament polyamide twine) and to assess the effect of blue/green lights on the juvenile fish by-catch of the metiers targeting invertebrates (cuttlefish and caramote prawn). Additionally the use of selvedge to reduce unwanted catches, as practiced by the fishers, will be examined and the amounts o discards and discarding practices assessed.

### CS 3.5 Trammel net fisheries in North Tyrrhenian sea

Bottom set nets (such as trammel and gill nets) used in the small scale fisheries are generally considered selective gears, especially if those passive gears are compared with other systems, such as bottom trawling. However, recent studies have shown that, although set nets are highly selective for certain periods of the year and on certain types of bottoms, they can capture large quantities of organisms belonging to non-commercial species (Kelleher, 2005). As a matter of fact, European Commission studies (EC, 2002) reported that discards of trammel net fisheries in the Mediterranean range from 15 to 35% of the total catch and those of gill net are around 10%. One example is provided by a specialised fishery for red mullet (*Mullus* spp.) performed along Italian coasts using trammel nets with small mesh (22-24 mm) in the inner panel; this fishery is scarcely selective, providing rather high amounts of discards, mainly gastropods and crabs (Sartor, 2013). Another similar example is the caramote prawn fishery, historically performed in Ligurian and Tyrrhenian Sea (Rossetti *et al.* 2006). It is a seasonal (spring-early summer) fishery, highly specialised and valuable, which provides up to 50% of the yearly incomes from the involved fishermen (De Ranieri*,* 2005). In coastal areas (10-15 m depth on average), fishermen employ a specific version of trammel net, with meshes of about 22 mm length in the inner panel. The presence of abundant amounts of discard, principally made by crabs, gastropods, algae, is a recurrent phenomenon. This aspect can often be a limiting factor for these fisheries, which normally are very profitable, as the "unwanted" catches substantially lengthen the working time for the cleaning of the nets and cause premature deterioration of fishing gear. From an ecological point of view, the removal of these organisms, which are usually thrown back into the sea dead, can have a significant negative impact on coastal populations. To overcome these problems, technical measures to reduce the capture of unwanted catches could be adopted. Among them, the installation of a gill net stripe or a “selvedge” at the base of the trammel net commonly used by the fishermen appears to be the most efficient. As a matter of fact, there is evidence (De Ranieri*,* 2005; Rossetti *et al.,* 2006) that a few fishermen are using, in the last years, trammel nets provided with the “selvedge”, reporting lower catches of unwanted species. A preliminary experimental study was carried out on the cuttlefish (*Sepia officinalis*) trammel net fishery in the Ligurian Sea, western Mediterranean (Sartor, 2006; Sartor *et al.,* 2007). The catches of a standard trammel net were compared with those of two experimental nets having a 19 mm or 24 mm height strip placed at the bottom of the net. Discard resulted significantly lower in the two nets with the strip, while catches of demersal and pelagic commercial species did not show significant differences among the different nets.

Therefore, the use of a selvedge in trammel nets could be suggested for those fisheries targeting benthic species, especially in zones or periods where the presence of non-commercial species is particularly high. At the same time, the use of this device could be suggested for the fisheries carried out in sensitive habitats, with the aim of a more sustainable exploitation. The results of the first experimental studies provided therefore encouraging insights to investigate in deep a proper technical device, targeted to reduce unwanted by catch, and to be routinely implemented in the commercial fisheries (EC, 2007).

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### CS 3.6 Longline swordfish fisheries in Aegean sea

Surface long-lines are extensively used for swordfish fishing throughout the Mediterranean by various fishing fleets. A recent analysis of data from the most important Mediterranean fisheries indicated that although there are differences among fleets regarding the gear configuration (hook size, size of main and branch lines, etc) and fishing strategy (e.g. depth setting of the gear), these are rather minor and all fisheries are quite homogeneous regarding the catch rates of the most commonly caught species (Anonymous, 2014). The swordfish fisheries can be characterized as monospecific given that commonly more than 90% of their catch in terms of number is composed of swordfish individuals. In general, the catch ratio of the rest commercial by-catch species in the Mediterranean swordfish fisheries varies mostly between 2-10 individuals per metric ton of the target species (Anonymous, 2014). Commercial by-catches are mostly composed of other large pelagic species such as tunas and occurring together with unwanted captures of small (undersized) individuals and other marine species, some of them being considered as “endangered” or “threatened” (e.g. sharks and sea-turtles) (Peristeraki et al, 2008; Tserpes & Peristeraki, 2008). The capture of threatened shark species, however, such as porbeagle and mako shark is extremely rare, while accidental catches of other sensitive species, depend on the fishing area and season. Independently of gear configuration and bait type all Mediterranean swordfish fisheries are typically using J-hooks having length larger 10 cm. Circle hooks that are used in some Atlantic pelagic long-line fisheries are not employed in the Mediterranean. In some fisheries, such as the US swordfish longline fisheries in the Atlantic and Pacific Oceans, circle hooks have been shown to be an effective tool to mitigate sea turtle bycatch and their use is now mandatory. Given that circle hooks are wider at their narrowest point than J hooks it is more difficult to fit into the mouths of sea turtles and in the case of capture it is more difficult to be swallowed into the esophagus or deeper. In addition, due to their shape it is more difficult to be foul-hooked on the body of sea-turtles. Findings however, cannot be easily generalized as it seems that the combination of hook style with bait type plays a fundamental role on sea-turtle catch rates (FAO, 2009). Regarding the effect of circle hooks on the catch rates of the target species, a series of studies (e.g. Curran and Bigelow, 2011; Coelho et al. 2012; Santos et al., 2013; Amorim, 2014), have shown that this depends on the species and the particular characteristics of the fishery (target age-class, fishing ground, etc). For this reason specific localized studies are needed in order to evaluate the effect of circle hooks on the commercial catches and promote relevant changes.

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### CS 3.7 Norway pots

Norwegian cod (*Gadus morhua*) fisheries produced a total catch landing of 470 000 t (NOK 4.7 billion) in 2013: 33% caught by trawl, 27 % by gillnet, 17% by Danish seine, 16 % by longline and by 5% hand-line. Each of these fishing methods is associated with collateral effects that are detrimental to marine ecosystems and environment including: emissions of greenhouse gases; disturbance of the seabed and benthic communities; and degeneration and waste of considerable quantities of none-target by-catch. Norway has signed several international agreements committing at reducing atmospheric emissions of greenhouse gases. The main challenge is to reduce annual emissions of NOx (Schau et al 2009), and Norwegian authorities are focusing on sea transport and fishing, which combined account for 40% of the NOx output (Ellingsen et al 2005). Pots could provide a responsible solution to these problems, provided that they could be made sufficient efficient to provide a commercially viable alternative. Pots are a passive fishing gear that depends upon the natural behaviour of its target species to attract and capture them. Fish caught by pots have potential for high market values do to comparatively high quality in comparison to alternative fishing methods. Further, catching fish alive and in good physical condition enable live storage and capture based aquaculture, which may further increase the profitability to fishermen and stabilise market supply. Fishing practices vary widely in terms of fuel efficiency, but in general terms, the amount of fuel required per kg of catch is more than three times higher for towed gears such as bottom trawls than for passive gears (pots, gillnet, hand-line, long-line) (Schau et al 2009). Effects of fishing activities on benthic fauna and habitats depend on the gear type used. Pots are a stationary fishing gear with a very small footprint and near negligible impact on the seabed. In contrast, towed demersal gears like trawls and demersal seines are known to induce significant disturbance to seabed habitats and communities, with potentially wide ranging associated ecosystem effects (Kaiser et al 2002; Buhl-Mortensen et al 2013). Furthermore, a total 607,683 km2 (25.1% of the Norwegian EEZ) was exposed to trawling activity, at least once, in 2011 (Buhl-Mortensen et al 2013). Another major problem in marine fisheries is the capture of unwanted species and sizes, which may constitute up to 40% of discards (Edelist et al 2011) that often are dead or mortally injured (Kelleher 2005; Suuronen et al 2012). Norway has implemented a landing obligation, and similar regulations will enter into force in the EU fisheries under the recently reformed Common Fisheries Policy for the EU zone. In pot fisheries discards are low due to their selective, and discards have high (80-90 %) survival rates (Davis 2002; Rudershausen et al 2014). Thus efforts leading to increased use of pots will contribute to a more responsible, sustainable and profitable Norwegian fishery.

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