Report on the alternative gears to be used in each area

Alternative fishing gears (Action C.3)

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SUMMARY

Premise

Small-scale artisanal fisheries (SSFs) play an important role within MPAs, supporting local economy. In these areas, passive nets (mostly gillnets and trammel nets) are among the most important fishing gears largely used by SSFs. The interactions between passive nets and dolphins mainly consists in the depredation of entangled fish, with a consequent damage of the net in form of holes. This issue leads to an increased time spent to adjust the nets, and to the reduction in fish catch and quality, with resulting economic loss. Also, bycatch and other injuries caused by the nets or fishers could affect dolphin populations. To reduce these interactions, the Action C3 of Life Delfi promotes the shift from traditional passive nets to pots as alternative gears. The use of pots in SSFs is likely to reduce these negative effects of passive nets and potentially maintain the catch efficiency, since they are not dangerous for dolphins and are able to capture a high variety of demersal, benthic and pelagic species.

Given that interactions between passive nets and dolphins mainly occur from late spring to early autumn, Life Delfi project does not intend to completely ban the use of passive nets, but it promotes the use of alternative gears during hotspot periods and areas (periods and areas with a high possibility of dolphins passive nets interactions). To achieve this goal, a detailed and extensive review of the pots used in the whole Mediterranean Sea, conducted by consulting the available scientific literature, is presented in this report. Also, a survey with questionnaires directed to the fishers operating in the SSFs of the areas covered by the project, was conducted, in order to identify the main gears (passive nets and pots) traditionally used and the main commercial species targeted. This double approach has allowed to overcome the lack of information that has often hampered or limited the use of pots in certain areas. In fact, it is a common situation in the Mediterranean that fishers from different areas, even belonging to the same country, ignore the pots used in other areas to capture certain species. According to the combination of target species/season/area, different types of pot will be developed and disseminated among fishers, to discourage the use of passive nets, at least during periods at high presence of dolphins in those areas.

The type of pots that best suit the target species and the features of the fisheries have been described in the present report. To evaluate the possibility of using traps in replacement of the nets, more than 800 pots will be purchased and tested on more than 30 vessels, for a total of more than 300 fishing days during the five years project.

1 Introduction

1.1 Fishing with pots – from definition to the current status

Pots are one of most traditional among the several and highly diversified fishing gears employed in the Mediterranean SSFs (Farrugio 2013), since primitive trapping is probably the oldest form of fishing (Slack-Smith 2001). A pot is classified as a sub-type of trap (FPO - 08.2), in the FAO catalogue of fishing gears (ISSCFG 2016).

A brief general description of the pot is here given. It is defined as a small enclosure with one or more entrances which lead animals to get in and prevent them to get out (Pol et al. 2010). Pots are passive gears that attract and retain fish, crustaceans and molluscs by means of bait or pasture, but they may also be employed without bait to target those species searching for a shelter or a hollow space in which to lay eggs (e.g. cephalopods, Sobrino et al. 2011). A pot is usually made of a rigid or semi-rigid frame of various natural or artificial materials and usually takes different shapes. The entrance(s) may have funnel(s) usually designed with a larger external opening, which allow species to access one or more inner chambers, and a narrower internal opening that make their exit difficult. They are set on the bottom or let floating, based on the target species, as single or in strings through branch lines that connect them to a mainline (longline system). They are movable gears, and after a variable soaking time (from hours to days) they are hauled, by hand or mechanized haulers, on the deck of the vessels to be emptied.

An old Greek document, dated about 2,000 years ago, and published in the fishing magazine 'Halieutica', stated that 'pots work while their masters sleep'. These ancient words emphasized one of the typical features of fishing with pots that made it not expensive or exhausting and at the same time profitable. In the past, fishing with pots was one of the most practiced by Italian coastal fishers, and was the main source of livelihood of entire families for a long time. This type of fishing, which was less expensive than fishing with nets, and was absolutely environmentally friendly, was based, in fact, on gear made of readily available natural materials such as rush and reed. Nowadays, pots are mainly made of galvanized iron wire and synthetic mesh, and are mainly used for catching octopus, cuttlefish, lobsters, shrimps, gastropods and fish.

In Italian coasts, fishing with pots is less important than other gears, such as trawling nets and dredges, in terms of landings and revenue. In SSFs, pots are often employed in small numbers and occasionally, to integrate the catches of other gears, such as passive nets and longlines. However, fishing with pots is quite important from the socio-economic point of view in some areas, seasons and for catching some target species. The most important catch quantities are made up of crustaceans (Norway lobster *Nephrops norvegicus*, pandalid shrimps *Plesionika* spp., spiny lobster *Palinurus elephas*) and molluscs (cuttlefish *Sepia officinalis*, octopus *Octopus vulgaris*, snails such as the changeable nassa *Nassarius mutabilis*), while fish pots are less locally known and employed.

Pot fisheries in Italy are regulated on a compartmental level with ordinances of the Harbour offices, which establish the maximum number of pots, the distance from the coast, the gear licenses and even the quantities fished. The only activity that is regulated at European level, by the Reg. CE 1967/2006, is the pot fishery for deep-sea crustaceans (pandalid shrimps of the genus *Plesionika* spp.), for which it is forbidden to keep on board or set more than 250 pots per vessel.

1.2 Pots as potential alternative fishing gears – what are their advantages?

The growing interest of the scientific community towards pots in recent years is justified by their potential to reduce the habitat impact, the fuel consumption, the equipment costs, the discards and bycatch compared to passive nets and bottom trawls (Low Impact and Fuel Efficient, LIFE; Suuronen et al. 2012). Moreover, the removal of the eventual discards from pots on board can leave high probability for the unwanted organisms to survive (Suuronen et al. 2012).

The high species and size selectivity observed in pot fisheries is an appealing feature for a better management of marine resources in the Mediterranean, because it could help reducing the high rates of discards currently produced by other fisheries. Tsagarakis et al. (2014) observed that the discards from pot fisheries are the lowest (1.6-9%) together with demersal longlines (0-9%), whereas those from gillnet may exceed 40% and bottom trawls up to 90%. This high selectivity may be also appealing for obtaining higher selling prices (e.g. pot fisheries in Adriatic Sea targeting Norway lobster; Brčić et al. 2017).

The scientific works conducted in the Mediterranean on the testing of experimental and innovative pots often showed promising results in terms of catch efficiency, despite requiring further investigations for the economic viability (Addis et al. 1998; Colloca 2002; Sartor et al. 2006; Sbrana et al. 2008; Morello et al. 2009; Amengual-Ramis et al. 2016; Petetta et al. 2020).

Pots used as an alternative to the passive nets could represent a solution to overcome the interaction between Mediterranean SSFs and cetaceans, especially the bottlenose dolphin *Tursiops truncatus* (Bearzi 2002). This interaction mainly consists in the damage of the net (in form of holes), with consequent increased time spent to adjust the gears, and in the reduction in fish catch and quality, with resulting economic loss. Also, bycatch and other injuries caused by the nets or fishers could affect dolphin populations (Bearzi 2002). The problem has been reported in several SSFs (Lauriano et al. 2009) and seem to increase, since dolphins exploit fish caught with nets as an alternative source of food (Geraci et al. 2019), probably due to the increased overexploitation of the Mediterranean fish stocks (Colloca et al. 2017). On the contrary, pots afford a more limited access to the catch, making them less subject to depredation by large predators such as dolphins, but also sea turtles and stingrays (e.g. the pelagic stingray *Pteroplatytrigon violacea*; Petetta et al. 2020). Accordingly, the small size of the pot entrance physically blocks these animals to get in and steal the bait or the catch, preventing them to be accidentally caught. As a consequence, this would help reducing the bycatch of sensitive and protected species.

1.3 Lessons learnt from TartaLife project

During the TartaLife Project - Reduction of sea turtle mortality in professional fishing (LIFE12NAT/IT/000937), several fish pots, realized in different shapes and sizes, have been tested as alternative gears to the set net. The pots manufactured by Trapula Ltd. (Croatia), resulted to be the most efficient. They had a stainless-steel bar frame with a pentagonal shape and a single oval entrance. Two steel structures on the top and bottom allowed folding them. A propylene rope 5 mm in diameter was externally reinforced with a nylon net (32 mm square-mesh bar). Flexible steel bars 2 mm in diameter allowed manual adjustment of the single opening leading to the chamber. One pentagonal pot design had three openings (the main oval entrance and two additional circular entrances) leading to three chambers not communicating with each other (Figure 1). This allowed the pot to always have at least one access regardless to its position on the bottom.

Figure 1. On the left, a photograph of one Trapula pot (three-chambers design), which was tested during the TartaLife project (LIFE12NAT/IT/000937). On the right, a photograph of Trapula pots stored on board a fishing vessel.

The main feature of the Trapula pots was the ability to collapse completely on themselves, taking up very little space on board (Figure 1). In fact, especially with small boats, such as those of SSFs, one of the main drawbacks is represented by the storage on board. With rigid structure pots, small boats are able to set only a small number of traps for each fishing session in the fishing ground. The use of collapsible pots allows even small boats to use more pots for each individual session, with the possibility of quickly recovering them in case of storms.

Petetta et al. (2020) tested two different pot sizes at three coastal sites in the north-western Adriatic Sea: a smaller pot (SP) measuring 40 × 100 cm (height × width) and a larger pot (LP) measuring 60 × 140 cm. The authors compared the catch efficiency of those pots with that of the traditional trammel net locally employed in the area. Data analysis demonstrated a similar catch efficiency for the commercial species, both among sites and as a whole. Moreover, the trammel net caught a larger amount of discards, both in terms of species number and of catch per unit effort ($CPUE_W$). The catch comparison study revealed that the pots were more effective for *S. officinalis*, whereas the trammel net was more effective for the shorter length classes for *D. annularis*, which were mostly under the minimal landing size (MCRS of 12 cm). This shows, as pointed out by the fishers themselves, that the innovative pots could provide a valuable alternative to the trammel nets traditionally used in the Adriatic Sea, at least in certain areas and periods such as in the spring-summer period, a period in which incidental catches of the loggerhead sea turtle *Caretta caretta* in coastal set nets are recorded. In fact, these pots prevent the capture of sea turtles that, physically, fail to penetrate inside the gear. As a demonstration of the goodness of the solution identified, several fishers have shown interest in voluntarily using the TartaLife pots. Some pots have already been entrusted to some fishers for their use on a purely voluntary basis. Their main advantages include that they do not require a different rigging and they can be used without bait, while their foldable design allows large numbers to be easily loaded on board SSF vessels. The results of this pilot study indicate that pots can achieve the objectives of reducing discards and bycatch in SSFs without penalizing the catch of commercial species.

2 Objectives

The present deliverable was focused on the review of the commercial and experimental types of pot employed in the whole Mediterranean region at FAO-GFCM (General Fisheries Commission for the Mediterranean) geographical sub-areas (GSAs) level.
The main objective was to provide an overview of the main pot designs, their spatial distribution and the main species targeted with them. Consequently, the best pot design for each area identified within the Life Delfi project has been described. The areas of interest were: Tuscany coast, MPA Egadi Islands, MPA of Tavolara, MPA Punta Campanella, MPA Area of Torre del Cerrano, Aeolian Archipelago, North Adriatic Sea, Central Adriatic Sea.

3 Review of the pot fisheries in the Mediterranean Sea

To identify the different pot designs used in the Mediterranean Sea, information coming from papers published in peer-reviewed scientific journals to the grey literature (e.g. research project reports, conference proceedings) was examined by this review. To find relevant literature, Google Search© and Google Scholar© were used, and papers written in English, Spanish, French or Italian available on the web were taken into account. Literature concerning brackish waters and lagoon environments was also considered. Both commercial pots (i.e. currently employed in fisheries) and experimental pots (i.e. tested in a scientific work) were included in the review.

To validate a reference, a minimum information on GFCM-GSA and target species was required. The technical data collected were included in three macro-categories: pot structure, netting mesh (if present) and entrance. In turn, pot structure was divided into shape, colour, frame, volume; netting mesh into material, type, size; entrance into number, shape, position, surface. Finally, details about the bait employed, if any, were reported.

A total of 107 references dealing with pots employed in the Mediterranean Sea was reviewed. They covered a period of more than 50 years (1968-2021) and 24 GFCM-GSAs. Figure 2 shows the main species targeted with pots in each GSA. 15 species and 2 genera were identified; moreover, 3 classes (namely ‘shrimp’, ‘fish’, ‘crab’) were created to group the references with undeclared species or those with more than one main target species. The common octopus *Octopus vulgaris* was found to be the species targeted in most GSAs (16) followed by fish (11), spiny lobster *Palinurus elephas* (9) and pandalid shrimps of the genus *Plesionika* (9). The GSAs with the higher number of species targeted with pots resulted to be GSA 6, 17 and 22 with 8 target species, respectively. Details on fishery information and technical characteristics of pots, collected for each target species, are summarized in Table 1.

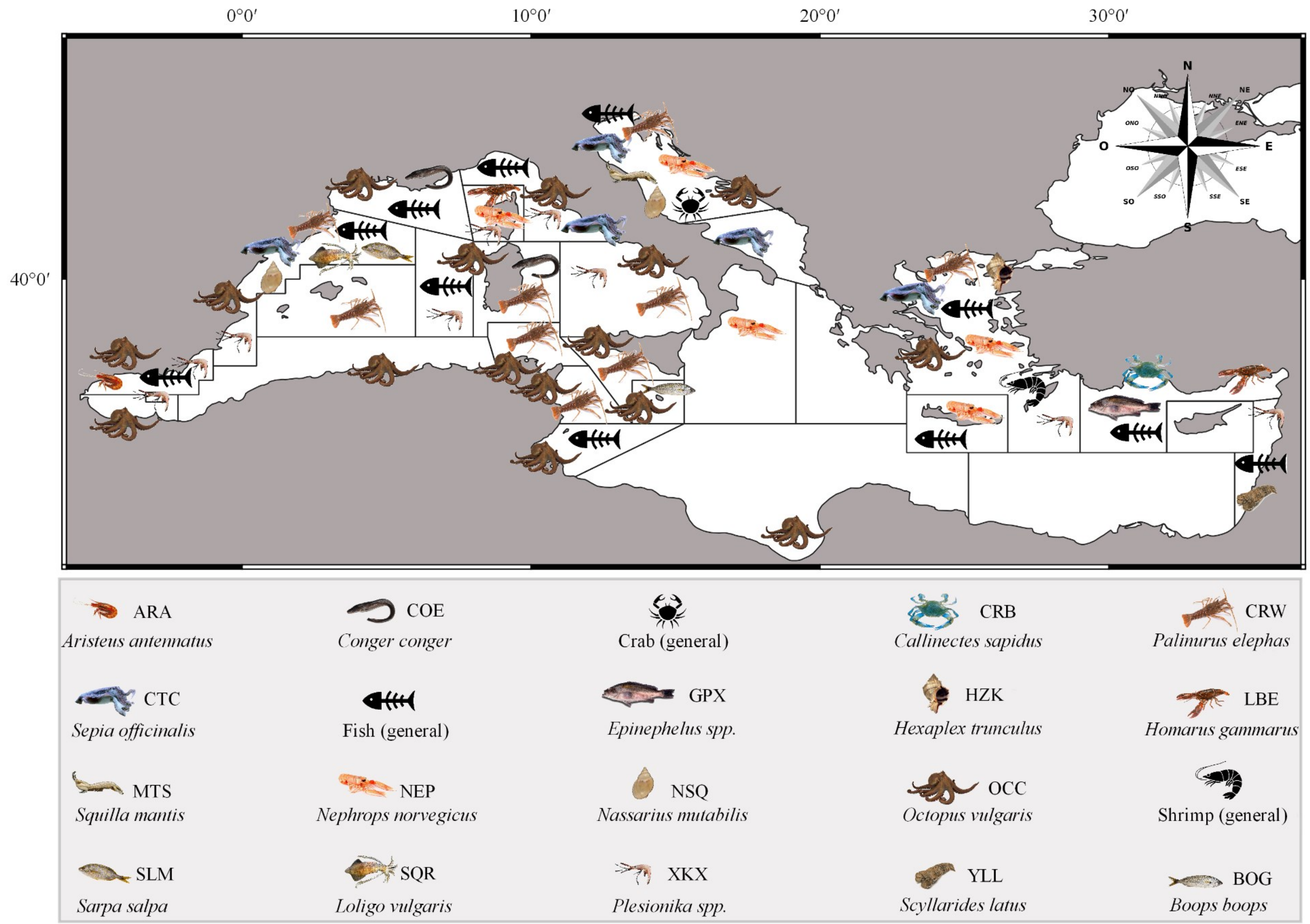

Figure 2. Main species targeted with pots in each GFCM geographical sub-area (GSA).

Table 1. Summary of the technical characteristics of Mediterranean pots collected for each target species. The name of the target species is given in FAO ALPHA 3-CODE (see Figure 2 for details).

SPECIES	DEPTH	POT STRUCTURE				NETTING MESH			ENTRANCE				BAIT
		Shape	Colour	Frame	Vol (L)	Material	Type	Size (mm)	Number	Shape	Position(s)	Surface (cm^2)	
COE	<50 m	conical	brown	N	-	N	△	-	1	CF	SS	-	MIX MO
CRB	<50 m	parallelepiped, other	-	M	68-175	PA	□	13-100	2	CF RF	LS(O) SS(O)	66-452	FH NO
CRW	<50 m, 50-100 m	conical, cylindrical, other	black, brown, green, white	M N P	60-445	M N PA PE P	△□	15-80	1-2	CF OF	SS SS(O) US	227-1256	FH
CTC	<50 m	conical, parallelepiped	black, green, white	M	101-268	PA PE P	□	22-56	1-2	CF RF	SS LS(O) SS(Ø)	154-565	NO
Fish	<50 m, 100-500 m	conical, cylindrical, spherical, parallelepiped, other	black, brown, green, white, red	M N	33-1800	M N PA PE P	◇⬡□△	10-70	1-3	CF OF RF	LS SS SS(O) US	-	FH MIX OTH NO
HZK	<50 m	parallelepiped, conical	pink, red, yellow, white, magenta	P	8-24	-	-	-	1	C	US	79	FISH
GPX	-	spherical	-	-	59-166	-	-	-	1	CF	US	-	-
LBE	50-100 m	cylindrical	black	M	79-393	-	⬡	30	1	CF OF	SS US	491	FH
MTS	<50 m	other	-	-	-	M	□	20	1	OF	SS	-	FH
NEP	50-100 m, 100-500 m	cylindrical, parallelepiped	black, pink, green, white	M	51-200	M PA P	◇□	12-44	1-2	CF OF	LS(Ø) SS(O)	47-76	FH MIX CR
NSQ	<50 m	conical	black, white	M	11-15	PA	□	18-28	1	C	SS US	-	FH MIX
OCC	<50 m	clay, cylindrical, conical	black, brown, green, orange	C M P	2-42	PA	□	-	1-2	CF C	SS SS(O) US	79-314	CR F MIX NO
Shrimp	50-100 m, 100-500 m, >500 m	cylindrical, parallelepiped	white	M	54	PA PP	⬡□	14-40	1	OF	US	314-1256	F
SLM	<50 m	spherical	-	-	90	P	△	-	1	CF	US	-	OTH
XKX	50-100 m, 100-500 m	conical, cylindrical, parallelepiped, spherical, other	black, green, grey, white	M P	53-385	M P PP	▭◇⬡□	16-50	1-2	CF OF C	SS SS(O) US	50-133	FH MIX

Depth range: =<50 m; =50-100 m; =100-500 m.; =>500 m.

Pot shape: =clay; =cylindrical; =conical; =parallelepiped; =spherical; =other.

Pot colour: =black; =brown; =green; =grey; =orange; =pink; =red. =white; =yellow; =magenta.

Pot frame: C=clay; M=metal; N=natural; P=plastic.

Mesh material: N=natural; M=metal; PA=polyamide; PE=polyethylene; PP=polypropylene; P=plastic (generic).

Mesh type: ◊=diamond; ⬡ =hexagonal; □=square; Δ =triangular.

Entrance shape: CF =circular section with funnel; C=circular section without funnel; OF=oval section with funnel; RF=rectangular section with funnel.

Entrance position(s): LS=long side; SS=short side; US=upper side; LS(O)=long side, opposite; LS(Ø)=long side, not opposite; SS(O)=short side, opposite.

Bait type: CR=crabs; FH=fish; MO=mollusc; MIX=mixed; NO=no bait; OTH=other.

Depth range. Most of the pots are employed in waters less than 50 m deep. Only few species, belonging to the crustaceans group are exclusively caught in deeper waters (50-1500 m).

Pot shape. It significantly varies among different species, and often within the same target. For instance, *P. elephas* is caught using traditional bell-shaped pots made of reed but also with experimental collapsible pots (Amengual-Ramis et al. 2016). *O. vulgaris* is mainly targeted through clay pots, cylindrical tubes, and the so called 'Spanish pots' with a cylindrical shape (Sbrana et al., 2008). On the contrary, one single pot design was recorded for some species. For example, semi-ellipsoidal pots are used for mantis shrimp *Squilla mantis* in North-western Adriatic Sea (GSA 17; Bon et al. 2006).

Pot volume. A wide range was observed for this parameter. Concerning 'fish' class, it varies from a 33 L spherical pot designed for salema *Sarpa salpa* and other small fish in Costa Brava (GSA 6; Rubiò et al. 1971) to a huge 1800 L experimental collapsible pot with parallelepiped shape that was tested in the Ligurian Sea (GSA 9; Sala et al. 2013) and in Heraklion bay (GSA 23; Papadopoulou et al. 2015).

Pot colour. Black and white were the most frequently observed colours on commercial scale. Green colour was also widely recorded, especially in pots targeting *P. elephas*, *Plesionika* spp., fish and also the cuttlefish *Sepia officinalis* (Fabi et al. 2001). Brown is the typical colour of clay pots and of natural pots made of reeds. White, green and pink colours were tested by Morello et al. (2009) in the 'Croatian', 'Italian' and 'Scottish' designs, respectively, for catching *N. norvegicus* in GSA 17.

Pot frame and mesh material. The pot frame is strictly related to the netting. Metal frames (mostly steel and iron) associated with PA or wire netting, were found to be the most frequent. Plastic pots are mainly used for catching *O. vulgaris*, such as the Spanish pot and the PVC tubes (Sartor et al. 2008), which sometimes have a cement-filled bottom which stabilizes them on the seabed. Frames and netting of natural origins, mostly represented by intertwined reeds, were rarely found, and almost exclusively in bell-shaped pots targeting *P. elephas* and other fish.

Mesh type and size. Square mesh was observed more often than other configurations (hexagonal, diamond, triangular). Mesh size greatly varies among species and also within the same species; the latter is often explained by experimental studies testing different mesh sizes (e.g. Grati et al. 2010 for changeable nassa *Nassarius mutabilis*).

Entrance number and position. The pots with single entrance are the prevalent. In clay and spherical pots, the single entrance is exclusively on the upper side, while in conical pots it is set on the short side (e.g. those targeting *Plesionika* spp.) or on the upper side (e.g. those targeting *N. mutabilis*). Two entrances on the long side are set in opposite position (i.e. parallelepiped pots targeting *S. officinalis*; Fabi et al. 2001), or not in opposite position (i.e. cylindrical Scottish design employed for *N. norvegicus*; Morello et al. 2009). On the contrary, two entrances on the short side were found to be set always in opposite position (e.g. parallelepiped Croatian pots used for *N. norvegicus*; Brčić et al. 2018).

Entrance shape. It is more often oval and circular rather than rectangular. The presence of funnel was usually observed except for a few pot models with the entrance on the upper side, which causes target species to fall into it without the possibility of coming outside (e.g. pots targeting gastropods; Grati et al., 2010). Furthermore, the funnel is absent in clay pots targeting *O. vulgaris*, being useless since octopus uses them as a shelter (Sartor et al. 2008).

Entrance surface. As the pot volume, this parameter displays a high variability. The smallest entrances were recorded for *N. norvegicus*. The ranges are wider for the pots targeting *Plesionika* spp., *O. vulgaris* and *S. officinalis*.

Bait. Fish and mixed bait were found to be the main types employed. Fish mostly included species with scarce economic value, such as sardines and mackerels, which are used in different conservation states (fresh, frozen, salted or fermented). Mixed bait is usually composed of fish waste with molluscs (squid or octopus. Bivalves are rarely used as bait. Live crabs are exclusively used to catch *O. vulgaris*; nevertheless, this species is more often targeted without the use of baits using clay pots and plastic tubes, which exploit its sheltering behaviour. No bait is necessary to catch *S. officinalis*, which is attracted by laurel leaves, plastic ribbons and other substrates used for laying eggs.

4 Preliminary survey – Questionnaires for the fishers

The survey was conducted through interviews to fishers operating in those areas identified within the Life Delfi project, to collect information on the traditional gears used by the local SSFs. The questionnaires concerned technical and operational features of traditional passive nets and pots used in each area (Annex II).

As regards passive nets, both trammel nets and gillnets are widespread (Table 1). Gillnets are mainly employed in in the Adriatic Sea (GSA 17) in shallow depths (10-20 m) during the warm season, from June to October. They target flatfish (common sole *Solea solea* and turbot *Scophthalmus maximus*), mantis shrimp *Squilla mantis* and other fish, such as sparids and the tub gurnard *Chelidonychthys lucernus*. On the contrary, the main target species of the gillnets traditionally used in the Eolian Archipelago (GSA 10) are small fish such as the blotched pickarel *Spicara maena*, the saddled sea bream *Oblada melanura*, the bogue *Boops boops*, the red mullet *Mullus barbatus* and the Atlantic horse mackerel *Trachurus trachurus*. These gillnets are deployed at depths of 15-35 m and their stretched height during fishing is 2.5-3 m.

Trammel nets are used for a longer period than gillnets (often all year round) and display a wider range of target species, especially in the Tyrrhenian sea (GSA 10) and in the Islands (GSA 11, 16). In the MPA of Egadi, two types of trammel nets are observed. The former is deployed at lower depths (40-60 m) and has a larger internal mesh length, to target larger fish (common dentex *Dentex dentex*, groupers of the genus *Epinephelus*, houndshark *Mustelus mustelus*) and the spiny lobster *Palinurus elephas*. The latter has a smaller internal mesh length and is used to catch red mullets *Mullus* spp. and fish belonging to the Labridae and Scorpanidae family, at depths ranging from 10 to 70 m. Large sparids (*D. dentex* and *Sparus aurata*) are also the target of the trammel net employed in the MPA of Punta Campanella, together with cephalopods (*O. vulgaris, S. officinalis*), mugilids and red mullets. The internal mesh length is large (90-100 mm) and the length of the net is up to 4 km; it can be deployed at different depths, from 20 to 120 m. In the MPA of Tavolara and in the Eolian Archipelago, the surmullet *Mullus surmuletus* is the main target of trammel nets, together with other rockfishes, such as scorpenids and the forkbeard *Phycis phycis*. The depth range is wide (from 10 to 80 m) as well as the net length (from 300 to 1200 m) and the internal mesh length (46-71 mm). The cuttlefish *S. officinalis* is targeted in trammel nets employed in Porto Ercole (Tyrrhenian Sea, GSA 9) and in Western Adriatic Sea (GSA 17): while in the Tyrrhenian Sea these gears are mainly employed in Autumn and Winter, in the Adriatic Sea the cuttlefish season starts at early Spring and ends in Summer.

Table 1. Synthesis of the questionnaires concerning technical and operational aspects of the passive nets traditionally employed in the areas identified within the Life Delfi project. Gear code: GTR = Trammel net; GNS = Gillnet. PA = Polyamide.

Area	Gear code	Target species	Mesh length [mm]	Vertical N. meshes	Stretched net height [m]	Netting colour	Netting material	Net length [m]	Horizontal hanging ratio	Weight leadline [g/m]	Mean depth [m]	Season
MPA Egadi - Favignana	GTR	Scorpaenidae, *Dentex dentex, Epinephelus spp., Palinurus elephas, Mustelus mustelus*	Int: 80-90 Ext: 400	30 (int)	1.7 (int)	Red	Multifilament PA	1000-1200	0.5	60-70	40-60	All year
MPA Egadi - Marettimo	GTR	Scorpaenidae, Labridae, *Mullus spp.*	Int: 60-90 Ext: 180-200	50 (int)	1.8 (int)	Red, Brown	Multifilament PA	1400-2450		62	10-70	All year
MPA Punta Campanella	GTR	*Dentex dentex, Sparus aurata, Octopus vulgaris, Sepia officinalis, Mugilidae, Mullus spp.*	Int: 70-100 Ext: 360		1-4 (int)	Red, Brown	Multifilament	3500-4000		120	20-120	All year
MPA Torre del Cerrano	GNS	*Solea solea, Squilla mantis, Scophthalmus maximus*	68-120	50	3.5-4	White, Yellow, Light Blue, Green	Monofilament PA	1400-2000	0.5	180-200	10-15	All year except January
MPA Tavolara	GTR	*Mullus surmuletus, Sepia officinalis, Scorpaena porcus*	Int: 46-50 Ext: 360	50 (int)	1.8-2 (int)	Red	Monofilament PA	1200	0.45	120	10-30	Autumn
Aeolian Archipelago - Filicudi	GNS	*Spicara maena, Oblada melanura, Boops boops*	62		2.5	Orange, Light Blue	Monofilament PA	400		50-70	15-18	Spring, Summer, Autumn
Aeolian Archipelago-Filicudi	GTR	*Mullus surmuletus, Phycis phycis, Boops boops, Scorpaena scrofa*	Int: 71 Ext: 360		2 (int)	Orange, Red	Monofilament PA	300		50-70	20-80	Spring, Summer
Aeolian Archipelago-Salina	GNS	*Spicara maena, Mullus barbatus, Boops boops, Trachurus trachurus*	62		3	Orange	Monofilament PA	680		50-70	20-35	Spring, Summer, Autumn
Aeolian Archipelago - Salina	GTR	*Mullus surmuletus, Phycis phycis, Boops boops, Scorpaena scrofa*	Int: 71 Ext: 360		3 (int)	Red, Brown	Monofilament PA	350		70	30-40	Spring, Summer
Chioggia	GNS	*Solea solea, Squilla mantis*	70	31	1.1	Light Blue	Monofilament PA	900	0.4	60	15-20	June-October
Chioggia	GNS	Sparidae, *Mustelus mustelus, Chelidonichthys lucernus*	72	34	1.2	Light Blue	Monofilament PA	570	0.38	80-100	6-20	April-October
Argentario - Porto Ercole	GTR	*Sepia officinalis*	Int: 54 Ext: 280	50 (int)	1.1 (int)	Brown	Monofilament PA	1400	0.67	110	2-30	Autumn-Winter
Ancona	GNS	*Solea solea, Squilla mantis*	68-69	44-50	3-3.4	Transparent	Monofilament PA	2000	0.37-0.45	50	9-10	June-October
Ancona	GTR	*Sepia officinalis, Lithognathus mormyrus*	Int: 68-70 Ext: 340	57 (int)	4 (int)	White, Brown	Multifilament PA	600	0.44	120	10	March-October

Pots were observed in all the areas where the survey took place (Table 2). Nevertheless, their use is mainly confined in the warm season (Spring, Summer and early Autumn), except for the small semi-conical pots employed from October to May to target the changeable nassa *Nassarius mutabilis* in the Western Adriatic Sea (GSA 17). In the same area and depth (10-20), small semi-ellipsoidal pots are used to catch the mantis shrimp *Squilla mantis*. A fisher is able to set up to 1000 of these pots per fishing session, and retrieve them after 24 hours.

The octopus *O. vulgaris* is the main target species of cylindrical pots, with variable dimensions, employed in the MPAs of Punta Campanella and Tavolara, in the Eolian Archipelago and in the Tuscany coasts (Porto Ercole, Talamone). They are made of PVC or of a metal frame covered with PA netting; the entrance often has a circular shape with funnel, and the bait could be constituted by sardines or mackerels (salted or fresh) or live crabs. The number of pots for each set is around 150-200.

The spiny lobster *Palinurus elephas* is caught in the MPA of Egadi and in the Eolian Archipelago through bell-shaped pots made of artificial (PVC) or natural (reeds) materials. They are usually large pots (100 cm high) and they are employed in small numbers (7, 8 up to 20-40). They are baited with sardines, and they also provide the catch of other species such as the European lobster (*Homarus gammarus*), the moray eel (*Muraena helena*) and small fish (serranids, bogues).

The cuttlefish *Sepia officinalis* is targeted in the Western Adriatic Sea (Ancona and MPA Torre del Cerrano) by pots with a parallelepiped shape and a metal frame covered with netting. They are employed in shallow depths (5-12 m) and without bait, since they exploit the sheltering behaviour of the target species during its reproduction phase that takes place in Spring. Cuttlefish is also caught with fyke nets (locally called “bertovelli” or “cogolli”), that are made of made of several and consecutive funnel-shaped entrances that connects the chambers, up to the final one where the cuttlefish are caught.

Table 2. Synthesis of the questionnaires concerning technical and operational aspects of the pots traditionally employed in the areas identified within the Life Delfi project. PVC = polyvynilchloride.

Area	Target species	Pot shape	Pot dimensions [cm]	Pot material	Entrance shape	Entrance dimensions [cm]	Bait	Number of pots per set	Distance between pots [m]	Mainline length [m]	Set duration (hours)	Mean depth [m]	Season
MPA Egadi - Favignana	*Octopus vulgaris, Palinurus elephas, Homarus gammarus*	Bell-shaped	80 - 130	PVC, reed	Circular with funnel	10-30	Yes (Sardines)	7-8 (*P. elephas*) 100 (*O. vulgaris*)	15	70-1500	24	25-70	March-September
MPA Punta Campanella	*Octopus vulgaris*	Cylindrical	60 x 30	PVC	Circular with funnel	10	Yes	150-200	12-20		24	20-90	Spring, Summer, Autumn
MPA Torre del Cerrano	*Sepia officinalis*	Parallelepiped	60 x 22 x 40	Metal	Rectangular with funnel	40 x 22	No	300	10-12	200	24-48	5-12	March-August
MPA Torre del Cerrano	*Sepia officinalis*	Semi-cylindrical	80 x 40 x 180	Metal + Nylon	Semi-circular with funnel	80 x 40	No	100-300	10-12	150-200	24-48	5-12	March-August
MPA Tavolara	*Octopus vulgaris, Muraena helena, Sepia officinalis,* small fish	Cylindrical	60 x 30	Metal + Nylon	Oval with funnel		Yes (Crabs)	20-30	15	450-500	48-72	10-20	Spring
Aeolian Archipelago-Filicudi	*Shrimp, Palinurus elephas*	Cylindrical	100 x 40	Metal + Nylon	Circular with funnel	30	Yes (Sardines, mackerels)	20	10	200	12	40-70	Spring-Summer
Aeolian Archipelago-Salina	*Octopus vulgaris, Palinurus elephas*	Cylindrical	100 x 40	Metal + PVC	Circular with funnel	10	Yes (Sardines, mackerels)	40	30	1200	48-72	35-50	Spring-Summer
Chioggia	*Squilla mantis*	Semi-ellipsoidal	30 x 30 x 15	Plastic-covered iron	Oval with funnel	3-4	Yes	1000	7-8	800	24	7-20	April-January
Argentario - Porto Ercole	*Octopus vulgaris*	Cylindrical	37	PVC	Circular with funnel	27	Yes (Crabs)	200	10	2000	72	25-45	All year except August
Orbetello - Talamone	*Octopus vulgaris*	Cylindrical	100-150	PVC	Circular with funnel	20-30	Yes (Crabs, sardines)	150	5-6	1000	72-168	5-30	Spring-Summer
Ancona	*Nassarius mutabilis*	Semi-conical	40 x 20	Metal + Nylon	Circular without funnel	15-20	Yes (mullet, sardines)	300-400	5-6	1200	24	13	October-May
Ancona	*Sepia officinalis*	Parallelepiped	80 x 45 x 30	Metal + Nylon	Rectangular with funnel	22 x 11	No	20	15	300	24-48	5-10	March-August

5 Choice of the best pot design for each area of the project

The review on the pot designs employed in the Mediterranean and their main target species, together with the survey carried out with questionnaires in those areas covered by the Life Delfi project, allowed to identify and propose the most suitable pot designs for each area. The choice was made based on the main target species of the SSFs in each area (Table 3). To this aim, we proposed two different fish pot designs, two innovative octopus pot designs and a recent commercial pot design for mantis shrimp.

Table 3. Summary of the areas, main target species and proposed pot designs within the present deliverable.

Area	Main Target Species	Proposed pot designs	References
Tuscany coast	Sparids, Cephalopods	Trapula pot, Wire pillow pot, Spanish pot, PVC tube	Petetta et al., 2020; Erzini et al. 2008; Sobrino et al., 2011; Sartor et al., 2008
MPA Egadi Islands	Sparids, Cephalopods, Lobsters	Trapula pot, Wire pillow pot, Spanish pot, PVC tube	Petetta et al., 2020; Erzini et al., 2008; Sobrino et al., 2011; Sartor et al., 2008; Morello et al., 2009
MPA Tavolara	Sparids, Cephalopods, Red mullets	Trapula pot, Wire pillow pot, Spanish pot, PVC tube	Petetta et al., 2020; Erzini et al., 2008; Sobrino et al., 2011; Sartor et al., 2008
MPA Punta Campanella	Sparids, Cephalopods	Trapula pot, Wire pillow pot, Spanish pot, PVC tube	Petetta et al., 2020; Erzini et al., 2008; Sobrino et al., 2011; Sartor et al., 2008
MPA Torre del Cerrano	*Squilla mantis, Sepia officinalis*, Sparids	Trapula pot, semi-ellipsoidal pot	Petetta et al., 2020; Bon et al., 2006
Aeolian Archipelago	Sparids, Cephalopods	Trapula pot, Wire pillow pot, Spanish pot, PVC tube	Petetta et al., 2020; Erzini et al., 2008; Sobrino et al., 2011; Sartor et al., 2008
North Adriatic	*Squilla mantis, Sepia officinalis*, Demersal species	Trapula pot, semi-ellipsoidal pot	Petetta et al., 2020; Bon et al., 2006
Central Adriatic	*Squilla mantis, Sepia officinalis*, Sparids	Trapula pot, semi-ellipsoidal pot	Petetta et al., 2020; Bon et al., 2006

5.1 Trapula pot

The Trapula[ltd] pots (Croatia; www.trapula.hr; trapula@vip.hr), which have been described in section 1.3, are suitable for all the areas, since these prototypes are the most versatile, being able to target cephalopods (mainly cuttlefish and octopus) and fish at the same time. During TartaLife project, they have been mainly tested in the North Adriatic Sea; this will be an occasion to evaluate their catch performances in other fishing grounds and for other target species, such as the Tyrrhenian sea and the Southern Islands.

5.2 Wire pillow pot

The wire pillow pots have been proposed to specifically target fish as an additional option to Trapula pots, since in the Mediterranean Region fish pots are not commonly employed. This prototype has been mentioned in Thomsen et al. (2010) as one of the most peculiar pot designs of Europe. These pots are traditionally used in the Eastern Mediterranean Sea (Lebanon, Turkey, Greece) and in the North-Eastern Atlantic (Erzini et al., 2008). They are spherical with a top entrance, and could have different dimensions based on the target species. They have to be baited with fish or molluscs. In Turkey and Lebanon, they are used to catch groupers of the genus *Epinephelus*, or other smaller fish (Sacchi and Dimech 2011; Kara et al. 2016). Therefore, they could be suitable in those rocky grounds for catching species of the Sparidae family.

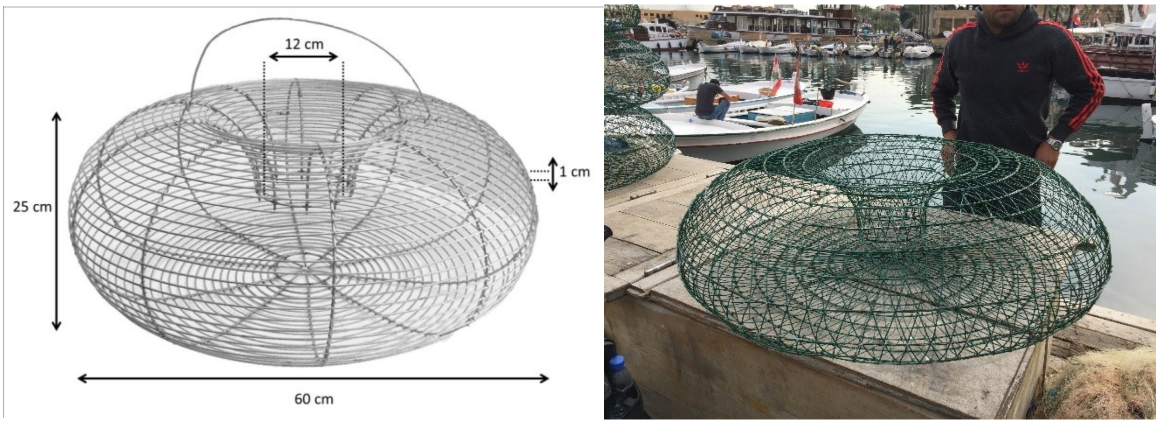

Figure 3. Illustration of a wire pillow pot (on the left; source: Kara et al., 2016) and photograph of one pot used in Lebanon (on the right; source: Sacchi & Dimech., 2011).

5.3 Spanish pot

The 'Spanish pot' (manufactured by Nasas Moreira; www.nasasmoreira.com) has been identified for the exploitation of the octopus. This design is widely used in Spain, in particular in Galician coasts. It was demonstrated by scientific studies that it has a better catch efficiency than other pot models in the Ligurian Sea (Sartor et al., 2008). Moreover, it can be disassembled and staked, therefore allowing fishers to carry out a larger number of pots per fishing session, compared to traditional clay or semi-conical pots (Figure 4; Sartor et al., 2008). It is a more complex plastic pot with a cylindrical shape and a single top entrance, and it is more resistant to the collisions than clay pots (Figure 4). This pot needs to be baited with live crabs.

Figure 4. Photographs of the 'Spanish pot' used for catching octopus in Galician coasts. The dimensions of the pot and entrance are represented on the left. The disassembled and stacked pots are represented on the right (Source: Sartor et al., 2008).

5.4 PVC tube

Another pot type specifically designed for octopus is the PVC tube, widely used in the artisanal fishery of Cadiz (Sobrino et al., 2011). It is proposed as an alternative to the Spanish pot because it does not require any bait or funnel, since the fishing method is based on the knowledge of the octopus behaviour, which presents cover-seeking habits and territoriality. This pot is more resistant to collisions with the vessel during the haul-back phase than the traditional pots made of clay (Pretti 2019). It is also cheap, and its little dimensions allow it to be stored on board in large numbers (Figure 5). It has a cement-filled bottom which stabilizes it on the seabed. The pot has two holes above the opening; the mainline pass through the holes and it is connected to the rear base of the pot to ensure that during the recovery it avoids the escapement of the octopus.
There are Italian retailers for this pot design.

Figure 5. Photographs of the PVC tube used for catching octopus in Cadiz coasts. The dimensions of the pot and entrance are represented on the left. The stacked pots are represented on the right (Source: Sobrino et al., 2011).

5.5 Semi-ellipsoidal pot

Until a few years ago, in the Western Adriatic Sea the mantis shrimp *S. mantis* was mainly targeted using gillnet, bottom trawl and beam trawl. Recently, pot fisheries targeting mantis shrimp have increased in the Northern part of the basin, extending down to the Marche region. Since the interest in using pots is growing for this species, we propose a pot designs that is already commercially employed (Figure 6), with the aim of improving its use and performance and to let it know in other grounds where the mantis shrimp is present but caught with traditional fishing gears.

Figure 6. Photographs of the semi-ellipsoidal pot design employed to catch mantis shrimp Squilla mantis.

This prototype is artisanal and mainly home-made, and structural variations were observed from area to area (Figure 7). Therefore, the aim will be to test several prototypes, differing in pot material, colour and other technical parameters, to determine the best design in terms of catch efficiency, ease of use and gear duration.

The use of these pots on a commercial scale means that they can be supplied by several retailers along the Adriatic coast.

Figure 7. Artisanal prototypes of pots targeting mantis shrimp S. mantis in Marche region. On the left a metal frame design; on the right a plastic frame design.

6 The challenge of Action C3

The experimental tests of the chosen pot designs in local SSFs within the Life Delfi project will allow to determine if these alternative gears could be economically viable. In fact, during the five years' project, more than 800 pots will be purchased and tested on more than 30 vessels, for a total of more than 300 fishing days, to evaluate the possibility of using them in replacement of the nets.

The introduction of pots in a fishery would be successful only if they are cost-effective, i.e. they are easy to use and not expensive to maintain, efficient, i.e. they guarantee a sufficient economic revenue, and practical, i.e. they do not involve major changes to common fishers' practices. Once these requirements are met, pots are likely to be considered as a real alternative to other fisheries.

The enthusiasm of the scientific community towards the use of pots is increasing, as well as the fishers' interest, as demonstrated in the previous projects (e.g. TartaLife). The reinforcement of pot fisheries, which will be carried out in the present project, does not represent a return to the past, or to something technologically less complex, but a step forward, since it guarantees a more sustainable future from several points of view.

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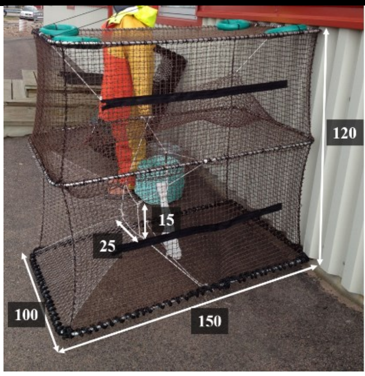
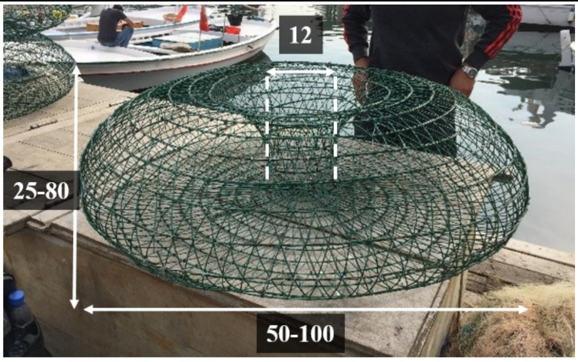
8 Annex I

Photographs of the pots designs found for the main target species (see Figure 1 for the FAO codes). The main reference for each pot design and the GSA(s) where it is employed are specified. Where available, pots dimensions are given in centimetres.

FISH



Sala et al. 2013 – GSA 9, 23



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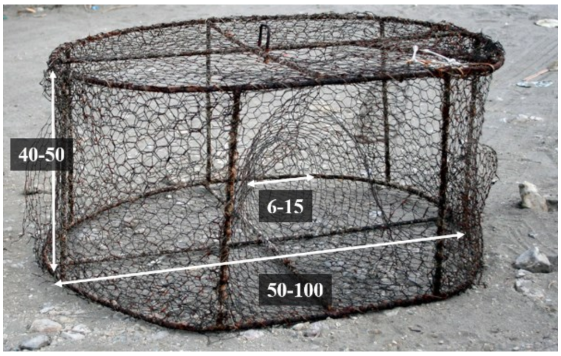

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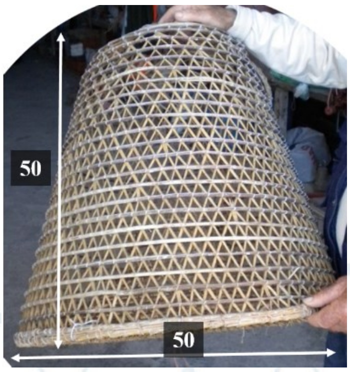
Authors' photograph– GSA 7, 27



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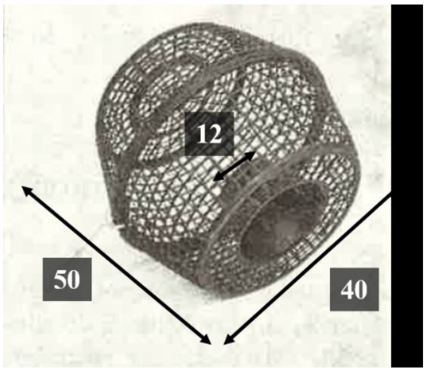
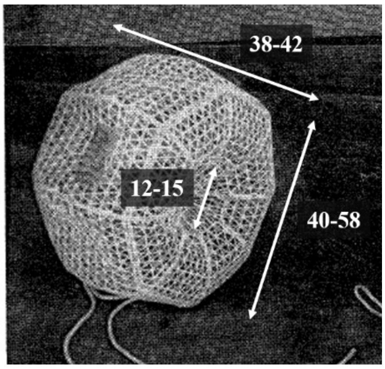
Viale et al. 2013 – GSA 11, 12, 13, 14



Rubiò 1968 – GSA 6



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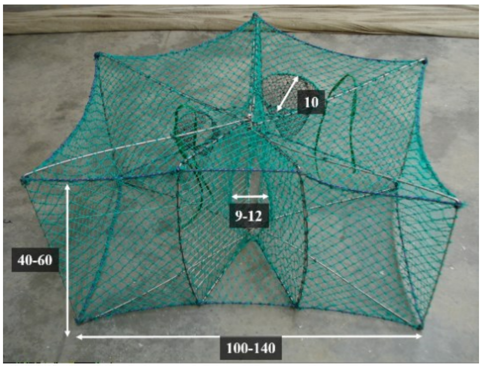

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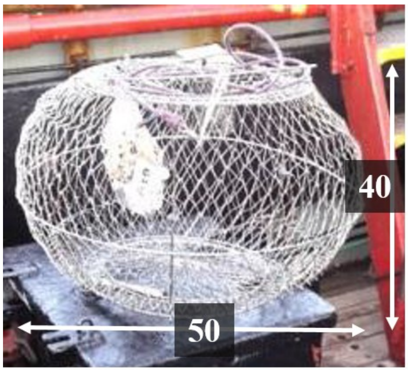

Sala et al. 2016 – GSA 22, 23

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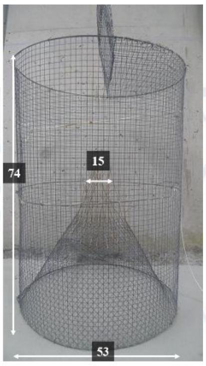
Amengual-Ramis et al. 2016 – GSA 5; 10; 11, 16

Amengual-Ramis et al. 2016 – GSA 5; 6; 10; 16



Amengual-Ramis et al. 2016 – GSA 5

Amengual-Ramis et al. 2016 – GSA 5

Adamidou 2007; GSA 22

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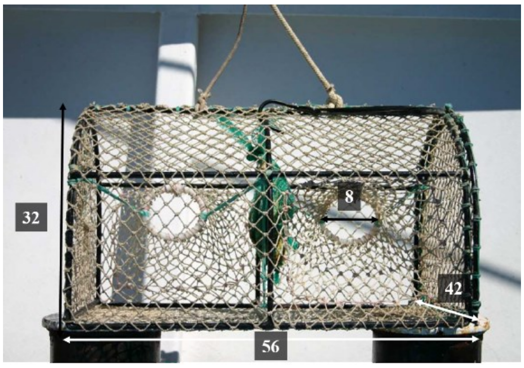

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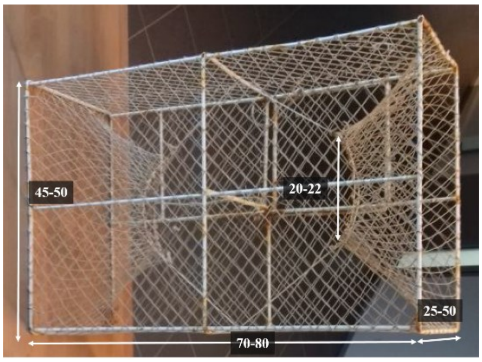

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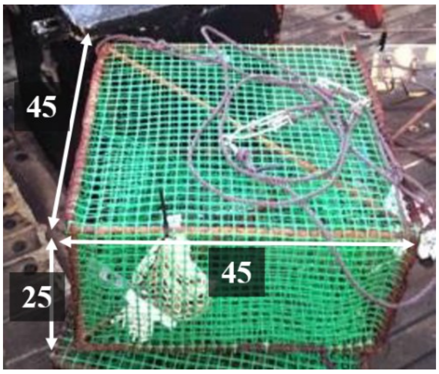

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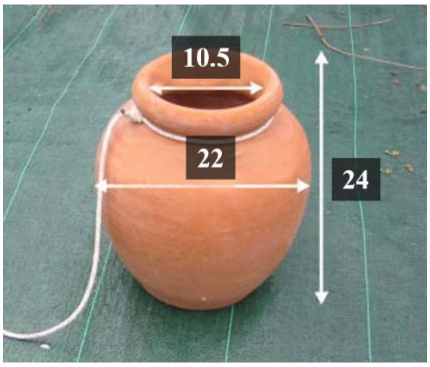	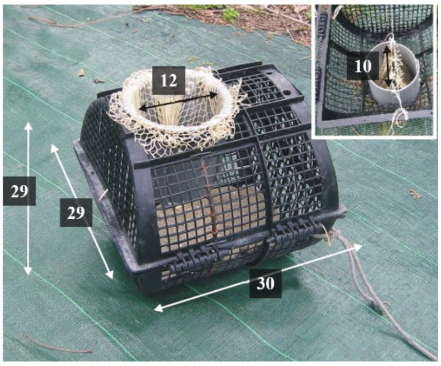
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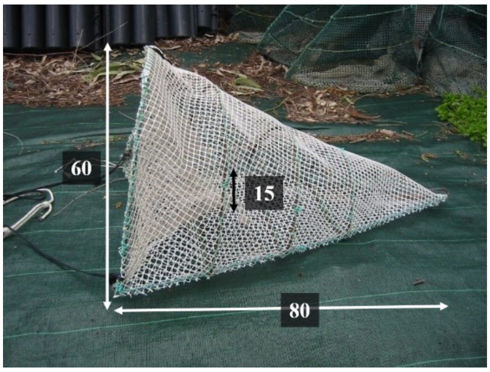	
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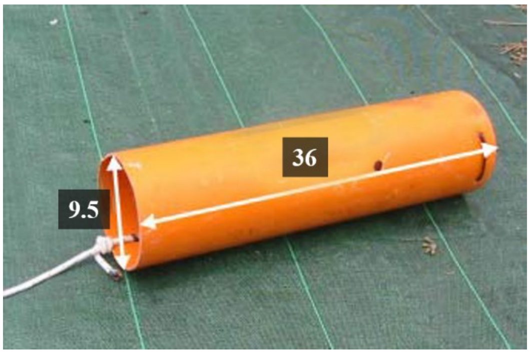
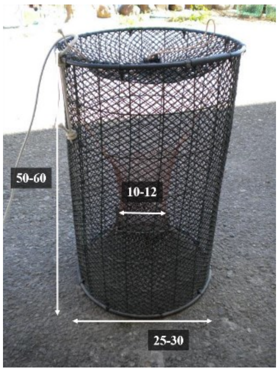
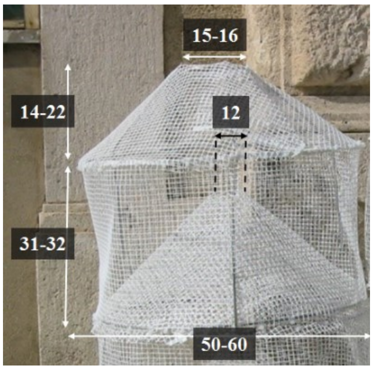
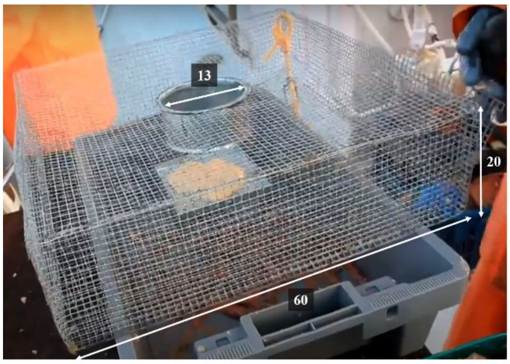
	
Sartor et al. 2008 – GSA 7, 9, 10, 22	Viale et al. 2013 – GSA 11

XKX



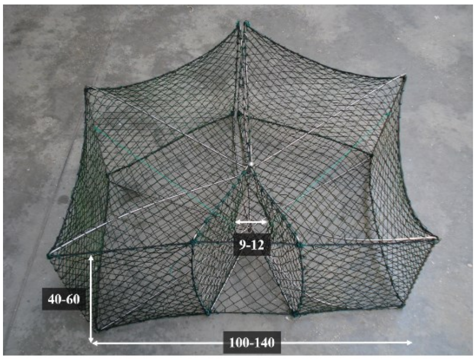
Guennegan 1990 – GSA 1, 6, 8, 9, 10, 27



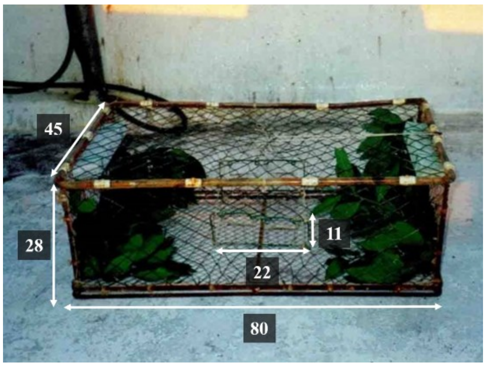
Kalogirou et al. 2019 – GSA 22

Plesionika Manage Project – GSA 22

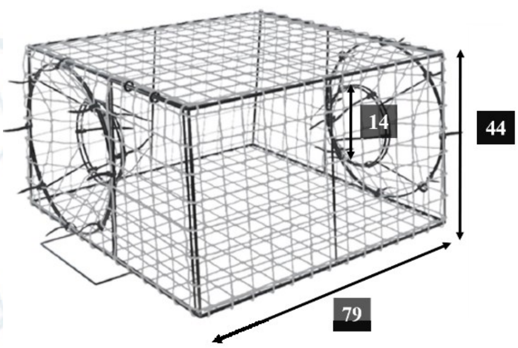
CTC



Petetta et al. 2020b – GSA 17

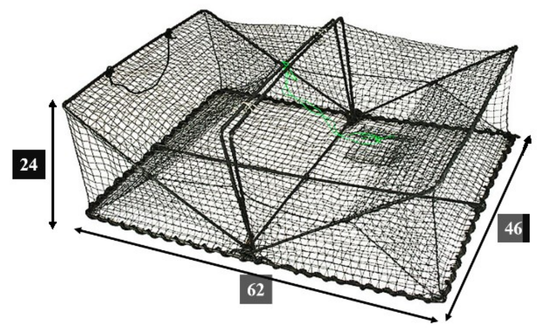


Fabi et al. 2001 – GSA 9, 17

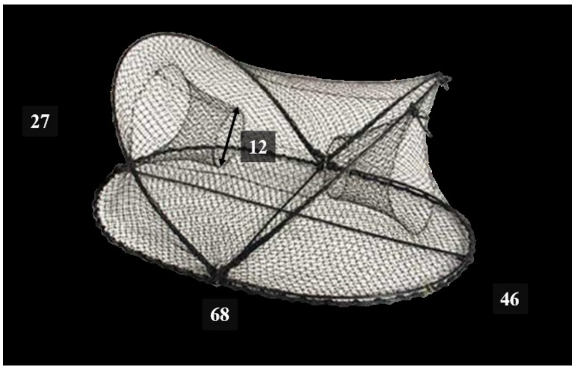


Ganias et al. 2021– GSA 22

CRB



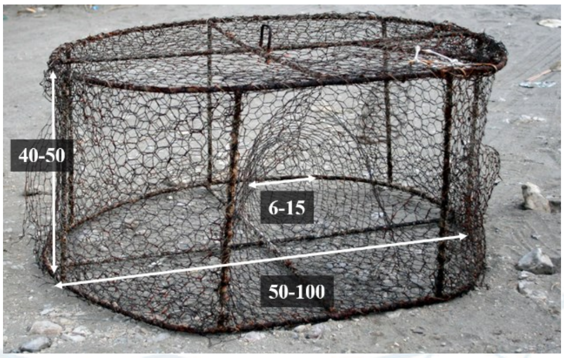
Atar et al. 2002 – GSA 24



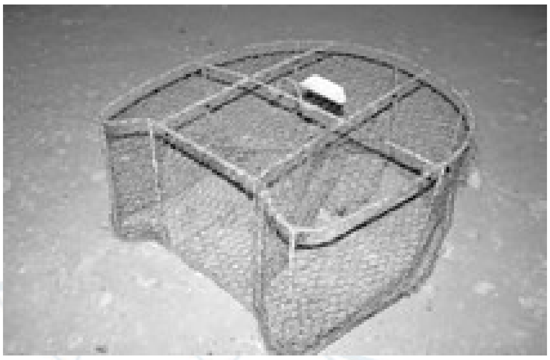
Atar et al. 2002 – GSA 24

Ozdemir et al 2015 – GSA 24

LBE



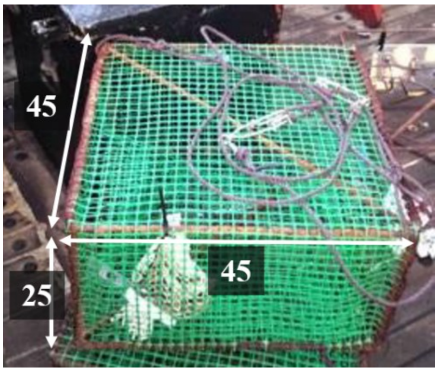
Ozyurt et al 2008 – GSA 24



Ozyurt et al 2008 – GSA 24

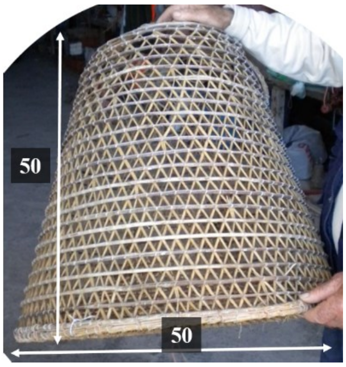
Shrimp

Adamidou 2007– GSA 22



Sala et al. 2016 – GSA 22, 23

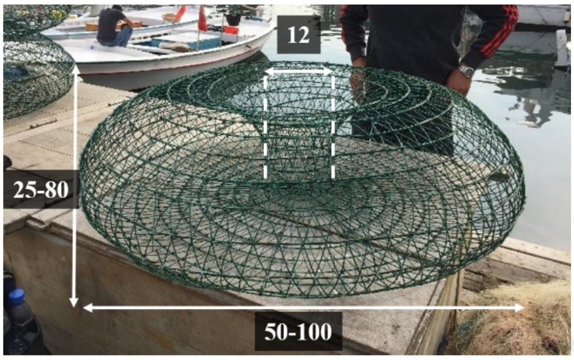
COE



Viale et al. 2013 – GSA 11

Viale et al. 2013 – GSA 11

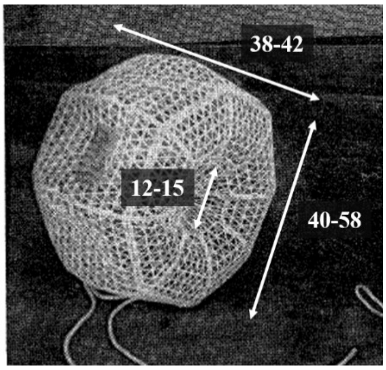
GPX



Sacchi & Dimech 2011– GSA 24

MTS

Authors' photograph – GSA 17

NSQ	SLM
	
Grati et al. 2010 – GSA 17	Rubiò 1971 – GSA 6

9 Annex II

Questionnaires presented during the fishers' interviews. The technical and operational aspects of the pots and passive nets traditionally used are showed in the form.

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INTERVISTE AI PESCATORI

NASSE

1) Informazioni generali

NOME INTERVISTATO:	LUOGO:
DATA:	INTERVISTATORI:

2) Caratteristiche generali dell'attrezzo

TIPOLOGIA DI NASSA	
DIMENSIONE NASSA (cm)	
MATERIALE NASSA	
FORMA NASSA	
FORMA ENTRATA	
DIMENSIONE ENTRATA (cm)	
SPECIE TARGET PRINCIPALI	
1)	2)
3)	4)

3) Area di pesca

AREA DI PESCA
STAGIONE DI PESCA
RANGE DI PROFONDITA' (MIN-MAX; m)

4) Operazioni di pesca

USO DI ESCA (sì, no)
NUMERO NASSE CALATE
DISTANZA TRA DUE NASSE CONSECUTIVE (m)
LUNGHEZZA CALO (km)
TEMPO DI PERMANENZA IN ACQUA (ore)

5) Informazioni sulle attività da svolgere

SEI DISPOSTO A SPERIMENTARE DELLE NASSE ALTERNATIVE?
Sì
NO

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INTERVISTE AI PESCATORI

RETI DA POSTA

1) Informazioni generali

NOME INTERVISTATO:	LUOGO:
DATA:	INTERVISTATORI:

2) Caratteristiche generali dell'attrezzo

TIPO DI RETE MISURATA	
TREMAGLIO	IMBROCCO
RETE COMBINATA	
SPECIE TARGET PRINCIPALI	
1)	2)
3)	4)

3) Area di pesca

AREA DI PESCA
STAGIONE DI PESCA
RANGE DI PROFONDITA' (MIN-MAX; m)

4) Specifiche tecniche della rete

DIMENSIONI E COLORE		
ALTEZZA DELLA RETE IN PESCA		
NUMERO MAGLIE IN ALTEZZA		
LUNGHEZZA DI OGNI PANNELLO (m)		
NUMERO PANNELLI		
LUNGHEZZA TOTALE RETE (m)		
COLORE DELLA RETE (Indicare se ci sono pannelli con colori diversi)		
TIPO DI FILATO		
MONOFILAMENTO	MULTIFILAMENTO TRECCIATO	MULTIFILAMENTO RITORTO
MATERIALE DEL FILATO		
PA (POLYAMIDE, NYLON)	PES (POLYESTERE)	
PE (POLYETHYLENE)	PP (POLYPROPYLENE)	
PVA (POLYVINYL ALCOL)	ALTRO:	

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DIMENSIONI MAGLIE PANNELLO INTERNO	
LUNGHEZZA MAGLIA (a; mm)	
APERTURA MAGLIA (MO; mm)	
DIMENSIONI MAGLIE PANNELLO ESTERNO (SE TREMAGLIO)	
LUNGHEZZA MAGLIA (a; mm)	
APERTURA MAGLIA (MO; mm)	
RAPPORTO D'ARMAMENTO ORIZZONTALE; conta 20 maglie nell'asse orizzontale e determina:	
LUNGHEZZA LIMA DEI SUGHERI (m)	
LUNGHEZZA LIMA DEI PIOMBI (m)	
LIMA DEI PIOMBI	
DIAMETRO (mm)	PESO (gr/m)
LIMA DEI SUGHERI	
DIAMETRO (mm)	
NUMERO E DIMENSIONE DEI GALLEGGIANTI (lunghezza, diametro)	
DISTANZA TRA DUE GALLEGGIANTI CONSECUTIVI (m)	

5) Informazioni sulle attività da svolgere

SEI DISPOSTO A SPERIMENTARE DELLE NASSE ALTERNATIVE?
Sì
NO