CYPRUS BYCATCH PROJECT

“Understanding multi-taxa ‘bycatch’ of vulnerable species and testing mitigation a collaborative approach in Cyprus”

TECHNICAL REPORT

Results of Phase 1 (2018-2019) of the bycatch monitoring programme in

CYPRUS

CYPRUS BYCATCH PROJECT
MAVA FONDATION POUR LA NATURE
BirdLife INTERNATIONAL EUROPE AND CENTRAL ASIA
BirdLife Cyprus
ENALIA PHYSIS ENVIRONMENTAL RESEARCH CENTRE

CONTENTS

AUTHORS

Annie Papadopoulou
(BirdLife Cyprus)

Marios Papageorgiou and Louis Hadjioannou
(Enalia Physis Environmental Research Centre)

Required citation:
Papageorgiou, M., Papadopoulou, A., Hadjioannou, L.. 2020. Cyprus Bycatch Project "Understanding multi-taxa 'bycatch' of vulnerable species and testing mitigation a collaborative approach in Cyprus". Technical Report: Results of Phase 1 (2018-20019) of the bycatch monitoring programme in Cyprus. BirdLife Cyprus and Enalia Physis Environmental Research Centre. Nicosia. Pp32.

ACKNOWLEDGMENTS

BirdLife Cyprus and Enalia Physis are most grateful for the long-term collaboration which has been established with the Cypriot fishers. We thank all participating fishers equally for their efforts to support the project and for their resolve to improve the situation for Cyprus's marine resources and marine biodiversity. For their permission to undertake onboard observations and full support in providing information, as well as their shared resolve to improve fisheries management, we thank the Department of Fisheries and Marine Research, and the leaders of fishing organisations across the studied ports. The advice and support on strategies and logistics of this office has been invaluable. We are also thankful to Antonis Petrou for his valuable support and knowledge transfer throughout the project. Together with these and other stakeholders, phase I of the Cyprus Bycatch Project has laid the ground for a better future and we look forward to building this together in phase II.

Stichting BirdLife Europe and Central Asia gratefully acknowledges the financial assistance of the European Commission, the EU LIFE Programme, and the MAVA Foundation for this publication. The contents of this document are the sole responsibility of the authors and cannot be regarded as reflecting the position of the funders mentioned above. The funder cannot be held responsible for any use which may be made of the information this document contains.

1. INTRODUCTION

Incidental bycatches were recorded according to standard data collection procedures (following the GFCM protocol) by on board fisheries observers. Wherever feasible, bycaught specimens were sampled at sea (or, alternatively, at landing place), and data, including, among others, body size measurements, weight, and sex determination were recorded. As much as possible, observers, mainly from Enalia Physis but also from BirdLife Cyprus, were placed on randomly selected vessels conducting typical fishing trips from the main ports ***(Fig.1)*** in the investigated area. Many times, however, the fishers were selected based on their willingness to collaborate with the Cyprus Bycatch Project and accommodate observers on board. The longstanding relationship and collaboration of Enalia Physis personnel with fishers has helped in creating and maintaining a network of fishers throughout the monitoring program.

The observer-monitoring program was implemented by staff of Enalia Physis and Birdlife Cyprus, with the close collaboration of a team of observers. Enalia Physis has broad expertise of the fisheries sector, marine biology, conservation and management in Cyprus, including working and communicating directly with fishers across Cyprus, while BirdLife Cyprus is one of the most active conservation organisations in Cyprus, with a long history of implementing monitoring and conservation work. Enalia Physis members, using their established network, liaised with the fishing community and created a network of fishers keen to participate in the monitoring program.

1.1 CHARACTERISTICS OF THE AREA

Cyprus is bathed in the Levantine Sea in the Eastern Mediterranean, which is one of the world's most oligotrophic seas, with very low nutrient availability resulting in a very low primary production and SST (Sea Surface Temperature) of 29-30°C in the summer. In addition, the Levantine Sea is characterized by very high temperatures ranging on an annual basis from 16 ° C in winter to 26 ° C in summer. Respectively, the evaporation and salinity are also high (annual average salinity of the Eastern Mediterranean> 37.5 PSU (Practical Salinity Unit) , average salinity in the coastal waters of Cyprus 39.1 PSU), as well as very limited inflow of fresh water due to lack of large rivers.

Cyprus has no rivers with a permanent flow, and the construction of many river and torrent water retention barriers (dams) further restricts the supply of coastal waters with nutrients, while the construction of the Aswan Dam in 1960, further reduced nutrient

[1] *Monitoring the incidental catch of vulnerable species in Mediterranean and Black Sea fisheries: Methodology for data collection*

deposits. In addition, coastal upwelling in the Levantine Sea is generally weak, with deep-water nutrients not being available in the light zone for primary production.

In the context of ensuring the viability of coastal fishing, the Department of Fisheries and Marine Research (hereafter DFMR) maintains and manages a total of 16 fishing shelters for the safe mooring of professional fishing boats. Out of the 16 fishing shelters in operation in Cyprus, 13 are managed by the DFMR. The other three, the Old Limassol Port, part of the Pafos Port and part of the Latsi Port are managed by the Cyprus Ports Authority.

The Fishing Shelter Law and relevant Regulations apply for all fishing shelters as well as the surrounding area within a 100m radius.

In the area of Larnaca - Famagusta there are shelters in Agia Triada, Paralimni, Agia Napa, Potamos Liopetriou, Xylofagou, Ormidia, Xylotymbou, Larnaca and Zygi. In the area of Limassol there are the fishing shelters of the old port of Limassol and Akrotiri. In the area of Paphos, part of the port of Kato Paphos, the fishing shelter of Agios Georgios Pegeias, part of the port of Latsi, the fishing shelter of Pomos, and in the District of Nicosia, that of Kato Pyrgos.

The project operates in the following fishing shelters:

Fishing Shelter	Port Latitude FROM	Port Latitude TO	Port Longitude FROM	Port Longitude TO
Ayla Triada	35° 03' 01.60" N	35° 03' 06.00" N	034° 01' 22.30" E	034° 01' 27.00" E
Paralimni	35° 02' 14.90" N	35° 02' 21.40" N	034° 02' 07.80" E	034° 02' 17.90" E
Ayia Napa	34° 58' 49.60" N	34° 58' 58.10" N	034° 58' 53.60" E	034° 00' 17.30" E
Potamos	34° 58' 07.60" N	34° 58' 29.40" N	033° 53' 44.70" E	033° 54' 11.10" E
Xylofagou	34° 58' 01.50" N	34° 58' 06.20" N	033° 49' 03.10" E	033° 49' 09.30" E
Ormidia	34° 58' 42.70" N	34° 58' 52.10" N	033° 46' 00.50" E	033° 46' 11.80" E
Xylotymbou	34° 58' 50.40" N	34° 58' 54.60" N	033° 44' 13.80" E	033° 44' 18.20" E
Lamaca	34° 53' 51.70" N	34° 54' 04.50" N	033° 38' 16.70" E	033° 38' 26.60" E
Zygi	34° 43' 30.40" N	34° 43' 41.10" N	033° 20' 11.80" E	033° 20' 26.70" E
Limassol	34° 40' 04.80" N	34° 40' 17.70" N	033° 40' 11.10" E	033° 02' 39.80" E
Akrotiri	34° 35' 11.50" N	34° 35' 15.60" N	032° 56' 10.90" E	032° 56' 14.80" E
Paphos	34° 45' 07.80" N	34° 45' 24.50" N	032° 24' 20.40" E	032° 24' 38.50" E
Ay. Georgios	34° 54' 08.30" N	34° 54' 17.80" N	032° 19' 00.10" E	032° 19' 10.80" E
Latsi	35° 02' 24.60" N	35° 02' 34.10" N	032° 23' 32.50" E	032° 23' 53.90" E
Pomos	35° 10' 27.50" N	35° 10' 32.80" N	032° 33' 15.90" E	032° 33' 23.10" E
Pyrgos	35° 11' 19.50" N	35° 11' 29.10" N	032° 40' 11.10" E	032° 40' 23.10" E

Figure 1: GPS Coordinates of all fishing shelters of Cyprus.

In 2019, two new Marine Protected Areas have been established by Decrees:

a) Marine Protected Area "Marine Caves of Pegeia": In February 2019 with the Prohibition of Fishing and Shipping in the Marine Protected Area of Marine Caves of Pegeia, the Place of Community Maritime Importance Caves of Pegeia, in which it has been ascertained that the Mediterranean monk seal, uses marine caves for breeding and resting purposes, with restrictions on professional and amateur fishing, as well as the passage and anchorage of boats.

b) Marine Protected Area "Kakoskali": In July 2019 Prohibition of Fisheries in the Marine Protected Area KAKOSKALI, of the Community Important Site Peninsula Akama by Decree of 2019. The area was declared a MPA (Marine Protected Area). The area is comprised of a unique mosaic of priority habitats (92/43/EEC- EU Habitats Directive) including coralliferous rocky reefs (code 1170), Posidonia meadows (code 1120) and an underwater cave (code 8330) with unique biostalactites created by a complex of organisms (e.g. corals, bryozoans, sponges) supporting high biodiversity.

Also, in 2019, the first offshore area of Cyprus, Oceanis, with an area of 8,317 Km^2, has been identified and submitted to the European Commission for inclusion in the Natura 2000 network to protect cetaceans (specifically, Common bottlenose dolphin – *Tursiops truncates*, Sperm whales – *Physeter macrocephalus*, Cuvier's beaked whale - *Ziphius cavirostris*) and sea turtles, which use the area as a migration corridor. With the accession of Oceanis, the percentage of marine protected areas in Cyprus rose to 19% compared to its entire maritime area (including territorial waters and Exclusive Economic Zones (EEZs)).

Sea turtles and their eggs have been protected by the Fisheries Law since 1971. The protection of their habitat in the Lara / Toxeftra area was ensured in 1989 by management measures of Regulations of the same Law.

The management of fishing stocks is a key goal of the Department of Fisheries and Marine Research in Cyprus and the Common Fisheries Policy (CFP) in general and is achieved through the implementation of appropriate management measures. As fish stocks in the Mediterranean region are subject to high fisheries pressure, compliance with management measures is essential.

Under Community and National Legislation (Regulation (EC) No 1967/2006 - APPENDIX III and Fisheries Regulations - APPENDIX II) fishing, possession, transport and sale of Mediterranean items shown in the *table 1* below are prohibited when they are smaller in size from the corresponding one listed.

Table 1: Minimum landing sizes of the marine organisms fished in Cyprus (National Legislation (Regulation (EC) No 1967/2006 - APPENDIX III and Fisheries Regulations - APPENDIX II)

SCIENTIFIC NAME	COMMON NAME	MINIMUM LANDING SIZE (CM)
Engraulis encrasicolus	European anchovy	9
Solea solea	Common sole	20
Mugil cephalus	Flathead mullet	16
Polyprion americanus	Wreckfish	45
Scomber japonicus *Scomber scombrus*	Chub mackerel Atlantic mackerel	18
Dicentrarchus labrax	European seabass	25
Pagellus erythrinus	Common Pandora	15
Lithognathus mormyrus	Striped bream	20
Merluccius merluccius	European hake	20
Pagellus bogaraveo	Blackspot seabream	33
Mullus surmuletus *Mullus barbatus*	Striped red mullet Red mullet	11
Epinephelus marginatus *Epinephelus aeneus*	Dusky grouper White grouper	45
Diplodus puntazzo	Sharpsnout seabream	18
Lophius budegassa	Black-bellied angler	30

Sardina pilchardus	European pilchard	11
Trachurus sp.	Horse mackerel	15
Diplodus sargus	White seabream	23
Diplodus annularis	Annular seabream	12
Sparus aurata	Gilt-head sea bream	20
Pagrus pagrus	Common Bream	18
Pagellus acarne	Axillary bream	17
Diplodus vulgaris	Two-banded seabream	18

Species (including vulnerable ones) that are prohibited from landing and selling are shown in Annex IIIa and b.

To assess the situation of fish populations, it is necessary to collect and process certain biological, statistical and even economic data, depending on the model used. Since 2005, the Fisheries Reserve Estimation Division of the Department of Fisheries and Marine Research in Cyprus, has been implementing the National Data Collection Program, which is based on the Community Fisheries Legislative Framework (Regulations (EC) No 199/2008, No. 665/2008 and Decision 2010/93 / EU).

The program is co-financed by the Republic of Cyprus and the European Union and aims to create multi-year data series, compatible between Member States, which will ensure the assessment of the state of fisheries resources and the viability of the fisheries sector. The Fisheries Reserve Estimation Division is responsible for the collection and processing of biological data.

1.2 DESCRIPTION OF FISHING EFFORT

During 2019, more than 1400 boats were moored in the fishing shelters of DFMR. Of these, 1,100 boats were moored under the annual mooring regime and more than 300 boats were moored under the daily mooring regime. Under the annual mooring regime, 400 professional fishing boats, 100 professional boats related to other blue occupations and 600 boats holding a C fishing license, amateur boats and yachts were moored. Small-scale fisheries vessels represent the highest percentage of all fishing fleets with 88% followed by longliners (9%), trawlers (2%) and purse-seiners (0.5%). *Table 1* shows the total number of vessels per fleet category in 2018.

Table 2: Fishing effort (total number of vessels) in 2018

FISHING EFFORT (TOTAL NUMBER OF VESSELS)	
Reference year: 2018	
Trawlers	8
Longliners	34
Small-scale vessels (with and without engine)	327
Polyvalents	-
Purse-seiners	2

In 2018, the fishing effort of the small-scale inshore fishery (0 – 12m length) was 30644 days. For the same year, the fishing effort of the pelagic longline fishery (12 – 18m length) was 1667 days. The fishing effort of trawlers and purse-seiners (24 – 40m length) was 441 and 5, respectively ***(see Table 3)***.

Table 3: Fishing effort (total number of fishing days) in 2018

FISHING EFFORT (TOTAL NUMBER OF FISHING DAYS)	
Reference year: 2018	
Trawlers	441
Longliners	1667
Small-scale vessels (with and without engine)	30644
Polyvalents	-
Purse-seiners	5

Cyprus's fishing sector consists of coastal fishing, polyvalent fishing and trawlers. Coastal fishing is carried out with small, usually wooden boats, 4 to 12 meters long, which use mainly bottom set longlines and static nets including trammel nets, monofilament nets and gillnets. , Set nets target a great variety of demersal fish such as the red mullet, striped red mullet, common pandora, bogue, picarel, white seabream, sand steenbras, Mediterranean parrot fish, dusky spinefoot, blotched picarel, common dentex, dusky grouper, red porgy and cuttlefish as well as some epibenthic and pelagic fish such as the greater amberjack, bullet tuna, horse mackerel and round herring. Bottom set longlines target mainly large predatory fish like the dusky grouper, common dentex, red porgy and common pandora.

Polyvalent fishing is practiced by boats over 12 meters long, which use, in addition to coastal fishing gear, surface drifting longlines targeting swordfish and albacore tuna. Fishing with bottom trawling is carried out by iron boats over 18 meters long. It is an efficient fishing gear and has the shape of a conical bag. It is towed by the fishing boat with two ropes tied both in plates (doors) that help keep the mouth of the tool open. When fishing, the trawl rests on the bottom and collects the catch in the extreme part of the bag that has the smallest net opening. The main fish stocks targeted by the Cyprus fishing sector can be divided into two categories, benthic and large pelagic species. Small pelagic species (e.g. sardines) are not targeted stocks. Benthic species are mainly targeted by coastal fishing and bottom trawling and include species such as picarel, bogue, red mullet, barbell mullet, octopus and others. Large pelagic species are targeted by polyvalent vessels and include species such as the elongated tuna, the red tuna and the swordfish.

Table 4: Active vessels per port in 2019

NUMBER OF VESSELS PER SAMPLING PORT						
Port	Trawlers	Longliners	Small-scale vessels (with and without engine)	Polyvalents	Purse-seiners	Total number of vessels in the port
Agia Triada			11			11
Paralimni			21			21
Agia Napa		3	27			30
Potamos			29			29
Xylofagou			7			7
Ormidia		2	12			14
Dekelia			3			3
Larnaka port		5	0		1	6
Larnaka fishing shelter		4	44			48
Zygi			30			30
Lemesos fishing shelter	7	6	45		1	59
Lemesos port	1		0			1
Akrotiri			8			8
Pissouri			2			2
Pafos		3	33			36
Coral Bay			1			1
Pegeia		1	17			18
Latsi		6	33			39
Pomos		2	5			7
Pyrgos			5			5
Total	8	32	333	0	2	375

2. MATERIALS AND METHODS

Data collection was achieved through onboard observations, at port questionnaires to fishers and fishers' self-reporting on logbooks. Among the three methodologies tested, onboard observations was the most effective and valid one due to the detailed information recorded from the experienced onboard observers during the fishing operations. There were several cases where the information recorded in the self-monitoring logbooks were inaccurate and incomplete making it difficult to process and use the data for meaningful results. Additionally, in the long term, fishermen were not much interested in taking part in self-monitoring and often avoiding filling the logbook. Interviews on the other hand, have shown to be effective in collecting important historical information from fishermen on bycatch as well as basic information on the current fishing trip. However, other important information on the fishing trip such as the fishing location and biological information of the bycaught species were missing or not accurately recorded. Pelagic longline and small - scale fisheries were targeted in the study. Data were collected between 2018 and 2019 from 12 ports/fishing shelters. In total 12 and 187 fishing trips were conducted with pelagic longline and small-scale fisheries, respectively. Interviews were conducted to 31 fishers during the winter where fishing effort is very low and 176 fishing days were recorded on logbooks through self-reporting.

Four observers participated in onboard observations. They were trained prior to the start of the fieldwork on identification and safe handling of marine vulnerable species. Organisms were identified to species level where possible. Identification of species was obtained from available identification guides, current literature and feedback from fellow taxonomists. The methodology followed for data collection was based on the manual for monitoring incidental catch of vulnerable species published by the United Nations body of Food and Agriculture Organization (FAO) (2019). At the end of every fishing trip, data were uploaded on a shared database and validated throughout the project.

3. RESULTS

3.1 BYCATCH ANALYSIS

During the sampling period (2018 – 2019), 36.1%, 33.2%, 18.8%, 9.1% and 2.9% of the gear used was trammel nets, combined gillnets and trammel nets, monofilament nets, bottom longline and gillnets, respectively. In technical terms, monofilament nets are gillnets, but due to their different usages by fishers depending on the target catch, monofilament nets were put in a separate category. The frequency of the gear used by longliners was 100% pelagic longline. The main target and discarded species as well as the discards occurrence per gear type are shown in ***Table 5***. Heat and distribution maps of bycaught species and taxa are shown in Annexes.

Table 5: Main fishing gear per vessel group.

MAIN FISHING GEAR PER VESSEL GROUP					
	Main gear	**Frequency (%) of gear used**	**Catch composition**	**Discards composition**	**Discards occurrence**
Longliners	**Demersal bottom longline**	**NA**			
	Pelagic longline	**100**	*Thunnus alalunga, Xiphias gladius, Prionace glauca, Thunnus thynnus*	*Thunnus alalunga*	Medium
	Trammel nets	**NA**			
Small-scale vessels (with and without engine)	**Gillnets**	**2.9**	*Seriola dumerili, Dentex dentex, Epinephelus marginatus*	*Lagocephalus sceleratus*	Low
	Trammel nets	**36.1**	*Mullus barbatus, Mullus surmuletus, Siganus luridus, Siganus rivulatus, Sparus aurata, Sepia officinalis, Parupeneus forsskali, various fish*	*Lagocephalus sceleratus, Torquigener flavimaculosus, Pterois miles, Sargocentron rubrum,*	High
	Combined gillnets-trammel nets	**33.2**	*Boops boops, Spicara maena, Spicara smaris, Mullus barbatus, Mullus surmuletus, Siganus luridus, Siganus rivulatus, Sparus aurata, Sepia officinalis, Parupeneus forsskali, various fish*	*Lagocephalus sceleratus, Torquigener flavimaculosus, Pterois miles, Sargocentron rubrum,*	High
	Bottom longline	**9.1**	*Dentex dentex, Epinephelus marginatus, Pagrus pagrus, Pagellus erythrinus*	*Scyliorhinus canicula, Muraena helena, Lagocephalus sceleratus*	Medium
	Monofilament nets	**18.8**	*Boops boops, Spicara maena, Spicara smaris, Mullus barbatus, Mullus surmuletus, Trachurus sp.*	*Sargocentron rubrum, Scorpaena scrofa, Bothus podas, Pterois miles*	High

Onboard observations covered 75% and 60% of planned fishing trips with longliners and small-scale vessels, respectively. 52% of planned at port questionnaires was covered. 178% and 70% of the planned self-reporting was covered by longliners and small-scale fisheries, respectively (see Table 6). Table 7 shows the total number of ports covered during the monitoring programme.

Table 6: Sampling plan (fishing days covered).

SAMPLING PLAN (FISHING DAYS COVERED)									
	PLANNED			ACHIEVED			% COVERAGE		
	by on board fishing observations	by number of questionnaires	by self-sampling operations	by on board fishing observations	by number of questionnaires	by self-sampling operations	by on board fishing observations	by number of questionnaires	by self-sampling operations
Longliners	16	0	40	12	0	71	75	0	178
Small-scale vessels (with and without engine)	312	60	150	187	31	105	60	52	70

Table 7: Total number of ports covered by the monitoring programme.

TOTAL NUMBER OF PORTS COVERED BY THE MONITORING PROGRAMME			
	Number of on board fishing observations	Number of questionnaires	Number of self-sampling operations
Psarolimano, Larnaca	50	16	0
Ayia Napa	8	5	30
Golden Coast, Paralimni	6	2	15
Paphos	22	0	32
Larnaca Main Harbour	12	0	36
Latsi port	9	2	0
Old port Limassol	32	0	30
Ormedeia	3	0	0
Potamos, Liopetri	26	3	0
St. Raphael Marina	2	0	0
Zygi	29	0	3
Ayia Triada, Paralimni	0	0	15

Elasmobranchs were the most abundant bycaught taxa among all vessel groups, gear types and methodologies tested. The second most bycaught taxa were turtles followed by cetaceans ***(see Figure 2)***. There was only one record of bycatch of common bottlenose dolphin (Tursiops truncatus) on pelagic longline targeting albacore tuna. The common bottlenose dolphin was bycaught during depredation on the catch and it was released alive without landing on-board. There were no records of seabird bycatch during the on-board observations and none reported during interviews or self-reporting.

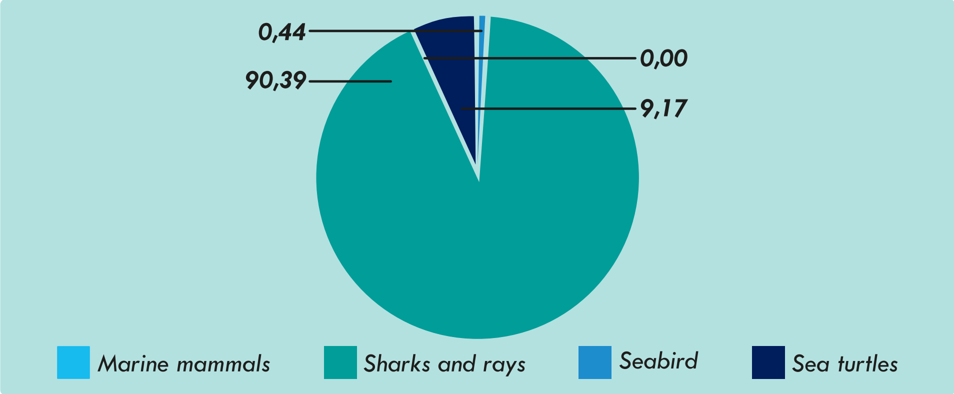

Figure 2: Total number (%) of bycaught individuals.

Table 8 shows the total number of individuals bycaught per species and vessel group. The most common bycaught species of small-scale vessels and longliners was *Dasyatis pastinaca* and *Pteroplatytrigon violacea*, respectively. Elasmobranch and turtle bycatch was higher in small-scale vessels than longliners ***(see Figure 3)***. The relationship between the number of fishing days and bycaught individuals is shown in ***Figure 4***. Results show that even though the number of sampling days is relatively low with longliners, the bycatch of elasmobranchs is high. The species bycaught on pelagic longline were *Tursiops truncatus*, *Prionace glauca*, *Pteroplatyrtygon violacea* and *Chelonia mydas*.

The species bycatch on small-scale vessels were *Carcharhinus plumbeus, Dasyatis marmorata, Dasyatis pastinaca, Glaucostegus cemiculus, Hexanchus griseus, Raja clavata, Raja radula, Raja sp., Scyliorhinus canicula, Squalus blainville, Torpedo marmorata, Caretta caretta* and *Chelonia mydas.*

Table 8: Number of bycaught individuals per species and vessel group.

MARINE MAMMALS		
	T. TRUNCATES	TOTAL
Longliners	1	1
Small-scale vessels (with and without engine)	0	0

SHARKS AND RAYS														
	P. violacea	P. glauca	C. plumbeus	D. marmorata	D. pastinaca	G. cemiculus	H. griseus	R. clavata	R. radula	Raja sp.	S. canicula	S. blainville	T. marmorata	Total
Longliners	72	5	0	0	4	0	0	0	0	0	0	0	0	81
Small-scale vessels (with and without engine)	0	0	1	4	75	20	1	7	6	41	8	9	6	178

SEA TURTLES			
	CARETTA CARETTA	CHELONIA MYDAS	TOTAL
Longliners	0	1	1
Small-scale vessels (with and without engine)	29	19	48

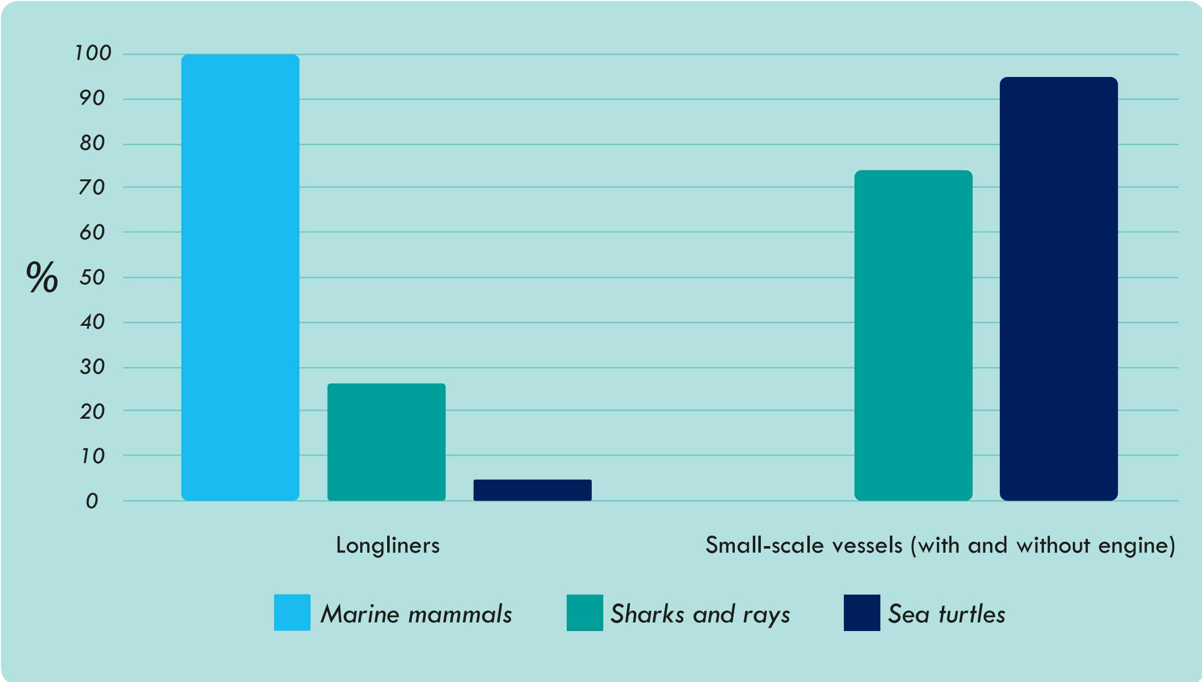

Figure 3: Total number of bycaught individuals (%) per vessel group.

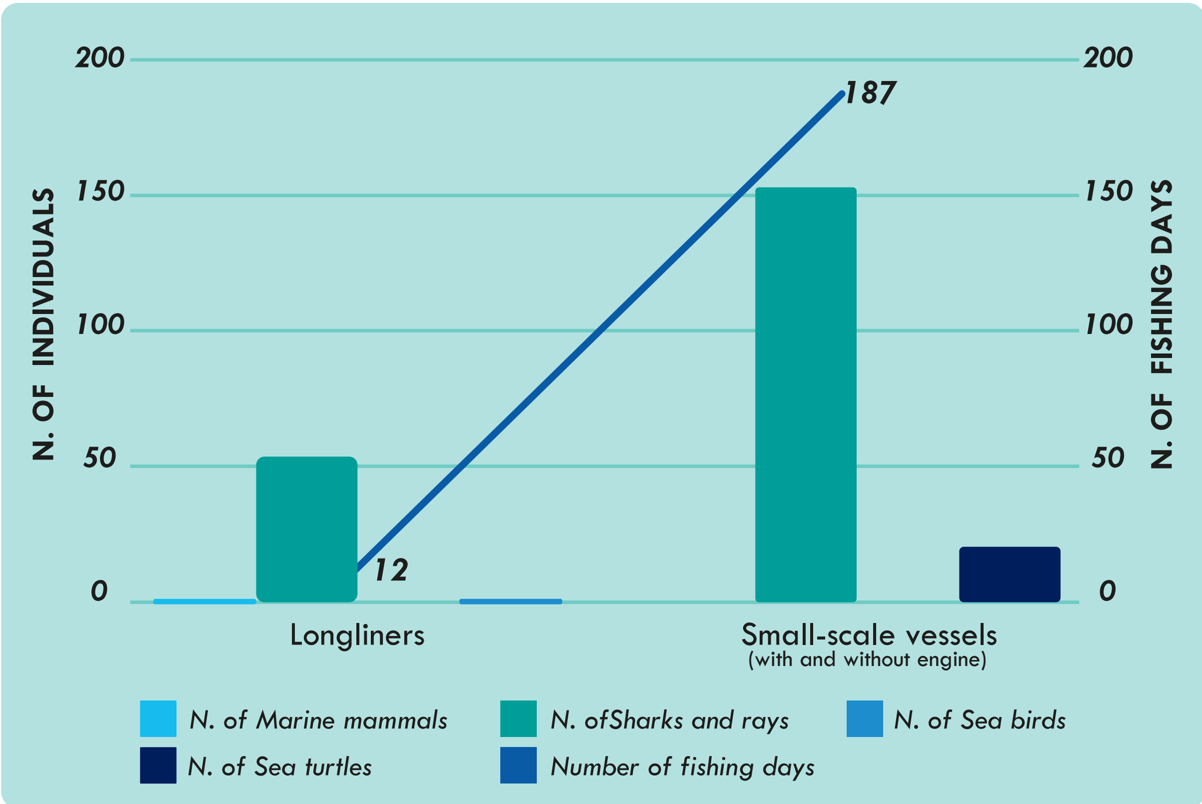

Figure 4: Relationship between number of fishing days and bycaught individuals.

The sampling effort was significantly higher in summer ***(see Figure 5)*** than in other seasons and this is linked to the higher fishing effort during those months. Results also revealed that bycatch and discards were significantly higher during summer. This is most probably related to variables such as higher fishing effort, longer set nets and fishing at greater depths as well as to some biological factors including migratory and breeding seasons especially for turtles.

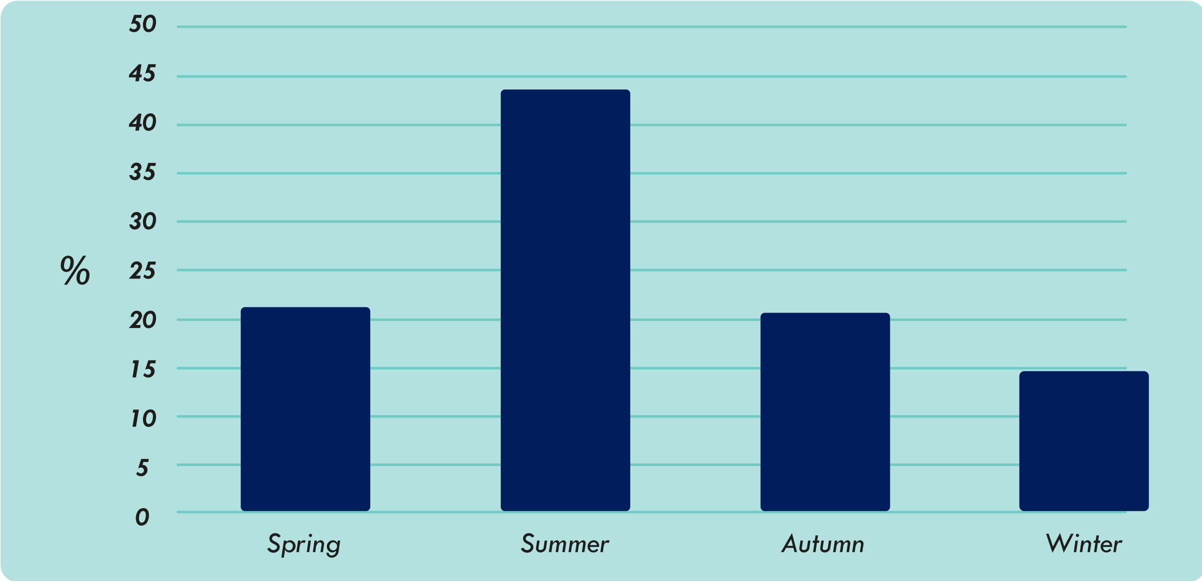

Figure 5: Sampling effort (%) by seasons.

Bycaught individuals that were released alive, were either species-prohibited-to-landing, undersized or had low or no commercial value. Species released alive were *Pteroplatytrigon violacea, Glaucostegus cemiculus, Carcharhinus plumbeus, Dasyatis pastinaca, Hexanchus griseus, Raja clavata, Raja sp., Scyliorhinus canicula* and *Torpedo marmorata* **(see Table 9).**

Table 9: Number of individuals released alive per species and vessel group.

NUMBER INDIVIDUALS RELEASED ALIVE PER SPECIES AND VESSEL GROUP

MARINE MAMMALS

	Tursiops truncatus	Total
Longliners	1	1
Small-scale vessels (with and without engine)	0	0

SHARKS AND RAYS

	P. violacea	*P. glauca*	*C. plumbeus*	*D. marmorata*	*D. pastinaca*	*G. cemiculus*	*H. griseus*	*R. clavata*	*R. radula*	*Raja sp.*	*S. canicula*	*S. blainville*	*T. marmorata*	*Total*
Longliners	72	0	0	0	4	0	0	0	0	0	0	0	0	76
Small-scale vessels (with and without engine)	0	0	1	0	29	14	1	2	5	22	3	0	4	81

SEA TURTLES

	CARETTA CARETTA	CHELONIA MYDAS	TOTAL
Longliners	0	0	0
Small-scale vessels (with and without engine)	31	12	43

Approximately 90% of sea turtles bycaught on small-scale fishing vessels were released alive and approximately 30% of elasmobranchs bycaught on small-scale fishing vessels and longliners were released alive. The single specimen of common bottlenose dolphin bycaught on pelagic longlines was also released alive ***(see Figure 6)***.

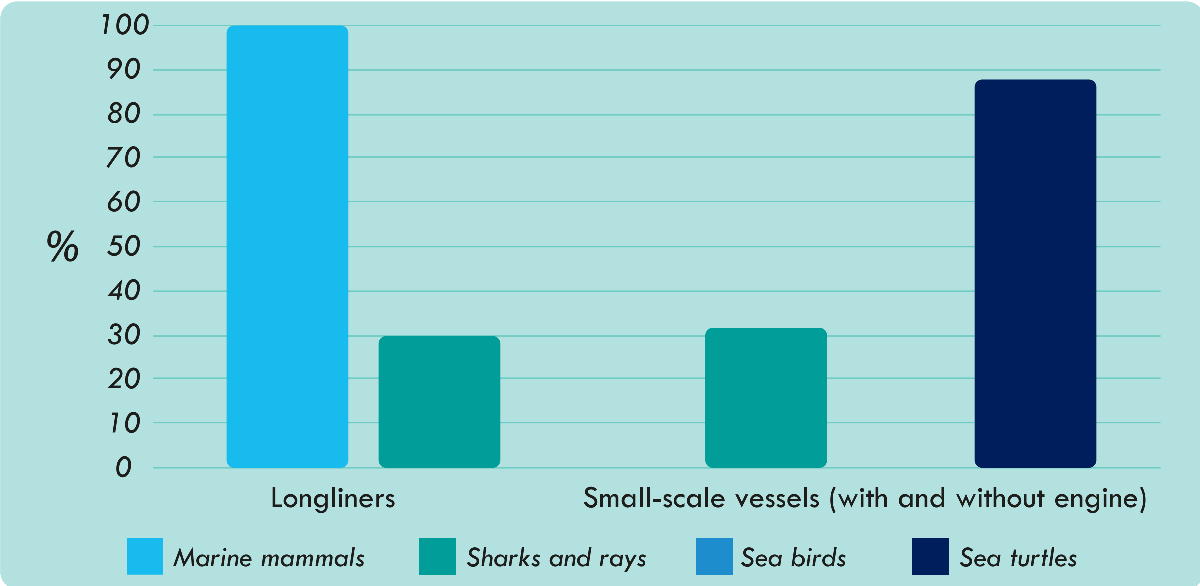

Figure 6: Total number of individuals (%) released alive per different vessel group.

3.2 ANNUAL BYCATCH RATE ESTIMATES

Estimated bycatch rate (T) during the sampling programme and estimated individuals caught by fleet (I) were calculated using the data from 2019 (2018 sampling started in April and ended in December of the same year and 2019 sampling started in January and ended in December of the same year). Furthermore, in 2018, 49 and 8 fishing trips were conducted with small-scale vessels and longliners, respectively, whereas in the second sampling year (2019), 150 and 4 fishing trips were conducted with small-scale vessels and longliners, respectively. Bycatch rate and estimated annual bycatch rate of elasmobranchs is significantly higher than for other taxa, for both small-scale vessels and longliners ***(see Table 10a and 10b)***.

Table 10a: Small-scale vessels: incidental catches rate and estimation in 2019.

SMALL-SCALE VESSELS: INCIDENTAL CATCHES RATE AND ESTIMATION				
Group of vulnerable species	**Bycatch of vulnerable species rate (T)**	**Estimation of individuals caught by that vessel group during the sampling year (I)**	**Probability % of catching a vulnerable species with that vessel group**	**Reference year**
Marine mammals	0	0	0	2019
Sharks and rays	0.766666667	23493.73333	0.002501849	2019
Seabirds	0	0	0	2019
Sea turtles	0.113333333	3472.986667	0.000369839	2019

Table 10b: Longliners: incidental catches rate and estimation.

LONGLINERS: INCIDENTAL CATCHES RATE AND ESTIMATION				
Group of vulnerable species	Bycatch of vulnerable species rate (T)	Estimation of individuals caught by that vessel group during the sampling year (I)	Probability % of catching a vulnerable species with that vessel group	Reference year
Marine mammals	0.25	416.75	0.014997001	2019
Sharks and rays	4.75	7918.25	0.284943011	2019
Seabirds	0	0	0	2019
Sea turtles	0.25	416.75	0.014997001	2019

3.3 MARINE VULNERABLE BENTHIC SPECIES

As per the GFCM Protocol, for those specimens which we could not identify at species level, the genus, family, order or the taxa were indicated. "In cases where species identification is not possible (especially for sessile taxa), assign organisms to morphological groups according to their growth form (e.g. massive, tubular, globular, arborescent, stalked, fan-shaped, lollipop-shaped, cup-shaped – see Annex I.c of the Protocol)".

Marine vulnerable benthic species including corals, sponges, bryozoans, reef-building polychaetes and other benthic species represented a very small percentage (0.7%) of the total catch out of the 199 sampling fishing trips. In fact, out of the 199 fishing trips conducted, only 3 of them had bycatch records of benthic vulnerable species on set nets. ***Table 11*** shows the percentage of contribution of each bycaught benthic taxa to the total catch as well as the composition by species (%) to that percentage. ***Figure 7*** shows the contribution (%) of VME to the total catch per vessel group. No benthic vulnerable species were recorded on longliners.

Table 11: Data (%) on marine vulnerable benthic species.

DATA (%) ON MARINE VULNERABLE BENTHIC SPECIES	
	PERCENTAGE (%)
Sponges in the catch	0.4
Corals in the catch	0.3
Other benthic species in the catch	
COMPOSITION BY SPECIES*	
Species/Family/Genus/Order/Taxa	PERCENTAGE (%)
Alcyonium palmatum	43.5
Pennatula rubra	43.5
Axinella cf.	6.5
Scalarispongia scalaris	6.5

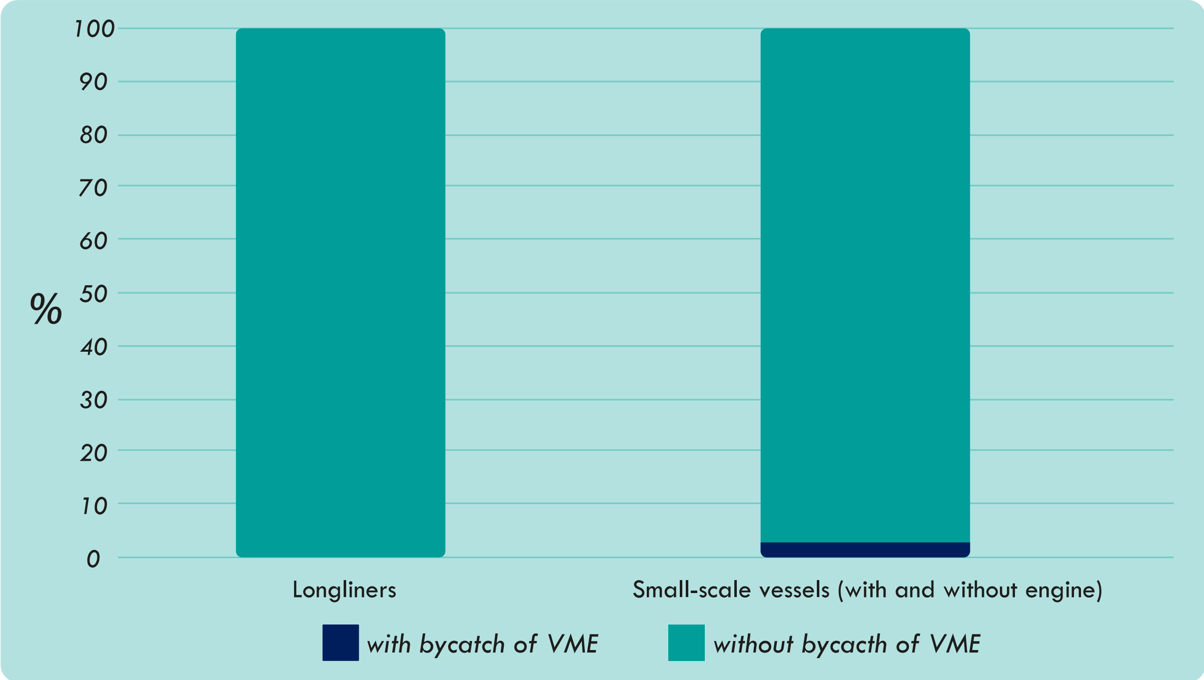

Figure 7: Presence of vulnerable benthic species per vessel group.

3.4 INTERACTIONS OF VULNERABLE SPECIES WITH FISHING ACTIVITIES

Interactions between marine vulnerable species and fishing operations have been reported with almost all existing fishing gears often resulting in significant catch loss and gear damage. During the monitoring programme, interactions with the common bottlenose dolphin *(Tursiops truncatus)* were frequently reported, causing depredation on the target catch, especially on pelagic longlines targeting albacore tuna ***(see Figure 8)***. From data derived from logbooks and onboard observations, the average catch loss from dolphin depredation for the albacore tuna is estimated at 30.4% of the total catch per fishing trip. This corresponds to an average loss of €430 per fishing trip due to depredation. Depredation from common bottlenose dolphins on pelagic longlines was also reported on bait. However, the loss from depredation on bait could not be quantified. The only bycatch record of T. truncatus on the pelagic longline was during depredation on albacore tuna.

Depredation on catch from the loggerhead turtle *(Caretta caretta)* was frequently reported on small-scale vessels. The increased numbers of turtles in recent years has led to more and frequent interactions with static nets often resulting in them being bycaught. Depredation from turtles also causes significant gear damage. Anecdotal evidence suggests that, in the past, due to the high numbers of turtles, fishers were aggressive to the turtles, often resulting in high numbers of induced injuries on turtles. Depredation on catch from monk seals on set nets was also reported from small-scale fishers. However, this is a rare event. Fishers who had reported the incident though were happily surprised with the seal encounter and had even attempted to feed them when it swam close to the boat.

There has been no evidence of seabird bycatch during the course of the monitoring programme. Yet different species of seabirds including juvenile and adult Yellow-legged gull *(Larus michahellis)* and, European shag *(Gulosus aristotelis)* were recorded during fishing trips (especially during hauling) and were seen feeding off fish discards or hovering close to fishing boats. *Gulosus aristotelis* was mostly seen close to ports.

It should be noted that Seabird bycatch is often characterised by zero inflated data (i.e. a high proportion of fishing trips with no bycatch), while infrequent mass-mortality events with a high number of individuals bycaught can also occur. Therefore, a high coverage is needed to get an accurate picture of the occurrence of seabird bycatch. It is crucial to take this into account when interpreting the results of any observation programme.

Other relevant considerations for all taxa when assessing annual bycatch rates include the fact that only certain fleet segments are covered by the observer programme, meaning that any interactions with marine taxa occurring in these fleet segments will not be recorded. In addition there are limitations with certain data collection methodologies (lower accuracy for questionnaires vs on-board observations) and gaps in the temporal and/or spatial distribution of observations (and/or use of different methodologies) both of which are important when assessing bycatch rates.

Figure 8: Example of a depredated albacore tuna (Thunnus alalunga) by common bottlenose dolphin (Tursiops truncatus) during pelagic longline fishing in July 2018.

3.5. MARINE LITTER

The percentage of marine litter in the catch (%), the frequency of occurrence (%) and the composition of marine litter (%) per litter type are shown in ***Table 12***. Marine litter was never recorded on long liners, only on small-scale vessels and in very low numbers. However, it is important to note that longline fishers were habitually discarding the empty boxes of bait in the sea, whereas small-scale fishers have been observed to discard their cigarettes.

Table 12: Presence (%) of marine litter in the catch.

PRESENCE (%) OF MARINE LITTER IN THE CATCH		
	Longliners	Small-scale vessels (with and without engine)
Percentage (%) of marine litter in the catch	0	0.2
Frequency of occurence (%)	0	0.1
Marine litter composition (%)		
Plastic	0	14.1
Rubber	0	0.1
Fishing gears	0	60.2
Metal	0	25.6
Glass	0	0.0
Ceramic	0	0.0
Cloth	0	0.0
Wood processed	0	0.0

3.6. STRANDING DATA

During the sampling period there was only one record of a stranded female Bluntnose sixgill shark *(Hexanchus griseus)* in Ayia Napa in December 2018 ***(see Figure 9)***. The total length was 214 cm and the standard length was 155 cm and weighted approximately 50kg. No hooks were found inside the mouth, which may indicate that it was bycaught on static nets.

Figure 9: Stranded female Hexanchus griseus in Ayia Napa, Cyprus in December 2018. Biological measurements were taken.

3.7. NON-INDIGENOUS SPECIES

In terms of biomass, discards were composed mostly of non-indigenous species (>70% of the total discard biomass – biomass from 199 fishing trips). In terms of number of species, indigenous species were more diverse than non-indigenous. The most common non-indigenous species were ***Lagocephalus sceleratus*, *Sargocentron rubrum*, *Torguigener flavimaculosus*** and ***Pterois miles*. *L. sceleratus*** was the most common and abundant non- indigenous species in the catch. Fishing for the non-native species such as the red sea goatfish ***(Parupeneus forsskali)*** has presented as a promising income opportunity for fishers, who strongly believe that it has displaced/replaced the indigenous ***Mullus barbatus*** and ***Mullus surmuletus***. In addition, the invasive silver-cheeked toadfish ***(L. sceleratus)*** is heavily targeted by fishers at specific seasons with the aim to control its population. This is an initiative from the Department of Fisheries and Marine Research as a control measure towards the invasion of this species. Fishers sell the pufferfish for 3 euros per kilo to the government. Today, this practice significantly supports their income. The invasive lionfish ***(P. miles)*** has also slowly started reaching the market but is not yet considered as a targeted species ***(see Figure 10).***

*Figure 10: **(A)** 34 lionfish (P. miles) were caught on a single set net targeting grouper, **(B)** venomous spines removed by fisher, **(C)** good size lionfish prepared and selected to be sold in the market and **(D)** lionfish sold in the market for €3 per kilo.*

4. CONCLUSIONS

During the 2-year sampling period (i.e. 2019), the main impacted vulnerable taxa to bycatch were elasmobranchs and sea turtles. *Dasyatis pastinaca* was the most common bycatch species on static nets and *Scyliorhinus canicula* and *Squalus blainville* were the most common bycatch species on bottom longlines. On pelagic longlines, the most common bycatch species was *Pteroplatytrygon violacea*. Most elasmobranch species are bycaught throughout the year, however higher number of individuals were bycaught during the summer period and this was related to the higher fishing effort. High bycatch rates of sea turtles were mostly recorded during summer and during autumn. *Caretta caretta* is bycaught more often than *Chelonia mydas* and this seems to be linked to the interactions that it has with fishing gear and catch. For example, *Caretta caretta* predominantly feeds on fish (i.e. carnivorous feeding behaviour thus more attracted to fishing nets) and *Chelonia mydas* grazes on Posidonia, hence more likely to come in contact with anglers in shallower waters. Also, summer is the time they are more active as they are travelling to beaches to lay eggs, a time that coincides with higher fishing effort, thus turtles would be more likely bycaught during summer.

There were spatial and temporal gaps during the first year (2018) of the data collection and this was due to various unforeseen circumstances. In the second year of sampling, data collection was well organised and there were no spatial and temporal gaps.

Potential mitigation measures to mitigate sea turtle bycatch and reduce their mortality rate could be the use of LED (light-emitting diodes) lights and shorter soak times. Adding to these, potential restrictions of fishing in some specific areas and/or periods of the year could prove helpful (e.g. closed areas and seasons to fishing). Shorter soak times seem to increase chances of survival in sea turtles when bycaught on nets and longlines. To date, the only available tool to mitigate shark bycatch on pelagic longlines is the 'SharkGuard' provided by FishTek Marine. The product has not been tested in the project and there are no studies yet to confirm its effectiveness on mitigating elasmobranchs bycatch. Bycatch of sharks is happening throughout the year with higher bycatch rates in summer. For this reason, temporal measures could not act as a potential mitigation measure. On the other hand, spatial measures such as temporary closures of important breeding, nursery and foraging areas could be applied to protect areas with high bycatch and diversity of elasmobranch species or areas of important habitats for such species during key periods of their life cycles (e.g. breeding). However, it is important to mention here **that areas with high elasmobranch bycatch and diversity are also important fishing areas**. This information should always be taken into consideration when applying conservation measures and during decision-making to avoid conflict with fishers. Therefore, a bottom-up approach is always the best way forward towards the protection of important/vulnerable marine species and habitats. Potential mitigation measures are shown in ***Table 14***.

Table 14: Potential mitigation measures.

POTENTIAL MITIGATION MEASURES			
Group of vulnerable species concerned	**Sharks and rays**	***Sharks and rays***	***Sea turtles***
Main species concerned (if any)	*Glaucostegus cemiculus, Oxynotus centrina, Hexanchus griseus, Gymnura altavela, Squatina squatina, Carcharhinus plumbeus, Aetomylaeus bovinus*	*Isurus oxyrinchus, Alopias superciliosus, Prionace glauca*	*Caretta caretta, Chelonia mydas*
The vessel group(s) interested	Small-scale fisheries	Pelagic longline fisheries	Small-scale fisheries
The fishing gear(s)	Gillnet, Trammel net, Bottom longline	Pelagic longline	Trammel net, gillnet
Area(s) where mitigation measures should be implemented (e.g. port, depth zone, GSA, country, etc.)	Depth zone: 50-300 m, GSA 25	GSA 25	Depth zone: 0-40 m, Open sea aquaculture cages, GSA 25
Short explanation on the choice of the area (e.g. most impacted, high presence of vulnerable species, nursery area, spawning area, breeding area, etc.)	High presence of elasmobranch species at greater depths	There is a high bycatch of elasmobranch species especially of the blue shark and pelagic stingray during swordfish and albacore tuna fishing period.	There is a high bycatch possibility of turtles between these depths and at close to aquaculture cages at open sea.
Period(s) where mitigation measures should be implemented (e.g. the whole year, a season, a month, a quarter, or any period of the year, etc.)	All year round with emphasis on summer and autumn	All year round with emphasis on summer and autumn	All year round with emphasis on summer and autumn
Short explanation on the choice of the period (e.g. highest density of vulnerable species, nursery period, spaw ning period, breeding period, etc.)	Fishers tend to fish at greater depths during summer and autumn	Swordfish and albacore tuna fishing period	Breeding period and higher fishing effort in summer and autumn
Suggestion on possible mitigation measure that could be applied (e.g. pingers, circle hooks, TED, grids, spatio-temporal measures, etc.)	Spatio-temporal measures during these periods could be applied, however this is the time of the year that small-scale fishers go out to fish more often. Policy and legislation should be enforced while the authorities should also apply better monitoring systems. Fishers should become more aware of marine vulnerable species and further trained on safe handling and release. With current mitigation measures available, it is almost impossible to avoid the bycatch of elasmobranch species.	Policy and legislation should be enforced while the authorities should apply better monitoring systems. Fishers should become more aware of marine vulnerable species and trained on safe handling and release. With current mitigation measures available, it is almost impossible to avoid the bycatch of elasmobranch species. Conduct mitigation trials with circle-hooks and or other technology (e.g. sharkguards)	Spatio-temporal measures could be applied. Shorter soak times also seem to increase the probability of the survival of sea turtles. Conduct further mitigation trials with LED lights.

Table 15: SWOT analysis of the adoption of the GFCM standardized methodology and implementation of the observation programme

STRENGTHS	WEAKNESSES
- Relatively cheap to execute because fishers do most of the data gathering (specific to self-reporting and at-port questionnaires methodologies). - Obtain reliable information on the interaction of vulnerable species with specific fishing gear. - Helpful in providing valuable information on the mortality by fishing gear. - Can be used for increasing the knowledge on the biology (e.g. data on sex and maturity) of the species impacted by bycatch at a relatively low cost. - May give an indication of an underlying seasonal or temporal trend in mortality, providing data that can be matched to seasonally and temporally variable fishing activities to build an evidence base. - Bycatch occurrence and absence data are very useful in flagging up bycatch hotspots. - Combination of the methodologies of the monitoring program can be used to provide positional data and information on fleet segments that could not be provided with the same precision through, one methodology alone.	- There may be substantial inconvenience to fishers in terms of on board and/or dockside processing because these activities involve an extra person (or persons) on board the vessel occupying deck space (in some artisanal vessels there is not space for an on board observer) and conducting activities that are outside normal fishing practices (e.g. measuring, weighing and recording information). - Methods very dependent on the confidence of the collaboration of fishers and with the fishing industry in general. - Fishers, like all humans, are likely to forget or miss-report specific details, such as numbers, over time (self-reporting). - Not every fisher will photograph or note down the details of every vulnerable species and they may be more likely to report live than dead specimens. - Monitoring program and collection of data dependent on weather conditions.
OPPORTUNITIES	**THREATS**
- Illustration aids to be produced of vulnerable species known or expected to occur in the study areas can be used to help fishers identify species caught. - Support the employment of observers. - Know the extent of the problem in each specific fishery, and then to be able to mitigate negative impacts on vulnerable species. - Utilization of the existing research results to optimise use of mitigation techniques.	- Data gathered can be inaccurate and biased, particularly when the bycatches of vulnerable species to be reported by fishers are perceived to be the subject of controversial issues, potentially leading to increased regulation. - Observer programmes usually cannot monitor 100% of all fishing trips in a fishery (problems with data interpretation) . - High irregularity of by-catches, extrapolations using a limited observer survey data might lead to high biases, usually underestimating bycatch. - Correct species identification is a major issue because fishers are not scientifically trained in proper identification techniques and thus the reporting form should be accompanied by a clear and easy identification guide.

5. REFERENCES

FAO. 2019. Monitoring the incidental catch of vulnerable species in Mediterranean and Black Sea fisheries: Methodology for data collection. FAO Fisheries and Aquaculture Technical Paper No. 640. Rome, FAO.

6. ANNEXES

Maps showing locations of bycaught individuals recorded through onboard observations.

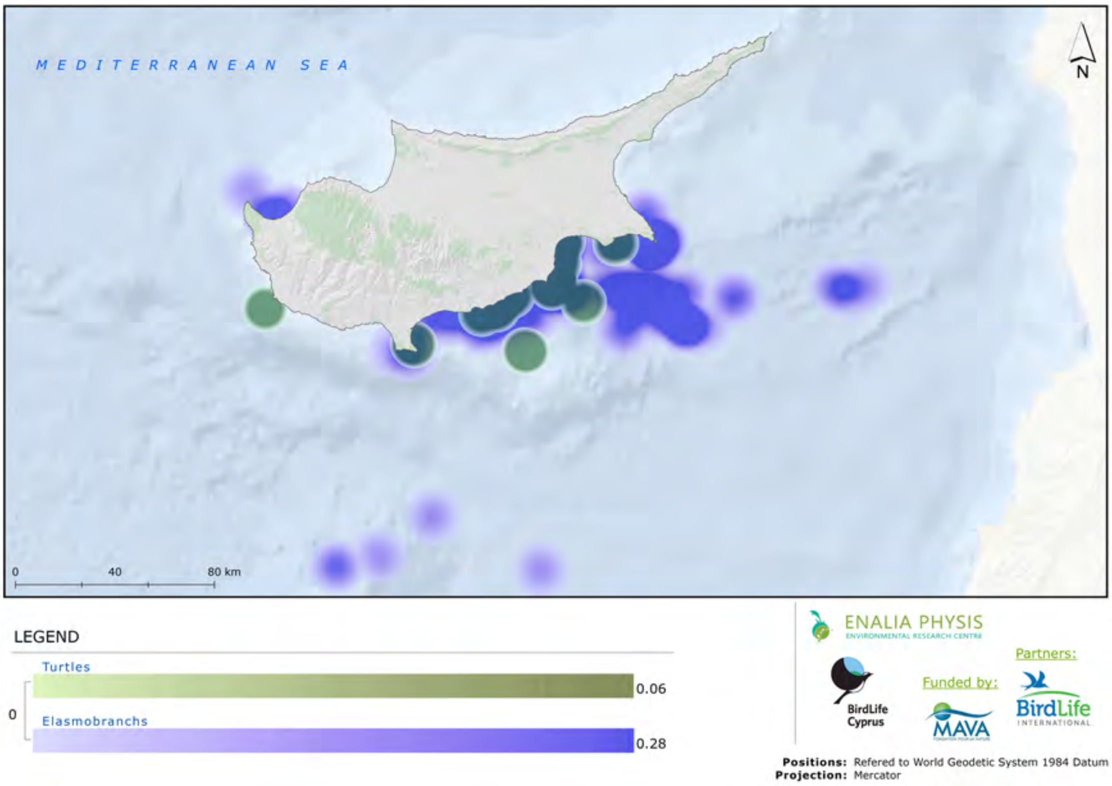

Figure A.1: Heat map of bycaught taxa. KERNEL density algorithm was used as a non-parametric spatial analysis method to present approximate distribution of the observed species in Cyprus and the probability density per 10 km radius. The analysis was performed using ArcGIS V.10.1 provided by ESRI.

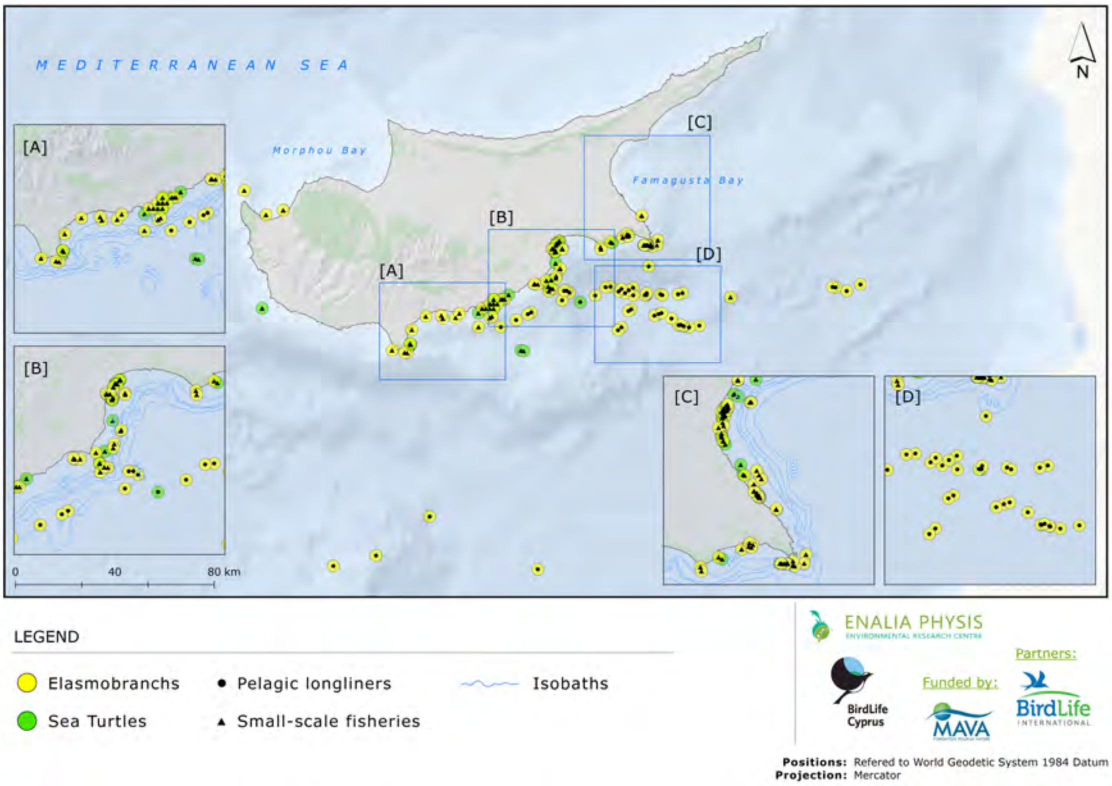

Figure A.2: Distribution map of bycaught taxa from the two different fishing fleets.

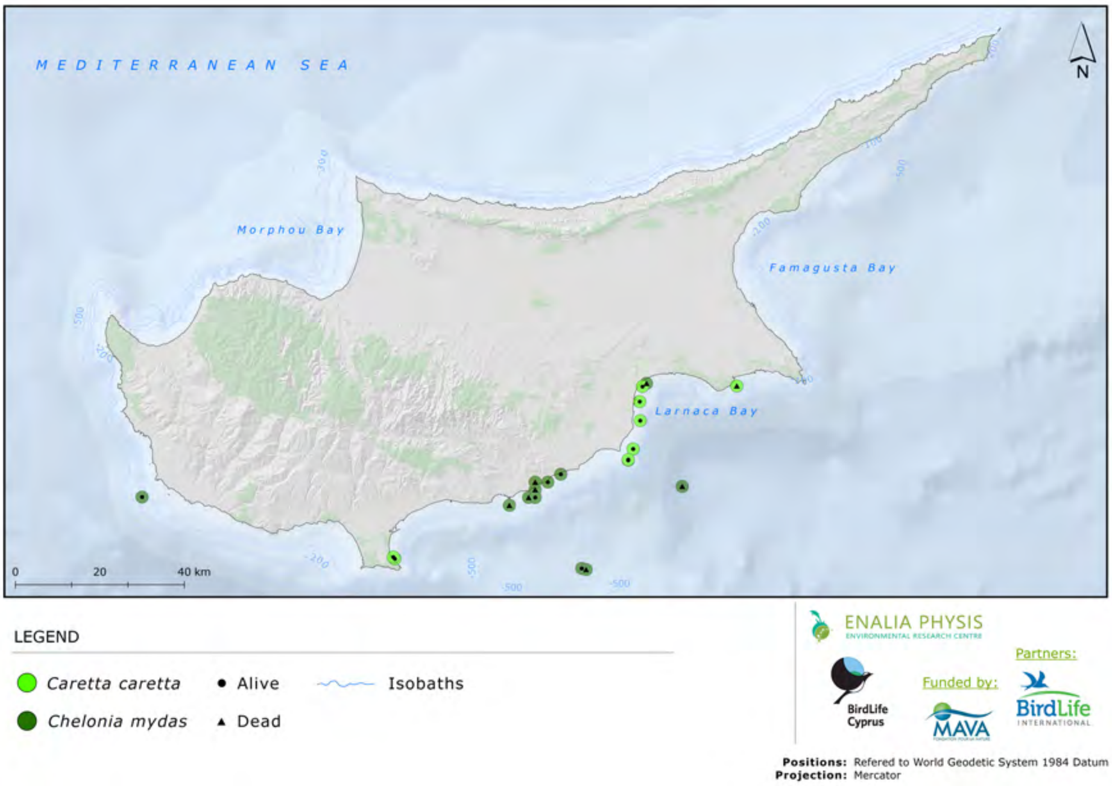

Figure A.3: Distribution map of bycaught turtles. Map shows the condition at release.

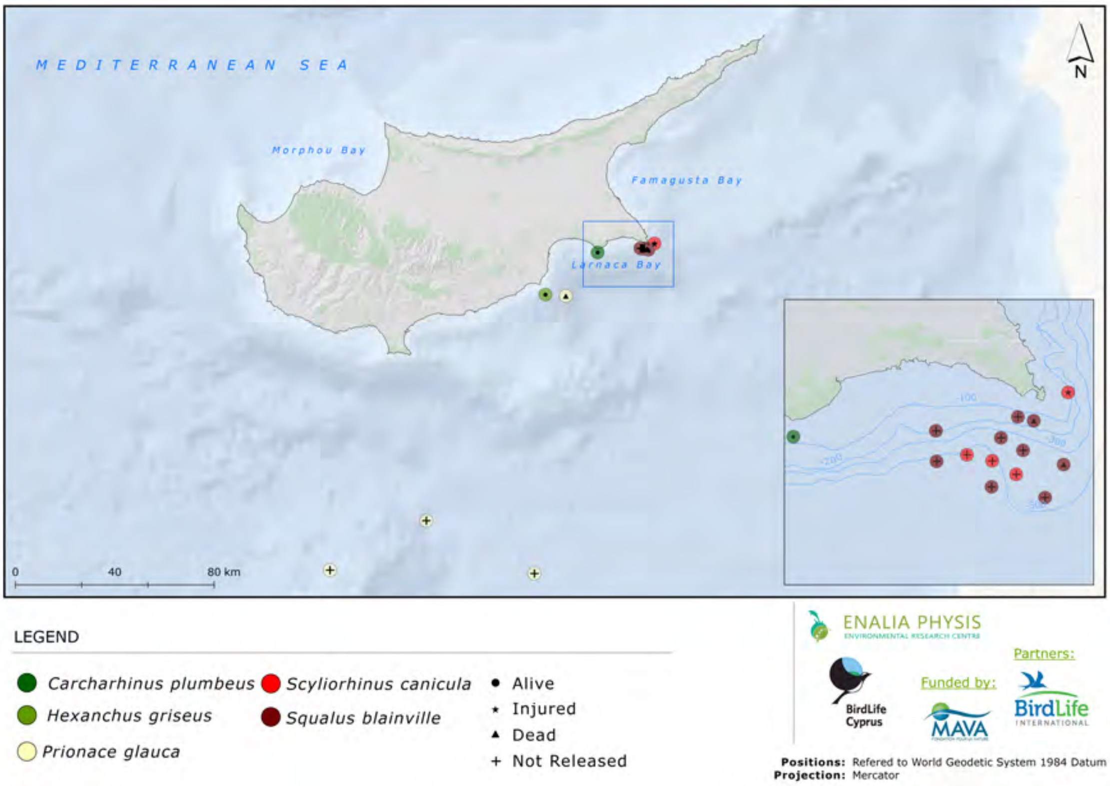

Figure A.4: Distribution map of bycaught sharks. Map shows condition at release.

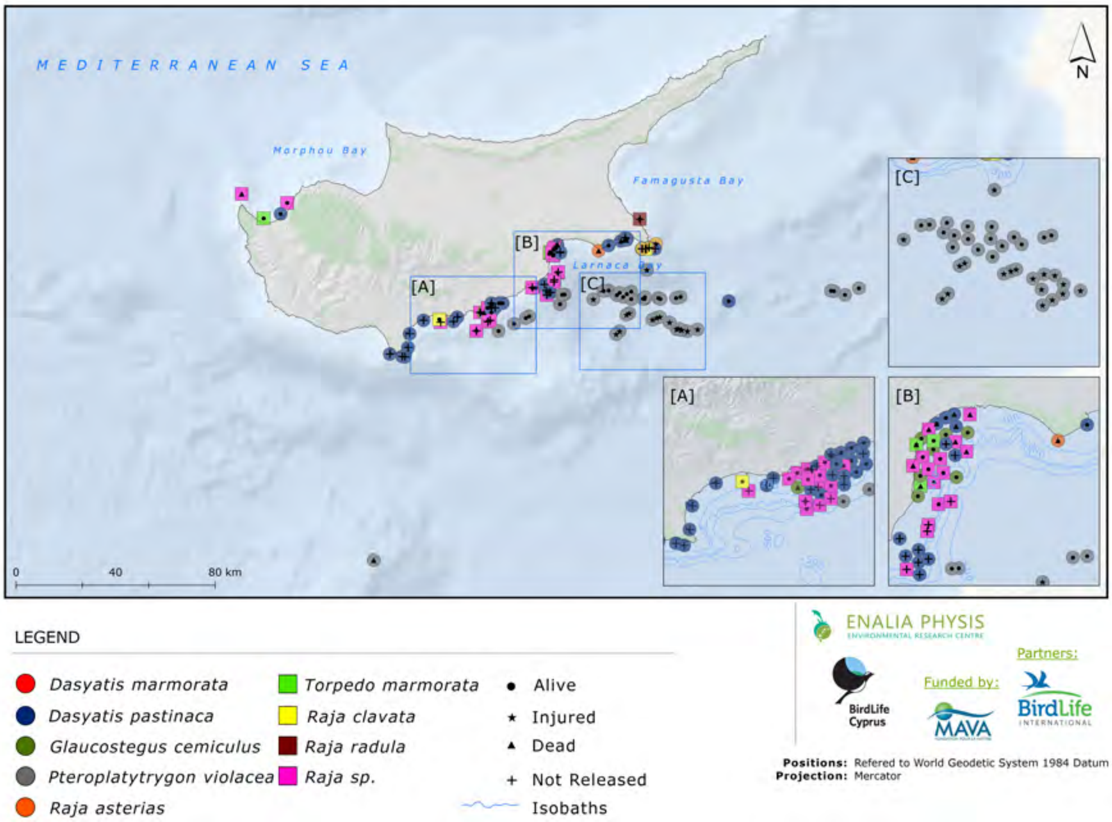

Figure A.5: Distribution map of bycaught rays. Map shows condition at release.

2020