MONITORING ACTIVITIES AND MITIGATION MEASURES FOR THE REDUCTION OF DOLPHIN DEPREDATION IN SMALL-SCALE FISHERIES - WESTERN IONIAN SEA

Note of the Secretariat

During the 2022-2025 triennium, the ACCOBAMS Secretariat was acting as coordinator/advisor in three projects funded by the General Fisheries Commission for the Mediterranean (GFCM) of the Food and Agriculture Organization of the United Nations (FAO), which are carried out in consortium with a local entity:

- The Monitoring Activities and Mitigation Measures for the Reduction of Dolphin Depredation in Small-Scale Fisheries - Western Ionian Sea (GSA 19)" project, also referred to as the "Depredation-3" in consortium with Marecamp Association;
- Reduction and mitigation of the catch of elasmobranchs, sea turtles, and any other vulnerable species incidentally captured by trawlers along Turkish coast (GSA 24 – Northern Levant Sea) in consortium with the Cukurova University (Adana, Türkiye);
- Monitoring activities and mitigation measures for the reduction of the elasmobranchs incidentally captured by trawlers and for the reduction of dolphin depredation in purse seiners (GSA 3 – Southern Alboran Sea), with the National Institute of Fisheries Research (Morocco).

FINAL TECHNICAL REPORT

MONITORING ACTIVITIES AND MITIGATION MEASURES FOR THE REDUCTION OF DOLPHIN DEPREDATION IN SMALL-SCALE FISHERIES - WESTERN IONIAN SEA (GSA 19)

Contents

Period covered: February 21th 2024 – August 31st 2025

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List of Acronyms

- **AAS** – Acoustic Alert System
- **ACCOBAMS –** Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area
- **ADI** – Acoustic Diversity Index
- **AIS** – Automatic Identification System
- **ASCOBANS** – Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
- **BS** – Boarding Survey
- **BYC** – Bycatch samplings
- **CBD** – Convention on Biological Diversity
- **CMS** – Convention on the Conservation of Migratory Species of Wild Animals
- **CPUE –** Clicks per Unit Effort
- **EU** – European Union
- **FAO** – Food and Agriculture Organization of the United Nations
- **FPOD / F-POD** – Fixed Passive Acoustic Monitoring Device (Chelonia Ltd.)
- **FS –** Fishing Set
- **GBR** – Generalized Binomial Regression
- **GFCM** – General Fisheries Commission for the Mediterranean
- **GIS** – Geographic Information System
- **GT –** Gross Tonnage
- **GSA 19** – Geographical Sub-Area 19 (Western Ionian Sea, FAO classification)
- **ICI** – Inter-Click Interval
- **IS** – Interaction Survey
- **JBWG** – Joint Bycatch Working Group
- **kg** – kilogram
- **kW** – kilowatt
- **LF** – Low Frequency
- **LOA** – Length Overall
- **MF** – Mid Frequency
- **MoC –** Memorandum of Collaboration
- **NDSI** – Normalized Difference Soundscape Index
- **NIS** – Non-Indigenous Species
- **OB –** Observation (survey)
- **ODV –** Voluntary Organization (Italian legal form of Marecamp)
- **PAM –** Passive Acoustic Monitoring
- **QP** – Questionnaire for Fishers – Preliminary interviews
- **QU** – Questionnaire for Fishers – Updates
- **RF –** Reports from Fishers
- **RMS** – Root Mean Square
- **SDG** – Sustainable Development Goals
- **SSF** – Small-Scale Fisheries
- **SS** – Sighting Survey
- **UN –** United Nations

1. INTRODUCTION

The interactions between vulnerable species and fishing gear primarily occur as incidental capture (bycatch) and depredation events, where these species (mainly marine mammals) partially or entirely remove catches from the fishing gear. Consequently, fishers incur economic losses due to damage to their gear caused by trapped individuals (with the associated most-likely death of the bycaught species) or by the resulting lost in fish captures. Finding a balance between utilizing marine resources and protecting vulnerable species is challenging due to the complex relationship between species and human activities.

To address the significant knowledge gaps regarding the actual extent of the interaction issue, the General Fisheries Commission for the Mediterranean (GFCM) of the Food and Agriculture Organization of the United Nations (FAO) launched Tender No. 2023/CSAPC/NFIGD/123383 on the implementation of monitoring activities, and mitigation measures for the reduction of dolphin depredation in small-scale fisheries, covering the eastern zone of the Sicilian coast (Western Ionian Sea - GSA 19). On 29th February, 2024, Contract No. 2023/CSAPC/NFIGD/123383 was signed between the (FAO) and the Consortium integrated by the Marecamp ODV Association (Lead partner) and the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS) (2^{nd} partner) to accomplish the objectives of the Tender mentioned above.

Marecamp's project proposal, approved by the FAO, focuses on deploying and evaluating new technologies to reduce interactions between vulnerable species and fishing activities, especially within small-scale fisheries. It also includes developing and implementing standardized data collection methods to gain a deeper insight into the factors affecting incidental catches and depredation in eastern Sicily.

This integrated strategy seeks to strike a sustainable balance between the utilization of marine resources and the conservation of vulnerable and endangered species in marine ecosystems. Furthermore, it supports decision-making processes related to fisheries management and the protection of critical habitats and species.

This **Final Technical Report** presents the complete outcomes of the project, covering the period from February 2024 to August 2025. It provides a comprehensive overview of project management, including the development and implementation of monitoring and mitigation protocols, as well as the active involvement of fishers through interviews, logbooks reviews and questionnaires. It also includes an in-depth description of the study area and fishing activities, as well as the methodologies employed for data collection and the results obtained from monitoring, mitigation trials, and acoustic surveys. It concludes with a discussion of the key findings, lessons learned, and recommendations to support future management strategies and policy decisions aimed at reducing dolphin depredation while promoting sustainable small-scale fisheries in the Eastern Sicily, Western Ionian Sea.

1.1. Objectives of the Project

Understanding and mitigating the impact of the interaction between dolphins and small-scale fisheries requires a structured, science-based, and participatory approach. Although previous studies have highlighted the severity of these interactions, significant gaps remain in quantifying their frequency, assessing their economic impact, and evaluating the effectiveness of potential mitigation strategies. This project addressed these challenges by focusing on the following main objectives:

- **Develop and test mitigation strategies** that can reduce both dolphin depredation and bycatch, while minimizing disruption to fishing operations.

- **Standardize and improve data collection protocols** to enhance the reliability and comparability of monitoring activities.

- **Assess the economic and ecological trade-offs** of various mitigation measures to evaluate their long-term feasibility.

- **Strengthen collaboration with the fishing community** by engaging fishers directly in monitoring activities and promoting the exchange of knowledge and best practices.

- **Support evidence-based policymaking** by generating robust, data-driven insights consistent with regional and international conservation frameworks.

1.2. Project management

The "Monitoring Activities and Mitigation Measures for the Reduction of Dolphin Depredation in Small-Scale Fisheries – Western Ionian Sea (GSA 19)", hereafter referred to as the "Depredation-3 Project" or simply the Project, was implemented by a consortium comprising the Marecamp Association (Lead Partner) and the ACCOBAMS Secretariat (Partner).

A Memorandum of Collaboration (MoC) was initially signed in January 2024 and subsequently amended to reflect evolving roles and responsibilities. According to the latest agreement, the distribution of tasks was as follows:

- ✓ **Marecamp (Lead Partner)**: Responsible for the overall coordination of the Project in liaison with FAO/GFCM, ensuring the successful implementation of activities, preparing reports and deliverables, and transferring the allocated budget to ACCOBAMS. Marecamp also led field operations, fishers engagement, and awareness-raising activities.

- ✓ **ACCOBAMS Secretariat (Partner)**: Provided support and facilitation to Marecamp's coordination efforts and, between July 2024 and February 2025, assumed a broader coordination role. ACCOBAMS established and managed the Steering Committee, organized quarterly meetings and reports, maintained technical communication with FAO/GFCM, provided scientific expertise on depredation and mitigation measures, and supported awareness and reporting activities.

The Project team was multidisciplinary and included:

- 1 Project officers and 1 assistant for coordination.
- 1 research assistant for field activities, data collection, analysis and reporting.
- Bioacoustics experts for the processing of F-POD and hydrophone data.
- 1 consultant providing scientific advice on depredation issues.
- 4 field assistants for monitoring, device maintenance, and support to fishers' self-reporting.
- 1 specialist in statistics and GIS for data analysis.
- Administrative and financial support staff.
- Technical personnel such as skippers, samplers, and observers for surveys and mitigation trials at sea.

A network of 9 small-scale fishers was actively engaged in monitoring and trials across the study area.

Additionally, FAO/GFCM provided technical oversight and ensured compliance with contractual requirements, while local port authorities and coast guard offices facilitated access to harbors and supported stakeholder engagement.

This collaborative structure—linking international organizations, research experts, and the fishing community—was fundamental for the successful implementation of the Project and to ensure that its findings can inform broader management strategies in the Mediterranean region.

1.3. Project timeline and Milestones

The Depredation-3 Project was implemented over 18 months, from **February 21, 2024, to August 31, 2025, following a** six-month extension granted by FAO/GFCM in March 2025. This timeframe allowed for the complete execution of monitoring activities, mitigation trials, bioacoustic surveys, and data analysis across the four macro-areas of the Eastern Sicilian coast (Messina, Catania, Siracusa, and Portopalo di Capo Passero).

Project implementation followed a structured sequence of phases:

- Start-up phase (February – April 2024): signature of the FAO/GFCM contract and of the Memorandum of Collaboration between Marecamp and ACCOBAMS; recruitment of staff; acquisition of equipment; initial contacts with local fishers and authorities.
- Operational phase I (Spring – Summer 2024): launch of field monitoring, including fisher interviews, logbook distribution, landing observations, and first onboard surveys. Deployment of the Floating Laboratories network. Procurement and installation of acoustic monitoring devices.
- Operational phase II (Autumn – Winter 2024): continuation of at-sea surveys, extended bioacoustic monitoring, and implementation of mitigation trials (acoustic alert systems,

visual deterrents, and gear modifications). Consolidation of data collection protocols and fisher engagement.

- Operational phase III (Extension, Spring – Summer 2025): additional surveys in underrepresented areas (Riposto), further testing of mitigation measures, and inclusion of new fishers in the monitoring network. Emphasis on data validation, analysis, and preparation of final outputs.
- Finalization phase (July – August 2025): completion of data collection, analysis, drafting of the Final Technical Report, and dissemination of key findings and recommendations.

The reporting process was structured around milestones agreed with FAO/GFCM:

- **Interim Report I** (July 2024) covering the initial implementation period.
- **Interim Report II** (April 2025) covering activities up to February 2025.
- **Final Technical Report** (September 2025) covering the entire implementation period, including the extension phase, and providing final results, lessons learned, and recommendations.

A detailed **timeline of activities and milestones** is provided in ANNEX I – Timeline of the entire Project**.**

Throughout the Project, the **Steering Committee**—comprising representatives from FAO/GFCM, Marecamp, and ACCOBAMS—met quarterly to review progress, address challenges, and ensure alignment with the objectives. This regular monitoring framework ensured transparency, accountability, and adaptive management of activities (see ANNEX II – Minutes of the Steering Committee meetings).

1.4. Background on dolphin depredation and its socio-ecological relevance in GSA 19

Dolphin depredation—defined as the partial or complete removal of catch from fishing gear—has long been reported in Mediterranean small-scale fisheries (SSF). It predominantly involves bottlenose dolphins (*Tursiops truncatus*), although other species, such as striped dolphins (*Stenella coeruleoalba*) and Risso's dolphins (*Grampus griseus*), occasionally contribute to gear damage and catch loss (Rocklin et al., 2009; Pardalou et al., 2020).

For fishers, depredation has a dual impact: direct economic losses from reduced catches and indirect costs resulting from torn nets, bent hooks, and the need for frequent gear repair or replacement. In Sicily, for example, single events have been estimated to cause losses of €500–730 per fishing trip, resulting in up to an 78% reduction in catch and damage to one-third of the gear used (Monaco et al., 2020). These costs, combined with operational inefficiencies and lost time, exacerbate the vulnerability of artisanal fishing livelihoods already affected by overfishing and depletion of fish stocks.

From an ecological perspective, depredation reflects opportunistic feeding behavior, facilitated by the overlap of dolphin home ranges with nearshore fishing grounds. Long-term concerns include the risk of behavioral conditioning in dolphin populations, which may lead to an increasing association between fishing gear and predictable food sources (Gonzalvo, 2022).

At the regional governance level, ACCOBAMS and GFCM have recognized depredation as a priority. The Joint Bycatch Working Group (JBWG) and the FAO/GFCM methodological manual provide harmonized standards for monitoring interactions and assessing mitigation options, thereby supporting comparability and policy uptake (Carpentieri & Gonzalvo, 2022).

In Sicily, two pilot projects carried out by Marecamp have been especially influential. The Depredation-1 Project (LIFE - Low Impact Fishers of Europe) established "Floating Laboratories" in the Gulf of Catania, creating a collaborative framework between fishers and scientists to monitor interactions. This project produced the first standardized estimates of depredation frequency, mapped interaction hotspots, and quantified the socio-economic impact on local fleets (Monaco et al., 2020).

Building on this experience, the Depredation-2 Project, also implemented by Marecamp, tested an Acoustic Alert System (AAS) specifically designed to mitigate the feeding-in-net behaviour of bottlenose dolphins. Preliminary trials demonstrated that the AAS could significantly reduce the incidence and severity of gear damage and catch loss during interactions with dolphins. The project also provided one of the first documented cases of dolphin bycatch verified with synchronized acoustic and visual data, underlining both the risks to cetaceans and the need for improved mitigation strategies (Monaco, 2022; Terranova et al, 2022).

At a socio-ecological scale, dolphin depredation epitomizes the broader challenge of reconciling biodiversity conservation with the viability of SSF. Addressing this issue requires integrated approaches that combine innovative deterrent technologies, participatory monitoring with fishers, and governance mechanisms that ensure both ecological protection and socio-economic resilience (Gonzalvo & Carpentieri, 2023).

2. STUDY AREA AND FISHING EFFORT

2.1. Study areas

The eastern coast of Sicily, facing the Western Ionian Sea Geographical Sub-Area (GSA 19), is characterized by remarkable geomorphological heterogeneity. Volcanic formations derived from Mount Etna dominate large portions of the coastline, alternating with sedimentary cliffs, sandy beaches, rocky shores, and estuarine environments. This coastal complexity creates a mosaic of habitats that sustain rich biodiversity and trophic networks, positioning the region as a significant area for marine and fisheries research.

The Depredation-3 Project covered a wide stretch of this coastline, from the province of Messina in the north, through the Gulf of Catania, to Portopalo di Capo Passero, the southernmost tip of the island in the province of Siracusa (Figure 1). To facilitate analysis and reporting, the area was divided into four macro-areas: Messina, Catania, Siracusa, and Portopalo, each with distinct geomorphological and anthropogenic characteristics.

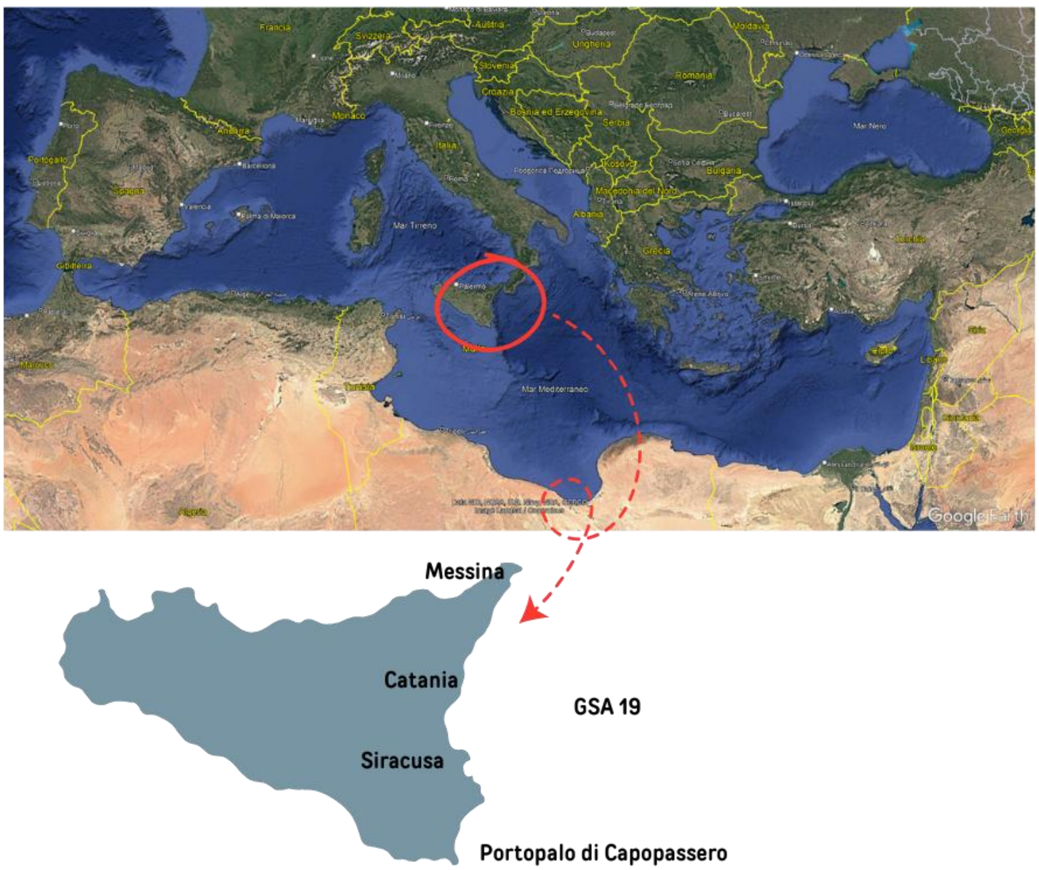


Figure 1. Study areas: Eastern coast of Sicily (Italy).

- ✓ **Messina.** The northernmost macro-area stretches approximately 60 km, from Ganzirri (at the edge of the Strait of Messina) to Giardini Naxos. The coastline alternates rocky reefs and sandy stretches, but the absence of a continental shelf means deep waters occur almost immediately offshore. The Strait is renowned for its powerful tidal currents, which reverse direction every six hours, creating upwelling and ascending flows that enrich surface waters with nutrients. These processes make Messina a hotspot for pelagic species and cetaceans. The area is ecologically strategic as a migratory corridor, but it is also subject to intense anthropogenic pressures, as it is one of the busiest maritime routes in the Mediterranean.

- ✓ **Catania.** Extending approximately 70 km from Riposto to Brucoli, this macro-area encompasses a highly diverse coastline. To the north, gravel beaches give way to rugged lava shores south of Riposto. South of the port of Catania lies the Playa, a sandy beach stretching over 20 km until the limestone cliffs of Brucoli. Steep slopes and deeper waters characterize the northern sector, while the southern part hosts a broad sandy continental shelf with shallow depths. Several rivers flow into the Gulf of Catania, enhancing productivity and supporting complex trophic chains that are essential for fish reproduction. The Isole Ciclopi MPA (≈6 km^2) lies centrally in this region and serves as a critical nursery ground for fish and invertebrates. However, the area is exposed to heavy anthropogenic pressure: the commercial port of Catania attracts cargo ships, cruise liners, and naval vessels throughout the year, while recreational boating increases significantly in the summer.

- ✓ **Siracusa.** Conventionally defined from Augusta to Ognina di Siracusa (≈50 km), this area features limestone coasts punctuated by small sandy beaches. The seabed descends gradually, supporting a wide range of fish species and marine megafauna. The Plemmirio MPA (≈14 km^2) protects valuable habitats but is juxtaposed with some of the heaviest industrial pressures in the Mediterranean. The macro-area includes the large port of Augusta and the Priolo–Gargallo petrochemical complex, one of Europe's largest energy and chemical hubs, with refineries, chemical plants, and storage facilities. While these activities are central to regional development, they raise serious environmental concerns, including water and air pollution, that have long affected marine ecosystems and local communities.

- ✓ **Portopalo di Capo Passaro.** The southernmost area (≈approximately 45 km), from Avola to Portopalo di Capo Passero, is characterized by shallow sandy habitats. Depths exceeding 1,000 m are only reached beyond 10 nautical miles offshore. The coastline is sparsely populated and lacks large ports, instead relying on small harbors that serve coastal villages. The economy is mainly based on agriculture, tourism, and small-scale fishing.

All four macro-areas support high biodiversity, including sensitive and protected species such as marine turtles, elasmobranchs, seabirds, and cetaceans (Monaco et al., 2016). This ecological richness, combined with intense human activities, underscores the socio-ecological importance of the region and its vulnerability to conflicts between fisheries and marine megafauna.

2.2. Local fisheries and metiers

According to the European Fleet Register, the study area hosts 458 small-scale vessels (under 12 m LOA and without towed gear), confirming the socio-economic relevance of SSF. The distribution of vessels is uneven: the largest fleets are registered in Portopalo di Capo Passero (90 vessels), followed by Siracusa (60), Messina (49), Augusta (45), and Catania (44) (Figure 2). In the Catania area, the total is even higher when including vessels moored in satellite ports such as Stazzo, Pozzillo, and Acitrezza. By contrast, Messina records a relatively high number of registered vessels despite lacking intermediate ports, while in Siracusa and Portopalo most vessels are concentrated in a few harbors (Figure 3).

However, interviews with fishers and port authorities revealed that **at least 50% of registered vessels are inactive**, highlighting discrepancies between registry data and actual operational capacity.

Figure 3. Fishing vessels in the port of Portopalo di Capopassero. Source: Marecamp.

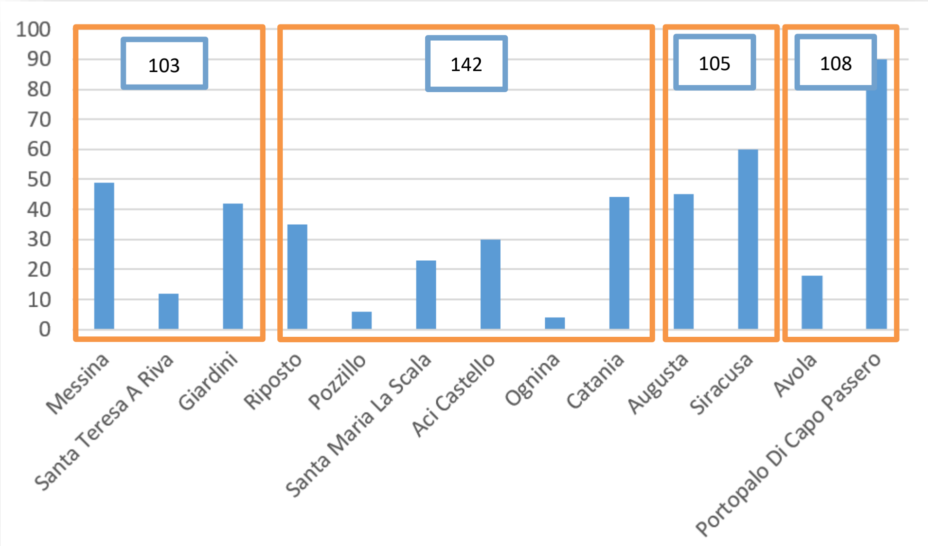


Figure 2. Number of small-scale fishing vessels per main areas (orange boxes) and ports of eastern Sicily, from North (Messina) to South (Portopalo di Capo Passero). Marecamp's elaboration of data from the European Fleet Register.

A central component of the Project was the **reactivation of the Floating Laboratories network**, first created under Depredation-1. These laboratories represent a modern participatory approach, with fishers collaborating as active research partners. Their vessels hosted observers and contributed detailed information on fishing effort, gear characteristics, catch composition, depredation and bycatch events, discards, and even fuel consumption. This near-real-time data collection enabled the rapid identification of interactions with vulnerable species and improved monitoring of SSF dynamics.

The network was reactivated through port meetings, direct interviews, and continuous communication with fishers. In Catania, long-standing trust facilitated recruitment, and observer boarding began in May 2024. In Siracusa and Portopalo, interest was high, though bureaucratic issues with safety documentation limited permits for boarding. In Messina, difficulties arose due to the scarcity of active vessels and reluctance to collaborate, partly linked to past negative experiences with other research groups and institutions.

Table 1 below details the eight vessels contracted as Floating Laboratories, distributed across the macro-areas and employing diverse gear types, including trammel nets, single-wall nets, longlines, and traditional *Menaide* nets.

Macroarea	Base port	Matricola	Main gear	LOA	GT	kW
CATANIA	Riposto	1CT621	Longline	6,49	1	18,4
CATANIA	Riposto	1CT630	Trammel net	8,73	3	56
PORTOPALO	Portopalo	3SR1140	Trammel net	9	2,8	100
CATANIA	Acitrezza	4CT1107	Single wall net/Trammel net	12	7	87,5
CATANIA	Acitrezza	4CT962	Longline	9,65	4,4	93
SIRACUSA	Avola	6SR195	Trammel net	10,25	3	100
SIRACUSA	Augusta	AU1769	Single wall net/Trammel net	9,82	3	46,5
CATANIA	Catania	CT2844	Menaide	10,6	6	73,65
SIRACUSA	Siracusa	SR2477	Longline	6,2	1	29

Table 1. Composition of the Floating Laboratories network for the Depredation-3 project.

Fishing gears

The fishing equipment considered in this project was:

1. **Single-wall gill net.** It is a single-layer gill net made from monofilament fibres, designed to minimize the gear's visibility in the water. Various versions of this net are available, featuring different mesh sizes tailored to specific fishing targets. The net is used as a stationary gear, positioned at or near the sea bottom, and is manually retrieved by fishermen using a hauler. Fish, unable to detect the net, become entangled by their gill covers (operculum) or appendages. The primary target species include bogue, cod, saddled seabream, and picarels (Battaglia et al., 2010). A commonly used single-wall net is the "*Monofilo*". This type of gear was involved in **monitoring** and **mitigation activities**.

2. **Trammel net.** Known in Italian as "*Tramaglio*" or "*Tremaglio*", this type of net features three layers of netting, with a fine slack mesh inner layer sandwiched between two layers of larger mesh netting, in which fish become entangled. The mesh sizes vary, and the fisher selects them based on the season and target species. The net is held vertically in the water by floats attached to the headrope and weights along the ground rope. It is typically used as a stationary gear, positioned at or near the sea bottom, and is manually retrieved with the aid of a hauler. Depending on the target species, mesh sizes range from 6 to 12 cm, and the net can be left in the water for a few hours, from sunset to sunrise (for most species), or even up to 2 days (when targeting lobster). The primary target species include scorpion fish, striped red mullets, cuttlefish, and common spiny lobster (Battaglia et al., 2010; Monaco et al., 2019). This type of gear was involved in **monitoring** and **mitigation activities**.

3. **Artisanal longline** (hooks and lines). Also known locally as "*Palangaro*", "*Palamito*", or "*Conzo*", this fishing method consists of interconnected lines, either set on the sea bottom or left drifting, carrying hundreds of baited hooks that remain underwater for periods ranging from 2 hours to 2 days. The hooks vary in size depending on the target species and season, typically ranging from 1 to 7 cm in diameter, with a thickness of 1.5-2.5 mm and varying stem lengths. Natural or artificial baits are attached to the hooks at the end of the line, luring fish that become caught by the mouth until they are hauled aboard by hand, often with the assistance of a hauler. The main target species include porgies, European hake, blackspot seabream, common dolphinfish, and little tunas (Battaglia et al., 2010; Monaco et al., 2019). This type of gear was involved in **monitoring** and **mitigation activities**.

4. "***Menaida***" **or** "***Menaide***"**.** It is a traditional driftnet used in the Gulf of Catania with a history spanning centuries, and is now employed in a very niche capacity. Its mesh size, ranging from 0.5 to 1.4 cm, is designed explicitly for capturing European anchovies or sardines, depending on the season. The net is set vertically near the surface or midwater, forming a 10-meter wall of nylon netting. It is anchored by floats on the headrope and weights on the footrope, which are adjusted based on the depth of the fish school. Fish become gilled in the net, resulting in a sweeter taste due to blood loss. After being underwater for about an hour, the net is hauled aboard manually, with fishers releasing anchovies one by one using a runner at the stern. This type of gear was involved in **monitoring activities**.

Other gears occasionally reported through fisher logbooks or during the questionnaires include:

- ✓ The "***palamitara***" is another type of single-wall gill net, with similar characteristics to the monofilo, but with changes in dimension and targeting different species of fish, such as more pelagic species like little tunas.
- ✓ The "***totanara***" is a squid-fishing gear with baited, multi-hooked arms, used at night in deep waters with a light source to attract flying squid. Up to three lines are used, each catching one squid per set.
- ✓ The "**sciabichedda**" is a boat seine net, 50 meters long and 4 meters high, used near the coast at sunrise or sunset to catch shrimp or sand eel. It is lightly ballasted and hauled back with a hauler.
- ✓ The **pot**, or "**nassa**", is a small cage trap set on the seabed for crustaceans and cephalopods. It can be baited and retrieved by hand or with a hauler, with a soaking time from a few hours to several days.

This diversity of métiers highlights the adaptive strategies of Sicilian SSF and the need for equally diversified approaches to monitoring and mitigation.

2.3. Project activities distribution and maps of the study area

To achieve the objectives of the Depredation-3 Project, activities were distributed across the four macro-areas of Messina, Catania, Siracusa, and Portopalo. A multifaceted methodological approach was adopted, integrating monitoring activities, mitigation trials, and stakeholder engagement.

Monitoring activities included preliminary interviews with fishers, systematic surveys of landing sites, and direct observations on board fishing vessels. These were complemented by the use of standardized **fisher logbooks**, where participants recorded fishing effort, catch composition, depredation, and bycatch events, discards, and fuel consumption. The monitoring design ensured continuous data collection, enabling near real-time identification of interactions with vulnerable species and improved assessment of SSF practices across the study area.

Mitigation trials were conducted to assess the effectiveness of various deterrent strategies. These included the deployment of an **Acoustic Alert System (AAS)**, developed and tested under previous projects; experimental echolocation disturbance devices; visual deterrents; and structural modifications to fishing gear. Trials were conducted in collaboration with the Floating Laboratories network, ensuring that fishers were directly involved in testing and evaluating measures.

Stakeholder engagement was a cross-cutting component of the methodology. Fishers were involved through interviews, questionnaires, and training sessions, which strengthened cooperation and facilitated the transfer of knowledge. Port meetings and continuous communication channels were also established, building on trust relationships consolidated in previous depredation projects.

The spatial distribution of activities is illustrated in Figure 4, which summarizes monitoring and mitigation efforts across macro-areas. The map highlights:

- landing sites where interviews and landing surveys were conducted;
- ports where Floating Laboratories were based (Riposto, Acitrezza, Catania, Augusta, Siracusa, Portopalo);
- offshore areas where observer trips and scientific vessel surveys were carried out;
- deployment zones of bioacoustic devices and mitigation trials.

This integrated approach ensured that all macro-areas were represented, capturing the ecological and socio-economic variability of the eastern Sicilian coast. The lack of marine activity in the Messina area reflects the local situation, where contact with fishermen is difficult due to both the lack of meeting places and the lack of trust in scientific research.

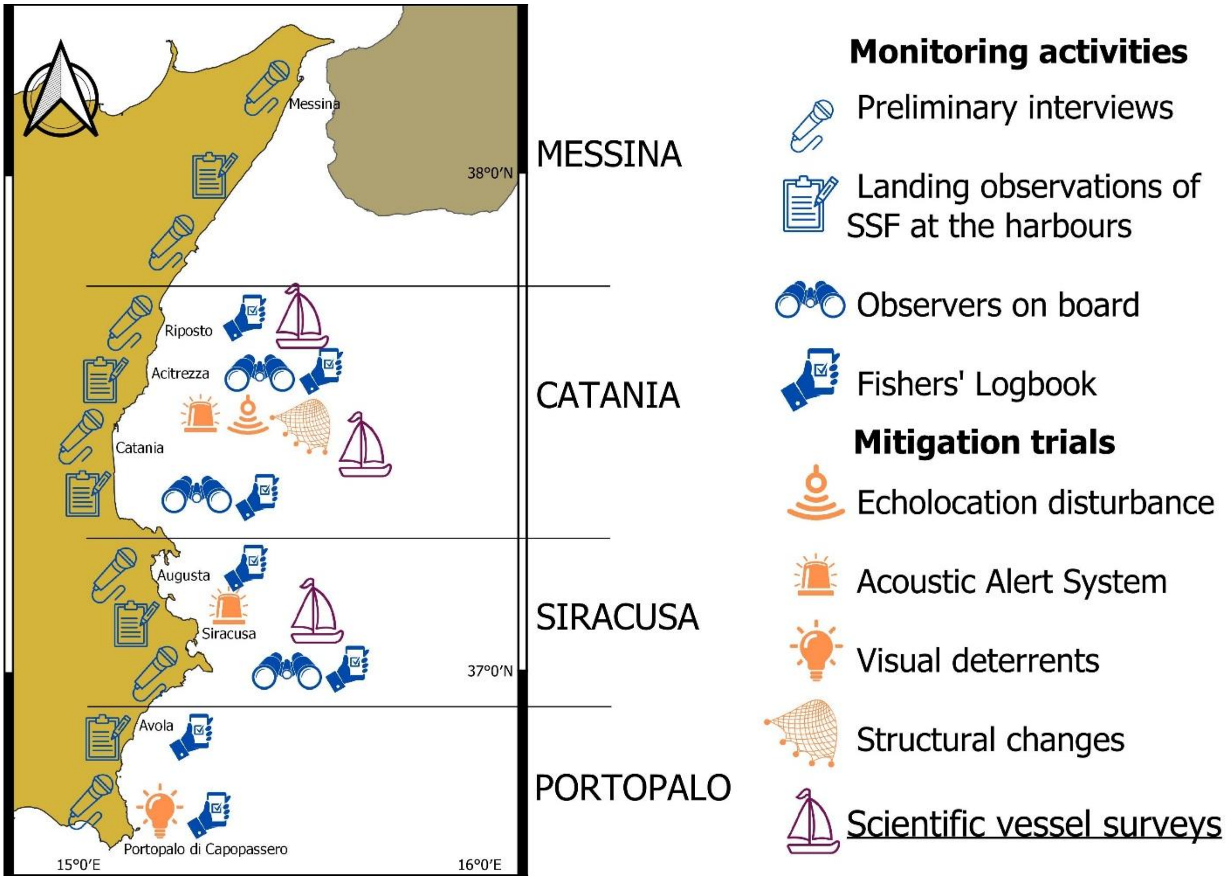


Figure 4. Overview map of the study area in eastern Sicily (GSA19), highlighting the division into four macro-areas and the distribution of the project's activities.

3. MATERIALS and METHODS

3.1. Methodology for monitoring, data collection, and mitigation testing

The project protocols built on outputs from previous initiatives carried out by Marecamp, ACCOBAMS, and FAO-GFCM, including recent reviews on depredation by marine mammals in fishing gear (Carpentieri, 2019; Monaco, 2020; Monaco, 2022; Gonzalvo and Carpentieri, 2023).

The data collection methodology was adapted from Marecamp's earlier projects, which had already established observation protocols for fishing vessels and scientific surveys. Cetacean sighting sheets were structured on this basis and included sections for behavior, interaction with fishing gear, and surfacing times.

Protocols were also developed for questionnaires, fishing logbooks, bycatch sheets, and all documentation related to interactions between fishing practices and vulnerable species. These were implemented in accordance with FAO-GFCM guidelines (FAO, 2019; Gonzalvo and Carpentieri, 2023). Acoustic data collection protocols were designed in collaboration with experts from SINAY (https://sinay.ai/).

All protocols were tested during the initial stages of the project to verify feasibility and adapted as needed. For each data type, a dedicated database was created and made accessible on the project's Google Drive. Additional folders were established for photo and video materials, while four external hard drives were used for backup. Table 2 summarizes the types of data collected, the associated survey sheets, and the databases.

Survey sheet title	Data collected	Survey ID	Databases title	Scope
Questionnaire for fishers – Preliminary interviews	Fishing effort, landings, interaction events; vulnerable species	QP_	Interviews	Evaluate seasonal fishing effort; reactivate and expand the Floating Laboratories network; vulnerable species presence and distribution; in-depth information on depredation and bycatch events
Questionnaire for fishers – Updates	Vessel characteristics, fishing crews, fishing activity and gear used, fishing zones, fishing time, commercial catch, discards, non-indigenous species (NIS), macrobenthic species, releases of alive specimens, presence of marine macro-	QU_	Interviews	Evaluate seasonal fishing effort; marine litter impact; cetacean and other vulnerable species distribution; bycatch and depredation frequency by species; replicability of the mitigation measures

	litter estimating weight, source, and material			
Logbook for fishers	Catch zone, vessel characteristics, fishing gear, catch composition, fuel consumption, discards, species involved in depredation and bycatch events, damages	LOG	Logbook; Bycatch	Define spatial distribution and frequency of interaction events; estimate fishing effort and damages from depredation; evaluate bycatch frequency and composition; provide insights for decarbonization
Reports from fishers	Depredation made by cetaceans and other megafauna, incidental catch of cetaceans and other vulnerable species as marine mammals, sea turtles, elasmobranchs, and seabirds	RF_	Reports	Define identification, presence, and distribution of marine vulnerable species; depredation and bycatch incidence
Boarding survey	Weight and composition of the catches, gear and catch damages in both physical and economic terms, presence of dolphins around the vessel or the fishing gears, biological information (e.g. length, individual weight and sex) of NIS and vulnerable species incidentally caught during that monitoring of commercial fishery, sea-weather conditions,	BS_	Observation on fishing vessels; Bycatch	Identification and biological characterization of non-target species; presence and distribution of NIS and vulnerable species; document depredation and bycatch cases; evaluate fishing effort; correlation with environmental parameters and anthropogenic pressures

	marine litter			
Observation survey	Environmental and anthropogenic data collected onboards the scientific/sentry boat	OB_	Observation on Marecamp boats	Calculate observation effort from the scientific boat (times, Nautical Miles, routes, etc.); estimate marine traffic and marine litter impact in the study area; Have a reference sheet where compiled correlated surveys of the day are mentioned
Sighting survey	Data on observed cetaceans and sea turtles (species, age, group composition, behavior). Survey compiled by experts onboard a fishing vessel or the scientific/sentry boat	SS_	Sightings	Characterize sighted species
Interaction survey	Dynamics of the depredation event, cetacean behavior (linked to the sighting survey)	IS_	Depredations	Define ethograms of cetacean in interaction with different types of fishing gear
Cetacean times	Surfacing/Dive times of cetaceans during sightings (linked to the behavior section of the sighting survey)	CT_	Dive times	Comparing cetacean behavior during feeding in net and other behavior applied
Bycatch sampling	Species identification and biometries	BYC_	Bycatch samplings	Create a register to permit evaluation on biological information of NIS and vulnerable species incidentally caught (species, length, weight, sex, etc.)
Bioacoustics - POD	Spatio-temporal data on POD activated in different zones and fishing gear	Bpod	POD Register	Characterize odontocete vocalizations, especially during feeding behavior and depredation events
Bioacoustics - Hydrophone	Spatio-temporal data on the fishing sets	Bhyd	Hydrophone Register	In-depth the soundscape of the study area; correlate acoustic data from the

				PODs; characterize odontocete vocalizations, especially during feeding behavior
Fishing set	Weight and composition of the catches, gear and catch damages, bycatch, marine litter, environmental and anthropogenic parameters	FS_	Fishing during mitigation	Estimate fishing effort, revenue, and damages both in normal conditions and in case of depredation events, during mitigation measures applied and not
Bioacoustics recordings folder - POD	Audio files to be processed	-	POD Register	Characterize odontocete vocalizations, especially during feeding behavior and depredation events
Bioacoustics recordings folder - Hydrophone	Audio files to be processed	-	Hydrophone Register	Define the soundscape of the study area, and odontocete vocalizations, especially during feeding behavior
Photo and Video	Video photographic material recorded during interviews and boardings	-	Photo and Video folders	Document research activities in the field, fishing trips, life onboard, fishing techniques and catch composition, observed species, depredation and bycatch events, anthropogenic pressures

Table 2. Project databases are divided by data collection type and the investigation's purpose.

3.2. Tools used: questionnaires, logbooks, observer sheets, sighting sheets

A set of standardized tools was developed and applied during the project to monitor fishing activities, record interactions with dolphins and other vulnerable species, and assess bycatch and depredation events. The following subsections provide a detailed description of each tool and its structure.

Questionnaire for fishers – Preliminary interviews

The preliminary questionnaire (ANNEX III - Questionnaire for fishers – Preliminary interviews) was distributed to fishers during the first phase of the project. Its objectives were:

- To evaluate seasonal fishing effort.
- To reactivate and expand the Floating Laboratories network.

- To collect information on the distribution of vulnerable species and their interactions with fishing gear.
- To obtain detailed data on bycatch and depredation events.

The questionnaire consisted of several sections:

General vessel information. This included GT, LOA, engine power, licenses, and all métiers used. For each métier, fishers were asked to specify the gear type, size, seasonality, time of day, seabed type, fishing distance from the coast, and whether it was associated with bycatch or depredation.

Catch composition. For each métier, fishers were asked to list target and discard species and to estimate the daily catch (kg) for each species.

Interaction section (two pages). This part asked whether interactions with cetaceans or other vulnerable species had increased, decreased, or remained stable over the last five years, and required identification of the species involved. Fishers were asked if they could identify dolphin species interacting with their gear, specify other animals causing damage, and identify the commercial species most affected. It also included questions on knowledge and experience of mitigation measures, their effectiveness, and openness to adopting new ones. Fishers were also asked to identify seasonal patterns of bycatch and depredation by mapping affected zones of their own fishing area.

Depredation section. This collected detailed information on gear type and specifications (mesh size, length, height, materials, number and size of hooks, lines, and bait), soak time, frequency of use, catch levels (minimum, maximum, average, value per kilogram), and discards. Fishers reported on the frequency of positive, neutral, and negative interactions with dolphins, as well as the damage caused (marks on fish, prey scattering, missing baits, and holes in nets). They also estimated the economic costs, including gear replacement, loss of catch, days lost, labor for repairs, and trip failures.

Bycatch section. Fishers described bycatch events, specifying species involved, number per year, seasonality, depth, and distance from shore. They were asked to indicate how they dealt with vulnerable species caught, how many individuals were released alive, and which species were most frequently affected. Opinions on the causes of bycatch and potential mitigation strategies were also collected.

Questionnaire for fishers – Updates

An updated questionnaire (ANNEX IV - Questionnaire for fishers – Updates and GRID MAPS) was developed later in the project to refine the data collected in the preliminary phase and to expand knowledge on fishing activities, bycatch, and depredation. It focused on improving accuracy in reporting bycatch and depredation, as well as assessing fishers' perspectives on mitigation measures.

The updated form included:

Vessel information. GT, LOA, main engine power, year of construction, licenses, and fishing segment.

Gear characteristics. Gear name, length, mesh size (for nets) or number of hooks (for longlines), period of use (months), depth range, seabed type, fishing time (day/night), fishing days per year, and grid-mapped fishing areas.

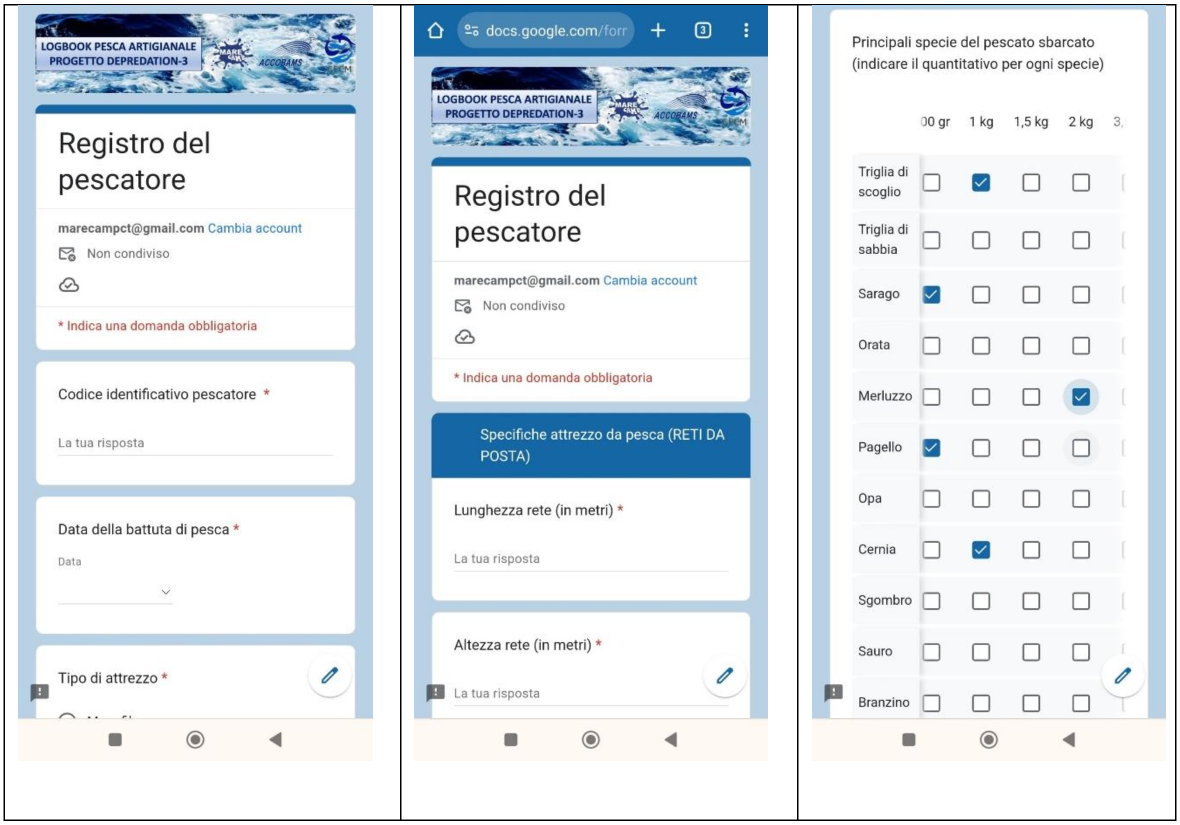
Bycatch and depredation events. Fishers reported the species caught, seasons of occurrence, and the gears used.

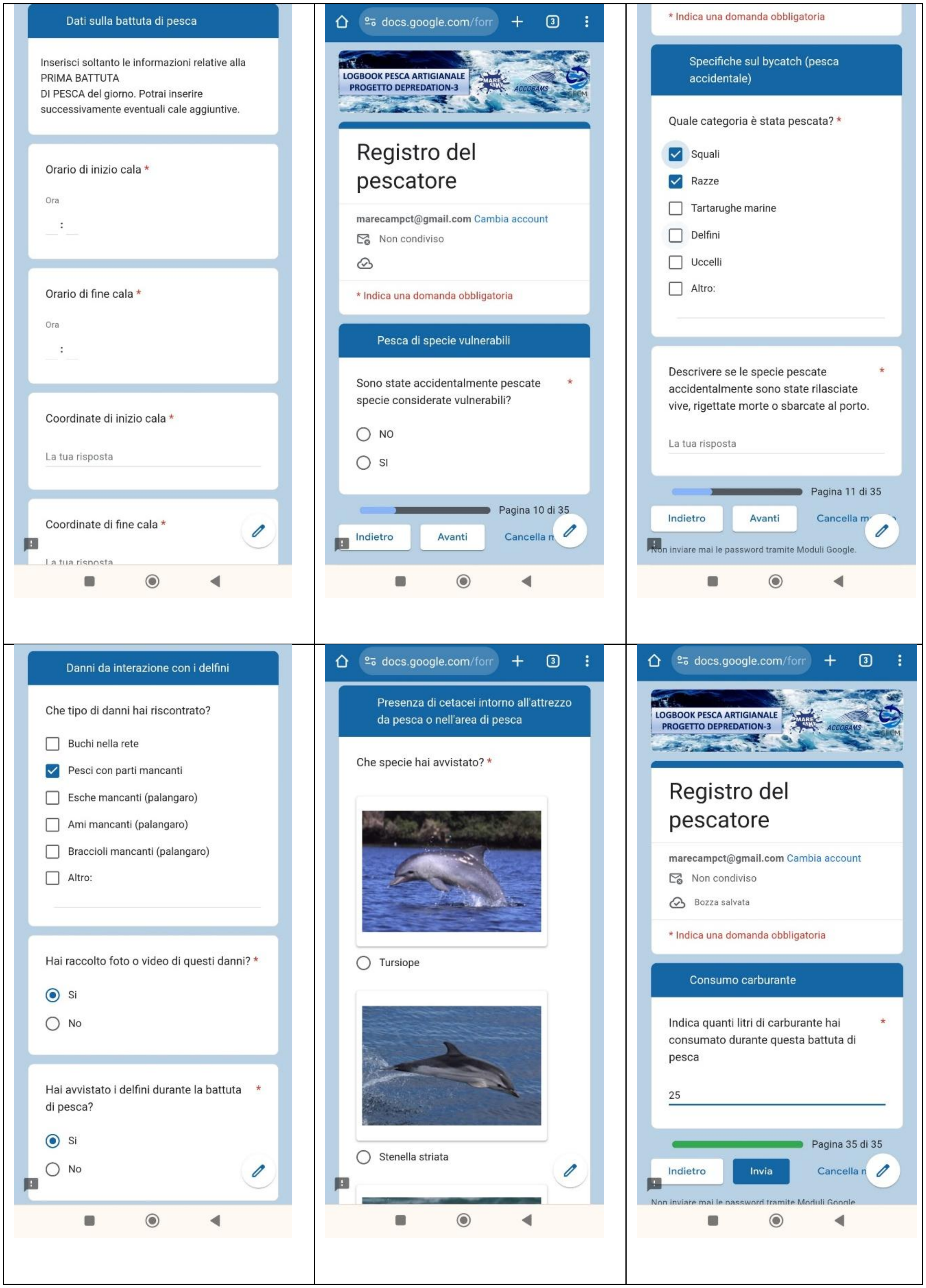
Opinions on mitigation. Fishers were asked to evaluate the effectiveness of AAS devices and provide suggestions for alternative mitigation.

Fuel consumption. Average daily liters of fuel used.

Logbook for fishers

The logbook tool was designed on Google Forms to be easily filled out by the 9 contracted fishers via mobile phone (Box 1). It aimed to define the spatial distribution and frequency of interaction events, estimate fishing effort and damages resulting from depredation, evaluate the frequency and composition of bycatch, and provide insights into decarbonization strategies.





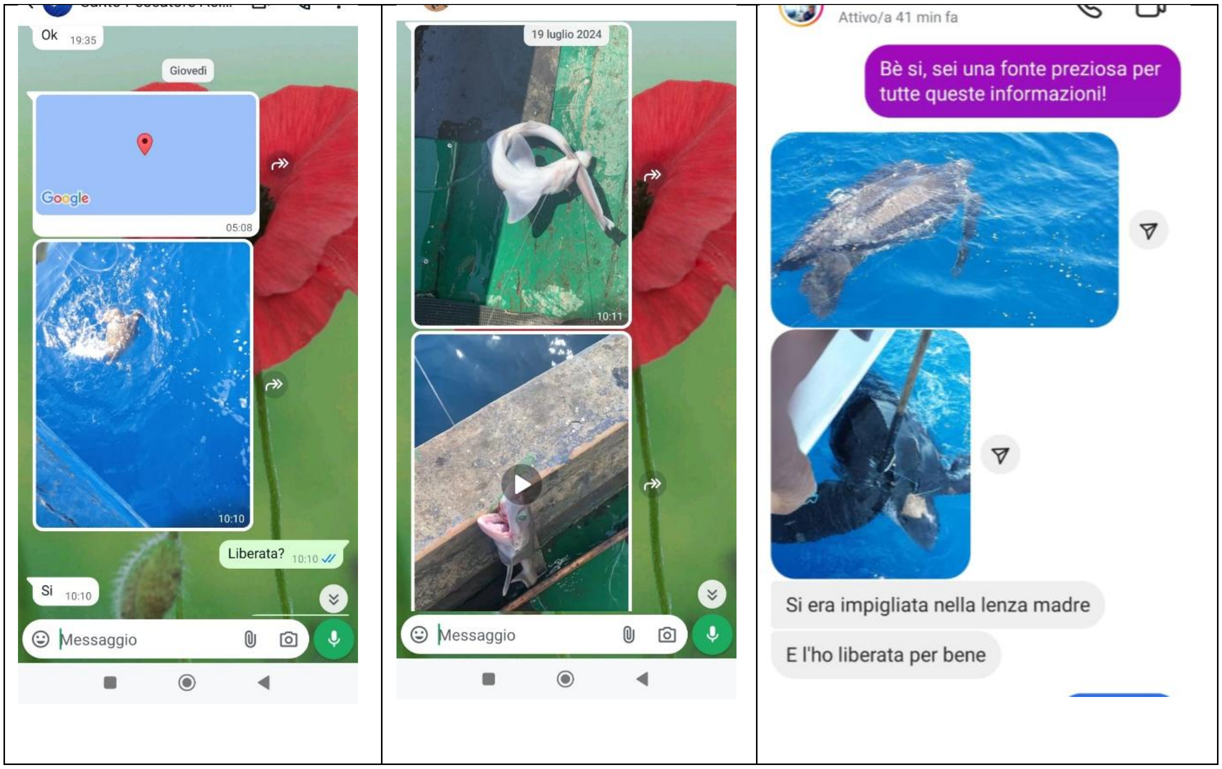
Box 1. Screenshots of the Logbook for fishers created on the Google Form platform.

It recorded:

- ✓ Fisher ID code and trip date.
- ✓ Gear used and detailed specifications (length, height, mesh size, hook number and size).
- ✓ Deployment and retrieval times, GPS coordinates, and depths.
- ✓ Catch composition: landed and discarded species, weights, and quantities.
- ✓ Bycatch of vulnerable species (category, number, condition, released or discarded).
- ✓ Depredation damages: type of damage (bite marks, missing hooks, gear tearing), extent, and supporting photos or videos.
- ✓ Dolphin sightings: species, group size, distance to gear, supporting media.
- ✓ Number of sets per day (with the possibility to repeat the form for multiple sets).
- ✓ Fuel consumption.

Reports from fishers

Fishers of the network also provided direct reports. These were communicated either by phone calls or text messages (Box 2) including photos, videos, coordinates, and biological details of captured or sighted species, especially alien or vulnerable ones. After a report was received, additional details were requested (e.g., size, weight, location). All reports were entered into a shared Excel file on Drive for centralized management.



Box 2. Screenshots of some reports made by fishers sent to Depredation-3 project experts.

Boarding survey

The boarding survey sheet (ANNEX V - Boarding survey sheet and LEGEND) was used by scientific observers during trips on Floating Laboratory vessels. It was used in the context of at-sea monitoring and mitigation trials. Its purpose was to provide independent, detailed records of fishing operations. It included:

- ✓ Date, boat code, and port of departure.
- ✓ Gear details (type, dimensions, mesh size, hook sizes).
- ✓ Deployment and retrieval information (times, coordinates, depths).
- ✓ Catch data (weight, composition, discards).
- ✓ Presence of cetaceans, depredation, and bycatch events, with space to link to related survey IDs.
- ✓ Gear damages (holes, lost hooks, missing baits).
- ✓ Notes on prey scattering, catch loss, and references to videos/photos.

Observation survey

The observation survey sheet (ANNEX VI – Observation survey sheet and LEGEND) was used during activities onboard the scientific vessel. It was filled every hour or whenever conditions changed. It was used in the context of both monitoring and mitigation activities. It included:

- ✓ Survey metadata: ID, observers, date, time.
- ✓ GPS coordinates, vessel route, and speed.
- ✓ Weather and marine conditions (sky coverage, precipitation, visibility, Douglas scale, wind).
- ✓ Marine life and anthropogenic activity (jellyfish, birds, turtles, cetaceans, waste, vessels).
- ✓ Notes on route changes, onboard activities, and cross-references to sighting IDs.
- ✓ Total distance covered (nautical miles).

Sighting survey

The sighting survey sheet (ANNEX VII – Sighting survey sheet and LEGEND) was used by scientific observers whenever cetaceans were sighted, either from fishing or scientific vessels. Data recorded included:

- ✓ Sighting ID, observers, date, start, and end times.
- ✓ GPS coordinates at the beginning and end.

- ✓ Distance, angle from the vessel, and swimming direction.
- ✓ Species sighted, total number of individuals, calves/juveniles.
- ✓ Behavior relative to the vessel.
- ✓ Number and size of nearby boats (fishing or non-fishing).
- ✓ Notes on associations with other fauna, changes in behavior, and disturbances.
- ✓ Photo and video references.

Interaction survey

The interaction survey (ANNEX VIII – Interaction survey sheet and LEGEND) was filled by scientific observers during encounters where dolphins interacted with fishing gear, both from fishing and scientific vessels. It was used in the context of targeted monitoring of dolphin–fishery interactions. Its purpose was to document the characteristics, duration, and consequences of interactions. It included:

- ✓ Date, observers, related survey IDs.
- ✓ Gear type, cetacean species, and number of individuals.
- ✓ Signs of presence, behavior, and positions relative to gear.
- ✓ Environmental variables (currents, bottom depth, gear depth).
- ✓ Start and end times, duration of interaction.
- ✓ Notes on associated vessels, photos, and videos.

Cetacean times

The cetacean times sheet (ANNEX IV – Cetacean times sheet) was filled by observers during dolphin encounters, mainly from the scientific vessel. It was used in the context of ethological monitoring. Its purpose was to document the surfacing and diving patterns of individuals. For each individual, observers recorded:

- ✓ ID, sex, calf presence, and photo-ID references.
- ✓ Start time of each surfacing and diving event.
- ✓ Sequential logging of multiple dive/surfacing events.
- ✓ These sheets were designed for detailed ethological analysis.

Bycatch sampling

The bycatch sampling sheet (ANNEX X – Bycatch sampling sheet) was used by observers onboard fishing vessels or during landing surveys at the ports, whenever a vulnerable species was caught.

It was used in the context of systematic bycatch monitoring. Its purpose was to record biological data and the condition of individuals. It recorded:

- ✓ Record number, common, and scientific names.
- ✓ Length (cm), weight (g), sex.
- ✓ Condition (alive, dead, or almost dead) and release status.
- ✓ Notes and references to photos/videos.

Acoustic data

Acoustic monitoring was conducted by both fishers, who deployed passive acoustic monitoring (PAM) devices on their nets, and by scientific observers during research cruises. The primary objective was to document deployment conditions, link acoustic detections with fishing activities, and establish a standardized dataset for assessing dolphin presence and vocalization patterns in the study area. Two complementary survey sheets were developed for this purpose.

PODs sheet (ANNEX XI– PODs sheet). This form was used by fishers when deploying three FPODs and, in some cases, an RT-Sys SYLENCE LP hydrophone directly on their fishing nets. It recorded the identification codes of each device, vessel, and fisher details, as well as the date and type of fishing gear, start and end times of setting and hauling, GPS coordinates, depths of gear and devices, and any observed interactions with dolphins. A notes section allowed fishers to add valuable contextual information for analysis.

Acoustic survey sheet (ANNEX XII – Acoustic survey sheet). This sheet was used by scientific observers on board the research vessel to document stationary hydrophone recordings at sampling stations. Recordings typically lasted 10 minutes, but were extended when cetaceans were present. The sheet included:

- ✓ Recording ID, start, and end times.
- ✓ GPS position, distance to fishing gear.
- ✓ Gear type monitored and portion observed.
- ✓ Presence of cetaceans, associated vessels.
- ✓ Notes on behavior, swimming direction, and vocalizations.

3.3. Deployment of materials and hydrophones for acoustic monitoring

The acoustic component of the Depredation-3 Project was designed to evaluate the presence and activity of dolphins in the study area and their interactions with fishing gear. To achieve this, a combination of autonomous PAM devices and research–vessel–based hydrophones was deployed across the areas. The methodology was based on previous experiences from Depredation-2 and adapted in collaboration with SINAY and Chelonai Ltd., which provided technical expertise for system design, data acquisition, and post-processing.

Instruments used

Two main categories of instruments were deployed:

- Fixed Passive Acoustic Monitoring devices (F-PODs, Chelonia Ltd.) (Figure 5). These self-contained devices record echolocation clicks of odontocetes using an omnidirectional hydrophone and a real-time digital signal processor.

Figure 5. Programming PODs before field use (Source: Marecamp).

- SYLENCE-LP system (RTsys, France). This compact PAM unit records continuous underwater sound in the 10 Hz–48 kHz frequency range, making it suitable for detecting cetacean vocalizations and background noise. It was used with the HTI-99-HF (frequency range: 2 Hz–30 kHz, sensitivity: −201 dB re 1 V/µPa).
- Hydrophones coupled with portable recorder. Two hydrophones were used in combination with two Zoom H5 recorders: HTI-96-MIN (frequency range 2 Hz–30 kHz, sensitivity −164 dB re 1 V/µPa). These systems were primarily deployed during scientific surveys to collect reference recordings, validate acoustic detections, and record dolphin behavior in the vicinity of fishing gear.

Deployment on fishing gear

For fishing-based monitoring, PAM devices were deployed directly on gillnets and trammel nets belonging to vessels in the Floating Laboratories network. The standard setup consisted of:

- Three or two F-PODs and one hydrophone (SYLENCE-LP) attached along a net, fixed with dedicated mounts.
- F-PODs were positioned at different distances from the net ends to ensure spatial coverage. Deployment depth was recorded for each unit.
- The hydrophone was positioned near the central section of the net to maximize detection probability during fishing operations.

Fishers were trained to operate the devices and to complete dedicated reporting sheets for each set.

Deployment from scientific vessels

Complementary surveys were conducted using the research vessel operated by Marecamp. During these activities, hydrophones were deployed in stationary mode at pre-defined sampling stations within the areas. The protocol included:

- Recordings of 10 minutes per station under normal conditions.
- Extended recordings were made when dolphins were sighted or acoustically detected.
- Documentation of vessel position, distance to fishing gear, gear type monitored, sea state, and concurrent visual sightings (linked to Sighting and Observation survey IDs).
- Notes on dolphin group size, behavior, direction of movement, and anthropogenic noise sources (ships, fishing vessels, recreational boats).

Data processing, quality control and objectives of the acoustic monitoring

Acoustic files from F-PODs and hydrophones were downloaded after each deployment and stored on the project's shared drive, with backup copies on external hard drives. Data management followed these steps:

1. **Signal validation.** F-POD click trains were extracted and validated using manufacturer software (FPOD.exe). False detections were removed after visual inspection of time–frequency plots.
2. **Standardization.** Acoustic detections were normalized to effort, expressed as Detection Positive Minutes (DPM) per hour of recording.
3. **Comparison of instruments.** FPOD and SYLENCE-LP results were compared to assess consistency in dolphin detection rates and to evaluate the performance of different sensor types.
4. **Integration with other data.** Acoustic results were linked with observer sheets, logbooks, and depredation reports to identify spatio-temporal overlaps between dolphin presence and fishing activity.
5. **Storage and accessibility.** All validated acoustic data were catalogued by station code and date, with metadata sheets summarizing deployment conditions and associated survey IDs.

The deployment of F-PODs, SYLENCE-LP, and hydrophones aimed to:

- Document the presence and temporal patterns of dolphins in GSA 19.
- Assess the overlap between dolphin activity and fishing effort.
- Provide independent confirmation of depredation events reported by fishers.
- Evaluate the effectiveness of mitigation devices (e.g., AAS) through paired deployments.
- Generate a long-term dataset that complements visual surveys and self-reporting.

3.4. Four mitigation strategies

Mitigation activities are essential for minimizing the negative impacts of fishing practices on vulnerable marine species and the damage and economic losses incurred by fishers due to depredation events. The mitigation component of the Project aimed to test practical solutions to reduce dolphin depredation and bycatch of vulnerable species in small-scale fisheries operating in GSA 19. Protocols were designed in collaboration with fishers from the Floating Laboratories network and refined in accordance with FAO–GFCM and ACCOBAMS recommendations. Each trial was monitored by scientific observers, who collected data through logbooks, boarding sheets, interaction surveys, and acoustic records. The following four approaches were tested as independent mitigation trials.

Echolocation disturbance

The mitigation trial utilizing echolocation disturbances was designed to be tested on deep-sea longlines to reduce the effects of depredation by dolphins. This trial was conducted in the area of Catania.

The most significant economic damage to longlines results from the depredation of bait.

Based on interviews and data from previous projects, fishers noticed that inserting lead rods or metal parts inside the bait (not artificial) deterred dolphins from preying on it. It could potentially "mask" the prey. This mechanism may distort the echolocation signals used by dolphins during their inspection, making it harder for them to detect the bait.

Figure 6. Previous mitigation approach utilizing weights inside the baits. Source: Marecamp.

During the first survey on the fishing vessel, 5g leads were tested and inserted inside sardines, one in the mouth and one in the belly. Under the supervision of the observer, the fisher applied this technique to about ten baits (Figure 6). However, it was immediately evident that this type of method was not sustainable in the long term. In fact, the leads, not being tied but only inserted inside the bait, could easily be lost. Furthermore, any fish caught would have had bait with metal parts inside it, making the catch unsellable.

Most importantly, there was also a potential animal welfare concern: in the event of dolphin depredation, individuals could inadvertently ingest sardines containing lead weights. This outcome would pose a direct health risk to dolphins, as the ingestion of metallic objects may cause internal injuries, poisoning or long-term physiological stress. For these reasons, the trial was interrupted immediately after the initial test, and this method was not pursued further. Alternatively, after discussions between experts and fishers, the mitigation protocol was transformed into a more conservative and safe approach by modifying the baiting method: the bait was not inserted onto the hook just from the head side, but it was passed twice across the hook, making the fish-bait take on a circular shape (Figure 7).

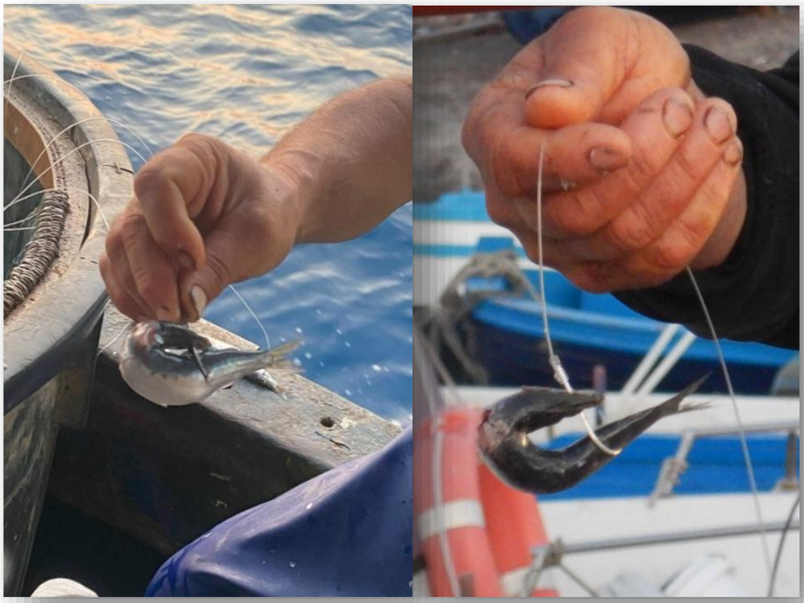


Figure 7. New methodology for the mitigation protocol, with the bait inserted twice inside the hook. Source: Marecamp.

Visual deterrents

Based on previous experiences with various Mediterranean fleets involved in the Depredation projects, visual deterrent devices – such as shiny compact discs, reflective glasses, and lights – had proven effective in reducing dolphin depredation, primarily on fishing nets. These devices illuminate the area and create disorienting reflections, which seem to make the catch less appealing to dolphins and reduce their catch. However, preliminary studies, have not yet provided conclusive evidence on the effectiveness of these visual deterrents. Despite this, net illumination systems, including affordable options like green LEDs, continue to be considered one of the most promising methods for mitigating dolphin-fishery conflicts (Terribile & Laspina, 2022; Gonzalvo & Carpentieri, 2023).

This mitigation method was tested on trammel nets in the Portopalo di Capo Passero area.

Fishers were trained on using and operating the LED devices on the net (Figure 8).

Figure 8. Training session for fishers about the use of LEDs for mitigation mesureas in Portopalo di Capo Passero. Source: Marecamp.

During the first tests, the lights used previously were replaced with devices that were easier for fishers to use and that activated automatically upon contact with water (Figure 9).

Figure 9. Changing the LED equipment on the net.

Acoustic Alert System

An Acoustic Alert System (AAS) to advise fishers of the presence of dolphins near their nets was implemented to reduce depredation damage by testing two possible scenarios when dolphins were detected engaged in depredation: 1) alerting the fisher to haul out the net, and 2) not intervening. Initial findings suggested that this may also help reduce dolphin bycatch (Monaco, 2022).

The protocol from the Depredation-2 project was implemented, and additional data collection devices, namely F-PODs and SILENCE LP (RT-Sys) devices with a hydrophone, were integrated as outlined in the monitoring activities.

Fishers were trained in the use and deployment of PAM devices. (Figure 10).

F-PODs and hydrophone buoys were deployed in two types of nets used by five small-scale artisanal fishing vessels, one in the Aci Trezza (Catania), two in the Augusta-Siracusa areas, and two in the Riposto area. Although the project initially planned to test the mitigation measure only on a single wall net (*Monofilo*), it was also tested on trammel nets in all trial areas, because preliminary interviews revealed that depredation events were common on this type of net as well.

Figure 10. Training session with a fisher about the use of PODs at Aci Trezza (Catania). Source: Marecamp.

Consequently, trials were conducted on both types of nets, considering the specific characteristics of the gear used and the depths at which they are set.

These trials were occasionally supported by a scientific vessel equipped with hydrophones, recorders, video and photo cameras, and expert personnel to collect visual and specialized acoustic data, which were analyzed alongside the data from the F-PODs (Figure 11) and buoys on the net.

Figure 11. The fisher collects the POD while is hauling up the net during one of the fishing trip. Source: Marecamp.

Structural changes

The trials conducted in the Gulf of Catania during the Depredation-2 project revealed a deadly bycatch event involving a bottlenose dolphin in a reinforced single-wall net (*Monofilo*) (Terranova et al., 2022). Minor modifications to fishing gear could prevent such occurrences without compromising fishing success. We advise against reinforcing artisanal nets because it may minimize the chances of the bycaught dolphin of escaping, ultimately leading to its certain death, while an unreinforced net may allow the dolphin or other vulnerable species to free itself (Monaco, 2022).

The current objective is to develop a modified *Monofilo* to reduce the risk of bycatch while preserving net functionality and resistance to local currents, thereby providing a solution beneficial to both fishers and dolphins. With this in mind, it was decided to change the most reinforced section, consisting of approximately 80 meters of mesh, similar to a trammel net, at the beginning and end of the net, to a non-reinforced monofilament net (Figure 12).

Figure 12. Reinforced section of the single wall net to be reduced, Aci Trezza. Source: Marecamp.

This new modified net was used by a small-scale artisanal fishing vessel operating in the Aci Castello area. The fisher used this new net and was trained to fill out the logbook, documenting all catch data and interactions with marine life.

3.5. Statistical analysis and models used

Data analysis (non-acoustic)

All datasets collected during the project were subjected to a structured statistical analysis to describe general patterns and test for significant differences across variables of interest. Initial data exploration involved calculating descriptive statistics (mean, median, and frequency distributions) for each variable.

All analyses were conducted using PAST v.4.10, with statistical significance set at $p < 0.05$. Depending on the data type and distribution, different approaches were applied:

- Contingency table analyses (Chi-squared tests) were used to investigate the associations between categorical variables, such as gear type and the occurrence of bycatch species.
- Non-parametric tests were applied to continuous data that did not meet parametric assumptions: the Mann–Whitney U test for pairwise comparisons (e.g., differences in fishing effort between two fleets) and the Kruskal–Wallis test for multiple group comparisons (e.g., fishing effort or catch data across mitigation trials).
- Spearman's rank correlation (ρ) was employed to assess monotonic relationships between continuous variables, such as the relationship between vessel characteristics (e.g. length overall, engine power) and fuel consumption.

In addition to the statistical treatment, all spatially explicit data (fishing effort, sightings, interaction events, depredation, and bycatch reports) were processed within a GIS environment using QGIS v.3.16. This enabled the production of standardized maps, spatial overlays, and hotspot analyses to support both descriptive and inferential findings.

Acoustic data analysis (June 2024 – January 2025)

Acoustic data were analyzed through a multi-tiered framework that combined F-POD detections, broadband recorders (RTSys), and portable hydrophone systems. For F-PODs, delphinid detections were extracted with the dedicated software, applying the KERNO algorithm at high, moderate, and low confidence levels. Detections were standardized into 10-minute bins and converted into Clicks per Unit Effort (CPUE), thereby controlling for variable deployment durations. In addition, Inter-Click Interval (ICI) analysis was performed to infer behavioral categories, with thresholds based on values from the literature (feeding <10 ms; socializing 10–130 ms; traveling>130 ms).

Broadband acoustic recordings from RTSys autonomous devices and from the portable Zoom-H5 hydrophone were processed using Sinay's AI-based detectors for clicks and whistles, each combining three trained algorithms. Detections were validated when the three classifiers converged with a confidence level of≥95%. Outputs were normalized into comparable metrics with F-POD data, using hourly detection rates and manual calibration factors (e.g., an average of 15 clicks per 2-second segment).

Comparisons between F-POD and RTSys detections were explored via linear models.

To assess environmental and anthropogenic drivers of dolphin acoustic presence, Generalized Additive Models (GAM) with negative binomial distribution were applied to CPUE data. Covariates included physical (sea surface temperature, salinity, and oxygen), bathymetric (depth, slope, and distance from the coast), and anthropogenic variables (maritime traffic density from AIS).

For behavioural analyses, hourly and seasonal patterns of dolphin detections were reconstructed through ribbon and polar plots.

Underwater noise monitoring was conducted on RTSys datasets. Broadband (25 Hz–20 kHz) and third-octave band levels were computed in 1-s windows and averaged over 20-min intervals. RMS and peak pressure levels were analysed across fishing days, with seasonal trends assessed through cubic spline fits. Vessel-related low-frequency dominance was quantified via LF (25–203 Hz) vs MF (256–2048 Hz) composite levels and spectral slopes, and flagged when thresholds were exceeded.

Finally, soundscape characterisation was performed using eco-acoustic indices. The Normalized Difference Soundscape Index (NDSI) was derived from anthropophony-proxy (64–406 Hz) and biophony-proxy (512–2,580 Hz) bandsets. The Acoustic Diversity Index (ADI, 0.2–8 kHz) quantified spectral evenness, and spectral occupancy was calculated across low, mid, and high frequency groups. Biophony-dominant intervals were conservatively flagged when mid-frequency energy exceeded baseline levels without concurrent low-frequency dominance.

All statistical modelling and visualisations were conducted in R, while acoustic data processing was carried out with F-POD software (Chelonia Limited, 2025) and Sinay's proprietary detection algorithms.

Bioacoustic data analysis F-POD (extension project period)

All data formatting and analysis were conducted in R (R Core Team, 2025). F-POD detections were extracted and exported using FPODexe software (Chelonia Limited, 2025). The net deployment and F-POD detection records were joined by matching deployments to overlapping F-POD time chunks, using buffered start and end times, to produce the complete dataset. For the answer no. 1, the data were reduced to one record per deployment with summary values calculated, and a Gaussian GLM was fitted with log(total catch weight + 1) as the response and water temperature, depth, deployment duration, proportion of time with dolphin detections, time from last encounter to net lifting, time from first detection to net lifting, solar altitude, net type, and port as fixed effects. For answer no. 2, the data were reduced to 30-minute intervals, calculating the proportion of minutes with dolphin detections per interval and summarising other variables. The data were fitted to a negative binomial GLM with dolphin detection proportion as the response and deployment phase (net lowering, net soaking, net lifting), depth, temperature, solar altitude, net type, and port as fixed effects.

3.6. Awareness-raising strategies

Awareness and communication activities played a crucial role in the Depredation-3 project, ensuring that results were effectively disseminated and that local stakeholders—particularly small-scale fishers—were engaged as active partners in mitigation and conservation efforts. In July 2024, a press release was issued to announce the project's launch to the public (ANNEX XIII– Press release 07/2024 Depredation-3 Project Announcement). The strategy combined direct territorial outreach, training sessions, creation of a project identity, and integration into broader Mediterranean networks of knowledge exchange.

Territorial outreach and training. Dedicated outreach was carried out across all the fishing communities involved in the project (Messina, Catania, Siracusa, Portopalo). During these meetings, project staff and observers presented the objectives of Depredation-3, the ecological and economic implications of dolphin depredation, and the monitoring and mitigation measures under testing. Importantly, fishers were trained on the recommended procedures for safely releasing vulnerable species accidentally caught in nets or longlines, in line with the FAO-GFCM *Guidelines to Reduce Bycatch of Vulnerable Species in Mediterranean Fisheries (*Figure 13*).* This practical training sought to build local capacity while promoting responsible fishing practices.

Figure 13. Fishers engaged during fishing operations and informed by project observers through the distribution of the FAO-GFCM Guidelines to Reduce Bycatch of Vulnerable Species in Mediterranean Fisheries. Source: Marecamp.

Direct engagement during fishing operations. Observers onboard vessels of the Floating Laboratories also acted as multipliers of knowledge, distributing guidelines, discussing interaction events in real time with fishers, and collecting feedback on the feasibility of mitigation measures. This dynamic exchange reinforced trust and fostered collaboration between researchers and the fishing community.

Communication tools and visual identity. To ensure visibility and recognition, the project developed a dedicated logo symbolizing a dolphin echolocating near a fishing net and a fish school, visually recalling the concept of depredation and the project's core objectives. The logo, combined with the "Depredation-3" brand, was applied to official materials, presentations, and online content, creating a coherent identity across communication channels (Figure 14).

Figure 14. Logo for the Depredation-3 project. Marecamp devealoping.

Digital outreach. Awareness was also expanded beyond local communities through the publication of thematic posts on social media platforms. Posts were tagged with references to FAO, GFCM, ACCOBAMS, Marecamp, Sicily, small-scale fisheries, and vulnerable species, thereby engaging a wider audience and linking the project to broader regional and international conversations on sustainable fisheries.

Integration in regional and international fora. Depredation-3 results and activities were presented in high-level meetings organized by ACCOBAMS and ASCOBANS, ensuring that local experiences were connected to Mediterranean-wide policy discussions. Notably, in December 2024 the 16th Meeting of the ACCOBAMS Scientific Committee in Barcelona included a review of cetacean depredation across the Mediterranean, with Depredation-3 cited as a case study. In January 2025, ACCOBAMS organized an online Joint Workshop on Fisheries Interaction with Vulnerable Species, where Depredation-3 was one of the projects discussed ANNEX XIV - Meeting Report of the ACCOBAMS Workshop on Commercial Fisheries Interactions with Vulnerable Species. Finally, in February 2025, the project was presented at the 2nd Meeting of the Joint Bycatch Working Group (JBWG) of ACCOBAMS and ASCOBANS (ANNEX XV– Slides presented during the 2nd Meeting of the Joint Bycatch Working Group (JBWG) of ACCOBAMS and ASCOBANS).

4. RESULTS

4.1. Depredation and Bycatch: monitoring activities' efforts and outputs

This section analyzes the magnitude, patterns, and consequences of depredation and bycatch affecting small-scale fisheries (SSF) operating along the eastern coast of Sicily (GSA 19). The analysis integrates four complementary data streams collected throughout the Project: (i) self-reporting logbooks compiled by fishers from the Floating Laboratories network, (ii) onboard surveys conducted by scientific observers, (iii) structured interviews with fishers, and (iv) scientific-vessel observation surveys. All the analysis in this section includes the additional effort carried out during the six-month extension.

The goals here are to: (a) quantify depredation frequency and characterize its variability across **gears**, **areas**, and **seasons**; (b) describe bycatch composition by **taxonomic group** and fishing métier; (c) compare **self-reported** versus **observer-validated** information; (d) summarize the **economic impact** borne by SSF; and (e) link results to spatial patterns of effort and dolphin occurrence documented by scientific-vessel surveys.

Detail on activities conducted across the entire Project period:

Activity	Number	Achieved	Involved personnel
Preliminary interviews	40	**43**	Observers at the harbors meet small-scale fishers.
Boarding on small-scale fishing vessels	40	**40**	Observers on the Floating laboratories.
Scientific vessel surveys	80	**80**	Observers on board scientific vessels.
Landing observations of small-scale fisheries at the harbor	40	**52**	Observers at the harbors meet with small-scale fishers to raise awareness.
Reporting using web logbooks	1200	**949**	Fishers, supported by observers.
Questionnaires	40	**40**	Observers at the harbors meet small-scale fishers.
Bioacoustics data collection during fishing trips	150 (fishing set)	**257**	13 months of continuous PAM recording made by 5 small-scale fishing vessels.

Spatial coverage from fishers’ logbooks

Figure 15 shows the spatial distribution of fishing effort based on 949 validated logbook entries from the Floating Laboratories vessels, each represented by a different color. The records cover almost the entire study area, extending from Riposto in the north to Portopalo di Capo Passero in the south.

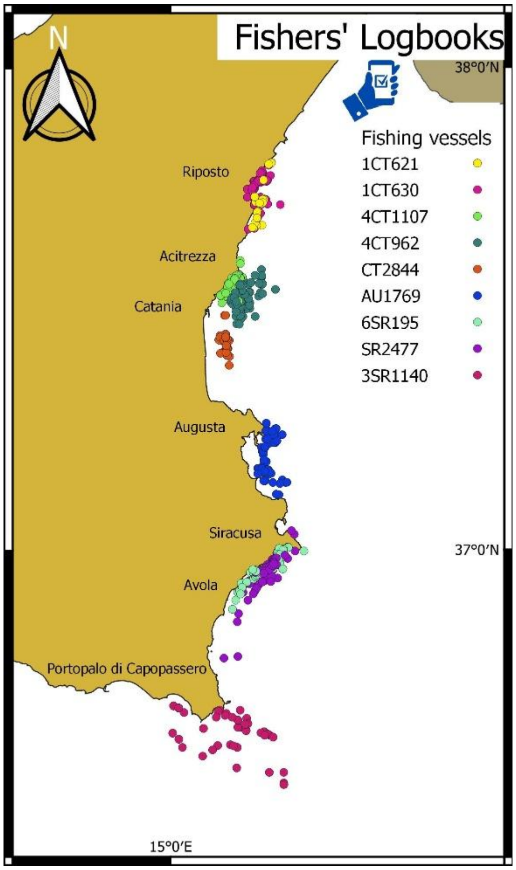


Figure 15. Spatial distribution of fishing operations reported through fishers’ logbooks along the eastern coast of Sicily (GSA 19). Each point represents a recorded set from an individual vessel, color-coded according to vessel ID.

The distribution of points was not uniform, with clear aggregations evident near Acitrezza–Catania, Augusta–Siracusa, and Avola–Portopalo, reflecting the main operating bases of the participating vessels. Importantly, the observed variation in spatial footprint was primarily determined by the seabed characteristics and the type of gear employed. Nets, such as single-wall gillnet and trammel nets, are typically set close to the coast over rocky or mixed bottoms, producing dense coastal clusters. In contrast, longlines are more frequently deployed offshore, over sandy bottoms, and at greater depths, generating more dispersed offshore points.

Spatial coverage with scientific vessels.

In total, 881.8 nautical miles (NM) of survey effort were conducted with the scientific vessel along the eastern coast of Sicily, for a total of 80 surveys started from three main ports (Catania, Siracusa, and Riposto). Importantly, these three harbors were selected as starting points because the fishing vessels engaged in the mitigation trials were based there, thus ensuring a direct overlap between monitoring and experimental activities.

Figure 16 provides an overview of the overall effort distribution, showing the spatial extent of monitoring activities.

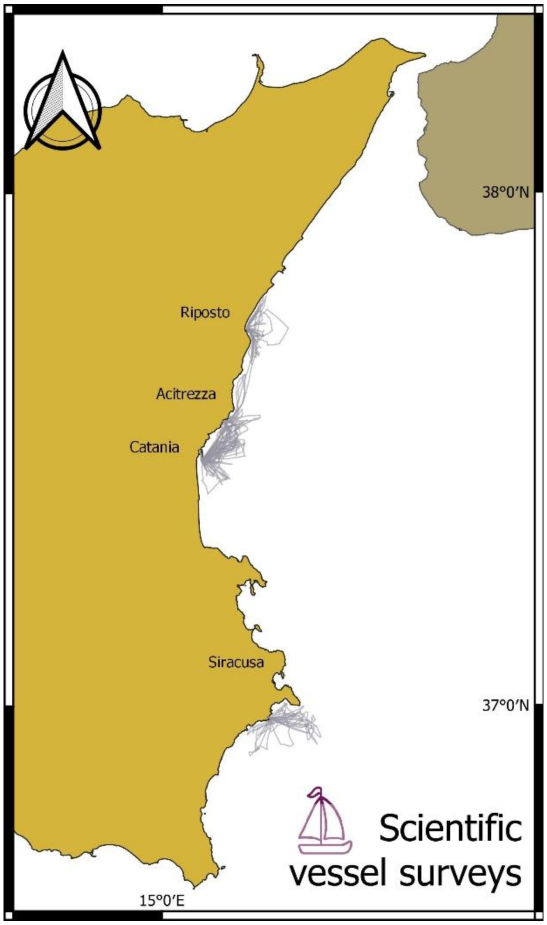


Figure 16. Survey tracks conducted by scientific vessels along the eastern coast of Sicily (GSA 19). Transects were concentrated around the ports of Riposto, Acitrezza, Catania, and Siracusa, covering coastal areas with high fishing activity.

Catania (518.7 NM): The Gulf of Catania represented the area with the most intensive monitoring, as illustrated in Figure 17. Repeated tracks departing from the harbor of Catania extended both northward and southward, covering a wide range of depths and fishing zones. This high level of coverage reflects the strategic importance of this macro-area, both in terms of fishing activity and interactions with vulnerable species.

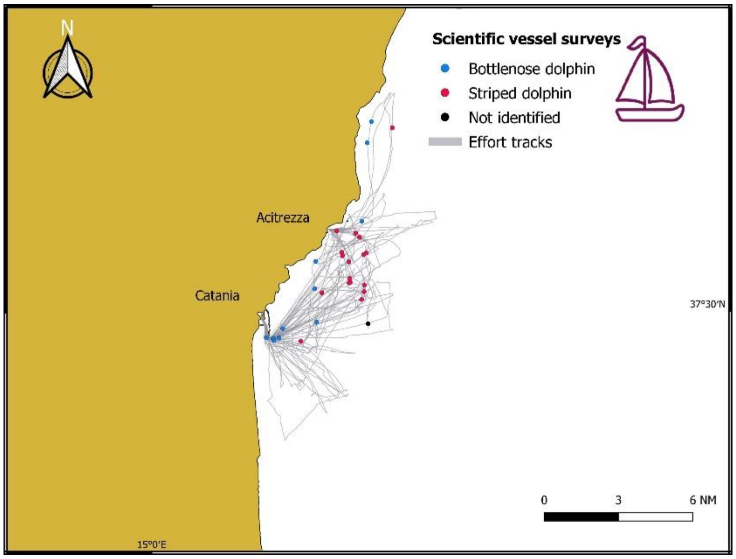


Figure 17. Scientific vessel survey tracks conducted off Catania and Acitrezza (GSA 19). Grey lines represent survey effort, while colored points indicate dolphin detections classified by species.

Siracusa (187.6 NM): As shown in Figure 18 survey effort in this area focused primarily on the stretch of coast between Ognina and the Plemmirio Marine Protected Area. This sector was revisited multiple times, providing consistent coverage of one of the key fishing grounds and interaction hotspots within the southern part of the study area.

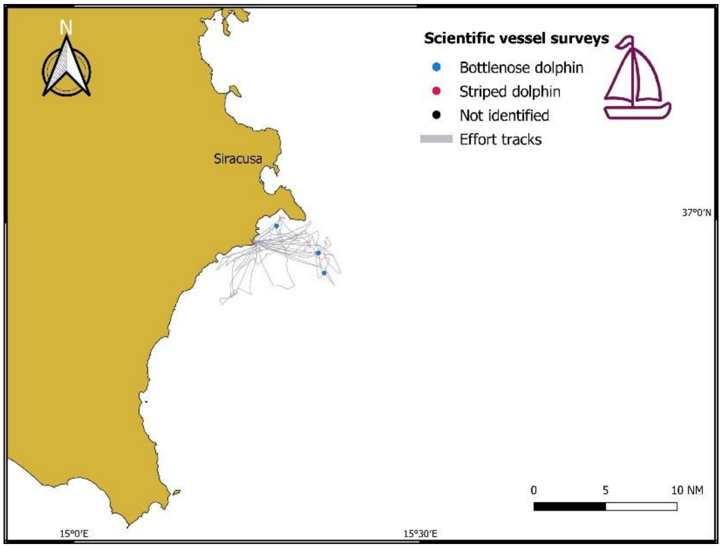


Figure 18. Scientific vessel survey tracks conducted off Siracusa (GSA 19). Grey lines represent survey effort, while colored points indicate dolphin detections classified by species.

Riposto (175.5 NM): Figure 19 shows survey tracks originating from Riposto harbor. The coverage here was more limited compared to Catania, but it provided valuable information from the northernmost sector of the study area.

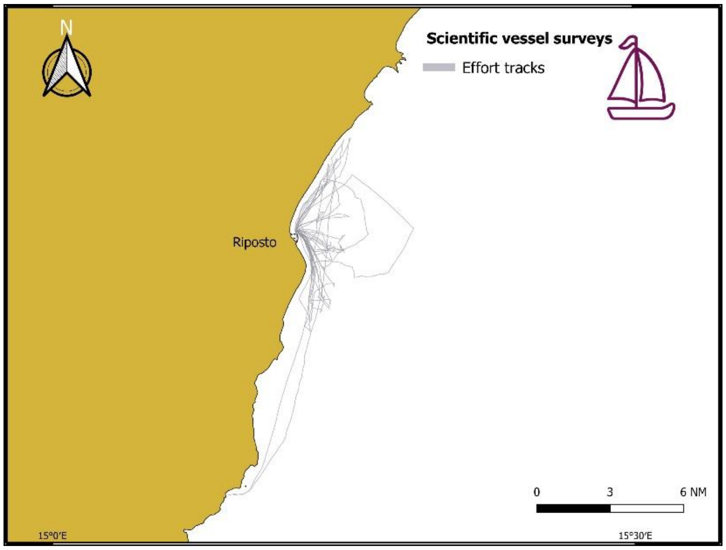


Figure 19. Scientific vessel survey tracks conducted off Riposto (GSA 19). Grey lines indicate survey effort carried out during monitoring activities.

The spatial distribution of vessel-based monitoring effort prioritized the Gulf of Catania and the Siracusa sector as focal points due to their higher fishing effort and ecological relevance. At the same time, Riposto contributed complementary coverage in the northern part of the study area. The alignment of survey ports with the mitigation trial fleet allowed a coherent integration of monitoring and experimental protocols.

Spatial coverage with observer boardings.

Figure 20 shows the positions of the 40 observer-monitored fishing operations near Acitrezza–Catania, color/symbol-coded by vessel (4CT1107, 4CT962, CT2844) and, overlaid on bathymetry to contextualize depth. Coastal sets by gillnets cluster within ~1–2 NM of shore along the lava coast, whereas longline operations (CT2844, stars) spread offshore to ~5–6 NM in deeper waters.

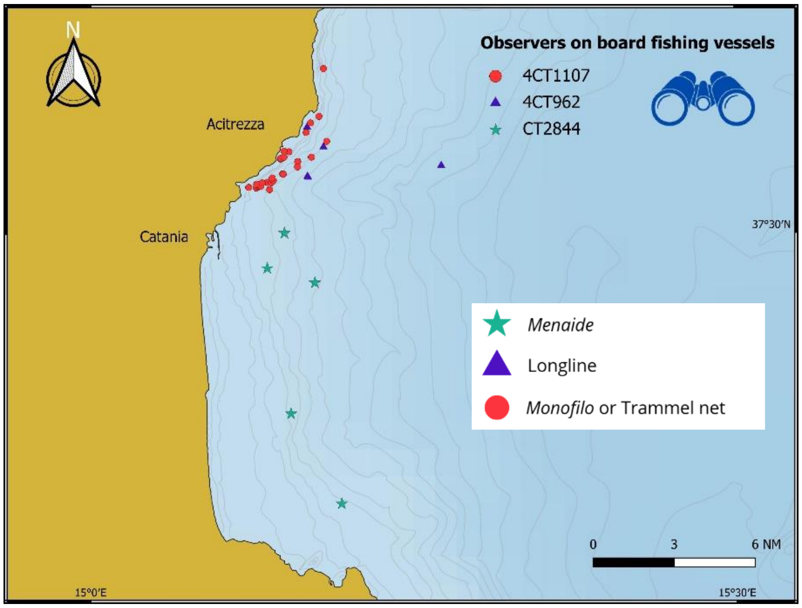


Figure 20. Locations of observer trips on board fishing vessels operating out of Acitrezza and Catania (GSA 19). Symbols indicate different vessels (4CT1107, 4CT962, CT2844) where monitoring activities were conducted.

Depredation and bycatch seasonality in the four macro-areas

An important finding from the preliminary interviews with fishers is the seasonality of dolphin depredation and the bycatch of vulnerable species. Interviews were conducted using maps featuring a 5 km grid to gather this information. Fishers were asked to specify the areas and seasons where these events occur most frequently. Their responses were quantified into percentages, reflecting the number of fishers identifying each particular grid square. The maps visually represent these percentages, with darker shades indicating areas with higher reported frequencies of depredation and bycatch.

Depredation (ANNEX XVI– Interviews outputs: Seasonal maps GSA19 –Depredation): The seasonal maps clearly indicate that depredation is not uniformly distributed throughout the year. In winter and spring, the phenomenon is concentrated along the Gulf of Catania and the northern Siracusa area, with several grid cells exceeding 40–50% of fishers' reports. During summer, hotspots persist around Catania and Siracusa but extend further south towards Avola and Portopalo di Capo Passero. In autumn, a second strong cluster emerges in the Messina area, suggesting a possible seasonal movement of dolphins across the study area. Overall, depredation appears to be more intense in the warmer months, with broader spatial coverage compared to winter.

Bycatch (ANNEX XVII– Interviews outputs: Seasonal maps GSA19 –Bycatch): The reported distribution of bycatch events also displays distinct seasonal patterns. In winter, higher frequencies are concentrated in the Siracusa–Avola–Portopalo sector, while in summer the reports shift northward, with Catania and Riposto emerging as hotspots. In spring, bycatch reports are generally more scattered and at lower intensity, whereas in autumn, a concentration of bycatch reappears both in Messina and in the southern sector.

4.1.1. Scientific-vessel sightings: species patterns and spatial structure

Sightings recorded from the scientific vessel distinguish bottlenose dolphins (*Tursiops truncatus*) in blue, striped dolphins (*Stenella coeruleoalba*) in red, and unidentified individuals in black (see figures of the chapter *Spatial coverage with scientific vessels)*.

- Siracusa. As shown in Figure 18, sightings in Siracusa during the monitored period were exclusively bottlenose dolphins, consistent with a coastal, shelf-associated distribution in the Ognina–Plemmirio sector. Points concentrate along the headlands and nearshore grounds also frequented by SSF. This pattern supports a high spatial overlap between *Tursiops truncatus* and small-mesh métiers in Siracusa and justifies the local focus on mitigation and release guidance during port meetings.
- Catania. Figure 17 shows a mixed species assemblage, with bottlenose dolphins close to the coast and striped dolphins more offshore, around and beyond the ~3–4 NM band where the bathymetry steepens. The cluster of red points east of Acitrezza aligns with deeper, pelagic-influenced waters; the blue points near the shore coincide with zones of intense gillnet and Menaide activity.
- Riposto. Figure 19 documents survey effort radiating from Riposto; despite lower cumulative field days than in Catania or Siracusa, these tracks expand the northern spatial window and will be valuable when cross-checking with any fisher reports from the Strait sector. However, no sightings were made during the survey in the Riposto area, although bioacoustic monitoring provided us with a completely different picture, revealing a large presence of dolphins during fishing operations.

Across macro-areas, bottlenose dolphins are the primary species in direct spatial overlap with SSF, particularly within the first miles from shore—precisely where trammel and single-wall gillnets are set and where traditional drift net operates. Striped dolphins were detected primarily off Catania and offshore of the nearshore gillnet band, and more near other types of gear (e.g., longline).

4.1.2. Depredation: frequency, gear-wise patterns, and spatial context

Frequencies by gear (logbooks and observers' role):

Analysis of fishers' logbooks reveals that depredation is not uniformly distributed across gears but shows marked variability (Table 3).

Gear name	NO DEP	YES DEP	Tot record	Frequency
Menaide	72	48	120	0,4
Monofilo	137	26	190	0,13684211
Artisanal Longline	173	75	248	0,30241935
Trammel Net	293	125	391	0,31969309
Total	675	274	949	0,28872497

Table 3. Frequency of depredation events recorded by fishing gear type, based on fishers' logbooks (n = 949).

Below are the main outputs from the analysis:

- The highest frequency was associated with **artisanal longlines**, where 75 out of 248 trips (30.2%) reported interactions with dolphins. Longline depredation typically manifests as missing baits, damaged hooks, or partially consumed fish, with higher occurrence during offshore sets.
- ***Menaide*** also exhibited high susceptibility, with depredation reported in 40% of monitored trips (48 out of 120). Field annotations describe cases where bottlenose dolphins partially removed entire schools of pelagic fish during net soaking or early hauling, behavior consistent with active predation facilitated by the gear structure.
- **Trammel nets** displayed a lower event frequency (31.9%, 125 of 391 trips) but caused the most severe impacts when events occurred, including torn meshes, scattered catch, and longer repair times, often requiring multiple days of labor.
- ***Monofilo*** were reported to have a lower frequency (13.7%, 26 out of 190 trips), although in some cases, fishers highlighted localized hotspots where events clustered spatially.
- Other gear types, such as pots, squid jigs (*totanare*), and small seines, were rarely affected, reflecting their limited accessibility and attractiveness to dolphins.

Overall, the aggregated logbook dataset indicates an average depredation rate of 28.9% across all gears (274 events out of 949 trips).

Onboard fishing vessels surveys provided a more conservative estimate of depredation, with only **3 events documented (7.5%)** across monitored trips. This lower frequency compared to self-reported logbooks likely reflects four factors:

i) stringent verification criteria applied by observers to classify interactions;
ii) the stochastic nature of depredation, which may not manifest during limited sampling windows;
iii) the cumulative advantage of logbooks, which aggregate information over many months of fishing activity, while observers are constrained to specific trips.
iv) Another option may be that fishers are reporting more interactions that those effectively occurring.

Research vessel monitoring documented fisheries interactions in 12.5% of all cetacean sightings (4 of 32). Both bottlenose dolphins (*Tursiops truncatus*) and striped dolphins (*Stenella coeruleoalba*) were involved.

- For bottlenose dolphins (14 sightings, Figure 21), depredation was recorded in 14.3% of encounters, including both feeding interactions with longlines and nets.
- For striped dolphins (17 sightings), depredation occurred in 11.8% of encounters, exclusively associated with feeding around nets.

Figure 21. A group of bottlenose dolphins swimming off the coast of Catania, during a monitong scientific vessels trip.

These findings confirm that striped dolphins, although often considered less directly involved in depredation, do interact with fishing gear in GSA 19. However, those results highlight the limitations of visual-only monitoring: many events occur underwater or at night and can easily go undetected without complementary approaches such as passive acoustic monitoring, fisher logbooks, and direct gear inspections.

Seasonal outputs

Logbooks and interviews converge on year-round depredation, with fishers in Catania often perceiving a summer uptick (interpretable as effort-driven exposure plus seasonal peaks in small pelagics). Menaide shows the most pronounced seasonal spike, consistent with its constrained operating season and prey dynamics. No substantial seasonal absence is apparent across the dataset.

4.1.3. Bycatch: composition and gear-specific profiles

Bycatch records extracted from preliminary questionnaires and logbooks show a consistent dominance of elasmobranchs across métiers, with turtles and seabirds forming minor components and cetaceans virtually absent as bycatch.

Data collected through fisher questionnaires represent annual average estimates, grouped by gear type (Table 4). These values indicate the relative composition of bycatch across métiers, rather than individual trip records.

Gear	Declared events (annual)	Elasmobranchs (%)	Sea turtles (%)	Seabirds (%)	Cetaceans (%)
Monofilo	1616	99,7	0,06	0,12	0,06
Palamitara	31	93,6	6,5	0	0
Longlines	3039	92,9	4,4	2,7	0
Trammel nets	34715	99,2	0,08	0,7	0

Table 4. Declared annual bycatch events by gear type, with percentage composition by taxonomic group, based on fishers' preliminary interviews.

These values represent annual average estimates as declared during structured interviews and are therefore not direct counts of fishing operations, but rather indicative reconstructions of the relative incidence of different taxa across gears. As expected, elasmobranchs dominate across all métiers, although turtles and seabirds emerge as minor but relevant components, particularly in longlines and palamitara nets. Cetaceans were almost absent from these self-reported estimates, confirming that interactions with dolphins are perceived more in terms of depredation than accidental capture (Figure 22).

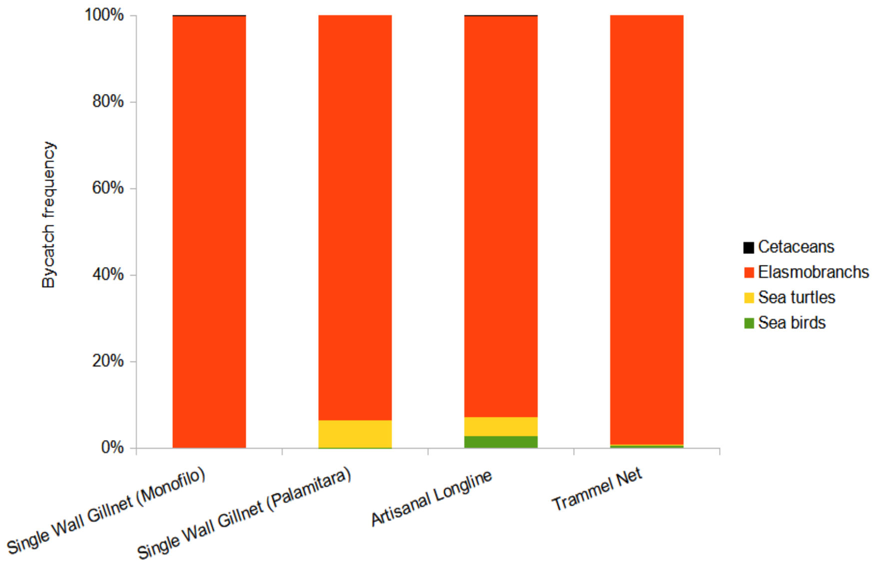


Figure 22. Relative annual frequency of bycatch taxa by gear type, as reported in fishers' preliminary interviews.

Logbooks provide systematic trip-level records compiled by fishers within the Floating Laboratories network. A total of 949 logbooks were analyzed, of which 142 (14%) contained at least one bycatch event (Table 5).

Gear	Logbooks analysed	Logbooks with bycatch	Bycatch frequency (%)	Elasmobranchs (%)	Turtles (%)	Seabirds (%)	Cetaceans (%)
Menaide	120	0	0	0	0	0	0
Monofilo	190	7	3,7	100	0	0	0
Longlines	248	55	22,2	98,6	1,4	0	0
Trammel nets	391	80	20,5	98,6	1,4	0	0

Table 5. Bycatch frequency and taxonomic composition by gear type, based on validated fishers' logbooks.

These records confirm the strong predominance of elasmobranchs, with a marginal contribution from turtles, while seabirds and cetaceans were absent. Bycatch incidence was highest in longlines and trammel nets. However, when comparing the absolute magnitude of events between questionnaires and logbooks, a significant discrepancy emerges. Questionnaire-based declarations yielded very high numerical estimates (e.g., more than 34,000 annual events attributed to trammel nets and over 3,000 to longlines), whereas logbooks—despite covering a full year of activity across 949 trips—produced much lower absolute numbers of recorded events.

This difference does not imply contradiction but rather reflects the methodological nature of each dataset. Questionnaire responses represent extrapolated annual averages shaped by fisher perception and recall, whereas logbooks provide systematic but necessarily limited samples tied to the actual trips monitored within the Floating Laboratories. As a result, questionnaires tend to amplify the numerical dimension of bycatch, while logbooks better capture frequencies and operational contexts.

More in detail, species and mortality bycatch records are discussed in **Species of Concern and Non-target Observations**.

4.1.4. Self-reporting vs. observer data comparison

The Project's design deliberately combined fisher knowledge and independent scientific observation. In Table 6, a **c**omparative summary of **observer-based boarding surveys (n=40)** and **self-reported logbooks (n=949)**. Boarding surveys provide validated estimates based on standardized observations, while logbooks cover a broader dataset reported directly by fishers. Differences are evident in reported frequencies of bycatch and depredation, as well as in mean catch per gear, with logbooks generally indicating higher values.

Parameter	Boarding survey (n=40)	Logbooks (n=949)
Samples (n)	40	949
Species recorded	52	53
Bycatch frequency (%)	7,5	14,96
Depredation frequency (%)	7,5	28,87
Mean catch *Menaide* (kg)	13,85	25,08
Mean catch *Monofilo* (kg)	5,98	8,01
Mean catch Longline (kg)	4,38	12,61
Mean catch Trammel net (kg)	2,76	10,02

Table 6. Comparative summary of observer-based boarding surveys (n = 40) and fishers' self-reported logbooks (n = 949).

A total of 40 boarding surveys were carried out with trained observers, during which 52 species were recorded. By contrast, the 949 logbooks collected from fishers reported 53 species caught, a nearly identical figure, indicating good convergence in terms of species diversity.

Differences emerge, however, when examining bycatch and depredation frequencies. In the boarding surveys, bycatch was documented in 7.5% of trips, while depredation was observed in 7.5% of trips as well. In the logbooks, fishers reported bycatch in 14.9% of trips and depredation in 28.9% of trips, a frequency significantly higher than that observed in observer-validated data. This discrepancy may reflect both the broader time coverage of logbooks and possible differences in perception or interpretation of interaction events by fishers versus trained observers.

Catch composition per gear type also showed variation between the two data sources. In the boarding surveys, mean catch per operation ranged from 13.9 kg for *Menaide* to 2.8 kg for trammel nets, with intermediate values for *Monofilo* (6.0 kg) and longlines (4.4 kg). In contrast, logbook data indicated generally higher average catches, particularly for longlines (12.6 kg) and trammel nets (10.0 kg), while *Monofilo* (8.0 kg) and *Menaide* (25.1 kg) also exceeded observer-recorded values.

These differences highlight two key considerations. First, self-reported logbooks tend to provide a larger dataset, covering a wider range of fishing operations and therefore detecting more frequent interaction events. Second, boarding surveys, though more limited in sample size, offer validated and standardized observations that may prevent potential overestimation or misclassification of bycatch and depredation. As noted in the dataset annotations, the higher values reported in logbooks must be interpreted with caution, as they may be influenced by fisher's perception, recall, or selective reporting practices.

Overall, the comparison underscores the value of using both approaches in parallel: observer data ensure methodological rigor, while logbooks capture broader temporal and spatial coverage. Their joint use improves the robustness of monitoring frameworks for bycatch and depredation in small-scale fisheries.

4.1.5. Economic impact on SSF

The economic consequences of dolphin depredation and bycatch were systematically assessed by integrating information collected through logbooks, observer data, and fisher interviews. These data provide insights into the direct and indirect costs faced by small-scale fishers in the Western Ionian Sea.

The majority of the surveyed fishers reported experiencing economic losses due to interactions with dolphins and other vulnerable species. Depredation emerged as the most frequent source of damage, with reports highlighting reduced catch value, physical damage to gear, and additional time required for repair. Bycatch, while less frequent, also contributed to economic impact.

Economic losses vary considerably depending on the type of fishing gear employed (Table 7).

Gear type	Mean % loss per event	Typical sources of loss
***Menaide* -Traditional drift gillnet**	Highest reported (up to 35–40%)	Catch reduction, net tearing, long repair times
***Monofilo* - Single-wall gillnet**	Intermediate (10–20%)	Localized mesh damage, scattered fish schools
Trammel net	Intermediate–high (15–25%)	Frequent holes in the gear, loss of catch quality
Artisanal longline	Variable (5–15%)	Depredated baits and hooks, loss of target species

Table 7. Reported mean percentage loss per depredation event and typical sources of loss by gear type, based on fishers' logbooks and interviews.

This ranking highlights how net-based métiers are disproportionately affected, consistent with their higher overlap with dolphin foraging zones. Longlines, while less impacted per event, face repeated low-intensity depredation that accumulates over time.

Fishers quantified the impact of depredation not only in terms of catch losses but also in terms of gear replacement costs and time spent on repair activities. The data showed:

- Net repairs often require several hours to days, depending on the extent of the damage. In severe events, entire gear panels must be substituted.
- Longline fishers report substantial costs in hooks and bait, particularly when dolphins repeatedly target strings.
- Economic estimates suggest that, on average, fishers lose the equivalent of several hundred euros per year per vessel, with extreme cases reaching several thousand euros.

In particular, Table 8 below summarizes the mean annual cost analyzed using the interview data:

Gear name	No interviewed	Mean costs (€)
Single Wall Gillnet (Monofilo)	9	7000
Artisanal Longline	10	3950
Trammel Net	30	8130
Squid-fishing gear	1	300
Traditional Drift Gillnet (Menaide)	2	7500
Single Wall Gillnet (Palamitara)	1	10000

Table 8. Mean annual economic costs of depredation by gear type, as reported by interviewed fishers.

The distribution of depredation costs was further examined using non-parametric tests, focusing exclusively on the three métiers with sufficient sample sizes (monofilament gillnets, trammel nets, and artisanal longlines), as these provided a statistically more robust basis for comparison. The overall Kruskal–Wallis test did not reveal significant differences among these gears ($p > 0.05$); however, pairwise Mann–Whitney tests indicated a significant difference between trammel nets and longlines ($p < 0.05$) (Figure 23). This result suggests that trammel nets not only incur higher average losses but also display systematically greater variability compared to other widely used gears.

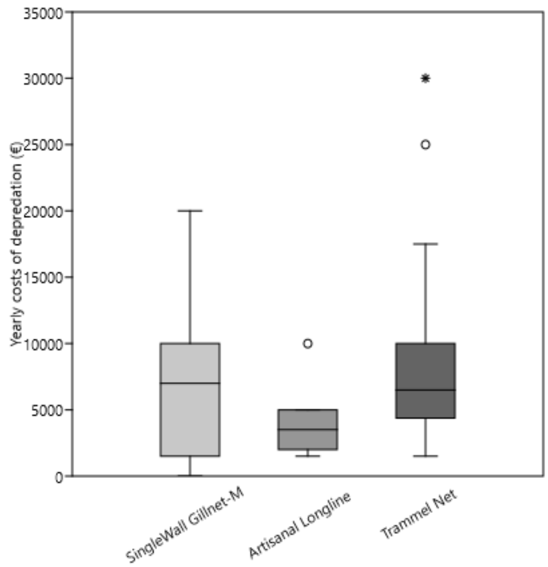


Figure 23. Distribution of annual depredation costs (€) reported by interviewed fishers for different gear types. Boxplots indicate medians, interquartile ranges, and outliers.

Although costs vary across métiers and among individual vessels, several robust patterns emerge:

- Annual losses attributable to depredation range from approximately €300 (least affected gears) to over €10,000 for métiers with recurrent interactions (single-wall and trammel, especially when damage is extensive; *menaide* during peak season; and longlines, when bait and hooks are repeatedly depredated).
- A failed trip—characterized by scattered catch, damaged gear, and high fuel waste—resulted in estimated combined losses of approximately € 500.
- Repair costs and downtime are significant hidden burdens. For nets, repairs after dolphin events can involve multiple crews, several days, and significant material replacement. For longlines, the cumulative cost of lost hooks/baits and time re-rigging the gear accrues quickly across the season.

4.2. Fishing effort outputs

This section presents an analysis of fishing effort based exclusively on logbook data collected during the project period. Unlike interviews or self-reporting, which provide broader perceptions, logbooks allow for a more precise and standardized quantification of small-scale fisheries (SSF) activities. The results described below, therefore, represent the most accurate snapshot of fishing effort in the Eastern Coast of Sicily.

<u>*Catch per trip by gear*</u>

Fishing effort data collected through logbooks show marked differences across the four main artisanal gears analyzed. *Menaide* achieved the highest average catch per trip (25.1 kg), followed by artisanal longlines (12.6 kg), trammel nets (9.8 kg), and monofilament gillnets (8.7 kg). Statistical analyses confirm that these differences are significant (Kruskal–Wallis, $p < 0.0001$), with pairwise Mann–Whitney tests showing that *menaide* values are consistently higher and *monofilo* are significantly lower (Figure 24). This ranking underscores the heterogeneity of gears in terms of efficiency and yield.

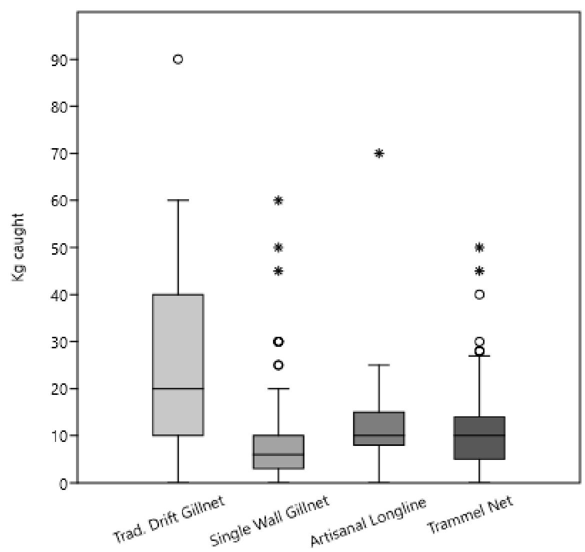


Figure 24. Boxplot of fish catch weight (kg) per fishing set by gear type. Differences were significant (Kruskal–Wallis, p < 0.0001); pairwise tests showed higher values for traditional drift gillnets (menaide) and lower values for single-wall gillnets (monofilo).

<u>*Fuel consumption and vessel characteristics*</u>

Fuel consumption was strongly associated with vessel size and power. Correlation analyses (Spearman's r, $p < 0.05$) confirmed that greater LOA, GT, and engine power correspond to higher mean liters consumed per operation (Figure 25). This relationship reflects structural constraints of the fleet: smaller coastal longliners and monofilament gillnetters are fuel-efficient but limited in range, while larger drift-net and trammel-net vessels invest more fuel for higher yields.

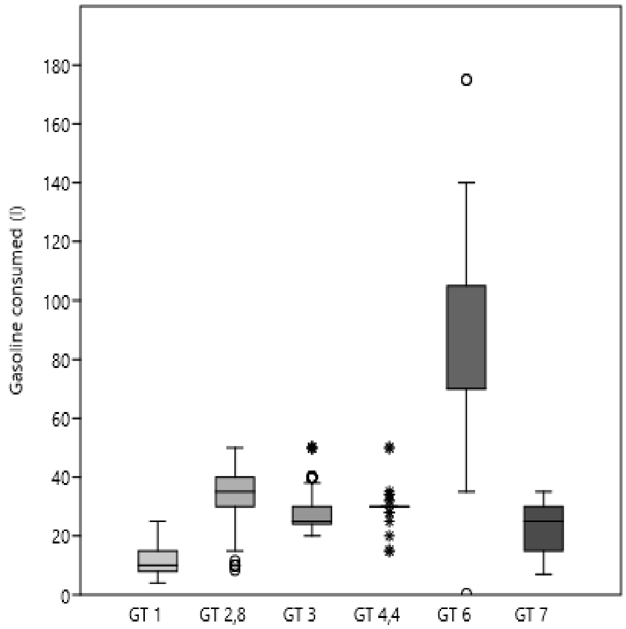


Figure 25. Boxplot of gasoline consumption (l) per operation across vessel gross tonnage (GT) classes. Fuel use increased with vessel size and power (Spearman's r, $p < 0.05$).

Data from the experimental Floating Labs fleet provided further detail at the vessel level (Table 9). The Catania *menaide* vessel (10.6 m LOA, 73.6 kW) reported the highest consumption, averaging 80.6 L/trip. In contrast, the Siracusa longline vessel (6.2 m LOA, 29 kW) consumed only 9.8 L/trip. Intermediate values include the Riposto longliner (18.7 L/trip) and the Portopalo trammel net vessel (32.8 L/trip). These results highlight the trade-offs between catch efficiency and operational costs, and illustrate the economic variability within small-scale fleets even across relatively short geographical distances.

Macroarea	Base port	Main gear	LOA	GT	Mean gasoline consumed (liters)
CATANIA	Riposto	Longline	6,49	1	18,73
CATANIA	Riposto	Trammel net	8,73	3	26,37
PORTOPALO	Portopalo	Trammel net	9	2,8	32,83
CATANIA	Acitrezza	*Monofilo*/Trammel net	12	7	23,63
CATANIA	Acitrezza	Longline	9,65	4,4	30,06
SIRACUSA	Avola	Trammel net	10,25	3	23,09
SIRACUSA	Augusta	*Monofilo* /Trammel net	9,82	3	33,07
CATANIA	Catania	*Menaide*	10,6	6	80,55

SIRACUSA	Siracusa	Longline	6,2	1	9,8

Table 9. Mean gasoline consumption per trip (liters) for vessels in the Floating Labs experimental fleet, with corresponding base port, main gear, and vessel characteristics.

The overall mean fuel consumption across all gears is 32.1 L per trip.

These patterns are clearly represented in (Figure 26), which illustrates the distribution of values for each gear. Drift gillnets not only display the highest median but also the widest range, with outliers exceeding 160 L per trip. Monofilament gillnets and trammel nets, in contrast, show similar mean values and partially overlapping distributions, though trammel nets present greater variability and numerous outliers. Artisanal longlines remain consistently at the lower end of consumption.

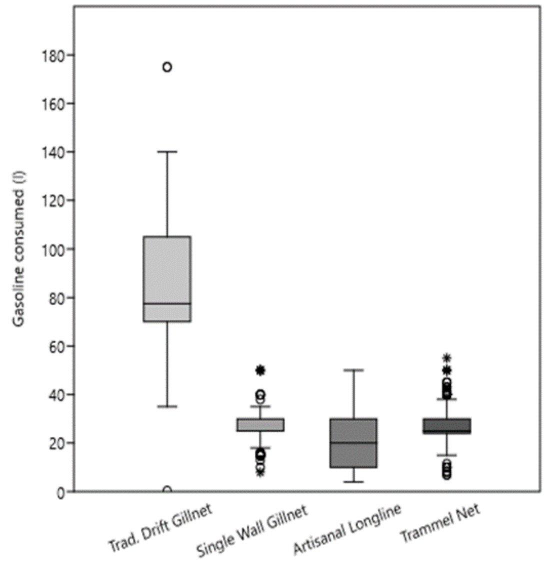


Figure 26. Boxplot of gasoline consumption (L/trip) by gear type. Traditional drift gillnets showed the highest fuel demand, while longlines and gillnets consumed significantly less.

A Kruskal–Wallis test confirmed that the differences among gear types are statistically significant ($p < 0.0001$). Pairwise Mann–Whitney tests further indicated significant differences across all gear types ($p < 0.0001$), with the sole exception of single-wall monofilament gillnets and trammel nets, which did not differ significantly from each other, reflecting their similar average consumption.

Taken together, these results underscore the disproportionate energetic costs of *menaide* compared to other métiers, while also emphasizing the variability within net-based fisheries.

Effort duration by gear

Temporal data on gear deployment (from setting to hauling) further refine the picture of fishing effort (Figure 27). Menaide operations averaged ~1.5 hours, consistent with their short-soak design, which targets small pelagics. Monofilament gillnets required longer sets, with a mean soak time of around 7.6 hours. Trammel nets extended even further, averaging 12.8 hours, reflecting their overnight use in coastal zones. Longlines, meanwhile, exhibited intermediate values, varying by season and target species, with average soak times of approximately 8 hours. These variations in deployment time complement the catch and fuel data, providing a holistic view of how different métiers distribute effort in space and time.

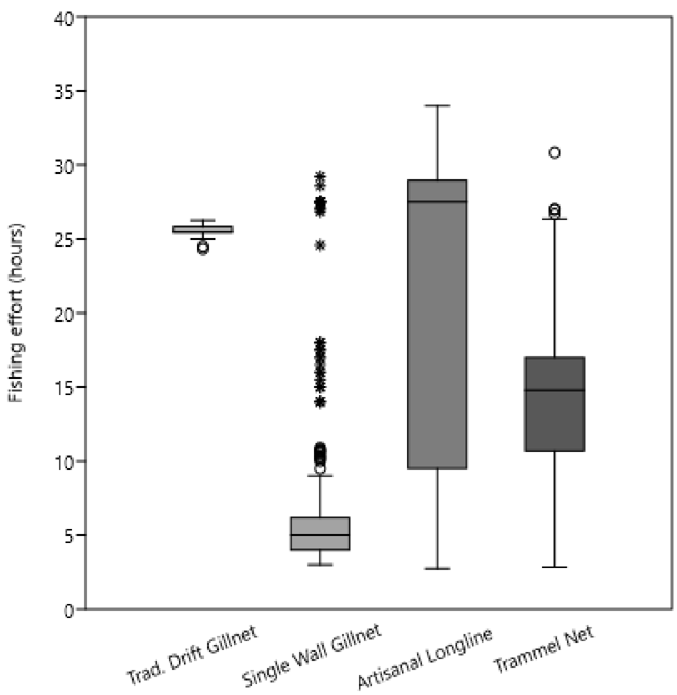


Figure 27. Boxplot of fishing effort (hours per trip) by gear type. Traditional drift gillnets showed consistently long sets, while artisanal longlines and trammel nets displayed the widest variability.

Taken together, the data confirm the high productivity but high fuel demand of menaide nets, the lower but stable yields of longlines, and the time-intensive use of trammel nets. This integrated analysis—encompassing catch, fuel, and temporal effort—highlights the diversity of fishing strategies in the eastern cost of Sicily and provides a quantitative basis for evaluating trade-offs among economic efficiency, environmental footprint, and interaction risks with vulnerable species.

4.3. Acoustic monitoring (1st year project results)

Acoustic monitoring was implemented to investigate interactions between dolphins and small-scale fisheries in eastern Sicily, with a specific focus on detecting cetacean presence around fishing nets, evaluating behavioral patterns, and characterizing the underwater acoustic environment. Data were collected between June 2024 and January 2025 across three sub-areas: **Aci Trezza, Augusta, and Siracusa** (Figure 28). Positions of gillnet operations over the study period.). Three complementary approaches were applied:

- F-PODs (2–3 devices per net, depending on gear length),
- Autonomous broadband acoustic recorder (RTSys SILENCE LP) deployed on a single wall net (*Monofilo*),
- Portable hydrophone-recorder system (Zoom H5) from a small research vessel.

F-PODs provided the most extensive dataset and were central to analyses on dolphin presence, behaviour, and fishery interactions. Broadband recorders were used to characterise the soundscape and compare detection reliability across instruments.

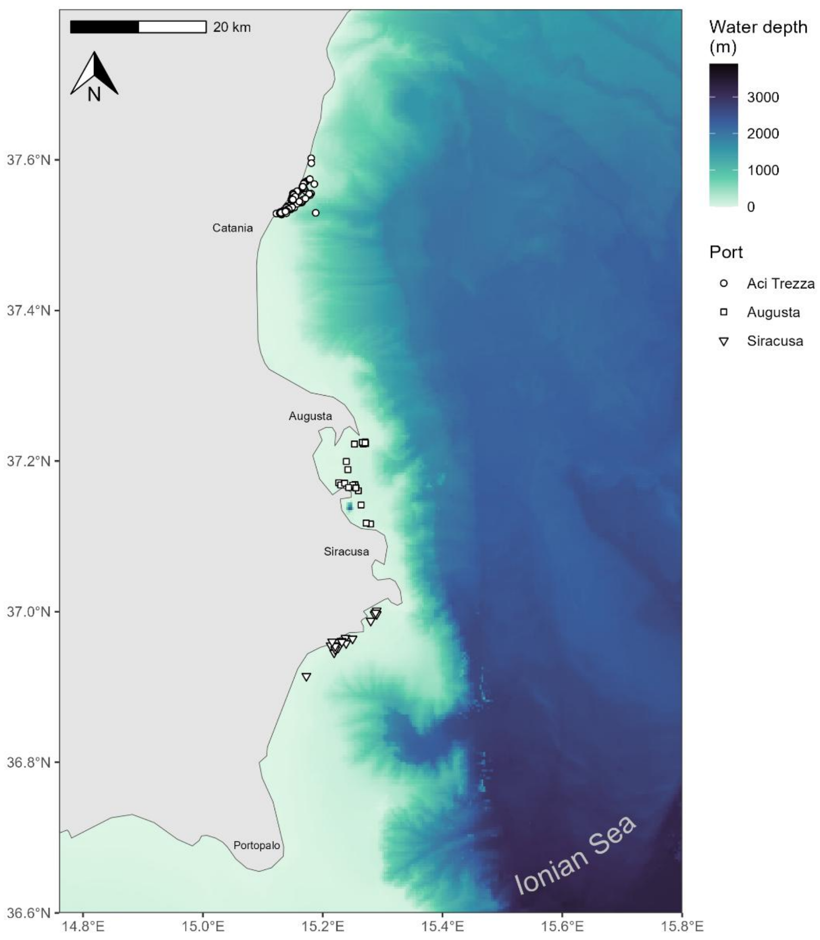


Figure 28. Positions of nets operations over the study period.

4.3.1. Cetacean-related outputs

Comparison: F-POD vs RTSys detections

- The linear model showed a weak, non-significant correlation between the instruments ($R^2 \approx 0.01$).
- F-POD tended to detect dolphins when RTSys showed none, but not vice versa (Figure 29). Detections (Number of click/h) from POD and RTsys data), and this appears to be in line with the available scientific literature (Sarnocinska et al., 2016).
- Conclusion: F-PODs are more suitable for detecting dolphin presence, while RTSys is better suited for noise/soundscape analysis.

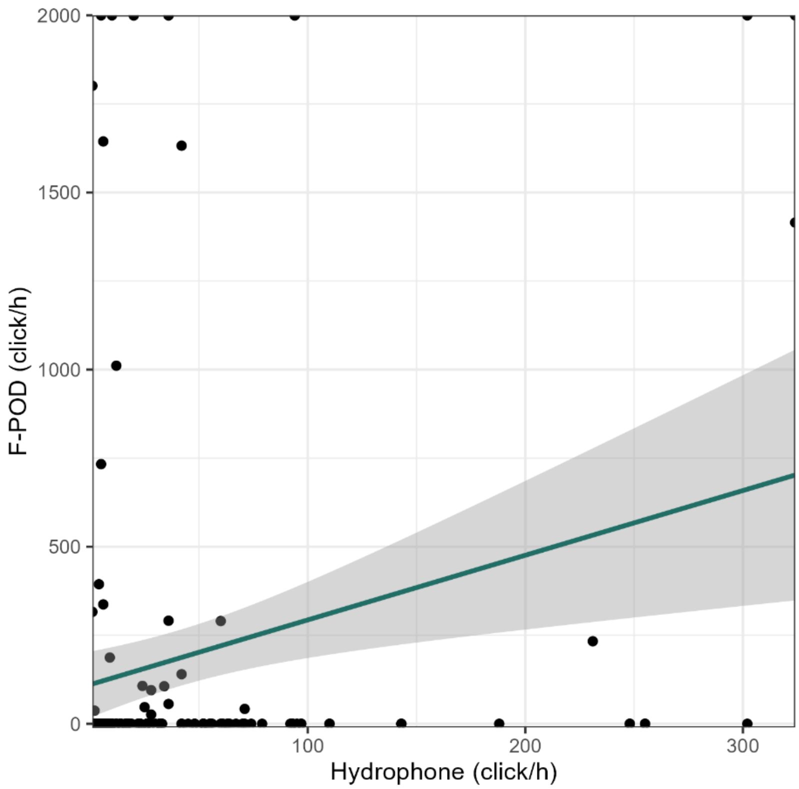


Figure 29. Detections (Number of click/h) from POD and RTsys data.

The comparison between the two acoustic systems highlights their **complementary roles**. F-PODs provided a higher rate of detections, often recording dolphin click trains even when the RTSys device did not, confirming their effectiveness for monitoring presence over long periods. Conversely, RTSys data proved more robust for **soundscape analyses**, offering higher bandwidth recordings that are crucial for quantifying anthropogenic noise and other broadband signals. This divergence highlights the importance of deploying both systems in parallel to strike a balance between sensitivity and spectral resolution.

Cetaceans' presence (F-POD analysis)

Between June 2024 and January 2025, a total of 157 fishing days were monitored using F-PODs, with detections of dolphin activity recorded on 76 days, corresponding to 48% of monitored effort. The F-POD deployments were maintained continuously during fishing operations, allowing the quantification of dolphin echolocation activity in terms of click trains per 10-minute bins, later standardized to clicks per unit effort (CPUE) (click trains per hour of net deployment).

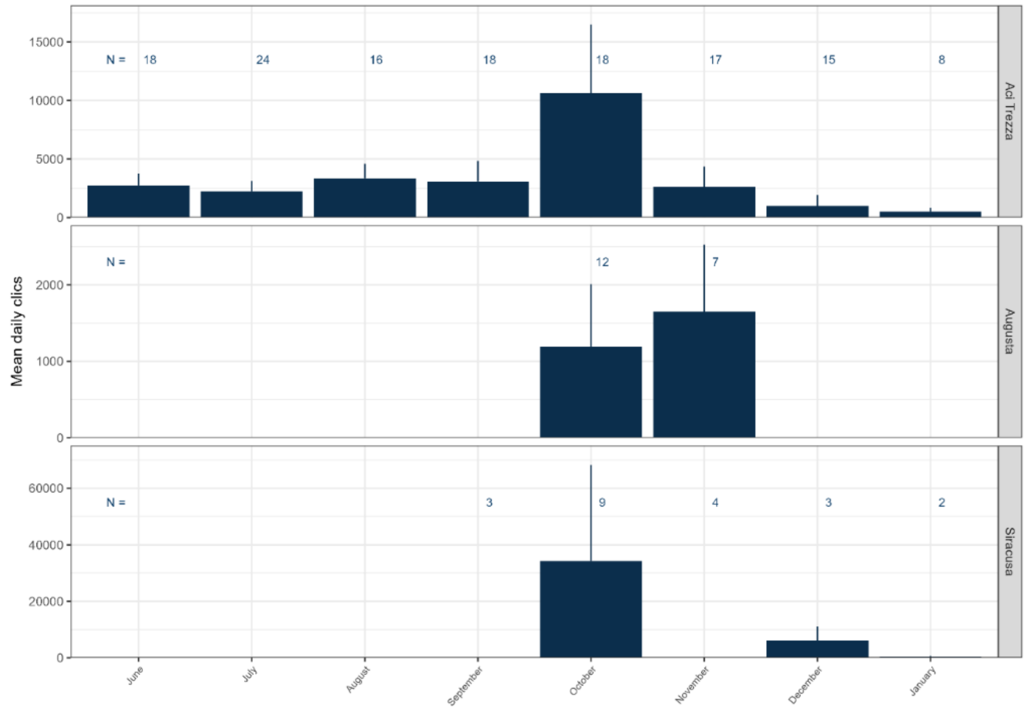


Figure 30. Dolphin daily bioacoustic activity over the study period summarized per month (mean daily CPUE/month.

The main findings are summarized in the (Figure 30) and below:

- Aci Trezza area: 118 days; peaks up to 6,000 click trains/day, monthly average ≈10,642 clicks; strongest in October.
- Augusta area: 19 days; peak ≈3,000 clicks in October; detections in November but absent in Dec–Jan (few samples).
- Siracusa area: 20 days; extreme peak >300,000 click trains (11 Oct); monthly mean ≈34,325 clicks in October; presence also in Nov–Jan at low intensity.
- Seasonal trend: Higher activity in Autumn–Winter than Spring–Summer (Aci Trezza).
- Daily cycles: Consistent detections 04:00–09:00, following sunrise (ANNEX XVIII– Daily cycle of dolphin bioacoustic activity).

In Aci Trezza, 118 fishing days were monitored between June 2024 and January 2025. The highest levels of dolphin activity were observed in October, with daily peaks reaching approximately 6,000 click trains. Monthly averages peaked at 10,642 click trains in October. Except for December and January, dolphin detections in this sub-area consistently exceeded 2,000 click trains per day. Seasonal analysis revealed a notable increase in activity during the autumn and winter periods, compared to the spring and summer months.

In Augusta, monitoring was conducted over 19 fishing days (October–January). The peak activity was again detected in October, with maximum daily values of about 3,000 click trains. The monthly mean was 1,191 click trains in October. Dolphin detections were recorded in November, while in December and January presence was marginal; however, effort in these latter months was limited (two and one days, respectively).

In Siracusa, 20 fishing days were monitored between October and January. October exhibited exceptionally high activity, with a single day (11 October) producing more than 300,000 click trains.This anomalous peak strongly influenced the monthly mean, which reached 34,325 click trains in October. Dolphin detections continued into November, December, and January, albeit with lower intensity (few click trains in November and January).

Daily cycles (ANNEX XVIII– Daily cycle of dolphin bioacoustic activity) showed early-morning activity peaks, often coinciding with **gear soak periods**, suggesting that depredation risk is higher in the first hours after sunrise. The detections were concentrated during the early morning hours (04:00–09:00), with first detections shifting progressively later as sunrise times were delayed into the winter months. In October, a significant increase in activity was observed during nighttime hours, although no consistent relationship with sunset could be established due to the limited evening monitoring effort.

Dolphin presence model

The GAM model (Table 10; Figure 31) provided valuable insights into the **drivers of dolphin presence**. The GAM identified three variables that had a significant effect on the bioacoustic activity (CPUE): sea surface temperature (SST), salinity, and density of maritime traffic.

	Estimate	Std. Error	Test value (z or χ^2)	p-value	Significance
(Intercept)	227.8	114.1	1.996	0.045	*
SST	0.382	0.173	2.208	0.027	*
Benthic temp.	0.271	0.203	1.331	0.183	
Current speed	4.661	6.147	0.758	0.448	
Primary prod.	-0.096	0.101	-0.946	0.344	
Salinity	-5.719	2.811	-2.035	0.041	*
Depth	0.004	0.008	0.468	0.640	
Slope	0.049	0.095	0.516	0.606	
Distance from coast	-0.0006	0.0007	-0.868	0.385	
Oxygen	-0.062	0.065	-0.962	0.336	
Traffic density (smoothed)	-	-	25.8	0.00003	***

*Table 10. Significance of terms (linear and non-linear relationships of dolphin presence with covariates). Significance codes: p < 0.001 '***'; p < 0.01 '**'; p < 0.05 '*'; p ~ 0.05 '.'*

Didascala tab: Significance of terms (linear and non-linear relationships of dolphin presence with covariates). Significance codes: p < 0.001 '***'; p < 0.01 '**'; p < 0.05 '*'; p ~ 0.05 '.'

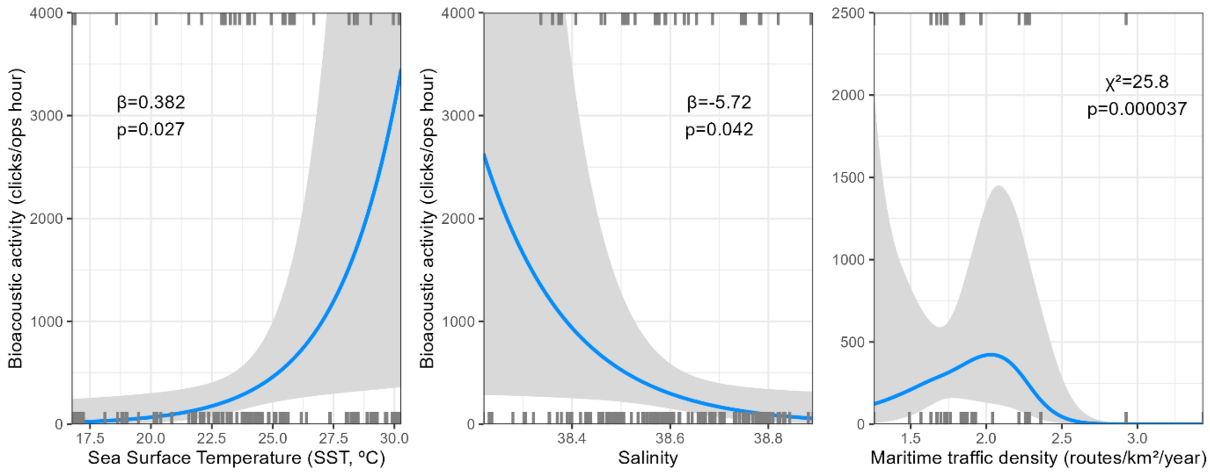


Figure 31. Partial effects of significant covariates on dolphin presence.

Below are the main findings:

- Significant predictors: SST (positive), salinity (negative), maritime traffic density (non-linear hump-shaped).
- Traffic densities exceeding 3 tracks/km²/year led to decreased dolphin activity.
- The model explained 11.7% of the deviance (moderate explanatory power).

Gear type and moon phase were not included in the final model, as their inclusion did not increase the deviance explained and rendered the other partial effects less clear. The complete set of covariates, including parameters and significance, is shown in Table 10.

Higher **sea surface temperature** was positively correlated with detections, consistent with known seasonal aggregations of prey in warmer surface waters. In contrast, **salinity showed a negative effect**, potentially reflecting the influence of riverine inputs and productivity gradients. Maritime traffic density had a **non-linear relationship**: dolphin detections increased at low-to-moderate traffic densities but dropped beyond a threshold of ~3 tracks/km²/year, suggesting that **intense vessel disturbance displaces dolphins**. The adjusted R-squared value for the global model was -0.288, indicating that the model suffers from overfitting. The deviance explained was 11.7%, suggesting moderate-to-low explanatory power. Interestingly, the intercept appears as a statistically significant factor, suggesting that baseline dolphin presence is nonzero even in average conditions, or, in other words, dolphins are present even when none of the measured environmental factors strongly influence them. It provides a baseline for linking dolphin presence with environmental and anthropogenic pressures.

Gear-specific activity

An analysis was conducted to specifically demonstrate the difference in recorded dolphin activity (Number of Clicks per Unit Effort) between Trammel and Single Wall Net (SWN), as shown below.

76 fishing days were monitored with SWN (all from the area of Aci Trezza) while 81 with Trammel net (N = 42, 19, and 20 fishing days with Trammel in Aci Trezza, Augusta, and

Siracusa, respectively). The boxplot analysis (Figure 32) showed higher values and variance in recorded dolphin bioacoustic activity related to SWN: the median value is located around 100 click trains per unit effort whereas 50% of the recorded daily bioacoustic activity lies between 0 and 400 click trains, with maximum value (1.5 times the inter-quartile difference) at around 1000 click trains and minimum at 0. For Trammel net, all boxplot diagnostics are very low, with a median value close to 0 and a maximum of around 30 click trains per unit effort.
Overall, a higher probability of dolphin interaction with SWN is observable compared to Trammel (Mann-Whitney test, $U = 4029$, $p = 4.8 \times 10^{-6}$).

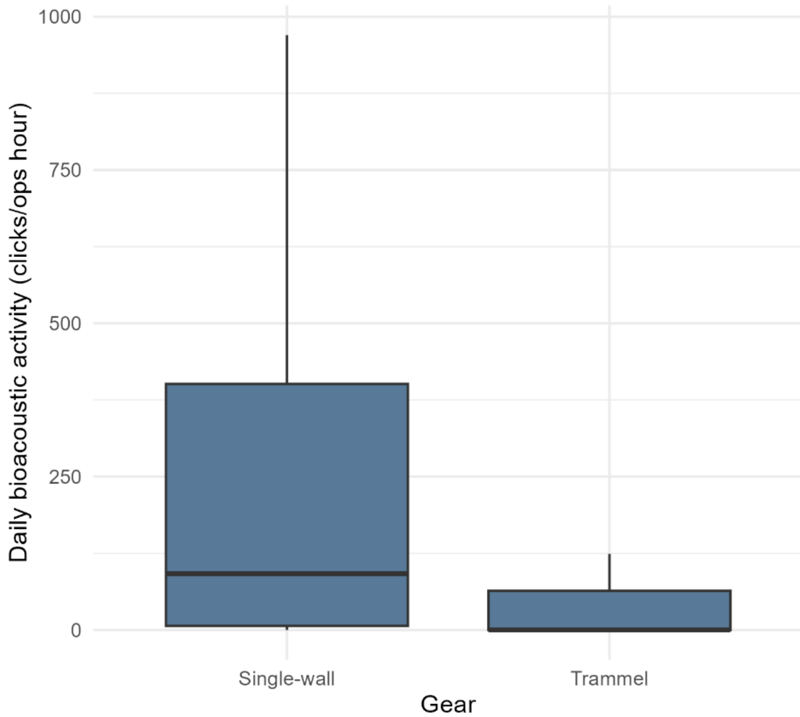


Figure 32. Dolphin activity per gear type.

Behavioural analysis

The behavioural patterns arising from the analysis of ICI in recorded dolphin click trains vary across the three locations: Aci Trezza, Augusta, and Siracusa.

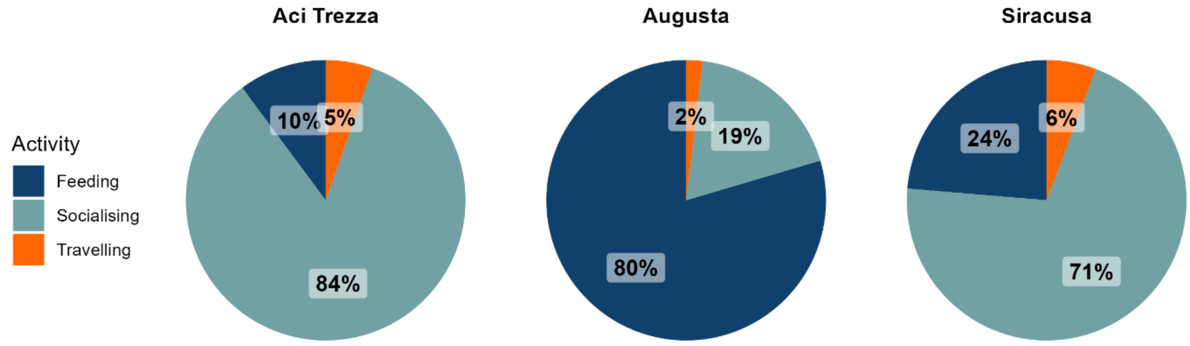


Figure 33. Preliminary behavioural patterns identified from POD data using the ICI as the main factor for assigning behavioural categories.

The summarized findings are shown in the (Figure 33) and below:

- **Aci Trezza:** 84% socialising, 10% feeding, 8% travelling.
- **Augusta:** 80% feeding, 19% socialising.
- **Siracusa:** 71% socialising, 24% feeding, 6% travelling
- Hourly data: peaks occur between 04:00 and 07:00; high-activity days (>10,000 clicks) exhibit unimodal or bimodal bursts (ANNEX XIX – Preliminary hourly behavioural analysis).

Based on the behavioural classification used, in Aci Trezza, the dominant activity appears to be socialising, accounting for 84% of observed behaviours, suggesting that this area may be viewed as primarily a social hub. Feeding is at 10%, while travelling is even lower at 8%.

Conversely, Augusta exhibits a stark contrast, with 80% of recorded dolphin activity dedicated to feeding. Socialising is considerably lower at 19%, and travelling is almost negligible at 2%, implying that dolphins recorded here were more focused on sustenance than on social interaction or movement.

In Siracusa, dolphin activity is more balanced compared to the other two locations. Socialising is the most frequent behaviour at 71%, but feeding is also relatively prominent at 24%. Traveling is slightly more common than in the other locations, at 6%, although it remains the least frequent behavior among them.

Furthermore, hourly behavioral patterns were analyzed (ANNEX XIX – Preliminary hourly behavioural analysis).

Based on data pooled from all sub-areas the hourly behaviour of dolphins recorded during the daytime exhibits distinct activity patterns, with peak activity occurring between 4:00 AM and 7:00 AM. During this period, socializing is the most dominant behavior, followed by feeding, while traveling remains minimal yet more pronounced during the peak activity hours (4:00 AM and 7:00 AM). After 7:00 AM, a gradual decline in activity is observed, with fewer click trains recorded across all behavioral categories, and the traveling category almost disappears. Notably, there is no fishing effort and no recordings between 10:00 AM and 5:00 PM; hence, no insights can be drawn about dolphin behavior during these hours. A slight resurgence of activity is observed in the late afternoon (after 8:00 PM), particularly in socializing and feeding behaviors, with traveling remaining marginal to absent. The periods of activity shown here are coherent with the temporal analysis of dolphin presence presented in previously.

Furthermore, bioacoustic data recorded in Aci Trezza (ANNEX XVIII– Daily cycle of dolphin bioacoustic activity) indicate slightly lower dolphin activity in the evening and late morning, as well as an overall lower proportion of feeding behavior than the results obtained with pooled data, while still exhibiting dominant socializing behavior.

Finally, we examined the proportion of different behavioral categories and hourly activity distribution after excluding days with fewer than 10,000 clicks, to focus on high-activity days (N = 11) only. However, this threshold (10,000 clicks) is quite arbitrary and is subject to further refinement.

Focusing on high-activity days only, we observe that most come from the sub-area of Aci Trezza (10 out of 11). Also, whereas the travelling behavioural category almost disappears, the socialising category remains dominant. Furthermore, each day we observe the absence of recordings for most fishing times and intense dolphin bioacoustic activity concentrated in a single period, which may last one or more hours. However, in 2 out of 11 high-activity days (October 1st and 27th), we can clearly observe a bimodal presence (i.e., two periods of intense activity separated by a long silent interval, which lasted 3 hours in one case and 5 hours in the other).

All the results of the behavioural analyses should be considered preliminary, as more robust approaches may be developed to address these analyses on F-PODs data.

4.3.2. Underwater noise monitoring and soundscape characterization

The study of the acoustic environment comprises two parts: the analysis of underwater noise levels, presented in this section, and the characterization of the underwater soundscape. All the analysis was conducted on RTSys datasets. Hydrophone deployments further enriched the dataset. The RTSys SYLENCE-LP recorder, equipped with HTI-99-HF hydrophones, deployed on a monofilo in Aci Trezza, collected 182 hours of data, identifying 145.3 minutes of dolphin vocalizations. The Zoom H5, equipped with HTI-96-MIN hydrophones and operated from the research vessel, acquired 33 hours of recordings, which revealed 320 minutes of dolphin activity. These results confirmed the feasibility of integrating mobile and stationary acoustic monitoring to capture both local and broader-scale cetacean presence.

Underwater noise

The underwater noise monitoring analyses presented in this section are the following:

i) an analysis of the sound energy distribution in third-octave bands per fishing day;
ii) an analysis of broadband noise values per fishing day;
iii) a seasonal analysis of broadband noise level statistics over the study period.

Across the 44 fishing days we analysed (ANNEX XX– Temporal variation of third-octave band noise levels), third-octave band noise levels displayed consistent spectral patterns, with the highest levels generally occurring in the lowest frequency bands (25–203 Hz) and progressively lower levels at higher frequencies (up to ~20 kHz). Low-frequency bands showed the greatest temporal variability, with several days characterised by pronounced peaks exceeding 100 dB re 1 µPa²/Hz, and in some cases surpassing 120 dB re 1 µPa²/Hz (e.g., 2024-10-23, 2024-11-03, 2024-12-10, 2024-12-30, 2025-01-02). These high-intensity events were typically concentrated in the 25–64 Hz bands and were often accompanied by elevated levels in adjacent bands up to ~512 Hz. In contrast, several days exhibited relatively stable conditions, with minimal fluctuations across all frequency bands (e.g., 2024-09-23, 2024-10-11, 2024-11-18, 2024-11-24). Mid-frequency bands (256–1290 Hz) exhibited moderate variability, whereas high-frequency bands above ~2.5 kHz remained largely stable throughout the study period, with typical levels ranging from 65 to 85 dB re 1 µPa²/Hz.

ANNEX XX– Temporal variation of third-octave band noise levels also shows, as grey bars, the periods with the presence of dolphins as recorded from F-POD data, to allow a preliminary qualitative analysis of the relationship between dolphin presence and underwater noise.

For greater clarity, a single graph is extracted from Figure 20 and discussed separately to illustrate how analyzing individual days can provide more insights. The graph is selected arbitrarily and corresponds to the fishing operation started on October 29th, 2024.

During the fishing operation that started on 29th October 2024, third-octave band noise levels exhibited marked temporal and spectral variability. Low-frequency bands (25–200 Hz) exhibited the highest amplitudes and largest fluctuations, with peaks exceeding 100 dB re 1 µPa²/Hz occurring shortly before midnight and again after 06:00. These peaks likely correspond to periods of intense vessel activity, such as gear deployment or retrieval. Mid-frequency bands (256–1290 Hz) displayed more moderate variability, with noise levels generally ranging between 65 and 85 dB re 1 µPa²/Hz. High-frequency bands above 2.5 kHz remained relatively stable throughout the day, with levels typically below 80 dB re 1 µPa²/Hz and limited temporal fluctuation. Two distinct quieter periods were observed during the night, coinciding with the grey-shaded intervals in the figure, where low-frequency energy was reduced and spectral levels across all bands appeared more stable. These patterns indicate a strong temporal correlation between fishing-related activities and elevated noise levels, particularly at low frequencies.

In the same fishing operation (started on 29th October 2024), broadband noise levels exhibited a clear rise at the start of the recording period, with the mean RMS level increasing from approximately 95 dB re 1 µPa at 21:30 to around 120 dB by 23:00. Over the same interval, the mean Lpeak rose from ~110 dB to ~135 dB, and maximum Lpeak values exceeded 160 dB, indicating the occurrence of high-intensity transient events. From midnight to the end of the session, mean RMS levels remained relatively stable between 110 and 115 dB, while mean Lpeak values stayed close to 130 dB. Maximum Lpeak values persisted at high levels throughout, typically between 150 and 160 dB, suggesting that loud impulsive or transient sounds were present across the entire fishing operationFigure 34.

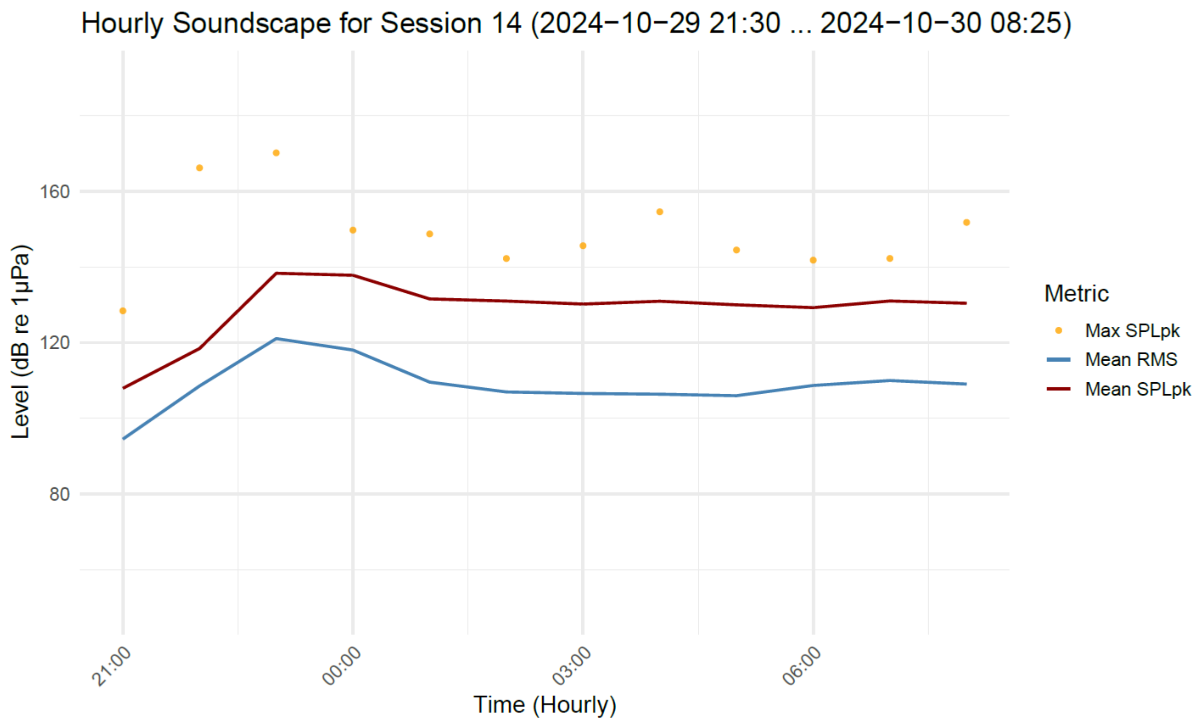


Figure 34. Broadband noise on October 29th, 2024.

Such graphs were produced for all 44 fishing days and are presented as an annexed section (ANNEX XXI– Broadband noise patterns). Across the 44 fishing operations, broadband noise patterns showed substantial variability in both amplitude and temporal evolution. In many fishing operations, noise levels rose sharply at the start of recording, often within the first one to two hours, with mean RMS levels increasing by 10–20 dB and maximum Lpeak values frequently exceeding 150 dB re 1 µPa. Several operations exhibited isolated peaks in maximum Lpeak above 160 dB, indicating the presence of high-intensity transient events.

In the majority of sessions, mean RMS levels during steady-state fishing activity typically ranged between 110 and 120 dB re 1 µPa, with mean Lpeak values around 130–140 dB. Periods of relatively stable noise levels were common during the middle phase of operations, indicating that a consistent background noise dominated by vessel presence and propulsion was present. Short-duration fluctuations, reflected in the maximum Lpeak traces, were present in almost all sessions, highlighting the recurrent occurrence of transient noise sources superimposed on the continuous background.

On some fishing days, particularly those with shorter operational durations, the profiles showed relatively flat patterns with limited variation in both RMS and Lpeak metrics. In contrast, operations involving extended time at sea displayed multiple noise peaks throughout the session. Overall, the dataset indicates a consistent baseline of elevated broadband noise during fishing operations, punctuated by frequent and sometimes loud transient events.

Over the course of the monitoring period (September 2024–January 2025), daily broadband SPL values exhibited notable temporal variability (Figure 35).

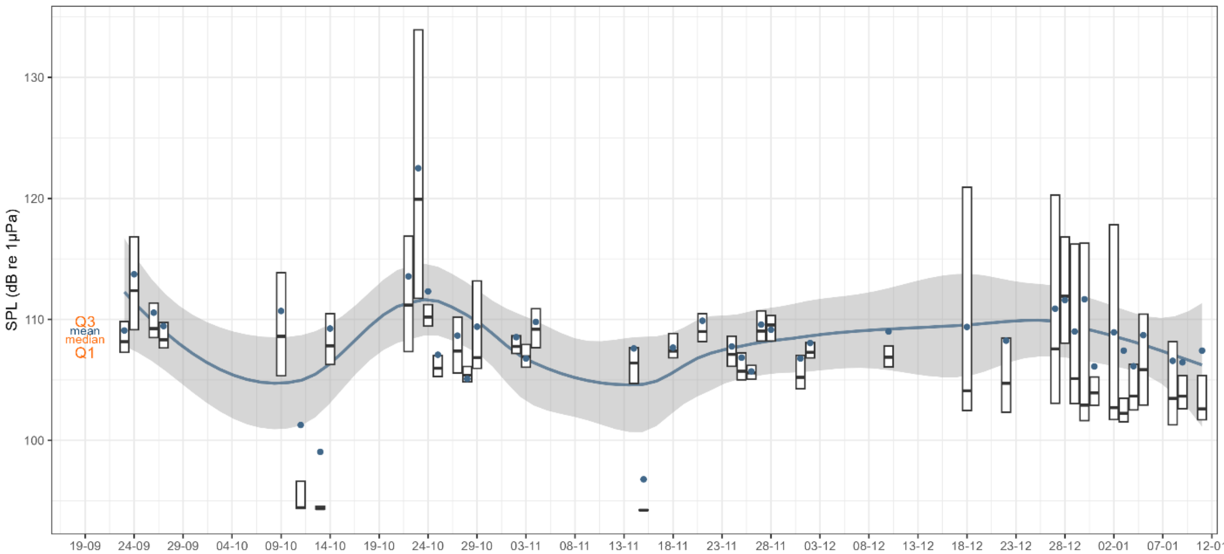


Figure 35. Temporal variation of daily broadband SPL (Lp,rms) during fishing operations (September 2024–January 2025).

Median levels generally ranged between 100 and 112 dB re 1 µPa, with one excursion at 120 dB re 1 µPa. Early in the period (late September), median values were relatively high, around 108–112 dB, before decreasing to a minimum of approximately 95 dB re 1 µPa in early October. From mid-October onwards, several days displayed markedly elevated levels, including a pronounced peak in late October (3rd quartile exceeding 130 dB re 1 µPa). Following this peak, median values fluctuated between approximately 105 and 110 dB re 1 µPa through November, with a minimum again near 95 dB re 1 µPa, and a slight upward trend in late November and early December. Towards the end of December and in early January, the daily statistics became more variable, with wider interquartile ranges.

The cubic spline fit to the daily means revealed a general decrease from late September to early October, followed by a broad increase that peaked around late October, a modest dip in mid-November, and a gradual rise towards late December, before declining slightly in January.

<u>Soundscape characterization</u>

Over the monitoring period, anthropophony associated with fishing activities was assessed through the analysis of low-frequency (LF, 25–203 Hz) and mid-frequency (MF, 256–2048 Hz) acoustic levels. The detection algorithm identified probable vessel presence in 18.8% of the 20-minute intervals analysed across all fishing days.

Daily percentages of intervals flagged for vessel presence (Figure 36) varied considerably over the study period. Some days showed no intervals meeting the detection criteria, whereas others exceeded 40% of flagged intervals, indicating prolonged or frequent vessel activity. This variability suggests differences in operational patterns, fishing effort, or environmental conditions across trips.

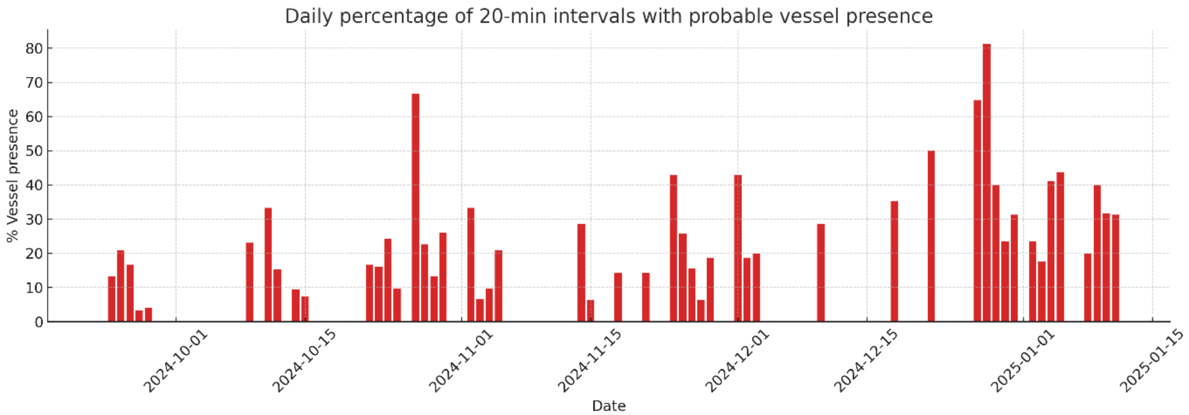


Figure 36. Proportion of time (%) with vessel-flagged 20-min segments.

Figure 36 shows mean daily noise levels in the defined bandsets. Mean daily LF levels ranged from approximately 63 dB re 1 µPa to over 78 dB re 1 µPa. Elevated LF levels were generally associated with higher proportions of flagged vessel presence, although not all high-LF days coincided with frequent detections, indicating that other factors (e.g., background shipping, local environmental noise) may also contribute to the observed low-frequency energy. MF levels were more stable across the period, typically ranging from 80 to 84 dB re 1 µPa, and showed less temporal variability than LF levels.

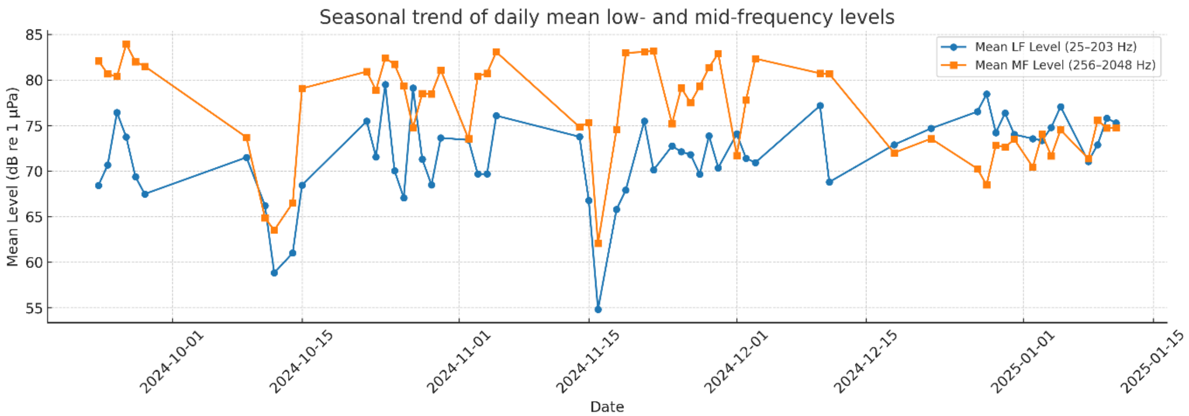


Figure 37. Seasonal trend analysis of LF and MF frequency bands

Those two key graphical outputs were generated to illustrate these patterns. The first is a bar plot showing the daily percentage of 20-minute intervals with probable vessel presence, which highlights temporal fluctuations in anthropogenic activity across the fishing season. The second is a seasonal trend plot of mean daily LF and MF levels, revealing periods of elevated low- and mid-frequency energy and their temporal distribution (Figure 37). Together, these outputs provide a coarse but consistent indicator of the occurrence and intensity of vessel-related noise during the monitored fishing operations.

The soundscape analysis continued with a characterization of biophony through the evaluation of eco-acoustic indices. The analysis used an anthropophony-proxy bandset covering 64–406 Hz, a range typically dominated by vessel propulsion noise and other low-frequency anthropogenic sources, and a biophony-proxy bandset covering 512–2,580 Hz, which overlaps with the frequency range of many fish calls and some odontocete whistles, while being less affected by the main tonal components of vessel noise.

Over the study period, daily mean NDSI values (Figure 38) fluctuated mainly between zero and 0.75. It was also observed that there were negative excursions in January. Positive NDSI periods indicate relatively greater energy in the biophony-proxy bands, while negative NDSI values reflect low-frequency dominance. Fluctuations towards or below 0 appeared to be more common during days with high vessel-presence percentages identified in the anthropophony analysis.

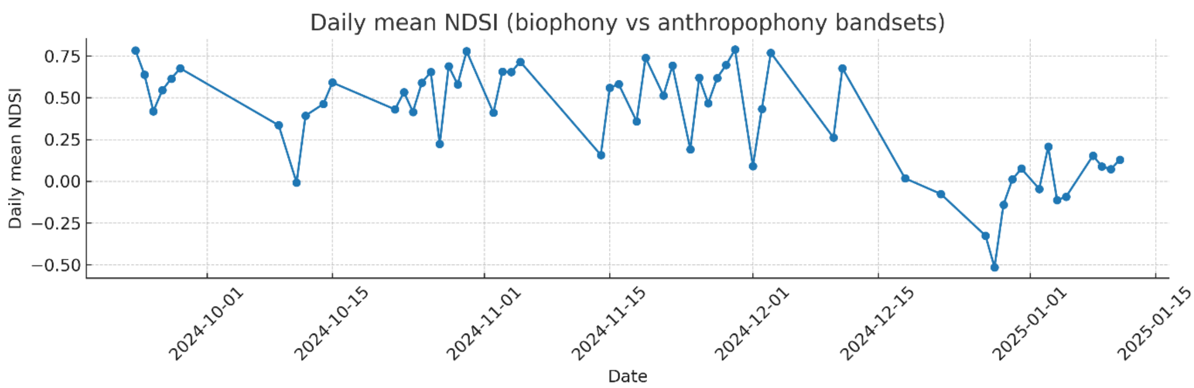


Figure 38. Normalized Difference Soundscape Index.

The Acoustic Diversity Index (ADI, calculated in the 200 Hz – 8 kHz range) exhibited moderate variation across days Figure 39. Most values ranged from 0.850 to 0.950, corresponding to acoustic energy distributed across the considered bandwidth. Higher ADI values correspond to a more even distribution of acoustic energy, indeed, while lower values suggest dominance by a limited number of frequency bands. No strong long-term trend in ADI was apparent, but short-term decreases were observed on certain days, potentially coinciding with less varied acoustic scenes.

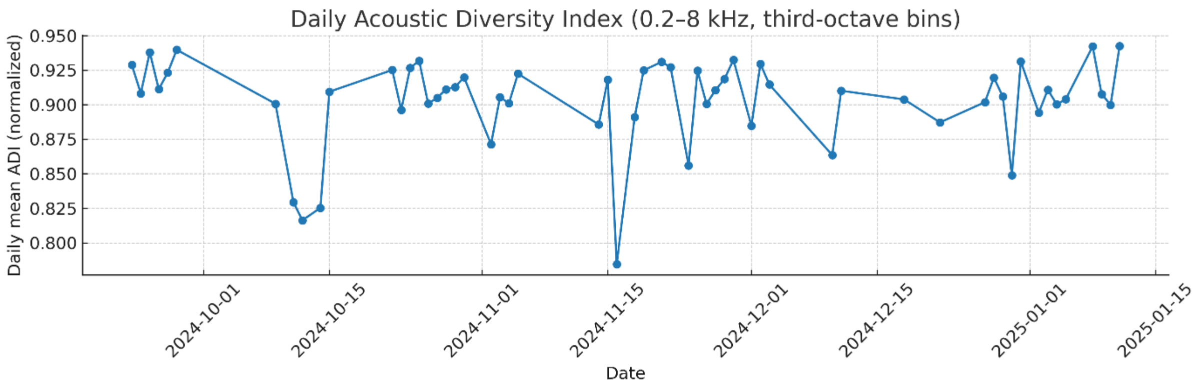


Figure 39. Acoustic Diversity Index (ADI).

The proportion of intervals flagged as biophony-dominant [512–2,580 Hz] ranged widely between fishing days, from 0% to over 30% of 20-minute intervals (Figure 40). Days with elevated biophony percentages sometimes, but not always, coincided with positive NDSI values, suggesting that both metrics captured overlapping but not identical aspects of the mid-frequency soundscape.

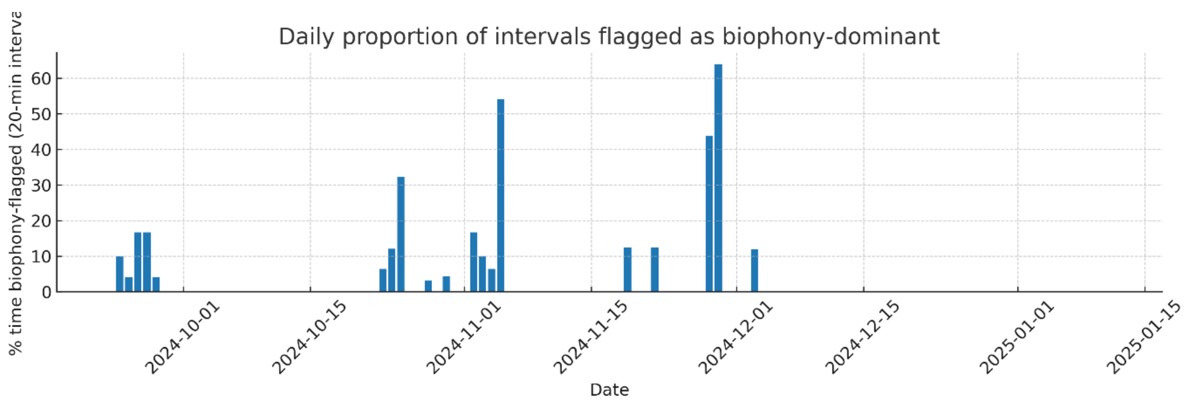
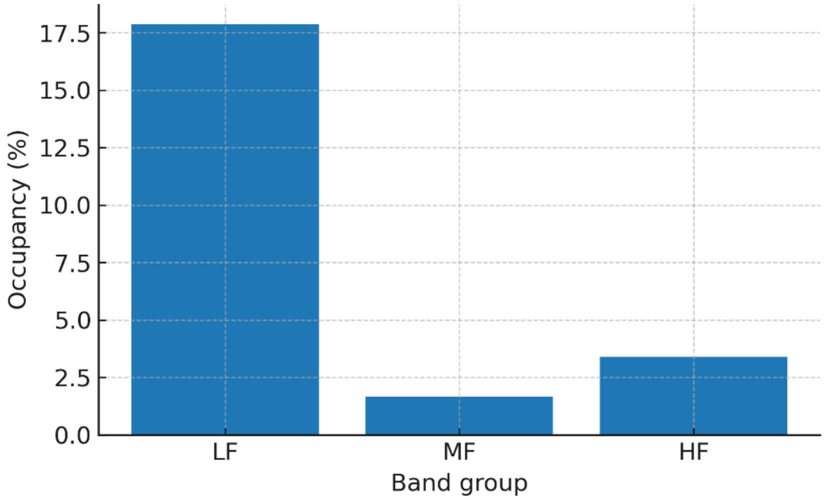


Figure 40. 20-min intervals flagged as biophony-dominant.

The spectral occupancy analysis revealed that the low-frequency group (25–203 Hz) had by far the highest occupancy (18% ca. of intervals above the baseline), indicating that elevated LF events occurred frequently during the monitoring period. By contrast, the mid-frequency group (256–2,048 Hz) showed very low occupancy (around 2%), suggesting that although mid-frequency energy was generally present at stable baseline levels, it rarely produced sharp peaks above natural variability. The high-frequency group (4,096–20,642 Hz) exhibited a slightly higher occupancy (3.4%) compared to MF, reflecting occasional but infrequent broadband transients. Overall, this pattern highlights a fundamental difference between frequency bands: low-frequency energy is event-driven and strongly linked to vessel-related anthropophony, whereas mid-frequency energy is more persistent and diffuse, potentially reflecting biological contributions but without many spiky event signatures.



4.4. Bioacoustic monitoring (Six-month extension)

The six-month extension of the Depredation-3 Project provided the opportunity to re-analyze the bioacoustic dataset collected through F-PODs during the entire project duration, including the additional deployments carried out after February 2025 in the new study area: Riposto. Unlike the first phase of acoustic monitoring (Section 4.3), which primarily focused on documenting dolphin presence, behaviour, and soundscape features, the extended analysis was conducted with different objectives and statistical approaches.

Specifically, the analysis aimed to:

- Quantify the direct relationship between dolphin encounters and fishery performance, particularly in terms of catch weight and depredation risk.
- Identify the temporal and environmental predictors that drive the probability of dolphin detections around nets, using a modelling framework adapted to fishery operations.
- Provide operationally relevant indicators to support mitigation design, with a stronger focus on the retrieval phase, which has emerged as critical for depredation events (see Acoustic Alert System).

From a methodological perspective, this second analytical phase also differed substantially from the first-year approach:

- ✓ In Section 4.3, analyses were primarily ecological, applying Generalized Additive Models (GAMs) to relate dolphin presence to environmental and anthropogenic covariates (e.g., SST, salinity, vessel traffic). Behavioural categorisation was derived from inter-click intervals, and soundscape descriptors were computed from broadband recordings.

- ✓ In the six-month extension, analyses were explicitly fishery-oriented, integrating F-POD detections with detailed catch and effort data collected by fishers. Generalized Linear Models (GLMs) with Gaussian and negative binomial distributions were applied to test how dolphin presence influenced landings and to model the probability of detections across 30-minute intervals in relation to solar altitude, soak phase, water depth, and port location.

This analysis, therefore, shifted the perspective from understanding dolphins' ecological use of the area to evaluating their practical impact on fishing activities, providing more targeted insights for management and mitigation within small-scale fisheries in GSA 19.

<u>*Data overview*</u>

- Net deployment records (Jan 2024 – Aug 2025): 247 deployments across five main harbors. Average soak times ranged from 6 to 8 hours, with two primary deployment windows: nighttime and early morning, and evening. Gear retrieval was concentrated between 06:00 and 09:00.

- Catch data: highly variable, ranging from 0 to 52 kg per set. The dominant species included *Boops boops*, *Merluccius merluccius*, *Mullus spp.*, *Sepia officinalis*, *Trachurus*

trachurus, and *Pagellus spp*.

- F-POD records: 351 fishing days monitored, yielding 4,090 minutes with dolphins detected (0.81% of total effort). Distribution across ports: Aci Trezza (1.99%), Riposto (0.93%), Siracusa (0.19%), Augusta (0.09%). In 57% of all sets, at least one minute of dolphin presence was recorded.

ANNEX XXII- Spatial PODs deployment patterns, timing and catch composition provide an overview of spatial deployment patterns and catch composition.

Of the 247 net deployments, 57% recorded at least one minute with dolphin detections (DPM). On average, each deployment recorded 17 minutes with dolphin activity. The port with the highest average detections per deployment was Riposto.
There appears to be a reduction in minutes with dolphins in periods with increased sonar activity, which may reflect either dolphin avoidance behavior or limitations in the Kerno-F assignment of cetacean trains under high sonar interference (when boat sonar was active, the F-POD instruments were less effective at detecting dolphins).

These results confirm that dolphins were regularly present around the monitored nets, though detections were concentrated in specific sites (notably Aci Trezza). Catch composition was dominated by small pelagic and demersal species, reflecting the typical small-scale fishery in GSA 19.

4.4.1. QUESTION 1: What factors correlate with fish catch weight?

A Generalized Linear Model (GLM) was implemented with the log-transformed total catch weight (log(catch+1)) as the response variable. Explanatory variables included:

- Solar altitude at the time of retrieval,
- Mean water temperature during deployment,
- Duration of net deployment,
- Port of operation,
- Time between the last dolphin encounter and the net retrieval.

This modelling approach enabled a combined evaluation of environmental conditions, operational practices, and dolphin interactions, with the explicit aim of quantifying the impacts of depredation on landings. In this analysis, the type of net was not taken into consideration.

The GLM identified several significant predictors of catch weight, illustrating the combined impact of environmental and operational conditions on landings (all results are shown in ANNEX XXIII – QUESTION 1 Outputs)

First, **solar altitude** had a strong positive effect: hauls conducted under higher sun elevations produced greater landings compared to those retrieved at night or twilight. This trend indicates that daylight conditions are favourable for catch efficiency, either by influencing fish behaviour or by facilitating retrieval.

Similarly, **mean water temperature** during deployment was positively correlated with catch. Warmer waters were associated with larger landings, suggesting seasonal or short-term thermal dynamics influence fish abundance and availability to nets.

The **duration of net deployment** also significantly influenced outcomes, with longer soak times producing higher catches. However, the model indicated a non-linear relationship: while moderate increases in soak duration improved landings, very long deployments introduced diminishing returns. These extended soak times expose nets to depredation risk and gear damage, potentially offsetting the benefits of prolonged effort.

Spatial variability among harbors was evident. Vessels from Acitrezza consistently reported the highest catches, serving as the reference category in the model. In contrast, Siracusa recorded landings at approximately half the level of Acitrezza (0.49×, $p < 0.05$). Riposto and Augusta produced intermediate values, not statistically different from the reference. These spatial patterns likely reflect a combination of ecological differences among fishing grounds, variability in fishing practices, and site-specific exposure to dolphin activity.

Together, these results establish that environmental conditions (solar altitude and temperature) and operational strategies (soak length and port of operation) are key drivers of baseline fishing performance. However, the analyses revealed that dolphin interactions introduce an additional and substantial source of variability, and that is discussed in the AAS chapter.

4.4.2. QUESTION 2: What factors correlate with dolphin presence?

This part focused on the probability of dolphin detections during net deployments, aiming to identify the temporal, spatial, and operational factors that drive dolphin presence around fishing gear. To achieve this, dolphin detections were aggregated into 30-minute intervals throughout each deployment, creating a structured time series dataset across all monitored nets.

A Generalized Linear Model (GLM) with a negative binomial distribution was applied, using the number of minutes with confirmed dolphin detections as the response variable. Explanatory variables included:

- Solar altitude,
- Deployment phase (setting, soaking, retrieval),
- Water depth,
- Port of operation,
- Water temperature,
- Gear type.

The GLM identified four variables as significant predictors of dolphin detections (all results are shown in ANNEX XXIV– QUESTION 2 Outputs): solar altitude, deployment phase, water depth, and port. In contrast, water temperature and gear type did not have a significant effect and were excluded from the final model.

The model achieved robust explanatory power, capturing the systematic patterns of dolphin presence across fishing sets:

- ✓ Solar altitude emerged as a strong predictor of dolphin detections. The probability of encounters was highest during the daytime, peaking at mid-solar altitudes, and lowest during nighttime or twilight intervals. This diurnal pattern reflects the general activity cycles of dolphins in the region, suggesting that they are more likely to approach fishing nets when visibility and prey availability are higher during daylight hours.

- ✓ The deployment phase also played a crucial role in shaping the occurrence of dolphins. Detections were significantly lower during the setting phase, when nets were being deployed, compared to both soaking and retrieval phases. During soaking, dolphins were regularly observed investigating stationary nets, with detections increasing further during retrieval, when fish are concentrated and more accessible. This confirms that the operational dynamics of fishing directly influence the likelihood of dolphin interactions, with retrieval representing the phase of highest risk for depredation.

- ✓ Water depth showed a positive correlation with dolphin detections. Nets deployed in deeper waters were more frequently associated with dolphin presence than those in shallow areas. This finding suggests that dolphins preferentially forage or patrol in deeper zones where prey density may be higher and nets provide greater opportunities for depredation.

- ✓ Port of operation was another significant factor, indicating spatial heterogeneity in dolphin activity across the study area. Nets operating from Acitrezza and Augusta exhibited higher detection rates compared to those from Riposto and Siracusa, which showed significantly lower values. These spatial differences may reflect ecological variation in prey distribution, local dolphin population densities, or differences in fishing effort among ports.

The graphical outputs included in the report clearly illustrate these effects, with modeled curves and predicted values providing strong visual evidence of how solar altitude, fishing phase, depth, and spatial location jointly shape dolphin interactions.

In summary, the model establishes that a combination of environmental and operational variables can reliably predict dolphin detections. These predictors can serve as the foundation for real-time forecasting of depredation risk, ultimately supporting the development of adaptive mitigation tools and management strategies for small-scale fisheries in the Western Ionian Sea.

4.5. Mitigation trials

A central component of the Project was the testing of mitigation measures aimed at reducing both dolphin depredation and the bycatch of vulnerable species. Trials were conducted across different gear types, following standardized protocols, to evaluate the feasibility, effectiveness, and potential integration of such measures into small-scale fisheries. Each approach was designed to address specific mechanisms of interaction, whether by deterring dolphins from approaching fishing gear or by reducing the likelihood of non-target species being caught.

The table below summarizes the mitigation strategies tested during the Project, the gears involved, and the number of trials carried out:

Mitigation measure	Fishing gear	Number of trials	No. trials done	Main object of mitigation
Echolocation disturbance	Longlines	60	60	Depredation
Visual deterrents	Trammels	60	60	Depredation
Acoustic Alert System	Single-wall net/ Trammel net	120	157-257(extension)	Depredation/Bycatch
Structural changes	*Monofilo* net	60	60	Bycatch

4.5.1. Echolocation disturbance

The trial compared fishing outcomes under two conditions, with and without applying the circular baiting mitigation technique, across a total of 60 fishing sets (30 control and 30 with mitigation). Initial attempts to use lead inserts within sardine bait (placing small weights inside the mouth and belly of the bait) were quickly deemed unsustainable and were abandoned after a limited pilot test. Consequently, the circular baiting method was adopted as the operational mitigation technique. This approach consists of threading the sardine twice through the hook shank, making it more resistant to removal by depredating dolphins. Overall, when considering all fishing trials (Figure 41), no significant difference was found in the total kilograms of fish caught between mitigated and non-mitigated longlines, as indicated by both Kolmogorov-Smirnov (KS) and

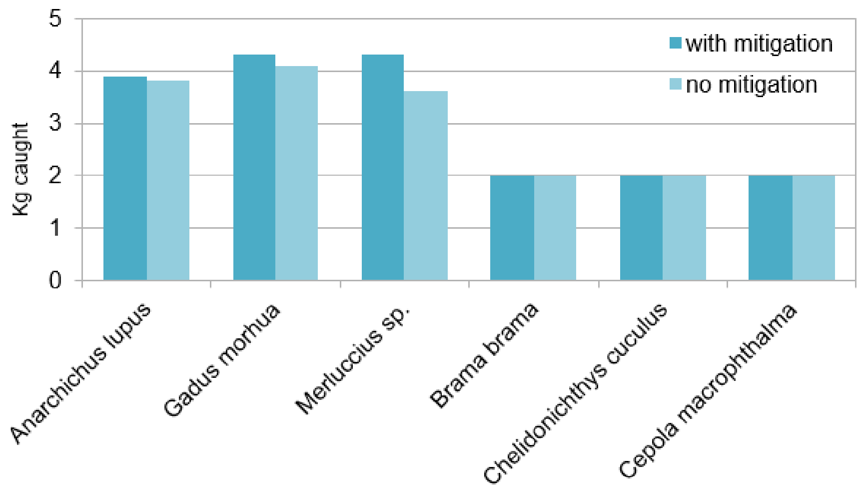


Figure 41. The graph illustrates the total weight (kg) of selected commercial species caught during trials with (dark blue) and without (light blue) mitigation devices.

Mann-Whitney (MW) tests (p>0.05).

However, a different picture emerged when analyzing data specifically from fishing sets where dolphins were present (n = 26) (Figure 42).

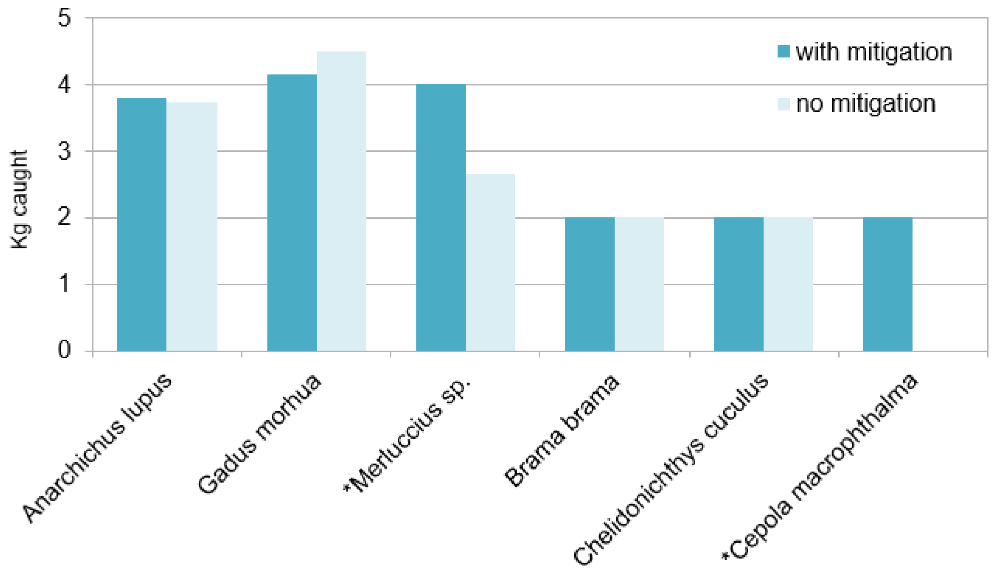


Figure 42. Comparison of catch per species (kg) under conditions with and without acoustic mitigation devices. (*) indicate statistically significant differences in catch between treatments.

In these dolphin-present scenarios, the application of circular baiting resulted in a statistically significant increase in the quantity of fish caught for two specific species: Merluccius sp. and *Cepola macrophthalma*. For *Merluccius sp*., both the KS and MW tests demonstrated a significant difference ($p < 0.05$), while for *Cepola macrophthalma*, the KS test showed significance ($p < 0.05$). These findings suggest that while the circular baiting mitigation may not impact overall catch rates across all fishing scenarios, it appears to be effective in mitigating the negative impacts of dolphin depredation, specifically leading to increased catches of particular commercially important species when dolphins are present.

4.5.2. Visual deterrents

Visual deterrents were tested as a potential mitigation measure in **trammel-net fisheries**, which represent one of the most widely used métiers in the Western Ionian Sea and one of the most affected by dolphin depredation. The rationale was that increasing the visibility of nets through light devices might discourage dolphins from approaching or depredating the catch, while leaving fishing efficiency unaffected.

Condition	No sets	Dolphin-present sets	Sets with depredation	Depredation % (all)	Catch (kg), mean ± SD	Net damage %	Bycatch events
Control nets	30	13	10	33%	15.3 ± 4.1	27%	0
Deterrent nets	30	11	8	27%	14.9 ± 4.6	35%	1 *Caretta caretta*

Table 11. Summary of trammel net trials with and without visual deterrents. Values include dolphin presence, depredation events, mean catch, net damage, and bycatch.

The Table 11 above illustrates all the main findings. A total of **60 trials** were conducted, comprising 30 control nets (without deterrents) and 30 nets equipped with deterrents. Dolphins were observed in **24 sets (40% of the total)**, specifically in 13 control and 11 deterrent sets. Overall, **depredation was recorded in 33% of control nets and 27% of deterrent nets (**Figure 43**).** Although this suggests a modest reduction in interaction frequency when deterrents were used, the difference was not statistically significant (Mann–Whitney test, $p > 0.05$). When considering only the dolphin-present sets, depredation occurred in 69% of control sets and 73% of deterrent sets, highlighting that deterrents did not reduce interactions when dolphins were actively present.

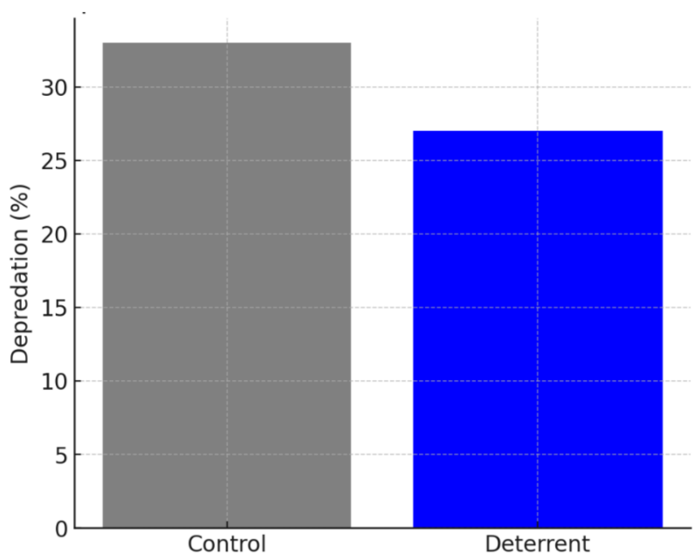


Figure 43. Depredation rates in control vs. deterrent nets.

The slight overall reduction in depredation across all sets appears to reflect stochastic variation rather than a genuine protective effect.

Catch biomass was highly comparable between the two conditions, with mean values of **15.3 ± 4.1 kg for control nets** and **14.9 ± 4.6 kg for deterrent nets**. Non-parametric tests confirmed the absence of significant differences ($p > 0.05$), indicating that the use of visual deterrents did not compromise catch efficiency (Figure 44).

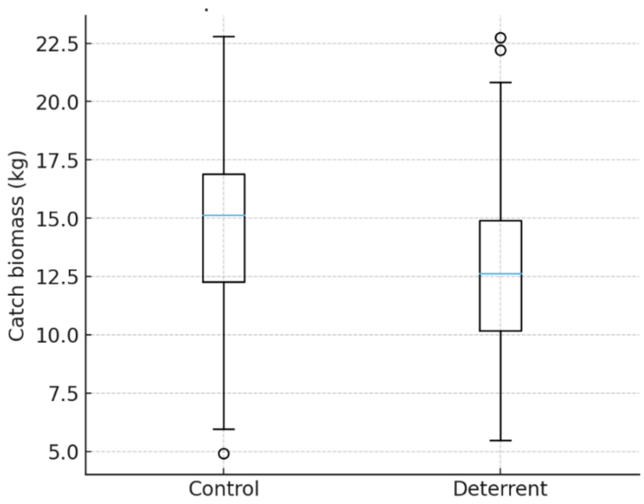


Figure 44. Catch biomass comparison between control and deterrent nets.

Net damage reports were slightly more frequent in deterrent nets (**35% vs. 27% in controls**), consistent with fishers' observations that light devices often became entangled or detached after repeated use. This reduced durability was seen as a practical limitation, raising concerns about the feasibility of large-scale application.

A notable finding was the bycatch of one *Caretta caretta* individual in a net equipped with deterrents. While isolated, this event raises concerns that visual stimuli may inadvertently increase turtle vulnerability by attracting them to the gear. This underscores the importance of testing mitigation measures not only for their effects on depredation but also for unintended ecological side effects.

In summary, the trial demonstrated that visual deterrents in trammel nets did not produce statistically significant reductions in dolphin depredation. A modest decline in interaction rates was observed when deterrents were deployed; however, this trend was not statistically significant and was accompanied by increased reports of gear fragility, as well as one recorded case of turtle bycatch.

Overall, the outcomes highlight that visual deterrents, in their current configuration, cannot yet be considered a reliable solution. However, the variability of responses across sets and the influence of environmental conditions suggest that the measure deserves further investigation.

4.5.3. Acoustic Alert System

The Acoustic Alert System (AAS) was designed to notify fishers when odontocetes approach set the nets, enabling a rapid response to minimize depredation and gear damage. During the 2024–2025 monitoring period, acoustic and operational datasets were integrated to evaluate whether such alerts could realistically reduce losses under small-scale fishing conditions along the eastern coast of Sicily. The evaluation combined: (i) continuous click-train detections from F-PODs mounted on nets and (ii) detailed net-deployment logs (timings, gear, locations, catch composition, notes). Although fishers were requested to systematically report damages to their nets, the absence of continuous observer presence on board significantly limited the reliability of this information. In practice, it proved difficult for fishers to quantify with precision both the number and the dimensions of the holes generated by depredation during each fishing set. As a result, the data received were fragmented, heterogeneous, and not comparable across vessels or gears. Given these inconsistencies, damage to gear was excluded from the quantitative analyses presented in this report, in order to ensure robustness and avoid introducing potential bias into the results.

The results presented in this chapter represent the integration of the findings obtained during the first year of the project with those derived from the additional six-month extension period.

Two timing metrics are critical for an alert-based mitigation:

1. **Reaction time to the first dolphin arrival** (proxy for the delay between an alert and the start of hauling).
2. **Proximity of the last dolphin encounter to the start of hauling** (indicator of whether depredation is concentrated at the end of the set).

F-POD detections. F-PODs were configured to extract delphinid click-trains using the KERNO classifier (species category set to “other cetaceans”). Classification quality thresholds included High, Moderate, and Low, acknowledging that segments with high vessel noise—typically at the beginning and end of operations—can lead to increased false positives. Detections were summarized at a 1-minute resolution for monitoring/triggering, and at 10-minute to hourly resolutions for analysis.

Net-deployment and catch logs. Logs provided start/end times (lowering, soaking, lifting), ports, gear types (*Monofilo*, trammel net), water depth/temperature (where available), catch weights (landings, discards, bycatch), and notes. Standardized soak/lowering/lifting defaults were applied with ±5-minute buffers to match acoustic records.

Across approximately 350 monitored fishing days using F-POD devices, dolphin detections accounted for less than 1% of the total recording time (0.81%). Nevertheless, 57% of net deployments registered at least one minute with dolphin presence. On average, each deployment recorded 17 minutes of dolphin activity, with Riposto showing the highest mean per set. The presence of vessel sonars, detected in 3.33% of the total recording minutes, likely reduced the effectiveness of F-PODs in detecting dolphins, potentially leading to an underestimation of activity levels.

Encounter structure relevant to alerting

Using F-POD minute-level detections aggregated into encounters (minimum encounter length 2 min; minimum gap between encounters 5 min), the **mean encounter duration was ~14 minutes** across sites, with maximums >1.5 hours in isolated cases (ANNEX XXIII – QUESTION 1 Outputs). The short, typical duration constrains the time window in which an alert can lead to an effective response: unless the vessel is already near the gear and prepared to haul, most encounters may begin and end before mitigation actions materially reduce depredation.

Catch outcomes vs timing of dolphin activity

Two complementary analyses were performed to link acoustic activity to landings:

1. *First-arrival timing vs landings* (reaction-time proxy). Landings were compared across categories defined by the interval between the first detected dolphin activity on a deployment and the start of lifting. Catches tended to be lower when dolphins arrived earlier (longer intervals before lifting), consistent with a longer window for depredation to occur. Gear-stratified summaries (single-wall vs trammel nets) showed the same qualitative pattern.
2. *Last-encounter proximity vs landings* (end-phase risk). A generalized linear model of log-transformed catch per deployment, retained mean solar altitude, water temperature, deployment duration, port, and the time from the start of the last encounter to the start of lifting, as significant predictors. Relative to deployments with no near-end encounters, catches were lowest when the last encounter began within ~30 minutes before lifting. Encounters starting earlier in the set (30–60, 60–90, >90 min before lifting) had catch levels similar to those of deployments without near-end encounters. This pattern is compatible with intense end-phase depredation.

Together, these two perspectives indicate that both early arrivals (longer exposure time) and near-retrieval encounters (end-phase concentration of loss) are problematic, but with different operational implications. Crucially for an AAS, the second result implies that by the time an alert is raised during a late encounter, a substantial fraction of the potential loss may already be committed, leaving minimal scope for recovery unless the response is near-instant, around 10-15 minutes.

Operational feasibility envelope for an alert-based response

Three latencies bound an AAS: (i) **detection latency** (time from dolphin presence to a reliable alert), (ii) **notification latency** (transmission + user recognition), and (iii) **action latency** (time for the vessel to reposition and begin hauling). With F-POD-based encounter means of ~14 min and the strongest catch penalties observed for encounters within ~30 min of retrieval, a conservative operational envelope emerges:

- **Alerting:** Prioritize high-specificity alerts on consecutive minutes of click-train detections near the net, favoring swift confirmation (<2–3 min) over long smoothing windows.

- **Response:** To materially reduce losses, the crew likely needs to **start hauling within ≤10–15 minutes of the initial alert** when the vessel is already proximal to the gear. If the vessel is distant or engaged in other operations, the effective window closes rapidly.
- **Net approach:** responses that require inter-site transits are unlikely to meet the timing constraints.

Modulators and trade-offs

Several covariates that influenced landings or dolphin presence also modulate AAS utility:

- **Solar altitude:** Catches increased with mean solar altitude, but dolphin detection probability also rose from twilight/night into daylight. Deploying predominantly in low-light windows may reduce interactions but can trade off catch rate and safety.
- **Deployment duration:** Longer soaks increased catch but extend the exposure window for interactions; alert value may be marginal unless hauling can be advanced promptly after a trigger.
- **Water temperature and depth:** Warmer and deeper settings affected both catch and detection probability.
- **Port/area effects:** Persistent differences among ports suggest that local density or habitat drivers are at play.
- **Vessel sonar:** Periods with active onboard sonar coincided with reduced FPOD effectiveness. An AAS should incorporate **sonar-use metadata** to adjust trigger confidence or recommend silent periods before/after deployment.

4.5.4. Structural changes

The structural modification of gillnets was introduced as a mitigation approach to reduce the risk of entanglement of dolphins and other vulnerable species, following a fatal bycatch event documented in a previous project. The strategy consisted of testing a modified monofilament single-wall net without reinforced sections at its ends (total length ~80 m). Trials were conducted in the Aci Trezza area between spring and autumn 2024. In total, 60 fishing operations were monitored: 30 with the non-reinforced *monofilo* net (mitigation trial) and 30 with the reinforced version (control trial, often used by fishers).

Monitoring included records of catch composition, bycatch events, gear condition, and operational feasibility. Results can be summarised as follows:

- No entanglement of dolphins or other vulnerable species was documented during the monitored sets with either net type. This absence does not necessarily imply effectiveness, as the probability of bycatch is inherently low in short trials. However, the absence of incidents provides preliminary reassurance that the structural modification did not increase risks.
- A noteworthy event occurred during one deployment in which a 6-kg swordfish (*Xiphias gladius*) was captured with the reinforced net. Although swordfish is not a vulnerable species, in this context, it is considered bycatch because it is a non-target species for the specific gillnet fishery tested. This result highlights that even when vulnerable species are not directly involved, structural modifications may influence the spectrum of incidental captures.
- Catch rates of target species remained broadly similar between the 30 mitigation sets and the 30 control sets. Variability in daily catch was primarily attributable to environmental conditions rather than gear type.
- Visual monitoring indicated that dolphins occasionally approached the fishing grounds during the trial period, but no direct interaction with either net type was documented.
- The short timeframe and limited number of deployments make it difficult to evaluate whether dolphins perceive or respond differently to the modified structure.

The results do not provide conclusive evidence of improved mitigation through structural changes alone. Several factors contribute to this outcome:

- Low event frequency: Bycatch events of large marine vertebrates are rare and stochastic. A limited number of sets (30 per treatment) is unlikely to capture a statistically significant difference.
- Complexity of interactions: Depredation and entanglement risk are influenced by behavioural patterns of dolphins, prey availability, and environmental variability. Structural changes to the net may play only a marginal role without complementary strategies.
- Non-target bycatch considerations: The capture of swordfish underscores that structural modifications do not eliminate the incidental capture of non-target species, and in some cases may even alter catch composition in unexpected ways.

4.6. Fisher feedback and operational feasibility

Understanding how mitigation measures are perceived and managed by the fishing community is as important as evaluating their ecological performance. During the project, information was collected through updated questionnaires administered in the final months, during the systematic observations of landings by port-based observers, and targeted interviews with fishers directly involved in the trials. Together, these complementary approaches provided a rich picture of how fishers evaluate both the effectiveness and the practicality of the different mitigation strategies tested.

Fishers consistently highlighted two fundamental criteria for any mitigation:

(i) that it must not significantly reduce the target catch or increase operational time;
(ii) that it must not be expensive;
(iii) that it must be simple enough to be integrated into daily routines without requiring additional human resources or complex handling.

Against this backdrop, perceptions of the tested measures varied considerably, but some common threads emerged.

Acoustic Alert System (AAS)

While technologically innovative, the Acoustic Alert System divided opinions. Fishers recognised its potential value in theory, as real-time information about dolphin presence could help them decide when to haul their nets. However, both interviews and questionnaire responses emphasised doubts about its practical feasibility. Many reported that by the time an alert was received, dolphins had often already caused damage, particularly when multiple nets were deployed or when the vessel was far from the gear. Confidence in the system was further eroded by occasional false alarms and missed detections. The consensus that emerged was that the AAS could be a useful complementary tool if implemented, but it could not be relied upon as a stand-alone solution.

Echolocation Disturbance

A separate line of experimentation tested the use of different bait positions to interfere with dolphin echolocation near the longline. The fisher who carried out the trial expressed strong enthusiasm and has continued applying the technique, despite the additional time required to arrange the bait differently from standard practice. One limitation highlighted is that the mitigation effect applies only to the bait and not to the catch itself; however, within the framework of this project, we demonstrated an increase in commercially important target species.

Structural Changes

The trial with non-reinforced *monofilo* nets was generally received more neutrally. Fishers reported that the modified nets were manageable and did not complicate hauling or setting. They appreciated that catches of target species were broadly comparable to those from conventional nets, meaning that there was no obvious economic penalty. In fact, from both an economic and time perspective, no differences were reported compared to standard practice. Since the issue primarily concerns conservation and the reduction of bycatch, and although not all fully grasp its importance, the fishers consulted indicated that they would be willing to avoid reinforcing the nets if this could help prevent harm to vulnerable species.

Visual Deterrents

Visual deterrents were easy to deploy and did not interfere with fishing operations, which fishers appreciated. The questionnaire results showed that fishers were willing to use visual deterrents again, mainly because they required minimal effort; however, their expectations of long-term effectiveness were low.

Cross-cutting perspectives

Economic considerations: Fishers reiterated that solutions must safeguard income. Even small reductions in catch or increases in workload undermine adoption.

Operational feasibility: Passive measures (structural changes, visual deterrents) were considered more realistic than active systems (AAS, echolocation disturbance), which required constant attention or reaction, but probably because they required less effort.

Trust and collaboration: Across data sources, fishers valued being part of the trials and expressed openness to future cooperation, especially if measures are co-designed to align with their practical constraints.

4.7. Species of Concern and Non-target Observations

A total of **65 bycatch events** were recorded between **June 2024 and February 2025**. The majority involved **sharks (42 events, 65%)**, followed by **rays (5, 8%)**, **sea turtles (4, 6%)**, **dolphins (1, 2%)**, and **sunfish (2, 3%)**. In addition, **alien fish observations (11 events, 17%)** were documented.

- **Dead:** 46 cases (71%)
- **Alive:** 10 cases (15%)
- **Almost dead:** 7 cases (11%)
- **Released alive:** only 2 individuals

Mortality remained consistently high, particularly among elasmobranchs. Turtles occasionally survived and were released; however, survivorship rates were generally very low.

The most frequently recorded non-target taxa were:

Species (English name)	Scientific name	Italian name	No. records	IUCN status (Mediterranean)	GFCM consideration (from report MedByCatch, 2016)
Small-spotted catshark	*Scyliorhinus canicula*	Gattuccio	23	**LC** (Least Concern)	Not listed under SPA/BD, CITES, CMS; **Not listed under GFCM**. Commercial species in parts of the Mediterranean.
Sharpnose sevengill shark	*Heptranchias perlo*	Squalo manzo	10	**VU** (Vulnerable)	SPA/BD Annex III; **GFCM/42/2018/2**.
Smooth-hound (group)	*Mustelus spp.* (*M. mustelus*, *M. asterias*, *M. punctulatus*)	Palombi	9	*M. mustelus* VU; *M. asterias* VU; *M. punctulatus* DD	*M. mustelus*: SPA/BD Annex III; **GFCM/42/2018/2** . *M. punctulatus*: SPA/BD Annex III; **GFCM/42/2018/2** . *M. asterias*: not listed under GFCM in the report.
Electric rays	*Torpedo* spp. (*T. torpedo*, *T. marmorata*)	Torpedini	5	**LC**	Not listed under SPA/BD, CITES, CMS, or GFCM.
Loggerhead turtle	*Caretta caretta*	Tartaruga caretta	4	**LC** (Mediterranean subpopulation)	SPA/BD Annex II; CITES Appendix I; CMS Appendices I, II; **GFCM/35/2011/4**.
Striped dolphin	*Stenella coeruleoalba*	Stenella striata	1	**VU**	Listed in the vulnerable species bycatch; included among

					cetaceans of Mediterranean concern.
Ocean sunfish	*Mola mola*	Pesce luna	2	VU (global, not regional)	Not mentioned in the report; no GFCM listing.

- **Small-spotted catshark (*Scyliorhinus canicula*)** – 23 records (35%).
- **Sharpnose sevengill shark (*Heptranchias perlo*)** – 10 records (15%).
- **Smooth-hounds (*Mustelus spp.*)** – 9 records (14%).
- **Electric rays (*Torpedo spp., T. ocellata*)** – 5 records (8%).
- **Loggerhead turtle (*Caretta caretta*)** – 4 records (6%).
- **Striped dolphin (*Stenella coeruleoalba*)** – 1 record (2%).
- **Sunfish (*Mola mola*)** – 2 records (3%).

These observations highlight the disproportionate impact on elasmobranchs and the occurrence of protected species such as dolphins and turtles, whose incidental capture, even at low frequencies, is of particular conservation concern. Bycatch events were concentrated around Acitrezza (41 events, 63%), followed by Ognina–Siracusa (15 events, 23%) and Riposto (6 events, 9%), with only isolated cases reported from Catania, Augusta, and Portopalo di Capo Passero. It is essential to note that these figures are derived from reports provided by fishers, not exclusively from those formally contracted, but also from other participants in the broader Floating Laboratories Network. Nevertheless, we encountered significant challenges in being notified each time a bycatch occurred, often learning of events only retrospectively or in an incidental manner. This reporting limitation should be taken into account when interpreting the spatial and numerical distribution of bycatch events, which differ significantly from the results derived from interviews and logbooks.

Alien fish observations

Alien fish accounted for **11 records (17%)** of the dataset:

- **Rabbitfish (*Siganus spp.*)** – 5 records – only genus-level taxa recognized by fishers
- **Dusky spinefoot (*Siganus luridus*)** – 4 records
- **Bastard grunt (*Pomadasys incisus*)** – 2 records

These species represent established **non-indigenous taxa** in the Mediterranean. Siganids are typical Lessepsian migrants from the Red Sea, while *P. incisus* is an Atlantic-origin colonizer. Their incidental capture confirms their presence and integration in coastal ecosystems of eastern Sicily, with potential ecological implications for local fisheries and habitats.

Although our fishers of the Floating Lab have not caught the lionfish (*Pterois miles*), several reports from divers indicate that the species has recently appeared in eastern Sicily. Over the past year, sightings have been recorded along the coast of Siracusa, and this summer an individual was observed near Catania. These diver-based observations confirm the ongoing spread of this invasive species in the central Mediterranean.

5. DISCUSSION AND RECOMMENDATIONS

5.1. Summary of the main monitoring findings

Monitoring Aspect	Findings (Quantitative)	Implications
Scientific vessel surveys	80 surveys (881.8 NM); 32 cetacean sightings: bottlenose dolphins (n=14), striped dolphins (n=17), unidentified (n=1). Depredation behavior observed in 12.5% of sightings (4 of 32).	Confirms overlap of dolphins with fishing grounds, both species involved in depredation.
Logbooks (949 analyzed)	Bycatch recorded in 142 logbooks (14.9%). Depredation in 28.9% of trips. Gear-specific depredation frequency: Menaide 40%, Monofilament nets 13.7%, Longlines 30.2%, Trammel nets 31.9%.	Depredation is frequent and gear-dependent, with nets most affected.
Bycatch composition	65 bycatch events (June 2024–Feb 2025): sharks 42 (65%), rays 5 (8%), turtles 4 (6%), dolphins 1 (2%), sunfish 2 (3%), alien fish 11 (17%). Mortality: 71% dead, 15% alive, 11% moribund, 2 released alive.	Elasmobranchs most impacted, but protected species (turtles, dolphins) also present; high mortality stresses conservation urgency.
Spatial hotspots	Bycatch concentrated: Acitrezza 41 events (63%), Ognina–Siracusa 15 (23%), Riposto 6 (9%); sporadic in Augusta, Portopalo.	Prioritization of mitigation in Acitrezza and Siracusa.
Seasonality	Turtle bycatch peaks in summer–early autumn; sharks/rays slightly higher in spring. Depredation occurs year-round with summer peak (especially menaide).	Seasonal restrictions could target turtle hotspots in summer/autumn. Depredation is frequent year-round, so the mitigation methods had to be used during all seasons.
Economic impact	Gear-specific mean losses per event: Menaide 35–40%, Monofilament 10–20%, Trammel 15–25%, Longline 5–15%. Annual average costs: Monofilament €7,000, Longline €3,950, Trammel €8,130, Menaide €7,500, Palamitara €10,000.	Substantial recurring costs; nets most vulnerable; cumulative impact threatens economic sustainability.
Acoustic monitoring (F-PODs)	157 fishing days: dolphin detections on 76 days (48%). Peaks: Aci Trezza up to 6,000 click trains/day; Augusta peak 3,000; Siracusa detections persistent until Dec.	Confirms frequent dolphin presence near nets; acoustic monitoring effective complement to sightings.

5.2. Conservation issue: the bycatch of vulnerable species

Bycatch of vulnerable species was a recurrent, though less frequent, interaction compared to depredation; yet, it remains a critical conservation issue in the Western Ionian Sea. Data were derived from fishers' logbooks, boarding surveys, and scientific vessel observations, providing complementary perspectives on the occurrence, species involved, and spatial distribution of bycatch events.

Logbook records supplied by the Floating Laboratories network indicate that fishers experienced bycatch episodes across all four macro-areas, with varying intensity. The most frequently reported species groups were sea turtles (particularly *Caretta caretta*) and elasmobranchs (rays and small sharks), followed by incidental captures of seabirds and occasionally cetaceans. Reports highlighted that bycatch was often associated with the use of gillnets and trammel nets, particularly in shallow coastal areas with mixed or rocky seabeds. Longlines, while less often associated with cetacean entanglement, occasionally caught turtles and pelagic sharks.

Boarding surveys provided direct evidence of bycatch, allowing observers to document both the circumstances of capture and the condition of the animals upon retrieval. Most sea turtles were recorded alive at the moment of gear hauling and were released back into the sea; however, in some cases, injuries from entanglement or hooks were evident. Bycatch of rays and small sharks was more variable, with survival depending on hook location and duration of gear deployment. These in situ records add precision to fishers' reports by linking events to specific gear characteristics, depth strata, and effort patterns.

Seasonality played a significant role: turtle bycatch peaked in summer and early autumn, coinciding with the species' migratory and foraging activities in coastal waters. Shark and ray bycatch exhibited a more diffuse distribution across seasons but was slightly more prevalent in spring, when nets were primarily targeting demersal species.

Overall, bycatch results confirm the disproportionate vulnerability of sea turtles and elasmobranchs in small-scale fisheries of the Western Ionian Sea. The combination of logbooks, observer reports, and scientific surveys provides robust evidence of the spatial and temporal patterns of bycatch. These findings reinforce the urgent need for targeted mitigation strategies—such as gear modifications, spatial-temporal fishing restrictions, and fisher training on safe handling and release protocols—to reduce the incidental capture of these threatened species.

Two implications follow:

1. Conservation prioritization for cetaceans in this context should focus on depredation (behavioral interactions and gear damage) rather than on direct bycatch, which is negligible in records and consistent with findings from Depredation-1 and Depredation-2.

2. Bycatch mitigation within this fishery portfolio would primarily benefit elasmobranchs and turtles (and locally seabirds in longlines). This supports the Project's emphasis on safe-release practices and the recording of biological details during Bycatch sampling activities.

Where available, species-level annotations from boardings/photographs confirm the expected composition for the Western Ionian Sea: small to medium demersal/benthopelagic elasmobranchs in gillnets, and mixed pelagic elasmobranchs with Cheloniidae and occasional Procellariiformes in longlines.

5.3. The Depredation issue

Depredation events were consistently documented throughout the study, confirming their relevance as a recurrent interaction between small-scale fisheries and cetaceans in the Western Ionian Sea. Data from fishers' logbooks, boarding surveys, and scientific vessel observations collectively provide a detailed picture of the frequency, distribution, and typology of damages attributed to dolphins.

Logbooks revealed that fishers regularly recorded instances of catch removal and gear damage, with a notable concentration of events in the Catania and Siracusa sectors. These areas coincide with higher fishing effort and the predominance of métiers vulnerable to depredation, particularly trammel nets and artisanal longlines. Reports often described partial predation of catches, bait removal, and holes in nets, which in some cases necessitated extensive repair work and replacement of gear sections. However, while logbooks provide valuable insights into the frequency and nature of these interactions, their reliability should be interpreted with caution. There remains a possibility that fishers may over-report dolphin depredation, either consciously or unconsciously, due to the strong economic and social relevance of these events. For this reason, cross-validation with observer-based monitoring is essential to ensure a balanced interpretation of the results.

Observers documented several depredation events in situ. These events were unevenly distributed along the coast: while depredation was sporadic in the northern macro-area (Messina–Riposto), events were recorded more consistently in the central and southern macro-areas (Catania, Siracusa, Portopalo). The variability in depredation intensity is linked to differences in fishing gear, bathymetry, and the composition of target species. Nevertheless, it is important to note that observer coverage was necessarily limited in time and space, making it difficult to capture the full extent of depredation events. A more continuous and daily monitoring effort would be required to provide a comprehensive and systematic picture of interaction patterns across the study area.

Scientific vessel surveys added an independent layer of information by mapping the spatial overlap between dolphin presence and fishing grounds. In both Catania and Siracusa, bottlenose dolphins (*Tursiops truncatus*) were sighted repeatedly within areas heavily used by artisanal fishers. Although direct depredation was not always observed during these surveys, the spatial co-occurrence strongly supports the fishers' testimonies and the data collected during boarding.

This highlights the importance of adopting a multi-platform strategy to assess depredation risk. While bottlenose dolphins remain the primary species intertacting with fishing gears in GSA

19, integrating visual, acoustic, and fisher-based data is essential to fully evaluate the potential role of striped dolphins and other species whose interactions may be subtler or less directly observable.

From the quantitative perspective, the data shows that depredation accounted for a significant fraction of interaction records. Events were reported across all four macro-areas, but with higher intensity in Catania (over 40% of logged interactions) and Siracusa (about 35%), while Riposto and Portopalo showed lower percentages. Most depredation involved nets, particularly trammel nets targeting demersal fish, but longline fisheries also reported frequent bait loss and hook damage. However, thanks to the acoustic monitoring, Riposto results in the highest presence of dolphin detection.

In terms of seasonality, preliminary analyses suggest that depredation was most frequently reported in spring and summer months, coinciding with peaks of fishing effort for certain target species (e.g., mullets, cuttlefish, and lobsters). This pattern aligns with previous findings from Depredation-1 and Depredation-2, indicating a persistent temporal overlap between dolphin foraging behavior and small-scale fishing activities.

Overall, the integrated dataset highlights depredation as a spatially and temporally structured phenomenon, disproportionately affecting certain métiers and areas. The results confirm both the economic significance of gear damage and catch loss for fishers, and the ecological importance of dolphin-fishery interactions in shaping fishing practices and perceptions along the eastern Sicilian coast.

From a management perspective, these results highlight the limitations of mitigation approaches that rely solely on early detection of dolphin presence during net soaking. Because the most damaging interactions occur immediately before hauling, deterrent strategies need to be specifically designed for the retrieval window. This could involve technological deterrents activated at the time of hauling, operational adjustments to reduce the predictability of retrieval times, or adaptive practices (e.g., reduction of nets soaking time) that minimize overlap between dolphin activity and fishing operations.

The increased probability of dolphin presence during retrieval, combined with the results of Question 1 showing catch reductions when dolphins are detected just before hauling, reinforces the conclusion that the retrieval phase is the key vulnerability point for small-scale fisheries. Moreover, the higher detection rates at specific ports suggest that localized strategies may be necessary, targeting high-risk areas with tailored interventions.

5.4. Evaluation of monitoring methodologies

The Depredation-3 Project relied on a multi-layered monitoring framework, combining self-reporting by fishers, onboard observer surveys, standardized questionnaires, landing site inspections, scientific vessel surveys, and passive acoustic monitoring. This integrated approach was designed to provide complementary perspectives on dolphin–fishery interactions, depredation, and bycatch. While effective in many respects, the methodology also revealed specific challenges and limitations that should be considered for future applications.

Strengths

1. **Comprehensive and standardized data collection**. The use of harmonized logbooks, observer sheets, and questionnaires—aligned with FAO–GFCM guidelines—ensured comparability across gears, ports, and seasons. This allowed a robust dataset of nearly 1,000 validated logbook entries, 80 scientific vessel surveys, and 40 observer boardings.
2. **Active fisher participation.** The Floating Laboratories network proved highly effective in engaging small-scale fishers as data providers and co-researchers. Their near real-time reporting, supported by photos and videos, significantly increased the volume and relevance of the monitoring data.
3. **Integration of acoustic monitoring.** F-PODs and hydrophones provided an independent and continuous measure of dolphin presence, even in the absence of visual sightings. Acoustic detections validated fisher reports and enabled fine-scale temporal analysis of dolphin behavior around nets.
4. **Spatial and temporal coverage.** The combination of scientific vessel transects (881.8 NM), fisher logbooks, and acoustic deployments ensured coverage from Riposto in the north to Portopalo in the south, across multiple seasons. This broad design allowed the identification of regional depredation hotspots and seasonal bycatch peaks.

Limitations

1. **Reliance on self-reporting bias.** Although fisher logbooks were essential, the project recorded 949 valid entries out of 1,200 planned, indicating under-reporting. Furthermore, some events (e.g., minor depredation or bycatch of low-value species) may have been omitted due to lack of incentive, leading to potential underestimation.
2. **Observer effort constraints.** Only 40 at-sea observer boardings were feasible, largely concentrated in Catania and Siracusa. Limited permits and logistical barriers (especially in Messina) restricted representativeness, leaving gaps in the dataset.
3. **Acoustic monitoring challenges.** While highly informative, acoustic data collection required specialized training and equipment maintenance. Device malfunctions, battery limitations, and noise pollution from intense vessel traffic (95–120 dB RMS, peaks >160 dB) reduced data reliability at times.
4. **Uneven spatial effort.** Monitoring intensity was highest around Catania and Siracusa, while Messina and Portopalo were less represented due to fewer active vessels and lower fisher participation. This skew limits extrapolation to the entire eastern cost of Sicilu (GSA 19).
5. **Species-level uncertainty.** Both fisher reports and some acoustic detections could not always discriminate between dolphin species. This introduces uncertainty in assessing the relative impact of bottlenose versus striped dolphins in depredation events.

Overall, the monitoring methodology achieved its objectives by combining complementary tools that generated a robust dataset on depredation and bycatch dynamics. The active involvement of fishers, standardized reporting formats, and integration of acoustic technologies were major strengths. However, reliance on voluntary self-reporting, logistical limits on observer coverage, and uneven spatial effort represent persistent weaknesses. Future projects could benefit from automated digital reporting platforms, expanded acoustic deployments with real-time data transmission, and broader stakeholder engagement in underrepresented ports to address these limitations.

5.5. Assessment of mitigation strategies' effectiveness and replicability

Mitigation Measure	Gear	Findings	Effectiveness & Limitations
Echolocation disturbance (circular baiting)	Longlines	No overall catch difference vs control; but in dolphin-present sets, higher catches of *Merluccius* sp. and *Cepola macrophthalma*.	Effective under depredation pressure; no catch loss; practical and eco-sustainable.
Visual deterrents (lights on nets)	Trammel nets	Depredation fell from 33% (control) to 27% (deterrent), but not significant; one *Caretta caretta* bycatch; durability issues.	Not reliable; may increase turtle bycatch; operational fragility.
Acoustic Alert System (AAS)	Single-wall & trammel nets	~350 net-days: dolphins detected in 57% of deployments; encounters short (avg. 14 min). Alerts useful only if vessel is nearby and ready to haul.	Limited standalone utility; best for haul-order reprioritisation; refinement needed (trigger logic, alert tiers, user interface).
Structural net changes	Monofilament nets	60 trials: no dolphin entanglement; bycatch included one swordfish; catches similar to controls.	No conclusive mitigation effect; feasible to deploy; needs redesign (escape panels, mesh geometry, acoustic add-ons).

Evaluation of Acoustic Alert System

- **Dolphin activity duration (DPTM):** Landings more variable and occasionally higher when DPTM ≤12; more uniform (and lower max) when DPTM >12.
- **First interaction timing:** Early arrivals (>30 min before retrieval) → higher variability; late arrivals → more stable but lower catches.
- **Gear differences:** SWN more affected; Trammel less influenced.
- **Regional differences:** Earlier interactions in Aci Trezza vs Siracusa.
- **Proxy test for 60-min alert delay:** No significant effect on landings.

5.6. Challenges in stakeholder engagement and policy implications

The experience gained during this project highlighted several interconnected challenges in engaging the small-scale fishing sector and in ensuring the institutional support necessary for effective monitoring and mitigation. A first, structural issue lies in the demographic and social profile of the fishing community. The sector is characterized by an aging workforce, with very limited generational renewal, which inevitably threatens the continuity of knowledge and practices. Those who remain active in the métier often lack formal training in ecological matters and in species identification, making it difficult for them to assess whether the organisms caught are vulnerable, protected, or ecologically significant. This gap underscores the importance of awareness-raising initiatives specifically designed for fishers, not as secondary components of data collection projects but as dedicated efforts aimed at strengthening ecological literacy. Such initiatives should emphasize the role of fishers as primary custodians of marine ecosystems, equipping them with the knowledge to recognize and protect vulnerable species while ensuring the sustainability of their own activities.

These social dynamics intersect with institutional and regulatory barriers that further hinder effective monitoring. A major limitation encountered in the project was the absence of a clear national framework regulating at-sea monitoring and observer embarkation on fishing vessels. Each port authority applied different criteria, generating delays and, in most cases, denials of authorization. Only in Catania was the project able to secure formal permits, while other ports struggled to accommodate observers. This fragmentation severely reduced data collection opportunities and weakened the representativeness of the results. Overcoming such barriers requires stronger involvement of higher-level institutions—regional administrations, national ministries, and international organizations such as FAO–GFCM—to harmonize procedures, provide clear mandates to local authorities, and secure institutional backing for scientific monitoring at sea.

Within this context, the level of trust between fishers and external actors emerged as a critical factor. Many fishers expressed skepticism not only toward researchers but also toward political and management institutions, reflecting a broader perception of exclusion from decision-making processes. Too often, they experience top-down measures imposed without consultation, which feeds resistance and disengagement. For small-scale fisheries to be safeguarded in the long term, it is essential to address this mistrust by ensuring that fishers are not merely subjects of regulation but active partners in shaping it. Their experiential knowledge must be valued, and they should be granted genuine opportunities to influence management decisions that affect their livelihoods.

The project also demonstrated that practical mechanisms can help bridge this trust gap. Offering financial compensation to fishers who actively collaborated in monitoring was not only fair recognition of their time and effort but also an effective means of fostering engagement. By placing fishers on an equal footing with researchers, these incentives reinforced their sense of ownership and participation in the scientific process. Such measures should be considered integral components of future projects if consistent and reliable data are to be secured.

Finally, the economic vulnerability of small-scale fisheries in the face of depredation must be acknowledged. Fishers reported substantial gear damage and catch loss, with recurring annual costs amounting to thousands of euros. Yet, unlike in agriculture—where compensation schemes exist for damage caused by terrestrial wildlife—no equivalent support mechanisms are available for marine depredation. Establishing financial relief systems for fishers affected by dolphin interactions would represent a crucial step toward equity, aligning fisheries management with broader conservation practices while reducing the economic burden on an already fragile sector.

At the same time, it should be recognized that depredation is only one of several pressures undermining the resilience of small-scale fisheries. Overfishing and the depletion of fish stocks, combined with rising fuel costs and broader market challenges, make the livelihood of artisanal fishers increasingly precarious. In this context, dolphin interactions are perceived as particularly severe because they add to an already fragile economic balance. If prey abundance were higher, occasional catch losses to depredation might be more easily tolerated; however, under current conditions of resource scarcity, even moderate levels of dolphin-related damage become critical for the viability of the sector.

Taken together, these challenges point to the need for an integrated strategy: one that combines ecological training and targeted awareness programs for fishers, regulatory clarity and institutional support at multiple governance levels, participatory frameworks to build trust, and financial mechanisms to buffer economic losses. Only through such a multidimensional approach can stakeholder engagement be strengthened and policy implementation rendered effective in addressing the complex issue of dolphin depredation in small-scale fisheries.

5.7. Proposals for future research

Building on the outcomes of the Depredation-3 Project, future research should follow two complementary directions that address both the technical and social dimensions of dolphin–fishery interactions.

A first priority is the further development and refinement of mitigation trials. While several approaches tested during this project—such as circular baiting on longlines, the Acoustic Alert System (AAS), and structural modifications to nets—showed promise, their effectiveness was not always consistent across gears, areas, or environmental conditions. Additional trials are therefore necessary to consolidate evidence on their performance and to adjust protocols in ways that enhance their practicality for fishers. Long-term deployments, broader replication across fleets and ports, and more systematic evaluation of ecological and economic trade-offs are essential to move from pilot-scale experiments to robust, operationally viable solutions. Refining these technologies will not only improve the reliability of mitigation measures but also facilitate their adoption within policy frameworks at the regional and Mediterranean levels.

Equally important is the social dimension of future research. The project has demonstrated that awareness-raising cannot remain a secondary activity coupled to monitoring or mitigation trials, but instead requires a dedicated program tailored to the specific needs of small-scale fishers. Such a project should focus exclusively on enhancing fishers' ecological knowledge, particularly their ability to identify vulnerable species and understand their conservation status. By engaging fishers as the first users of the sea and as crucial partners in marine stewardship, awareness campaigns can build trust, strengthen the legitimacy of management decisions, and foster a culture of shared responsibility. In turn, this will help address the generational and educational challenges facing the sector, ensuring that fishers are better prepared to reconcile livelihood needs with conservation objectives.

Future research should therefore integrate these two strands: advancing the technical refinement of mitigation measures while simultaneously investing in dedicated awareness programs. Together, they represent the most promising pathway toward reducing dolphin depredation, supporting small-scale fisheries, and securing the long-term sustainability of marine ecosystems in the Western Ionian Sea and beyond.

To ensure the successful replication of this initiative across other Mediterranean Geographical Sub-Areas, future efforts must be embedded within a coordinated framework that leverages the institutional strengths of both GFCM and ACCOBAMS. This includes harmonizing monitoring protocols, securing observer access through streamlined regulatory pathways, and establishing long-term funding mechanisms to support fisher participation and technological deployment. It is important that replication must be context-sensitive—adapting to local ecological conditions, fleet structures, and governance realities—while maintaining core principles of co-design, transparency, and scientific rigor.

By anchoring future projects within this dual framework, Mediterranean region can move toward a unified strategy that reduces cetacean–fishery conflicts, strengthens the resilience of small-scale fisheries, and advances regional conservation goals in line with international commitments (from FAO, CBD, CMS, Barcelona Convention, EU strategies, and the United Nations Sustainable Development Goals (SDGs), particularly SDG 14: Life Below Water).

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ANNEXES

ANNEX I – Timeline of the entire Project

			Months																	
Activity	**Start**	**End**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Preparatory activities and Inception report	February 2024	April 2024																		
Acquisition of permits and agreements. Selection of interns, experts, and fishers	February 2024	May 2024																		
Procurement and purchase of the equipment	February 2024	June 2024																		
Draft and approval of the monitoring and trial protocols	March 2024	May 2024																		
Interviews to fishers in the main ports	April 2024	November 2024																		
Collection of reports/logbooks from fishers on interaction with cetaceans and other marine vulnerable species	March 2024	August 2025																		
Implementation of monitoring activities	March 2024	August 2025																		
Implementation of mitigation activities	July 2024	August 2025																		
Data loading, analysis, and reporting	April 2024	August 2025																		
Interim Report I		July 2024																		
Interim Report II		February 2025																		
Internal meeting and other conferences	February 2024	August 2025																		
Final Report		August 2025																		
			1st year project period												Extension period					

Milestones
Field activities
Management

ANNEX II – Minutes of the Steering Committee meetings

MONITORING ACTIVITIES AND MITIGATION MEASURES FOR THE REDUCTION OF DOLPHIN DEPREDATION IN SMALL-SCALE FISHERIES – WESTERN IONIAN SEA (GSA19)

Minutes of the Steering Committee Meeting

Project name	Monitoring activities and mitigation measures for the reduction of dolphin depredation in small-scale fisheries - Western Ionian Sea (GSA19)
Tender	2023/CSAPC/NFIGD/123383
Contract	2023/CSLP/NFIGD/CPA-364085
Project Leader	Associazione Marecamp ODV
Project Partner	ACCOBAMS
Meeting location	**Zoom** Link https://us06web.zoom.us/j/85609625090 ID Meeting 856 0962 5090
Meeting date & time	**August 1st, 2024**, 11:00-12:00 AM UTC +2/CEST

Attendees	Organisation	Role
Paolo Carpentieri (SC)	FAO-GFCM	Contract Manager/Fishery Resources Monitoring Officer
Clara Monaco (SC)	ACCOBAMS Secretariat	Contract Manager/Project Coordinator
Alessandra Raffa (SC)	MARECAMP	Project Assistant

partially reactivated, with some difficulties in finding operational fishing vessels in the northernmost area of the study. All planned activities have been initiated, although not with the same intensity in all areas due to delays in obtaining boarding permits for observers.

All protocols, questionnaires, survey forms, and databases to be adopted for the project have been defined. A digital logbook has been created for the fishers and explained to them during individual and group meetings (https://docs.google.com/forms/d/e/1FAIpQLSdp4XdXUsb-hEMOQMCruyL7tdjMmsXO4XPdfiJa_IgR5qkx6Q/viewform?usp=embed_facebook).

Overall, the work is progressing well and, in addition to internal team meetings, meetings with fishers, and equipment test trials, it includes:

- 35 preliminary interviews distributed throughout the action area from Messina to Portopalo di Capo Passero.
- 10 observer boardings on fishing vessels in the central area.
- 280 logbooks filled out by fishers from the FL network (bycatch and depredation).
- 30 fishing trips with acoustic monitoring (using PODs) in the central area on gillnet (monofilo), and 30 fishing trips for future tests of the Acoustic Alert System. Soon, acoustic monitoring will also be supported by the use of a hydrophone.
- 1 mitigation experiment with small leads inside longline baits, later modified with the use of sardines wrapped on the hook in 7 additional fishing trips, in the central area.

Partial experimentation with LEDs on a trammel net in the southern area will start this week.

Monitoring and mitigation activities using PODs will be replicated as soon as possible also on a trammel net in the southern area. Initially, this second trial was planned for a gillnet but, following the preliminary results of the interviews, the trammel net was deemed more suitable as it is currently more affected by dolphin depredation events.

In general, bycatch events of elasmobranchs in nets, and turtles and birds in longlines are frequent. Depredation events by dolphins have been recorded. The collection of photographic and video documentation of accidental catches involving vulnerable species also continues.

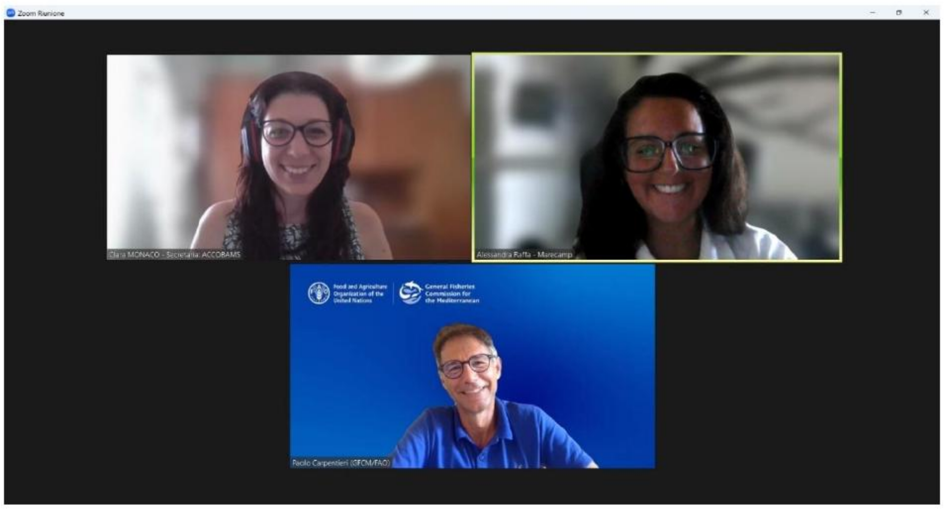
Paolo Carpentieri recommends not including thornback skate (*Raja clavata*) and starry skate (*Raja asterias*) among the bycatch species considered vulnerable.

Communication

Paolo Carpentieri indicates to contact dominique.bourdenet@fao.org for all the issues concerning the project logo and editing, and adele.peenaert@fao.org for press releases and social media.

All the attendees agree with what has been said, including the changes to some project activities described above. It is confirmed that the next Steering Committee Meeting will take place in about 3 months, or earlier in case of urgent issues to discuss.

Screenshot from the Zoom call



Recorded by:

Clara Monaco

MONITORING ACTIVITIES AND MITIGATION MEASURES FOR THE REDUCTION OF DOLPHIN DEPREDATION IN SMALL-SCALE FISHERIES – WESTERN IONIAN SEA (GSA19)

Minutes of the 2nd Steering Committee Meeting

Project name	Monitoring activities and mitigation measures for the reduction of dolphin depredation in small-scale fisheries - Western Ionian Sea (GSA19)
Tender	2023/CSAPC/NFIGD/123383
Contract	2023/CSLP/NFIGD/CPA-364085
Project Leader	Associazione Marecamp ODV
Project Partner	ACCOBAMS
Meeting location	**Zoom** Link https://us06web.zoom.us/j/81151815123
Meeting date & time	**December 12th, 2024**, 11:00-11:45 AM UTC +1/CET

Attendees	Organisation	Role
Paolo Carpentieri (SC)	FAO-GFCM	Contract Manager/Fishery Resources Monitoring Officer
Clara Monaco (SC)	ACCOBAMS Secretariat	Contract Manager/Project Coordinator
Alessandra Raffa (SC)	MARECAMP	Project Assistant
Joan Gonzalvo	ACCOBAMS	Consultant
Dario Garofalo	MARECAMP	Observer

Agenda:

Opening and Registration of Participants (Clara Monaco)

1- Project Updates (Alessandra Raffa):

2- Recruitment of experts

3- Purchase of materials and equipment

4- Status of data collection and analysis (trials of mitigation measures, monitoring, interviews, …)

5- Communication and awareness activities

6- Budget and timeline updates

7- Planning for the next meetings (SC, Workshop, …)

8- Any Other Business

9- Questions & Answers

Minutes:

Welcome and Introductions

A representative from each organisation involved in the project is present: Paolo Carpentieri (FAO-GFCM), Alessandra Raffa (Marecamp), and Clara Monaco (ACCOBAMS). These are the three members of the Steering Committee. Joan Gonzalvo is also attending the meeting in his condition of ACCOBAMS Consultant for implementation of the two FAO funded projects in Italy and Turkey. Dario Garofalo in also present as president of the Marecamp association and observer at the meeting.

Finances

The group discussed initially financial issues related to the research project, including problems with the budget, taxes and bank fees. Alessandra Raffa clarified that the budget for six additional months was not included in the original contract. The team expresses concern about high bank and tax fees, especially the dollar-euro exchange rate.

Upcoming meetings

ACCOBAMS Secretariat informs about an upcoming meeting on by-catch and fisheries interactions in early 2025 (2nd Meeting of the Joint Bycatch Working Group of ACCOBAMS and ASCOBANS, online, 5-6 February 2025), and highlights the convenience of identifying in the next weeks, possible participants that may contribute with their experience in this field with presentations and during a round-table discussion. It is also noted that the joint workshop on monitoring and mitigation of vulnerable marine species has been scheduled for 28 January 2025.

Fisheries monitoring

Alessandra Raffa gave an update on the project, mentioning that field technicians were finishing their contracts and that the all necessary materials had been acquired. Division of activities between the four geographic sectors in which the study area is divided has not changed significantly with respect to what was originally planned. Slight concern was raised about the Messina area (between Giardini and Messina), where the project had encountered difficulties in contacting fishers because the lack of ports and permanent mooring sites, together with some degree avoidance by fishers, complicates the possibility of meeting with them. Four interviews done so far and there are plans to contact the Coast Guards office in January to get more precise data on the number of fishers active in the area.

Alessandra and Joan discuss the possible discrepancy between the number of registered fishing vessels and those actually active in the area, and coincide in the convenience of confirming this information with the relevant authorities.

Alessandra reported on the progress of overall project activities, including preliminary interviews, vessel boardings, landings and questionnaires. She reports that data collection via the Logbook app is progressing well, with 700 fishing days uploaded by 8 fishermen, in some cases exceeding the required 10 days per month.

Joan asked for clarification on the reliability of the information included in the logbook reports and Alessandra explained that about 60-70% of the data is collected with the assistance of observers at the landing sites. It was also highlighted the importance of the relationship of mutual trust between researchers and fishers, as well as the training provided to encourage accurate reporting.

(for more detail on progress report, refer to ppt presented by Alessandra Raffa during the meeting)

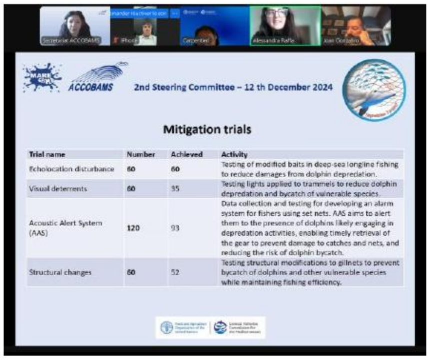
Project's satisfactory status and possibility for extension.

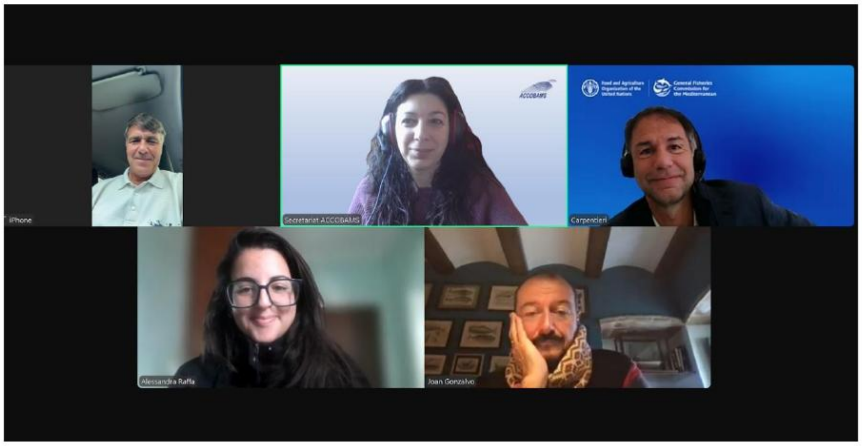
Paolo Carpentieri expressed his satisfaction on the progress of the project and asked for confirmation on the ability to spend all funds by February, noting that other project partners are further behind in activities and spending. Alessandra confirms that the expenses of the funds and the work proposed will be completed by the end of the project as originally planned. At the moment no project extension is foreseen.

Paolo Carpentieri expresses satisfaction with the results obtained so far and discusses the possibility of extending the project, also mentioning the problem of depredation by dolphins. If 6-months extension was to be requested to FAO this should be proposed as soon as possible with adequate reasoning for it and associated budget.

The ACCOBAMS Secretariat informs that the final report is due by the end of February. The last payment will be done after receiving and approving the final report.

Screenshots from the Zoom call





NOTES by:

Joan Gonzalvo

MONITORING ACTIVITIES AND MITIGATION MEASURES FOR THE REDUCTION OF DOLPHIN DEPREDATION IN SMALL-SCALE FISHERIES – WESTERN IONIAN SEA (GSA19)

3rd Steering Committee

Agenda

Project name	Monitoring activities and mitigation measures for the reduction of dolphin depredation in small-scale fisheries - Western Ionian Sea (GSA19)
Tender	2023/CSAPC/NFIGD/123383
Contract	2023/CSLP/NFIGD/CPA-364085
Project Leader	Associazione Marecamp ODV
Project Partner	ACCOBAMS
Meeting location	**Zoom** Link https://us06web.zoom.us/j/81427102858 ID Meeting 814 2710 2858
Meeting date & time	**March 21st, 14:30-15:30 PM (CET)**

Attendees	Organization	Role
Paolo Carpentieri **(SC)**	FAO-GFCM	Contract Manager/Fishery Resources Monitoring Officer
Clara Monaco **(SC)**	ACCOBAMS Secretariat	Senior Programme & Project Officer
Alessandra Raffa **(SC)**	MARECAMP	Project Assistant
Maÿlis Salivas	ACCOBAMS Secretariat	Executive Secretary
Dario Garofalo	MARECAMP	President

Speaker	Subject	Expected duration
Clara Monaco	• Opening and registration of participants • Introduction	5 min
Alessandra Raffa	• Updates on the state of the art of the project: - Purchasing of materials and equipment - Data collection and DBs - Preliminary analysis - Modified activities - Budget updates - 6-months extension - 2nd Interim Report - Subregional Committee for the Central Mediterranean (SRC-CM)	30 min
Clara Monaco	• ACCOBAMS joint Workshop • Communication activities • Next Steering Committee meeting	10 min
Any Other Business Questions & Answers		15 min

Minutes

Opening

A representative from each organisation involved in the project is present: Paolo Carpentieri (FAO-GFCM), Alessandra Raffa (Marecamp), and Clara Monaco (ACCOBAMS). These are the three members of the Steering Committee. Maÿlis Salivas, as Executive Secretary of ACCOBAMS, and Dario Garofalo, as president of the Marecamp Association, are also present at the meeting.

It is recalled that the initial phase of the project, implemented under the leadership of Marecamp, is approaching completion. The project is now entering its second phase, supported by a six-month extension funded by the FAO. She expresses her sincere appreciation to Paolo Carpentieri and the GFCM for the confidence placed in the working group, which remains fully committed and has already initiated the implementation of a mitigation measure in a new, recently identified area.

Updates on the state of the art of the project and discussion

Alessandra Raffa reports that **90% of the project activities have been completed** (interviews, boardings on SSF vessels, landing observations, acoustics data collection). In particular, the trials of the mitigation measures have concluded, and data analysis is currently underway. Reporting through logbooks and surveys on scientific boats will continue in the next months.

She presents several **databases and preliminary results**, including a map that provides a first analysis of the timing of dolphin interactions with fishing nets (see slides below).

Regarding the outcomes of the **mitigation trials**, she explains that a significant amount of data still requires analysis and further in-depth. However, she highlights the following general conclusions:

- **Echolocation disturbance**: this measure proves effective for dolphin depredation, mainly in reducing bait damage, particularly for certain commercially important species, such as hake.
- **Visual deterrent**: no significant differences are observed in catch quantity, bycatch, or gear damage between standard fishing trips and those carried out with LED lights activated on the net.
- **Structural changes**: no significant differences are observed in bycatch between standard fishing trips and those using the modified "monofilo" net.
- **Acoustic Alert System (AAS)**: this measure, tested for mitigating both bycatch and depredation, is promising and shows positive results, particularly in terms of catch quantity. Further analysis will follow.

Alessandra Raffa presents the table of contents of the **2nd interim report** of the project currently being drafted, which Marecamp intends to submit shortly. She outlines the various sections that will be included in the document, which will cover the activities carried out to date and the preliminary results of the project.

Paolo Carpentieri thanks for the presentation and congratulates Marecamp on the work carried out so far. With regard to the upcoming **Subregional Committee for the Central Mediterranean (SRC-CM) meeting**, he asks Marecamp to update the submitted abstract by including a greater number of preliminary results.

In light of the growing issue of depredation throughout the Mediterranean, he also requests an estimate of the budget required to **replicate** and implement the **AAS mitigation action** in a new area.

Alessandra Raffa explains that the AAS is not yet an automatic device, and that a cost estimate could be provided based on what has been developed within the current project. However, consultation with bioacoustics experts and engineers is required to develop a real prototype capable of automating the necessary processes.

Maylis Salivas proposes that Marecamp will consult with Sinay (the external company currently managing the acoustic component of the project) to gather further information and provide a more concrete response to the request.

An important aspect to consider when replicating the model is the willingness of fishers to test the AAS. In this regard, Alessandra Raffa reports that field **interviews with fishers** reveal highly divergent opinions: some are open to collaborating in the testing phase, while others are sceptical about the effectiveness of the AAS and would prefer to try alternative devices, such as pingers. These decisions appear to depend on the level of information available to the fishers, suggesting that greater engagement and awareness-raising efforts would be beneficial.

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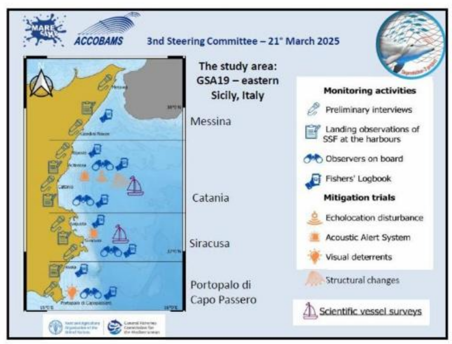

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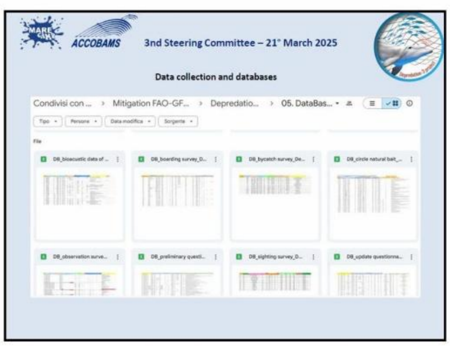

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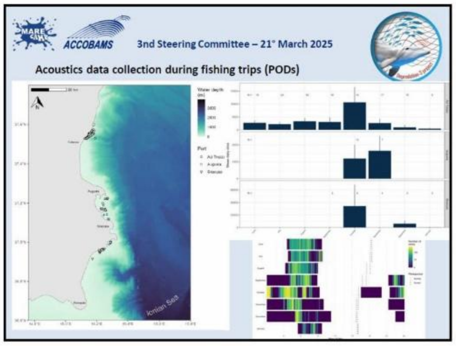

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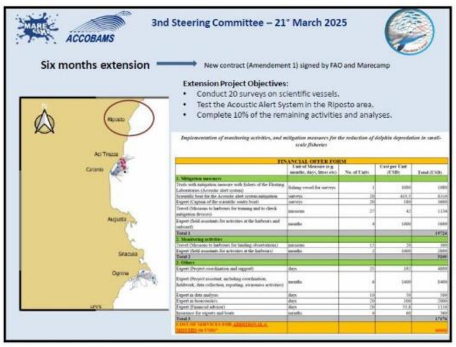

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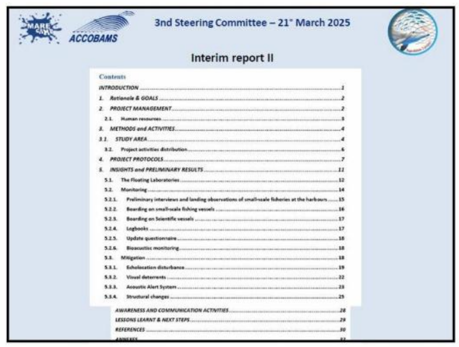

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Budget

Alessandra Raffa reports that the expenses incurred as of this date are aligned with the planned budget. She also presents the budget related to the six-month project extension, as outlined in the new agreement signed between FAO and Marecamp. This **additional budget** will cover the costs of 20 further surveys using the scientific vessel, as well as the continuation of mitigation trials using PODs in the Riposto area (GSA19).

During the six-month extension period, the remaining 10% of activities from the project's first phase will also be completed.

ACCOBAMS is currently preparing an **amendment to the Memorandum of Collaboration** with Marecamp, in alignment with the latest contract signed between FAO and Marecamp for the six-month project extension. The amended document will be shared shortly for Marecamp's review.

In this context, since the next payment Marecamp is expected to receive from FAO upon submission of the interim report will not cover all the expenses to be incurred during the current phase of the project, Alessandra Raffa requests that ACCOBAMS continue to support Marecamp as agreed in the previous phase of the project. Specifically, she asks that the agreement include a provision to transfer the remaining funds in a single final payment at the end of the project and after FAO's final payment to Marecamp. Maÿlis Salivas responds that an internal check is needed with the accountant. Feedback will be provided accordingly.

Alessandra Raffa also requests clarification on the modality of coordination that ACCOBAMS will implement for the project in the coming months.

Clara Monaco replies that ACCOBAMS' role will remain unchanged in the agreement, and that only the amounts and dates will be modified.

ACCOBAMS Joint Workshop

A brief update on the ACCOBAMS Workshop held in February on interactions between commercial fisheries and vulnerable species was provided. The event gathered 77 participants, including 53 external experts from the five FAO-funded projects. The workshop represents a key opportunity for knowledge sharing, exploration of innovative trials, and discussion of recent studies and ongoing challenges on the mitigation of bycatch and dolphin depredation in the ACCOBAMS and GFCM areas, and beyond.

The workshop conclusions will be included in a dedicated report, which will be annexed to both the interim and final project reports. The annex will also contain the abstracts and the list of participants.

Communication

In the past months, ACCOBAMS has promoted the workshop on its website, where a reduced version of the report will also be published. Additionally, some posts related to the project have been shared on its social media channels.

Marecamp is encouraged to continue sending materials for future posts, whether about field activities, fishers, or the monitored species.

Any Other Business

Clara Monaco regretfully informs the group that the abstract submitted for the joint poster with INRH of Tanger, intended for the 36th Annual ECS Conference, has not been accepted. She adds that there will be the opportunity to present more substantial results once the project is completed. She will send an email to Marecamp and INRH informing them about the abstract rejection and future opportunities to present their results.

A consensus is reached to hold a final Steering Committee meeting before the project concludes, preferably in June or July 2025.

Screenshot from the Zoom call

ANNEX III - Questionnaire for fishers – Preliminary interviews

info@marecamp.com

Preliminary QUESTIONNAIRE Depredation-3 project – ID PQ-___

DATE: ________________ *SAMPLER:* ______________ *PORT:*____________

ID VESSEL ________________ *NAME OF THE VESSEL* ____________ *(OPTIONAL)* *FISHER* ______________

GT TONNAGE ___ , *LOA* ___ , *MAIN POWER* ___ , *YEAR OF CONSTRUCTION* _____

LICENSES (GEAR TYPE ACRONYM) ____

SEGMENT ____ , *PERMISSION* ____________________

WHAT FISHING GEAR (METIER) DO YOU USE ALONG THE YEAR:

N.	*NAME OF THE GEAR, MESH SIZE*	*PERIOD (MONTHS)*	*DEPTH (MIN. AND MAX) AND TYPE OF BOTTOM*	*TIME OF FISHING*	*DISTANCE FROM THE BASE PORT*	*BYCATCH*	*DEPRED.*
1						☐	☐
2						☐	☐
3						☐	☐
4						☐	☐
5						☐	☐

info@marecamp.com

<u>Preliminary QUESTIONNAIRE</u> Depredation-3 project – ID PQ-___

REFERRING TO EACH FISHING GEAR (METIER), INSERT THE TARGET SPECIES AND THE DISCARD SPECIES:
(WRITE FOR EACH SPECIES AN ESTIMATION OF KG CAUGHT IN ONE FISHING SET)

N.	TARGET SPECIES	DISCARD SPECIES
1		
2		
3		
4		
5		

Do you have a bluefin tuna fishing quota? Y/N ___ If yes, indicate in which years you had it and how many kg: ____

Do you have a swordfish fishing quota? Y/N ___ If yes, indicate in which years you had it and how many kg: ____

Do you have a permission for fishing tourism? Y/N ___ If yes, indicate how many people can come on board____

Do you have a permit to fish in MPA? Y/N___ If yes, indicate which MPA_______________

info@marecamp.com

Preliminary QUESTIONNAIRE Depredation-3 project – ID PQ-___

INTERACTION SECTION (PAGE 1)

In the last 5 years, interference with cetaceans or any other vulnerable species is
□ increased □ the same □ decreased
Specify what species ____
____

Did you ever see cetaceans while fishing? □ No □ Yes
(specify if : □ dolphins or □ whales)

Do you recognize the species of dolphin(s) that interact with fishing gear?
____

In addition to cetaceans, are other animals causing damage to the gear/catch? (Y/N)___
If yes, could you indicate which other species (group, family, genus) are responsible for the damages?____
____

What are the commercial species particularly affected by dolphin depredation?
____

What are the commercial species particularly affected by other species interaction?
____

Do you know solutions implemented in other fisheries to reduce the interactions? If yes, provide some examples:
____

Have you ever tested mitigation measures? (Y/N)___
If yes, provide a description of the mitigation measure tested:
____

How did you feel about adopting this mitigation measure?
____

Personal suggested solutions
____
____

Notes
____
____
____

info@marecamp.com

Preliminary QUESTIONNAIRE Depredation-3 project – ID PQ-___

INTERACTION SECTION (PAGE 2)

Does any fishing area you use more subject to interference? □ No □ Yes

If Yes, *INDICATE THE AREAS SUBJECTED TO NEGATIVE INTERACTION DURING THE SEASONS (INSERT A D FOR DEPREDATION AND A B FOR BYCATCH)*

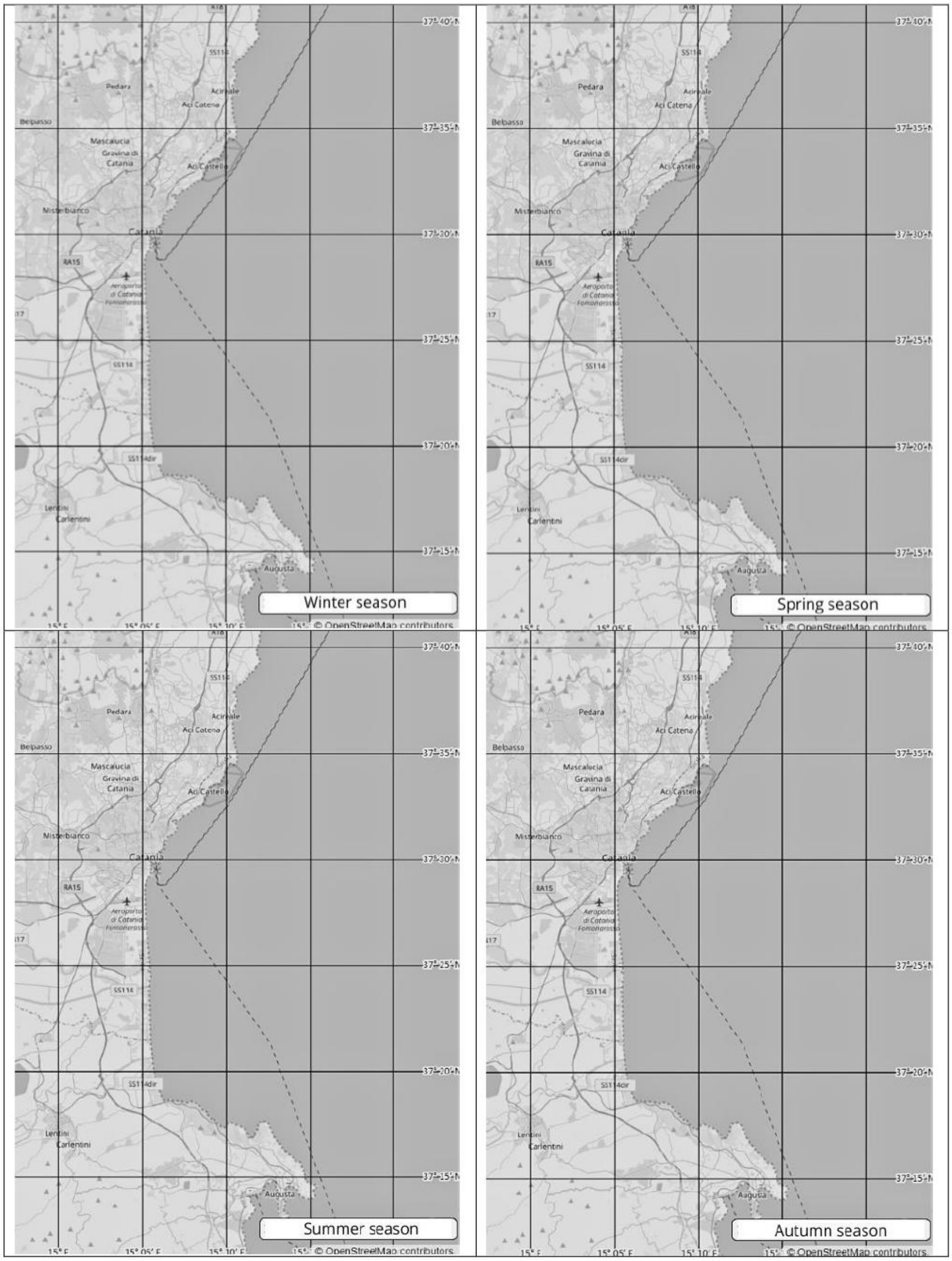
info@marecamp.com

<u>Preliminary QUESTIONNAIRE</u> Depredation-3 project – ID PQ-___

INTERACTION SECTION (PAGE 2)

Does any fishing area you use <u>more</u> subject to interference? □ No □ Yes

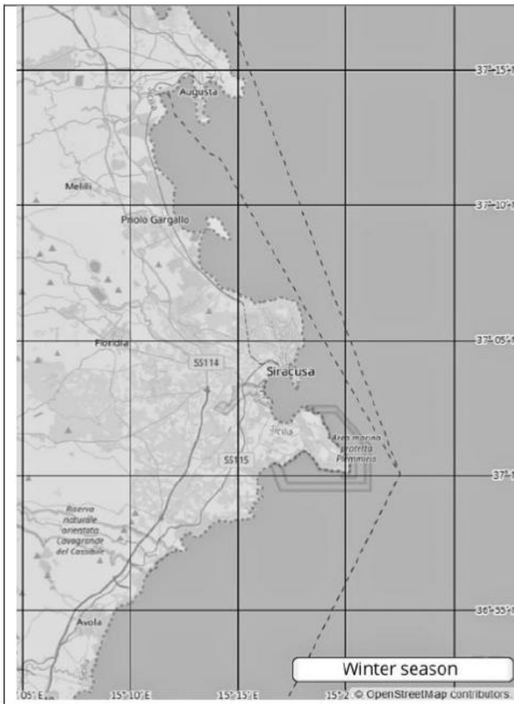
If Yes, *INDICATE THE AREAS SUBJECTED TO NEGATIVE INTERACTION DURING THE SEASONS (INSERT A D FOR DEPREDATION AND A B FOR BYCATCH)*

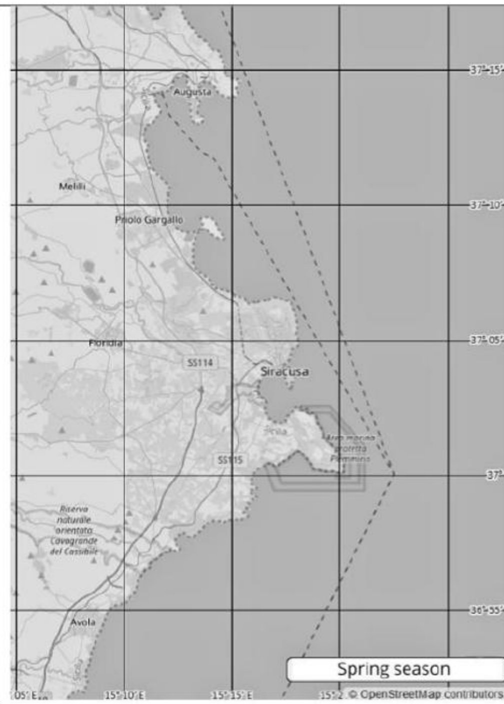


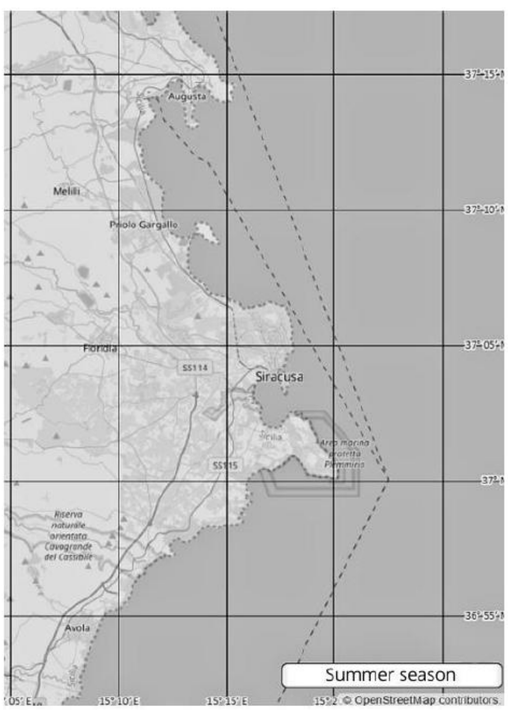
INTERACTION SECTION (PAGE 2)

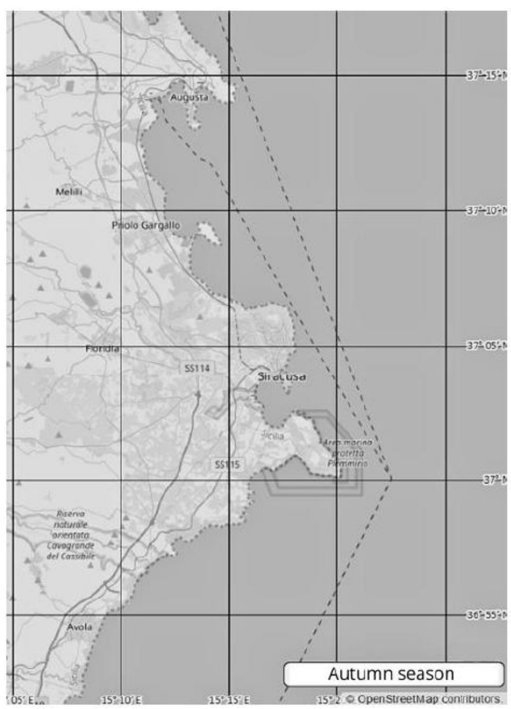
Does any fishing area you use <u>more</u> subject to interference? □ No □ Yes

If Yes, *INDICATE THE AREAS SUBJECTED TO NEGATIVE INTERACTION DURING THE SEASONS (INSERT A D FOR DEPREDATION AND A B FOR BYCATCH)*









INTERACTION SECTION (PAGE 2)

Does any fishing area you use <u>more</u> subject to interference? □ No □ Yes

If Yes, *INDICATE THE AREAS SUBJECTED TO NEGATIVE INTERACTION DURING THE SEASONS (INSERT A D FOR DEPREDATION AND A B FOR BYCATCH)*

info@marecamp.com

<u>Preliminary QUESTIONNAIRE</u> Depredation-3 project – ID PQ-___

DEPREDATION SECTION

MODULE TO REPEAT FOR EACH METIER EXPERIENCED IN DEPREDATION WITH CETACEANS

Metier No.____ Gear type _______ Common names ___________________________
Material ___________ Mesh size ________ Length (m) _______ Height (m) ______ Age ____
(Only for longlines) Number of hooks _______ Size _______ Number of lines________________
When using lures, specify if ☐ artificial baits or ☐ natural (species) _______________________

Soak time (time during which the gear is actively in the water (per day): _______
Number of days using this gear in one year _______
Number of times using this gear in one day _______
Price of a complete new gear € ____________________

Kg of catch per day: Minimum ____ Maximum _____ Average value of the catch €/kg _______
Kg of discard: ___________

Incidence of <u>positive or cooperative</u> interaction with cetaceans _____ /100 times
Type____

Incidence of <u>indifferent</u> presence of cetaceans _____ /100 times
Incidence of <u>negative</u> interaction (damage for fishermen) _____ /100 times
Types of damage ☐ depredation on catch → If yes, specify if leaving:____________________
(per one event): ☐ bite marks ☐ fish head in the gear ☐ other signs
☐ scattering prey ☐ lures depredated → If yes, specify _______________
☐ holes → If yes, specify size and number: ☐ small (0-30 cm) ____ ☐ medium (31-80 cm) ____ ☐ big (81-120 cm) _______ ☐ very big (>120cm) ______

Losses incurred: ▫ reducing catch How much _____ %
(per one event) ▫ complete loss of the catch

Costs incurred per one event of negative interaction: _________€ and __ __:__ __ (hours)
Medium percentage of the fishing gear damaged ______ %
Fishing days not worked _________
Number of people working in fixing up the gear ______ Number of days in which they are involved to repair ______ Material used _____________________

Price of the piece to substitute (€ per piece) ____
Price of the other parts to substitute ____
Total cost of a failed fishing trip (considering n. of operators, fuel consumed, missing catch etc.)
____
Number of pieces necessary to eliminate after one event of depredation ____________________
Can you provide an estimate of the number of holes (or %) in the net in one year?
____
Can you provide an estimate of the number of hooks damaged (or %) along the longline in one year?____
Can you provide an estimate of the number of hooks (or %) depredated in one year?
____
Can you provide an estimate of the total cost in € during one year?________________

info@marecamp.com

<u>Preliminary QUESTIONNAIRE</u> Depredation-3 project – ID PQ-___

BYCATCH SECTION

MODULE TO REPEAT FOR EACH METIER EXPERIENCED IN BYCATCH OF VULNERABLE SPECIES

Metier No.____ Gear type _______ Common names ___________________________
Material ___________ Mesh size ________ Length (m) _______ Height (m) ______ Age _______

(Only for longlines) Number of hooks _______ Size _______ Number of lines________________
When using lures, specify if ☐ artificial baits or ☐ natural (species) _______________________

Number of days using this gear in one year _______
Number of times using this gear in one day _______

Specify No. of bycatch events in one year and which species per each categorise:

	No.	Species	Season/Months with more frequency	Depth and distance from the coast
Dolphins				
Whales				
Sharks				
Rays				
Sea turtles				
Sea birds				

Generally, when you catch a vulnerable species, what do you do with it?

____

How many have been released alive? (Insert a number in one year)
☐ Dolphin ___ ☐ Whale ___ ☐ Shark ____ ☐ Rays ____ ☐ Sea turtle ___ ☐ Sea bird ____

What is (are) the species most affected?

____

What are your opinions on the factors influencing bycatch and on how best to mitigate (if any) these interactions?

____

____

Additional Comments

____

____

____

ANNEX IV - Questionnaire for fishers – Updates and GRID MAPS

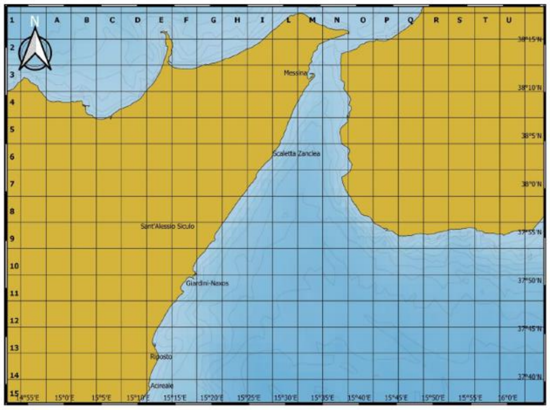
info@marecamp.com

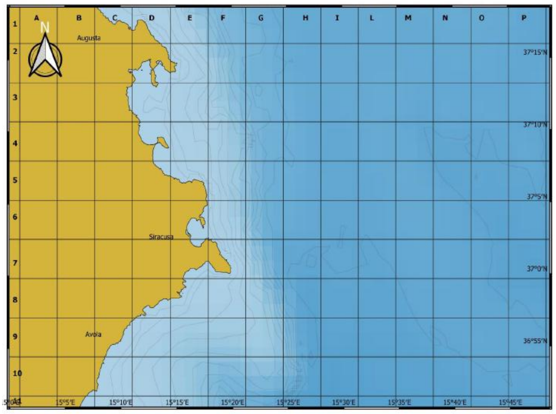
Update QUESTIONNAIRE Depredation-3 project – ID UQ-___ *DATE:______ SAMPLER:_________ PORT:_________*

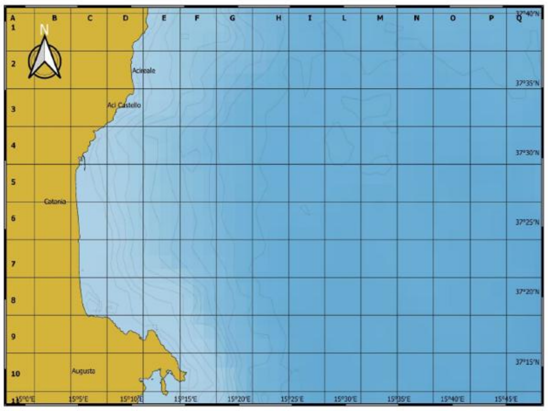
ID VESSEL ________________ NAME OF THE VESSEL ____________(OPTIONAL) FISHER ______________ TEL NUMBER _______________
GT TONNAGE ___ , LOA ___ , MAIN POWER ___ , YEAR OF CONSTRUCTION _____ LICENSES (GEAR TYPE ACRONYM)_____________________________
SEGMENT ____ , PERMISSION _____________________ PRELIMINARY QUESTIONNAIRE: YES / NO

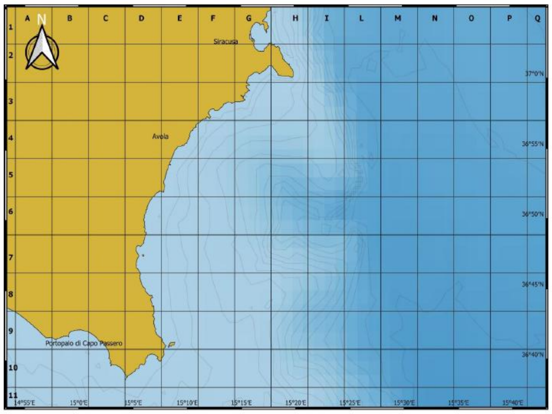
N.	NAME OF THE GEAR, LENGTH, MESH SIZE (OR NO. HOOKS)	PERIOD (MONTHS)	DEPTH (MIN. AND MAX) AND TYPE OF BOTTOM	TIME OF FISHING	DAYS IN ONE YEAR	FISHING AREA (INDICATE THE CELLS CODE)	BYCATCH (IF YES, WRITE ALL THE SPECIES CAUGHT AND THE PERIOD)	DEPREDATION (IF YES, WRITE ALL THE SPECIES THAT INTERACT WITH THE GEAR AND THE PERIOD)
1								
2								
3								

(FOR NET USERS) WHAT DO YOU THINK ABOUT AAS EFFICIENCY?: ______________________________________
HOW MANY LITERS OF PETROL DO YOU CONSUME ON AVERAGE EVERY DAY?___________________________________
NOTE:____









ANNEX V - Boarding survey sheet and LEGEND

info@marecamp.com

BOARDING SURVEY Depredation-3 project – ID BS- _______

DATE: ______________ FISHNG BOAT CODE: ______________ PORT:____________

OBSERVERS: _______________________________ BIOACUSTIC DATA: __________

SEA CONDITIONS (BEAUFORT SCALE): ___________ CLOUD COVERAGE: _____-_______

STARTING TIME SURVEY	STOP TIMES OF THE SURVEY (IF APPLICABLE)	ENDING TIME SURVEY	AREA
__ __ : __ __		__ __ : __ __	

TYPE OF FISHING GEAR:			LENGTH (METERS):	
FOR NET	HEIGHT:	MESH WIDTH (cm):		
FOR LONGLINE	NO. OF HOOKS:	SIZE HOOKS (cm):	TYPE OF BAIT:	

		FISHING SET 1	FISHING SET 2	FISHING SET 3
START LOWERING	COORDINATES	N E	N E	N E
	BOTTOM DEPTH (m)			
	FISHING GEAR DEPTH			
	TIME			
END LOWERING	COORDINATES	N E	N E	N E
	BOTTOM DEPTH (m)			
	FISHING GEAR DEPTH			
	TIME			
START LIFTING	COORDINATES	N E	N E	N E
	TIME			
	1ST PORTION HAULED UP			
END LIFTING	COORDINATES	N E	N E	N E
	TIME			
KG OF ______________ CAUGHT				
KG OF ______________ CAUGHT				
KG OF ______________ CAUGHT				
KG OF ______________ CAUGHT				
KG OF ______________ CAUGHT				
KG OF ______________ CAUGHT				
KG OF ______________ CAUGHT				
KG OF ______________ CAUGHT				
KG OF ______________ CAUGHT				
KG OF ______________ CAUGHT				
KG OF ______________ CAUGHT				
KG OF ______________ CAUGHT				
PRESENCE OF CETACEANS (YES/NO) IF YES, ADD SIGHTING SURVEY ID				
DEPREDATION EVENT (YES/NO) IF YES, ADD INTERACTION SURVEY ID				
BY-CATCH OF VULNERABLE SPECIES (YES/NO) IF YES, ADD BYCATCH SAMPLING SURVEY ID				

1/2

NOTES ABOUT DISCARDS (INDICATE SPECIES, QUANTITY, AND IF SOLD OR REJECTED): ____________________

____

____

____

____

IN CASE OF DAMAGES TO THE NET (ADD THE NUMBER OF NEW HOLES AND OF THE DIFFERENT DAMAGES):

	No. OF HOLES				No. OF DAMAGED CATCH	
FISHING SET No.	SMALL (0-30 cm)	MEDIUM (31-80 cm)	BIG (81-120 cm)	VERY BIG (>120 cm))	BITE MARKS	FISH HEADS IN THE GEAR

IN CASE OF DAMAGES TO THE LONGLINE (ADD NUMBERS OF HOOKS/BAITS/CATCHES LOST OR DAMAGED):

	No. OF BAITS		No. OF DAMAGED CATCHES	
FISHING SET No.	DAMAGED	LOST	BITE MARKS	FISH HEAD IN THE GEAR

GENERAL STATUS OF THE CATCHES (fill in case of depredation event occurred in a net or a longline):

INTERACTION CAUSING:

□ SCATTERING PREY

□ REDUCING CATCH HOW MUCH (%) __________

□ COMPLETE LOSS OF THE CATCH EXPLAIN ____

____

VIDEO OR PHOTOS OF REFERENCE: ____
(AUTHOR, CAMERA, ID…)

LEGEND OF BOARDING SURVEY

The following form must be filled in every time you board on a fishing vessel.

BOARDING SURVEY – ID BS-____

Write the progressive number of the boarding survey.

DATA

Write the data of the day.

OBSERVERS

Write the names of all observers present during the survey.

FISHING BOAT CODE / PORT

Write the id code of the vessel / Write the name of the port you are leaving from.

BIOACUSTIC DATA

Write if acoustic devices to record cetaceans are active on the gear.

SEA CONDITIONS (Beaufort scale) / CLOUD COVERAGE

Rate the sea conditions based on the Beaufort scale / give a percentage value to cloud cover (es. 30% or 3/10).

STARTING TIME SURVEY / ENDING TIME SURVEY / STOP TIME OF THE SURVEY

Indicate the start time of the survey and the ending time in the corresponding line. If the fisher returns to the harbor after lowering the gear, write in the section ''stop time of the survey'' the time you spent away from the gear before returning to lift it.

FISHING GEAR

Write the type of fishing gear used by the fisher (es. net, longlines) and add info about it in the corresponding section (es. height, mesh width, number of hooks, size hooks in cm, type of bait).

FISHINGSET

Fill in this section considering the number of times a fisherman uses the gear in a day (es. fishing-set 1 for the first time, fishing-set 2 for the second one)

START/END LOWERING

When the fisherman starts/finishes putting the gear into the water, mark the time, the position in decimal coordinates, bottom depth and the fishing gear depth in meters.

START/END LIFTING

When the fisherman starts/finishes lifting the gear out of the water, mark the time, the position in decimal coordinates and the time the first portion is hauled up.

KG OF CAUGHT

Write the amount of fish caught per species in kg.

PRESENCE OF CETACEANS / DEPREDATION EVENT / BY. CATCH OF VULNERABLE SPECIES

If you notice cetaceans during the boarding survey, fill in the sighting survey sheet / If you notice cetaceans interacting with the gear, fill in the interaction survey sheet / If the fisher finds vulnerable species in the gear (sharks, cetaceans, rays, birds or turtles) fill in the bycatch sampling survey.

NOTE ABOUT DISCARDS

If there are species with no commercial value, indicate the species, the amount in kg and if rejected or sold.

info@marecamp.com

BOARDING SURVEY Depredation-3 project – ID BS-______

DATE:__________ FISHING BOAT CODE:__________ PORT:__________

OBSERVERS:____________________ BIOACUSTIC DATA:__________

SEA CONDITIONS (BEAUFORT SCALE):__________ CLOUD COVERAGE:____-_____

STARTING TIME SURVEY	STOP TIMES OF THE SURVEY (IF APPLICABLE)	ENDING TIME SURVEY	AREA
__:__		__:__	

TYPE OF FISHING GEAR:		LENGTH (METERS):	
FOR NET	HEIGHT:	MESH WIDTH (cm):	
FOR LONGLINE	NO. OF HOOKS:	SIZE HOOKS (cm):	TYPE OF BAIT:

		FISHING SET 1	FISHING SET 2	FISHING SET 3
START LOWERING	COORDINATES	N E	N E	N E
	BOTTOM DEPTH (m)			
	FISHING GEAR DEPTH			
	TIME			
END LOWERING	COORDINATES	N E	N E	N E
	BOTTOM DEPTH (m)			
	FISHING GEAR DEPTH			
	TIME			
START LIFTING	COORDINATES	N E	N E	N E
	TIME			
	1ST PORTION HAULED UP			
END LIFTING	COORDINATES	N E	N E	N E
	TIME			

PRESENCE OF CETACEANS (YES/NO) IF YES, ADD SIGHTING SURVEY ID			
DEPREDATION EVENT (YES/NO) IF YES, ADD INTERACTION SURVEY ID			
BY-CATCH OF VULNERABLE SPECIES (YES/NO) IF YES, ADD BYCATCH SAMPLING SURVEY ID			

NOTES ABOUT DISCARDS (INDICATE SPECIES, QUANTITY, AND IF SOLD OR REJECTED).

ANNEX VI – Observation survey sheet and LEGEND

info@marecamp.com

OBSERVATION SURVEY Depredation-3 project ID OS- _______

DATE: _______________ *PLATFORM:* ______________ *TRACK DEVICE:* ____________

OBSERVERS: ____

	POSITION		OBSERV.		WEATHER AND SEA CONDITIONS				
TIME	LATITUDE	LONGITUDE	ROUTE	SPEED	SKY COVERAGE	VISIBILITY	SEA STATE	WIND DIREC./SPEED	NOTE
	N	E							
	N	E							
	N	E							
	N	E							
	N	E							
	N	E							
	N	E							
	N	E							
	N	E							
	N	E							
	N	E							
	N	E							
	N	E							
	N	E							
	N	E							
	N	E							Total NM:

LEGEND FOR OBSERVATION SURVEY

info@marecamp.com

The following form must be filled in continuously during the observation activity dedicated to marine macrofauna. A new line must be filled every hour or whenever there is a change in one of the variables in the table (e.g. route, speed, weather, vessels, sightings, activities, etc.).

Indicate the progressive number of the survey, the date (dd/mm/yyyy), the observation platform, and the names of all observers on board in the form's header.

1. TIME

Indicate the **date** only at the change of day, in other cases, indicate only the **time**. E.g. 1.30 pm, 5.00 am

2. POSITION

Indicate the **geographical coordinates in the appropriate Latitude N** and **Longitude E** boxes.
E.g. 37.09467 N, 15.90087 E (decimal)

3. Observation platform

ROUTE – Indicate the ship's **route** in degrees. E.g. 144°
SPEED – Indicate the **speed** of the vessel in knots (KN). E.g. 5

4. WEATHER-MARINE CONDITIONS

SKY COV. – Indicate the degree of **sky coverage** in percentage. Also indicate the possible presence of **atmospheric precipitation** (Rain= **R**; Hail= **H**) and their intensity (Slight= **S**; Moderate= **M**; Strong= **S**; Very strong= **VS**). E.g. 70% RS
VISIBLE – Indicate the degree of **visibility** (Excellent= **E**; Good= **G**; Medium= **M**; Low= **L**). E.g. B
SEA STATE – Indicate the state of **the sea** according to the Douglas scale (see Table 1). E.g. 1
WIND DIR./SPEED – Indicate the origin of the **wind** (NSWE) and the speed. E.g. E/5KN; SW/2KN; etc.

Table 1

Beaufort number	Description	Knots	m/s	Wave Height, m	What the sea looks like
0	Calm	0-1	0.0-0.2	0.0	Sea like a mirror
1	Light Air	1-3	0.3-1.5	0.1	Ripples without crests
2	Light Breeze	4-6	1.6-3.3	0.2	Small wavelets
3	Gentle Breeze	7-10	3.4-5.4	0.3-1	Large wavelets
4	Moderate Breeze	11-16	5.5-7.9	1.0-1.5	Small waves
5	Fresh Breeze	17-21	8.0-10.7	1.5-2.5	Moderate waves
6	Strong Breeze	22-27	10.8-13.8	2.5-3.5	Larger waves
7	Near Gale	28-33	13.9-17.1	3.5-5	Sea heaps up
8	Gale	24-40	17.2-20.7	5-6.5	Moderately high waves
9	Strong Gale	41-27	20.8-24.4	6.5-8	High waves
10	Storm	48-55	24.5-28.4	8-10	Very high waves
11	Violent Storm	56-63	28.5-32.6	10-13	Exceptionally high waves
12	Hurricane	≥64	≥32.7	≥14	Phenomenal high waves

5. NOTES

Indicate the change of routes, and the ongoing on-board activities (visual observation, acoustic listening, transfer, sampling, etc.). If you are not compiling the forms on anthropic activities, *marine litter*, and macrofauna at the same time, indicate here the presence of jellyfish, birds, fish, reptiles, cetaceans (number and species). Report the presence of large quantities of floating **waste**, as well as buoys, nets, flags, boats, and any other element/event deemed useful. Where possible, indicate the water **temperature** in degrees centigrade (e.g. 27 °C), the depth, and the **salinity** in parts per thousand (e.g. 38.27‰). Specify the ID of **the other survey sheets** connected to this.
At the end of the monitoring, indicate the total number of nautical miles traveled.

ANNEX VII – Sighting survey sheet and LEGEND

info@marecamp.com

SIGHTING SURVEY Depredation-3 project ID SS- ______

DATA: ____________________ RELATED SURVEY SHEETS IDS: __________________

OBSERVATION PLATFORM: _______________ OBSERVERS: ______________________

ID RECORD	OBSERVER:	SPECIES:	NO. BOATS (S-M-L SIZE)+ (F IF FISHING)
START OF THE SIGHTING	TIME __ __ : __ __	NO. TOTAL	
	LATITUDE N	NO. JUVANILES	NOTES
	LONGITUDE E	NO. CALVES	
	DISTANCE	ASSOCIATION WITH OTHER SPECIES OR ACTIVITIES	
	ANGLE		
	DIRECTION		
END OF THE SIGHTING	TIME __ __ : __ __		
	LATITUDE N		
	LONGITUDE E		

BEHAVIOUR			
	TOWARDS OUR PLATFORM	☐MOVING AWAY ☐APPROACHING ☐INDIFFERENT N. ___________	SUBGROUPS' COMPOSITION (e.g. 1M/1C mom and calf; 1+2+4 subgroups)
	PATTERNS	☐TRAVELING ☐SOCIALIZING ☐FEEDING IN WILD ☐FEEDING IN NET ☐MATING ☐RESTING ☐NI	
	BLOWS	☐SYNCRONIZED ☐½ SINCRO ☐NOT SYNCRO	PHOTO/VIDEO
	DIRECTION	☐EVEN ☐DIFFERENT ☐CIRCULAR	
	SWIMMING	☐SPEED SLOW ☐SPEED NORMAL ☐SPEED FAST ☐SPEED FLOATING ☐FIXED INDIVIDUALS	☐BOW RIDING ☐SKIMMING ☐SURFING ☐PORPOISING ☐INVERTED SWIM
	AERIAL (no.)	____FULL-LEAP ____BREACH ____BOW ____TAIL-SLAP ____SPY-HOP ____TAIL-OUT ______	
	FORMATIONS	☐COMPACT ☐SCATTERED ☐REGULAR ☐DIAMOND ☐ECHELON ☐LONG ☐RANK ☐STAGGERED	

BIOACOUSTIC DATA (YES/NO) IF YES, CODE OF THE SURVEY SHEET:

LEGEND OF SIGHTING SURVEY

info@marecamp.com

The following form must be filled in every time one or more cetaceans are sighted.

1. **ID SIGHTING SURVEY SS-___**
Write the **progressive number** of the sighting (during the same date). E.g. 1 for the first, 2 for the second and so on.

2. **RELATED SURVEY SHEETS ID**
Write all the other survey sheets IDs, depending on the activities of that date. E.g. BS-02

3. **OBSERVERS**
Write the names of all observers present during the survey. On the table, write only the **name** of the first sighter(s). E.g. Clara

4. TIME
Indicate the start **time** of the sighting in the top line and the end time in the corresponding line.

5. POSITION
LATITUDE – Indicate the geographical coordinates of the **Latitude** of the start of sighting in the top line and those of the end sighting in the corresponding line.
LONGITUDE – Indicate the geographical coordinates of the **Longitude** of the start of the sighting in the top line and those of the end sighting in the corresponding line. E.g. 37.09467 N, 15.90087 E (decimal)
DISTANCE – Estimate the **distance between** the cetacean and the observation platform at the beginning of the sighting in meters or nautical miles (NM). E.g. 700 m; 1.5 NM
ANGLE – About the first animal sighted, indicate the **angle** with respect to the bow of the observation platform (help yourself with the protractor). E.g. 30°
DIRECTION – Write the **direction** in which the cetaceans swim at the beginning of the sighting, according to the cardinal points (N, S, W, E).

6. CETACEANS
SPECIES – Indicate the **species sighted** with the correct code (table 4). In the case of NI, specify its dimensions (**s=small**; **m=medium**; **b=big**). E.g. Tt, NIs
No. TOTAL – Indicate the **total number** of animals sighted. Ex. 10; e.g. 6Tt + 1 Dd
No. JUV. and **CALVES**. – Indicate the number of **young individuals** or **calves**. E.g. 2J; 1C

7. BEHAVIOUR
REFER TO PLATFORM – Mark with an "X" the behaviour adopted by the animals towards the platform of observation on which we find ourselves.
OTHERS BEHAVIOUR - Mark with an "X" all the behaviour noted. (SWIMMING; BLOW; PATTERN and so on)

8. No. BOATS
Write the number and size of the boats near the cetaceans sighted (**S=small** 3-7 meters; **M=medium** 8-15 meters; **L=large** >15 meters). If they are fishing, also write an **F.** E.g. 3S; 1MF

9. NOTES
Indicate the presence of associations (birds, fish, reptiles, other cetacean species, fishing gear, etc.), the directional changes in cetacean swimming, the variation of any other element/event, or particular behaviors. Note if there are any reference **photos** or **videos** and their authors (e.g. Clara **V** Sony, Ale **P** Nikon).

Table 4

CODE	Species	EN	ITA
Bp	*Balaenoptera physalus*	Fin whale	Balenottera comune
Pm	*Physeter macrocephalus*	Sperm whale	Capodoglio
Gg	*Grampus griseus*	Risso's dolphin	Grampo
Tt	*Tursiops truncatus*	Bottlenose dolphin	Tursiope
Sc	*Stenella coeruleoalba*	Striped dolphin	Stenella striata
Dd	*Delphinus delphis*	Common dolphin	Delfino comune
Zc	*Ziphius cavirostris*	Cuvier's beaked whale	Zifio
Gm	*Globicephala melas*	Long-finned pilot whale	Globicefalo
Sb	*Steno bredanensis*	Rough-toothed dolphin	Steno
NI	Unidentified species		

ANNEX VIII – Interaction survey sheet and LEGEND

info@marecamp.com

INTERACTION SURVEY **Depredation-3 project – ID INT-____**

DATE: ________________ PLATFORM: ______________ AREA: ____________

OBSERVERS: ____

SIGHTING SURVEY ID RELATED: _________ OTHER SURVEY ID RELATED: _________________

TYPE OF FISHING GEAR ___________________________________ SIGHTED SPECIES ___________________________________

FIRST SIGNS OF CETACEAN PRESENCE (DORSAL FIN; JUMP; ACUSTIC DATA; ECT.) ___________________________________

INTERACTION: STARTING TIME __ __ : __ __ END TIME __ __ : __ __ TOTAL DURATION __ __ : __ __

NUMBER OF INDIVIDUALS ON INTERACTION _______________ NUMBER/ID OF IDENTIFIED INDIVIDUALS _______________________________

PRESENCE OF THE BOAT TO WHICH THE FISHING GEAR INVOLVED BELONGS _____ PRESENCE OF OTHER BOATS ____________________________

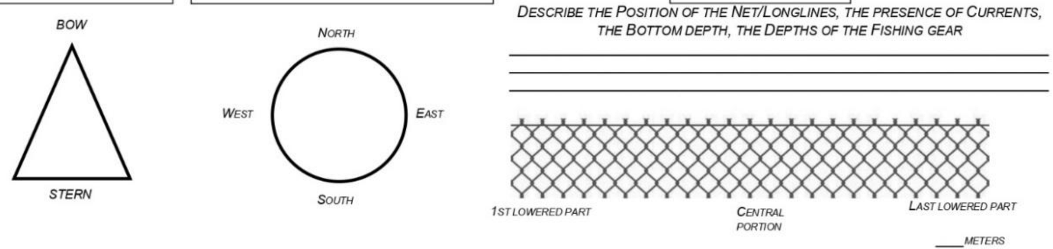
PRESENCE OF OTHER SPECIES / LITTER / ANY RELEVANT ENVIRONMENTAL OR HUMAN FACTORS: ______________________________

NOTES / PHOTOS / VIDEOS ____

BEHAVIOR: PUT NUMBERS TO DESCRIBE THE POSITION OF THE CETACEAN IN RELATION TO THE FISHING BOAT AND ITS FISHING GEAR DURING THE INTERACTION

BOAT | DIRECTION OF SWIMMING RELATIVE TO THE CARDINAL | FISHING GEAR

DESCRIBE THE POSITION OF THE NET/LONGLINES, THE PRESENCE OF CURRENTS, THE BOTTOM DEPTH, THE DEPTHS OF THE FISHING GEAR



LEGEND OF INTERACTION SURVEY

info@marecamp.com

The following form must be filled in every time one or more cetaceans are involved with fishermen actions.

1. ID INTERACTION SURVEY INT-___

Write the **progressive number** of the interaction (during the same date). E.g. 1 for the first, 2 for the second and so on.

2. RELATED SURVEY SHEETS ID

Write all the other survey sheets IDs, depending on the activities of that date. E.g. BS-02

3. OBSERVERS

Write the names of all observers present during the survey.

4. TYPE OF FISHING GEAR

Write the type of fishing gear in which the interaction is occurring.

5. CETACEANS

SPECIES – Indicate the **species sighted while interacting** with the correct code (table 4).

No. TOTAL – Indicate the **total number** of animals sighted and the first signs of cetacean presence: dorsal fin, jump or acoustic data for example.

No./ID of identified individuals involved in the interaction.

Table 4

CODE	Species	EN	ITA
Bp	*Balaenoptera physalus*	Fin whale	Balenottera comune
Pm	*Physeter macrocephalus*	Sperm whale	Capodoglio
Gg	*Grampus griseus*	Risso's dolphin	Grampo
Tt	*Tursiops truncatus*	Bottlenose dolphin	Tursiope
Sc	*Stenella coeruleoalba*	Striped dolphin	Stenella striata
Dd	*Delphinus delphis*	Common dolphin	Delfino comune
Zc	*Ziphius cavirostris*	Cuvier's beaked whale	Zifio
Gm	*Globicephala melas*	Long-finned pilot whale	Globicefalo
Sb	*Steno bredanensis*	Rough-toothed dolphin	Steno
NI	Unidentified species		

6. INTERACTION TIME

Indicate the start **time** of the interaction line and the end time in the corresponding line.

7. No. BOATS

Write the presence of the boat to which the fishing gear involved belongs and if present, the numbers and sizes of other boats (**S=small** 3-7 meters; **M=medium** 8-15 meters; **L=large** >15 meters). If they are fishing, also write an **F.** E.g. 3S; 1MF

8. NOTES

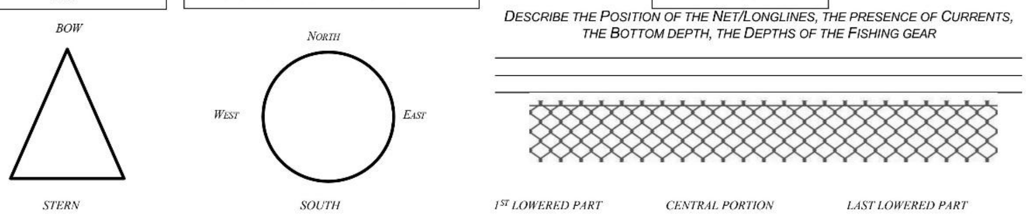
Indicate the presence of associations (birds, fish, reptiles, other cetacean species, fishing gear, etc.), the directional changes in cetacean swimming, the variation of any other element/event, or particular behaviors. Note if there are any reference **photos** or **videos** and their authors (e.g. Clara **V** Sony, Ale **P** Nikon).

9. BEHAVIOUR

Put numbers to describe the position of the cetacean in relation to the fishing boat and its fishing gear during the interaction using ascending numbers according to the movements done by the cetaceans along the vessel and/or the net in the graphs below.

BOAT | DIRECTION OF SWIMMING RELATIVE TO THE CARDINAL | FISHING GEAR

DESCRIBE THE POSITION OF THE NET/LONGLINES, THE PRESENCE OF CURRENTS, THE BOTTOM DEPTH, THE DEPTHS OF THE FISHING GEAR



ANNEX IV – Cetacean times sheet

info@marecamp.com

<u>CET DIVE TIMING</u> SURVEY Depredation-3 project – ID CT-______

DATE: ________________ PLATFORM: ______________ AREA: ____________

OBSERVERS: ____

SIGHTING SURVEY ID RELATED: __________ OTHER SURVEY ID RELATED: __________________________

INDIVIDUAL ID		SEX			CALF			PHOTO ID REF.			NO. INDIVIDUALS IN THE GROUP						
START TIME	SURF	DIVE	SURF	DIVE	SURF	DIVE	SURF	DIVE	SURF	DIVE	SURF	DIVE	SURF	DIVE	SURF	DIVE	NOTE
__ __ : __ __																	
__ __ : __ __																	
__ __ : __ __																	
__ __ : __ __																	
__ __ : __ __																	

NOTE (WRITE IF THERE ARE PARTICULAR ASSOCIATIONS OR BEHAVIORS):

____

____

____

INDIVIDUAL ID		SEX			CALF			PHOTO ID REF.			NO. INDIVIDUALS IN THE GROUP						
START TIME	SURF	DIVE	SURF	DIVE	SURF	DIVE	SURF	DIVE	SURF	DIVE	SURF	DIVE	SURF	DIVE	SURF	DIVE	NOTE
__ __ : __ __																	
__ __ : __ __																	
__ __ : __ __																	
__ __ : __ __																	
__ __ : __ __																	

NOTES (WRITE IF THERE ARE PARTICULAR ASSOCIATIONS OR BEHAVIORS):

____

____

____

ANNEX X – Bycatch sampling sheet

info@marecamp.com

<u>BYCATCH SAMPLING</u> Depredation-3 project – ID BYC-___

DATE: ________________ *BOAT:* ______________ *PORT:*____________

OBSERVERS: ____

BOARDING SURVEY ID RELATED: _________

RECORD NO.	GROUP OF VULNERABLE SPECIES*	COMMON NAME	SCIENTIFIC NAME	LENGTH (cm)	WEIGHT (gr)	ALIVE (A), DEAD (D), ALMOST DEAD (AD)	RELEASED ALIVE (YES/NO)	SEX (IF KNOWN)	NOTES (REF. TO PHOTOS AND VIDEOS)
1									
2									
3									
4									
5									
6									
7									
8									

*GENERAL NOTES:*____

____

**VULNERABLE SPECIES CATEGORIES: MARINE MAMMAL, SHARK, RAY, SEABIRD, SEA TURTLE.*

ANNEX XI– PODs sheet

info@marecamp.com

Depredation-3 Project

Codice POD 1 ________

Codice POD 2 ________

Codice POD 3 ________

Nominativo pescatore ____________________

Matricola peschereccio ____________________

Porto base ____________________

Data	Attrezzo	Orario inizio cala	Posizione GPS inizio cala	Profondità inizio cala	Orario fine cala	Posizione GPS fine cala	Profondità fine cala	Prof. POD 1	Prof. POD 2	Prof. POD 3	Orario inizio ritiro	Orario fine ritiro	Interazione con i delfini	Note

ANNEX XII – Acoustic survey sheet

info@marecamp.com

ACOUSTIC SURVEY – AS-____
DEPREDATION-3 project – referred to OS- _______

DATA: ____________________

ID REC	START TIME	END TIME	DISTANCE SENTRY BOAT-GEAR + TYPE OF GEAR	PORTION OF THE GEAR	CETACEAN PRESENCE(Y/N), IF YES SPECIFY THE SPECIES	PRESENCE OF THE MAIN BOAT (Y/N, AND ID) AND OTHER BOATS	NOTES WITH TIME (BEHAVIOR, DIRECTION OF SWIM, SOURCE AND CATEGORIES OF SOUNDS, TYPES OF SOUNDS)

ANNEX XIII– Press release 07/2024 Depredation-3 Project Announcement

Associazione Marecamp
Ente del Terzo Settore
Organizzazione Di Volontariato

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Interazione tra delfini e altre specie vulnerabili con la pesca

Pescatori e ricercatori sperimentano soluzioni

Catania, 5 agosto 2024 – È la Sicilia orientale la regione scelta dalla **Commissione Generale per la Pesca nel Mediterraneo (CGPM) della FAO**, per implementare gli studi e sperimentazioni sulle flotte di pesca affinché le interazioni con le specie marine vulnerabili vengano ridotte.

Cetacei, squali, tartarughe e uccelli marini possono essere **catturati accidentalmente** dagli attrezzi da pesca utilizzati dai pescatori professionali nella ricerca di altre specie bersaglio. Questo può causare il ferimento o la morte di animali non destinati al mercato ittico, determinando al contempo un'importante perdita di biodiversità per l'ecosistema marino. In aggiunta, spesso i delfini si avvicinano ai pescherecci per predare il pesce catturato in ami e reti, provocando ingenti danni sia al pescato che agli attrezzi, nonché rischiando di restare intrappolati a loro volta. Tale fenomeno interessa maggiormente la piccola pesca artigianale, e viene definito "**Depredazione**", con ripercussioni sia di tipo ambientale che economico e sociale.

Da qui, la denominazione del progetto in corso "**Depredation-3**", abbreviazione del titolo "**Attività di monitoraggio e misure di mitigazione per ridurre la predazione degli attrezzi da pesca artigianale ad opera dei delfini nel Mar Ionio occidentale**". Si tratta del terzo lavoro realizzato dall'**Associazione Marecamp** in Sicilia orientale su tale tematica, la quale negli ultimi anni ha dimostrato di avere delle importanti intuizioni nel campo della conservazione della fauna marina. Marecamp ha attivato una **rete composta da pescatori artigianali** che collaborano con i ricercatori per **monitorare** la presenza e distribuzione di specie marine a rischio di estinzione, e **testare** innovativi metodi di pesca e dispositivi accessori utili per ridurre gli eventi di interazione di delfini e altre specie vulnerabili con le attività di prelievo ittico.

I "**Laboratori galleggianti**" in questione, rappresentati dai pescherecci, uniti alle imbarcazioni scientifiche dell'Associazione, sono il fulcro del lavoro in campo di una squadra di biologi osservatori che già da 5 mesi raccoglie informazioni sullo sforzo di pesca e i casi di depredazione e by-catch lungo tutta l'area d'azione del progetto, coinvolgendo una ventina di **marinerie che vanno da Messina a Portopalo di Capo Passero**.

Tra le specie maggiormente minacciate nell'area vi sono elasmobranchi come Trigoni (*Dasyatis pastinaca*), Verdesche (*Prionace glauca*), Squali capopiatto (*Cetorhinus maximus*), uccelli marini come Berte maggiori (*Calonectris diomedea*), Tartarughe marine come la Comune (*Caretta caretta*) e la liuto (*Dermochelys coriacea*), e delfini come il Tursiope (*Tursiops truncatus*).

Le sperimentazioni per ridurre o eliminare il tasso di interazione di questi gruppi vulnerabili con la pesca sono in corso nelle aree costiere del Mar Ionio occidentale, e i loro risultati saranno condivisi nei prossimi mesi in occasione di un **Workshop internazionale** al quale parteciperanno esperti provenienti da diversi Paesi del Mar Mediterraneo e Mar Nero che lavorano costantemente per i ridurre nel lungo termine i rischi di sopravvivenza delle specie ritenute in pericolo.

Il progetto è finanziato dalla **Commissione Generale per la Pesca nel Mediterraneo** (CGPM) della FAO, e vede come partner l'**Accordo sulla Conservazione dei Cetacei del Mar Nero, del Mediterraneo e della zona Atlantica adiacente (ACCOBAMS)**, per il quale la valutazione e la mitigazione dei conflitti delle attività di pesca con balene, delfini e focene sono di primaria importanza.

"Questo progetto rappresenta un passo cruciale verso la conservazione delle risorse marine. Desidero esprimere la mia sincera gratitudine a tutta la comunità di pescatori e ai colleghi collaboratori (**Dario Garofalo, Alessandra Raffa, Helen Accolla, e Pietro di Bari** *in primis*) per il loro impegno e dedizione nel progetto Depredation-3. Tutti i nostri sforzi sono essenziali per la protezione delle specie marine vulnerabili e la promozione di pratiche di pesca sostenibili" dichiara **Clara Monaco**, coordinatore del progetto.

Foto allegate su attività progettuali. ©Marecamp

ANNEX XIV - Meeting Report of the ACCOBAMS Workshop on Commercial Fisheries Interactions with Vulnerable Species

Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area, concluded under the auspices of the Convention on the Conservation of Migratory Species of Wild Animals (CMS)

Accord sur la Conservation des Cétacés de la Mer Noire, de la Méditerranée et de la zone Atlantique adjacente, conclu sous l'égide de la Convention sur la Conservation des Espèces Migratrices appartenant à la Faune Sauvage (CMS)

ACCOBAMS

Meeting Report

ACCOBAMS Workshop on Commercial Fisheries Interactions with Vulnerable Species

Online, 28 January 2025

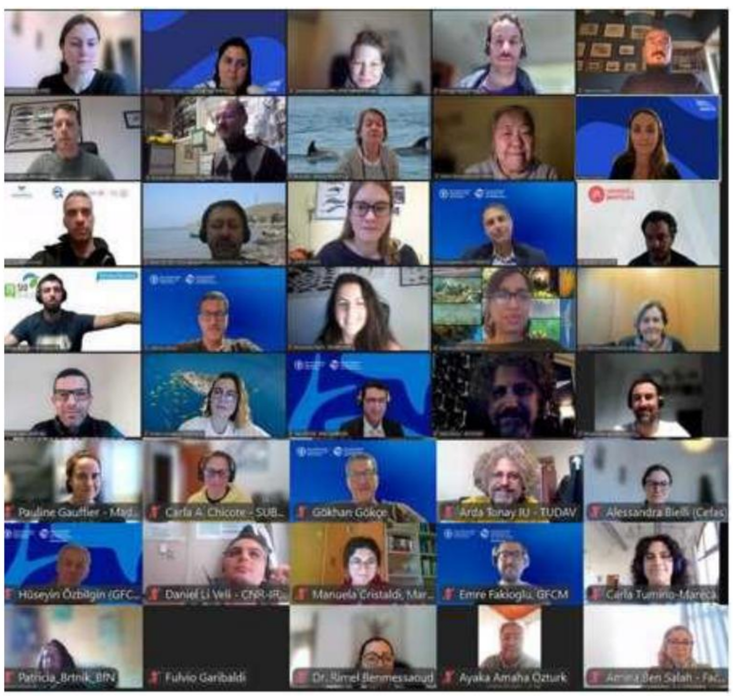


Table of Contents

ACCOBAMS Workshop on Commercial Fisheries Interactions with Vulnerable Species

Online, 28 January 2025

Opening

The **ACCOBAMS Workshop on Commercial Fisheries Interactions with Vulnerable Species** was held online on 28 January 2025, within the framework of three ongoing projects funded by the General Fisheries Commission for the Mediterranean (GFCM) under the FAO, for which the ACCOBAMS Secretariat was involved as coordinating partner.

The workshop aimed to exchange knowledge and experiences on the monitoring and mitigation of incidental catches and depredation involving vulnerable marine species drawing on expertise from a wide network of experts and organizations active across the ACCOBAMS and GFCM areas, and beyond.

This initiative was rooted in a long-standing collaboration between ACCOBAMS and GFCM, established through the 2012 Memorandum of Cooperation, to cooperate and support initiatives focused on assessing, monitoring, and mitigating fisheries interactions with marine megafauna, as demonstrated by previous projects such as MedBycatch (2017–2022) and the Dolphin Depredation project (2018–2022).

The workshop gathered 72 participants, including representatives from five ongoing GFCM-funded projects carried out by national partners: BirdLife (Spain), Çukurova University (Türkiye), Marecamp Association (Italy), the National Institute of Fisheries Research (INRH) of Tangier (Morocco), and WWF Adria (Croatia). The final list of participants appears in Annex 1.

The workshop targeted the following three main objectives:

- **Share experiences, knowledge and insights on interactions between commercial fisheries and vulnerable marine species (including cetaceans, elasmobranchs, reptiles, seabirds, juvenile fish, etc.).**

- **Discuss monitoring and mitigation strategies to address bycatch of vulnerable species and dolphin depredation within the ACCOBAMS and GFCM areas, as well as in other relevant regions.**

- **Promote collaboration among experts, organizations and institutions across countries working on these critical issues.**

These objectives are essential as species such as cetaceans, sea turtles, seabirds, and elasmobranchs face significant risks from incidental capture (bycatch) and depredation, particularly by dolphins, is a cause of strong concerns for fishers and fisheries managers in the Mediterranean, Black Sea, and adjacent Atlantic. The fisheries interaction with marine megafauna can result in injury or mortality to non-target species and economic losses for fishers, yet data on their extent and distribution remain fragmented, hindering the development of effective mitigation strategies and prompting for innovative and adaptive solutions, based on scientific evidence and grounded in collaboration with stakeholders.

The ACCOBAMS Secretariat welcomed all participants and recalled that the workshop represented a key step in enhancing collaboration and knowledge-sharing across countries and institutions, aligning with GFCM and ACCOBAMS efforts to minimize negative impacts on marine biodiversity while supporting sustainable fisheries.

In particular, this workshop highlighted the priorities of the **GFCM 2030 Strategy**, which aims to consolidate scientific knowledge on marine living resources—especially vulnerable species and ecosystems—and to develop effective area-based management tools to mitigate fishing impacts. The workshop also aligned with the **GFCM's Regional Plan of Action for Small-Scale Fisheries (RPOA-SSF)**, which promotes investments to improve the selectivity of fishing gear, reduce incidental catches, and minimize interactions with vulnerable species.

Moreover, it fell within ACCOBAMS commitment to foster regional cooperation for the protection of cetaceans and the conservation of marine biodiversity, with a strong focus on addressing the threats posed by fisheries interactions, particularly bycatch and dolphin depredation. Over the years, ACCOBAMS has strengthened collaboration with other regional and international organizations working on complementary mandates, including the GFCM, the Barcelona Convention, the Regional Activity Center for Specially Protected Areas (SPA/RAC), the Bucharest Convention, the Bonn Convention on Migratory Species (CMS), the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS), and the International Whaling Commission (IWC), among others.
Recent **ACCOBAMS Resolutions**, such as Resolution 8.16 on interactions between fisheries and cetaceans, call for reinforced cooperation among competent bodies and advocate for more robust monitoring of bycatch and depredation, with the goal of reducing these impacts and promoting sustainable fishing practices.

Before adopting the agenda (Annex 2), the ACCOBAMS Secretariat underlined that, the workshop offered a valuable opportunity to present approaches, highlight emerging results, and align efforts for coherent, effective, and science-based action regarding commercial fisheries interaction with vulnerable species.

No. 01 - An approach to tackle seabird bycatch in the western Mediterranean: self-reporting logbooks and mitigation methods.

ORGANIZATION	**SEO/BirdLife, Spain**
SPEAKER	Daniel Rey Faura
COAUTHORS	Antonio Vulcano, Jose Manuel Arcos
ABSTRACT	Bycatch in fishing gear is the greatest hazard to some of the most threatened seabirds in the Mediterranean, particularly shearwaters. Here we present work in the Spanish Mediterranean to assess this threat and develop mitigation measures. Assessment is particularly complex in the region, due to the numerous and highly diversified local fishing fleet, mostly small-scale, that makes it difficult to follow traditional approaches, particularly on-board observations. We present a complementary methodology based on self-reporting logbooks filled in by the fishers themselves on a daily basis and regularly monitored by a network of observers in the fishing ports. This approach was implemented by SEO/BirdLife since 2017, with fishers from 82 collaborating vessels coordinated by eight observers at port. Data were collected from 3,522 fishing days in which 1,142 birds were caught (2017 - 2021), with shearwaters being the most affected (93%). Of particular concern was the critically endangered Balearic shearwater *Puffinus mauretanicus*. Bycatch rates varied between years and areas and according to the configuration and operational characteristics of the gear, being more frequent in the small-scale fleet in late spring. The greatest risk of bycatch occurred when setting during the day, using small pelagic fish as bait, and adding little or no weight to the line. Self-reporting logbooks turned out to be a good method to assess seabird bycatch in small-scale fisheries, with lower effort compared to observer programs, and helped at raising awareness and involving fishermen in finding solutions to mitigate bycatch, showing promise for extension to other areas and gears, mainly in the small-scale fleet. Current work funded by the FAO-GFCM (2023-2025) supports the approach of the logbooks to keep evaluating the issue and puts particular attention on the development of mitigation measures.
KEYWORDS	Seabird, bycatch, mitigation, logbooks

No. 02 - Reduction and mitigation of bycatch of vulnerable species in Turkish trawl fisheries (GSA 24 – Northern Levant Sea).

ORGANIZATION	**Çukurova University, Türkiye**
SPEAKER	Cagatayhan Bekir Ersu
COAUTHOR	Gokhan Gokce
ABSTRACT	This summary presents the preliminary findings of the "Reduction and Mitigation of Bycatch of Vulnerable Species in Turkish Trawl Fisheries" project. Focused on protecting vulnerable species such as elasmobranchs, sea turtles, and marine mammals, the study is being conducted in the Northern Levant Sea (GSA 24) using bottom trawlers as the primary fishing gear. For mitigation trials, two types of grids were tested, 45° PA grids (50 mm bar spacing) for red shrimp and 135° PA grids (95 mm bar spacing) for fish species. The trials were conducted at a trawl towing speed of approximately 2.5 knots with towing durations of 3 hours to reflect commercial fishing practices. Results demonstrated a significant reduction in ray and shark catches, highlighting the effectiveness of these mitigation measures. A short-term post-release mortality experiment (1 hour) was conducted to assess the survival rates of several vulnerable species. Species tested in shallow waters included *Rhinobatos rhinobatos, Gymnura altavela, Rhinoptera marginata, Aetomylaeus bovinus*, and *Dasyatis pastinaca*. In deeper waters, the species tested included *Heptranchias perlo*, *Dalatias licha*, *Hexanchus griseus*, and *Dipturus oxyrinchus*. The experiment involved placing individuals into a survival tank with approx. 1000 L volume: 930 immediately after the completion of the trawl operation. The results from shallow water trials indicated that most individuals of Rhinoptera marginata survived, with only two fatalities, while survival was not observed for individuals in deeper waters (*Heptranchias perlo, Dalatias licha, Hexanchus griseus*, and *Dipturus oxyrinchus*). These outcomes highlight the critical role of depth and methodology in post-release survival. The long-term survival experiments conducted over two periods using net cages for deep-water species confirmed that the methodology was unsuitable as all individuals tested in these conditions died. These findings highlight the effectiveness of grid systems as a significant step toward mitigating the bycatch of vulnerable species in trawl fisheries while emphasizing the need for further development and optimization.
KEYWORDS	Bycatch, post-release, vulnerable species, trawl, mitigation

No. 03 - Reduction and mitigation of the catch of elasmobranchs incidentally captured by gillnets and combined nets along the Croatian Coast (GSA 17 – Northern Adriatic Sea).

ORGANIZATION	**WWF Adria, Croatia**
SPEAKER	Hrvoje Čeprnja
ABSTRACT	Sharks and rays in the Adriatic face significant threats from incidental capture in fisheries, offshore but also in coastal areas with intensive fishing activities. The MedBycatch (2020-2022) project aimed to address this issue by investigating the bycatch of sensitive species, including elasmobranchs, marine mammals, seabirds, and turtles, across the Mediterranean, and showed that sharks and rays bycatch frequently occurs inter alia in small-scale vessel fisheries in Croatia. This emphasizes the need for further testing of widely used set nets within this fleet segment to develop effective mitigation measures to protect vulnerable species and maintain ecosystem integrity. In 2024, a new pilot project, "Reduction and Mitigation of the Catch of Elasmobranchs Incidentally Captured By Gillnets and Combined Nets along the Croatian Coast (GSA 17 – Northern Adriatic Sea)" FAO-GFCM funded project, aims to further add to data collection and to test strategies to minimize elasmobranch bycatch. This project actively engages Croatian fishers and national authorities. Data collection includes on board observations and port questionnaires conducted by scientific experts across key and smaller fishing ports. Mitigation measures include at-sea trials testing two strategies: LED lights on gillnets and modified mesh slack. Additionally, tagging of elasmobranch species using "Spaghetti tags" is being carried out within the project. The aim is to enhance the reach of tagging efforts through social media, targeting fishers directly. Similar to database established by the University of Padova, a new and improved database will be established supporting the sharing and hosting of tagging data in collaboration with the Institute of Oceanography and Fisheries in Split and University in Padova for long-term monitoring of elasmobranch movements and behaviour. It will support the development of effective conservation strategies and fisheries management practices, as well as awareness raising for the reporting of recaptures in the Northern Adriatic (GSA 17).
KEYWORDS	Data collection, mitigation, gillnets, sharks and rays, Adriatic Sea

No. 04 - Clean Catch: combining stakeholder-led approach and technological innovation for evidence-driven management.

ORGANIZATION	**Centre for Environment, Fisheries and Aquaculture Science (Cefas), United Kingdom**
SPEAKER	Alessandra Bielli
ABSTRACT	Incidental capture (bycatch) of sensitive marine species including marine mammals, seabirds, and elasmobranchs in commercial fisheries is a major threat to their conservation and can have socio-economic and well-being consequences for the fishing industry. Key to addressing this challenge is a robust understanding of the population abundance and distribution of these species, along with their bycatch rates, to enable the development and implementation of targeted mitigation measures. Clean Catch is a collaborative research programme that is working directly with the fishing industry to support the UK government's aims to minimise the bycatch of sensitive marine species. In 2019, participating fishers in the programme requested the trial of technologies to reduce cetacean bycatch in their gillnet fishery. The first phase of the Cetacean Bycatch Mitigation Trial (2019-2022) was designed to investigate if Acoustic Deterrent Devices (or 'pingers') and Light Emitting Diodes (LEDs) were practical, robust and effective at reducing bycatch of common dolphin and harbour porpoise, without increasing the bycatch of other sensitive species. A smartphone mobile application was co-designed to enable self-reporting of fishing activity and bycatch events, alongside the use of onboard Remote Electronic Monitoring to capture independent video data. Following feedback on the practicality and design of the trial, a second phase was implemented from August 2024. Here we present how the design of the trial was simplified and scaled to specifically understand the effectiveness of Fishtek Marine's "Banana pinger" at reducing cetacean bycatch, informed by a priori power analysis, and summarise early results.
KEYWORDS	pingers, gillnets, co-design

No. 05 - Depredation 3 project: insights into small-scale fisheries and vulnerable species interactions in Sicilian waters of GSA19.

ORGANIZATION	**Marecamp Association, Italy**
SPEAKER	Alessandra Raffa
ABSTRACT	The Depredation-3 project aims to tackle the challenges posed by interactions between small-scale fisheries and marine species in the Western Ionian Sea (GSA 19) in the eastern Sicilian waters. This initiative, led by Marecamp in partnership with ACCOBAMS and funded by FAO-GFCM, adopts an integrated approach combining monitoring and mitigation activities with innovative technologies and standardized protocols, focusing on mitigating dolphin depredation and bycatch events to ensure the sustainable use of marine resources while protecting vulnerable species. Key actions include extensive monitoring using observer-based surveys, fishers' logbooks, bioacoustic analyses, and structured interviews across four macro-areas from Messina to Portopalo di Capo Passero. Preliminary results indicate significant economic losses from dolphin depredation, with high-value catch species particularly affected. Bycatch incidents involving vulnerable species, such as sea turtles and elasmobranchs, further underline the ecological and economic challenges faced by small-scale fisheries in this region. Mitigation efforts focus on deploying and assessing tools such as the Acoustic Alert System, visual deterrents, and structural adaptations to fishing gear. Bioacoustic monitoring has provided valuable insights into dolphin behaviour, enabling a data-driven refinement of mitigation measures. Collaborative efforts with fishers, including implementing the Floating Laboratories network, enhance real-time data collection, encourage stakeholder engagement, and promote effective conservation strategies. This project bridges scientific research with practical solutions, addressing the complex dynamics of fisheries and vulnerable species interactions. It demonstrates how sustainable fisheries management can be aligned with marine conservation, offering a scalable model for similar initiatives globally.
KEYWORDS	Vulnerable species, dolphin depredation, bycatch, mitigation, Sicily

No. 06 - Depredation caused by the bottlenose dolphin (*Tursiops truncatus*) in the Moroccan Mediterranean and the proposed mitigation measures.

ORGANIZATION	**National Institute of Fisheries Research (INRH), Morocco**
SPEAKER	Mohammed Idrissi Malouli
ABSTRACT	The project "Contribution to understanding the phenomenon of interaction between bottlenose dolphins (*Tursiops truncatus*) and purse-seine fisheries" aims to study cetaceans and more precisely the bottlenose dolphin that causes the problem of depredation in the Moroccan Mediterranean in two main areas: M'diq and Al-Hoceima. This project combines behavioral and ecological studies for this population of dolphins to find a sustainable solution to this problem. In 2024, various methods of monitoring the population of bottlenose dolphins were used, such as passive acoustics, photo-identification and biopsy, surveys and the embarkations on board of purse seiners carried out by scientific observers, these approaches have led to a better understanding of bottlenose dolphin behavior and ecology, By 2025, the National Institute of Fisheries Research aims to continue this monitoring and to deepen analyses, including by extending the observation areas to the Jebha area, and integrating new technologies as a measure to mitigate the problem of depredation, to reduce depredation and minimize economic losses and negative impacts from these interactions between bottlenose dolphins and purse seiners.
KEYWORDS	Depredation, bottlenose dolphin, mitigation measures, Moroccan Mediterranean

No. 07 - Bio-inspired acoustic beacons to limit fishery by-catch of dolphins.

ORGANIZATION	**University of Montpellier - Marine Biodiversity, Conservation & Exploitation, France**
SPEAKER	Bastien Merigot
ABSTRACT	Acoustic repellent pingers have been developed to reduce dolphin by-catch. However, mixed results regarding their efficiency have been reported worldwide on different species and fisheries. Within the DOLPHINFREE project "Dolphins free from fishery by-catch", we have developed a new generation of acoustic beacon, bio-inspired. It emits signals in link with the echolocation system to help dolphins in detecting net presence. Ultimately, the objective is to reduce common dolphin *Delphinus delphis* by-catch in the Bay of Biscay, France. The device also contains a passive acoustic listening system to identify dolphin presence, allowing beacon emission only when detected. Behavioral responses of 47 groups of common dolphins in response to beacon emission have been assessed by experiments at sea during summers 2020 and 2021. The results highlighted that the device led dolphins to echolocate and communicate more (x2.46 in mean echolocation clicks and x3.38 in mean whistle duration, respectively). In addition, observations showed that dolphins calmly left the source emission's area without showing stressful behaviour. Tests made during 1043 fishing operations (FOs) of professional gill netters, to assess the practicality and to provide preliminary data on the efficiency of the new device, have been performed with observers onboard during 228 days at sea in 2021 and 2022. No by-catch was observed for the FOs in which no disfunctioning in their practice occurred. These results being encouraging, complementary tests of bio-inspired acoustic beacons during FOs of professional gill netters are planned during winter 2024 to assess statistically its efficiency in reducing common dolphin by-catch.
KEYWORDS	Acoustics, bycatch, conservation, mitigation, threatened and endangered species

No. 08 - Cetacean bycatch in the ACCOBAMS and ASCOBANS areas.

ORGANIZATION	**ACCOBAMS-ASCOBANS Joint Bycatch Working Group**
SPEAKER	Ayaka Amaha Ozturk
COAUTHOR	Peter Evans
ABSTRACT	ACCOBAMS and ASCOBANS established a Joint Bycatch Working Group (JBWG) in January 2019 to exchange scientific information on monitoring and mitigating cetacean bycatch in the two agreement areas. In the Mediterranean Sea (ACCOBAMS), drifnets for large pelagic fishes were the main concern due to the bycatch of common dolphins, striped dolphins, Risso's dolphins and sperm whales. It has been banned since 2002, but there are still illegal drift nets occasionally. In the Black Sea (ACCOBAMS Area), turbot fishing causes bycatch, mainly of harbour porpoises. A recent study estimated annual bycatch of over 10,000 animals (Popov et al. 2023), well above the sustainable level. The main species in NW Europe (ASCOBANS) with serious bycatch issues are the harbour porpoise, common dolphin, minke whale and humpback whale. Bottom set gill nets, trammel and tangle nets cause mortality for harbour porpoise and common dolphin; pelagic trawls for common and striped dolphins, semi-driftnets for harbour porpoise in the Baltic Proper, whilst entanglement in ground-lines between fish pots as well as ghost netting (discarded and lost netting) for minke whale and humpback whale is causing concern. Seasonal risk maps have been produced for all of the main cetacean species and for every gear type across Atlantic European waters. Bycatch rates have been shown to be unsustainable for harbour porpoise in the North Sea, and may also be in the Celtic Seas. There is also a very high bycatch of common dolphins in the Bay of Biscay, as many as 10,000 animals estimated per year. In terms of mitigation, different measures have been considered and partially implemented, from fishery closures to application of pingers and modification to fishing gear. Various projects have been carried out to investigate bycatch and explore a range of mitigation measures, such as MedBycatch, GFCM's BlackSea4Fish, the Cetambicion Project and most recently CIBBRiNA Project.
KEYWORDS	Cetaceans, bycatch, ACCOBAMS, ASCOBANS

No. 09 - On a new smart acoustic deterrent device based on dolphin recognition through artificial intelligence.

ORGANIZATION	**Institute for Biological Resources and Marine Biotechnologies of the Italian National Research Council (CNR-IRBIM), Italy**
SPEAKER	Alessandro Lucchetti
ABSTRACT	Predation is recognized as the most concerning type of dolphin-fishery interaction, with pingers being the most commonly used mitigation tool. However, a limitation of the currently available pingers is their lack of "interactivity". A new acoustic deterrent device based on artificial intelligence was developed, consisting of four fundamental components: a receiving part or hydrophone, a computational system for dolphin recognition based on AI, an emitting part, and a battery pack. The entire system has been developed with the aim of minimizing both the size and cost of the device (less than €500). This innovative tool employs advanced algorithms to analyse dolphin vocalizations in real time, detecting their presence near fishing nets (whistle detection > 95%; other emissions > 55%). Once the cetacean is identified, the device emits customized acoustic signals to deter it from approaching. Compared to traditional pingers, which emit continuous and non-reactive acoustic signals, this new technology introduces an unprecedented level of interactivity. It not only reduces acoustic pollution in the ocean but also avoids the risk of habituation by the animals, thanks to its ability to modulate and vary the emitted signals according to specific needs. Developed as part of research initiatives such as the European Life Delfi program and the National Biodiversity Future Center, the device represents a promising solution for balancing marine species protection with the demands of fishing activities. Currently in the testing phase, the project is focused on refining the device's performance to further enhance its effectiveness and adaptability in complex marine environments.
KEYWORDS	Artificial intelligence, pinger, dolphin detection, acoustics

No. 10 - Mitigation of bottlenose dolphin's depredation: Tunisian experience & lessons learned.

ORGANIZATION	**National Institut of Agronomy of Tunisia (INAT), Tunisia**
SPEAKER	Rimel Benmessaoud
ABSTRACT	Bottlenose dolphins are most commonly involved in depredation along the Tunisian coast, in particular in areas where fishing activities targeting small pelagic fish overlap with dolphin populations. Purse seiners generally report that depredation causes significant damage to fishing gear as well as reductions to both the volume and composition of their catch. Many fishers have expressed a willingness to collaborate with research initiatives to assess the impact of dolphins and explore potential mitigation strategies. Mitigation measures to reduce bottlenose dolphin depredation in Tunisia are diverse and involve a combination of strategies. These include deploying acoustic deterrents, testing reinforced materials to enhance the resistance of fishing nets to dolphin bites, and adjusting fishing practices by redirecting efforts away from areas with high dolphin densities. The overarching goal is to minimize interactions between dolphins and fishing operations effectively. Certain depredation mitigation measures have been deemed ineffective and subsequently dismissed, while others remain under evaluation, showing promising potential and gradually proving their effectiveness in reducing conflicts between dolphins and fishing activities. Gaining a deeper understanding of the foraging strategies of bottlenose dolphins appears to be a crucial element in developing effective and sustainable conflict mitigation solutions.
KEYWORDS	Bottlenose dolphin, depredation, purse seine, mitigation measures, Tunisia

No. 11 - Fishery interaction with cetaceans: insight from 38 years of stranding monitoring (1986-2023) along the Italian coastline.

ORGANIZATION	**Department of Comparative Biomedicine and Food Science, University of Padova, Italy**
SPEAKER	Guido Pietroluongo
ABSTRACT	The Italian Stranding Network aims to monitor fishery interaction on stranded cetaceans to identify risk patterns and support targeted conservation policies through improved forensic methods and collaboration. Historical and new data spanning 38 years on fishery-related findings and mortalities were analyzed in 5355 cetaceans stranded in Italy, focusing on the most represented species. Literature review and evidence of interaction on stranded carcasses supported the findings' categorization, from animal history to pathological findings. Evidence assessment and post-mortem investigation methods evolved over three macro-periods, from non-standardized reporting (1986–2014, Tier 1) to an integrated national stranding network (2015–2019, Tier 2), and finally to the creation of a new standardized, evidence-based diagnostic framework under the EU-funded LIFE DELFI project (2020–2023, Tier 3). Evidence of fishery interactions was reported in 12.9% of carcasses (691/5355), with significant differences observed between species, sexes, and geographic areas. Geographic analysis identified distinct risk hotspots, such as geographical sub-areas (GSA) 17 for bottlenose and GSA 10 for striped dolphins. The most represented categories of interaction were the "presence of fishing gears" and the "larynx entanglement", particularly affecting bottlenose dolphins. The adoption of the new diagnostic framework attributed fishery-related causes of death to 12.07% of necropsied carcasses during Tier 3 (21/174), with adult male bottlenose dolphins more represented. For the first time in Italy, these results supported recommendations for species- and region-specific mitigation strategies, including gear modifications, seasonal bans, and marine protected areas. Engaging fishing communities in conservation efforts and standardizing forensic investigations across the Mediterranean are crucial for advancing cetacean conservation. This research represents a new model within the ACCOBAMS area and highlights the value of stranding networks in monitoring anthropogenic threats and shaping effective conservation policies.
KEYWORDS	Fishery interaction, stranding, cetaceans, Italy

No. 12 - Sampling for population demography is a tool for bycatch assessment.

ORGANIZATION	**Schmalhausen Institute of Zoology, National Academy of Sciences, Ukraine**
SPEAKER	Pavel Gol'din
ABSTRACT	Assessment of cetacean bycatch may be complicated in data-deficient areas (such as the Azov and Black Seas) due to incomplete catch and bycatch reporting, bad observer coverage, contradictions in effort assessment and impact of IUU fisheries. Now it is additionally complicated by the war in the Azov and Black Seas. Therefore, it is important to use indicators of population structure and demography for indirect assessment of bycatch rate and bycatch impact on populations. Modelling of population demography (e.g. using Bayesian estimation framework) can be used for assessing contributions of different mortality factors to the overall mortality rate, age-specific mortality by each age class and, subsequently, population growth rate (Moore and Read, 2008; Moore et al., 2013). Bycatch is considered as the harvest rate in such demographic modelling. Input data for such a study should include age- and sex-stratified samples of both bycaught (directly sampled onboard) and stranded (i.e., reflecting all causes of death) animals from the same population. Both sources of data are equally necessary. Also, age should be identified by year, so teeth and, when possible, bones, eye lenses and flippers – all the structures used for exact age estimation should be sampled. Other sampling procedures for age determination (e.g., for DNA methylation and metabolomics) may be appropriate depending on the species and its life history. Also, the status of sexual maturity should be checked, especially for data deficient populations and life histories, which may rapidly change under the climate change and bycatch pressure. The respective sampling protocols should be widely introduced elsewhere.
KEYWORDS	Population demography, modelling, age, life history, sampling procedures

No. 13 - Bottlenose dolphins and small-scale fisheries in the Pelagos Sanctuary: searching new mitigation strategies.

ORGANIZATION	**Istituto Zooprofilattico Sperimentale del Piemonte, Liguria e Valle d'Aosta, Italy**
SPEAKER	Camilla Testori
ABSTRACT	The common bottlenose dolphin (*Tursiops truncatus*) is a prominent species in the Pelagos Sanctuary, known for its adaptability and opportunistic interactions with fishing activities to supplement its diet. These interactions often lead to conflicts with fishermen, but the extent of the issue remains poorly understood. The TursioNet project, supported by the Pelagos Initiative of the Prince Albert II of Monaco Foundation, aims to address this challenge by developing an automated acoustic monitoring device. This device, installed on fishing nets, will allow real-time mapping of interactions between dolphins and small-scale fisheries in the Pelagos Sanctuary. Initial efforts included surveys with fishermen in Liguria and Corsica to identify high-interactions area where underwater acoustic recorders could be deployed. Over 136 days, more than 1,970 hours of recordings were collected from gillnets distributed evenly across the study area. Analysis focused on echolocation click patterns, revealing that only a small percentage (approximately 1%) of the analysed recordings contained biological signals attributable to cetaceans. These spectrograms are now used to train automated devices, integrating artificial intelligence (AI) technology. Validation tests are ongoing in the dolphin tanks at the Genoa Aquarium, aquaculture cages, and will extend to open-sea validation in the coming months. Additionally, carcasses of dolphins stranded along Liguria region are examined to assess fishery impacts, such as bycatch and net ingestion. The project's findings will estimate the mutual impact of bottlenose dolphins and fisheries, with the aim of developing conflict mitigation strategies and improving conservation efforts for this important species within the Pelagos SPAMI.
KEYWORDS	Pelagos Sanctuary, bottlenose dolphin, fishery interactions, acoustic monitoring

Conclusions

A diverse and collaborative exchange for transboundary challenges and shared priorities

The ACCOBAMS Workshop on Commercial Fisheries Interaction with Vulnerable Species brought together a wide range of researchers and practitioners for a full day of fruitful exchange and reflection. The diversity of projects presented, in terms of geographic coverage, methodological approaches, and target marine species, offered a rich overview of the state of research and ongoing actions across the Mediterranean, Black Sea, Atlantic Ocean, and surrounding areas.

The workshop covered critical issues such as incidental catch of vulnerable marine species — including seabirds, sea turtles, elasmobranchs, porpoises, dolphins, and whales — and dolphin depredation. These interactions are increasing in frequency and are not limited to the areas of ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area) and GFCM (General Fisheries Commission for the Mediterranean of the FAO). Presentations from France and the UK highlighted similar challenges in the Atlantic, reinforcing the need for coordinated, cross-regional responses. These interactions are complex and multifaceted, requiring long-term investment and cooperation across borders

Converging approaches and technological Innovation

Despite regional differences, many projects are converging on similar strategies to monitor and mitigate interactions. This included the use of fishers' ecological knowledge, the testing of selective fishing gear and innovative visual and acoustic devices, as well as efforts to improve data collection and sharing.
Technological innovation was a recurring theme, with several teams exploring advanced tools to reduce bycatch and depredation.
The Clean Catch programme in the UK trialed acoustic pingers and LED lights to reduce cetacean bycatch in gillnet fisheries. France's DOLPHINFREE project developed bio-inspired acoustic beacons that mimic dolphin echolocation and activate only when dolphins are detected. Italy's CNR-IRBIM introduced an AI-powered acoustic deterrent that customizes signals based on real-time dolphin vocalizations. These innovations aim to reduce unintended ecological impacts such as habituation and acoustic pollution, while improving the effectiveness of mitigation measures.

Toward harmonisation and regional integration

The workshop fostered dialogue around the potential harmonisation of methodologies to enable a more comparative and collaborative regional approach. Participants discussed the development and exchange of standardised questionnaires, protocols and data collection frameworks. These efforts are particularly relevant in the context of joint initiatives between ACCOBAMS and GFCM-FAO which are working across various Geographical subareas (GSAs) to support coordinated conservation strategies.

Promising results and persistent challenges

Many projects presented encouraging preliminary results in reducing bycatch and mitigating depredation. The Depredation-3 project in Sicily, for instance, combined observer-based surveys, bioacoustic monitoring, and fisher interviews to assess dolphin depredation and bycatch impacts. Türkiye's trials demonstrated significant reductions in elasmobranch bycatch using grid systems.

However, challenges remain. Post-release survival of deep-water species was low in Türkiye, indicating the need for species-specific handling protocols. In Morocco, the lack of baseline data on dolphin abundance and distribution continues to hinder the development of targeted mitigation strategies. Concerns were also raised about the long-term effectiveness of acoustic deterrents, particularly regarding habituation and the "dinner bell" effect. These findings underscore the importance of adaptive, context-specific solutions and robust long-term monitoring.

The workshop also emphasized that many of the scientific studies addressing these interactions are long-term in nature, often evolving through multiple phases over the years. This includes the continuation of significant initiatives such as the Depredation-3 project, which over the past six years has brought together several organizations in a joint effort to develop shared strategies for monitoring and mitigation. Long-term monitoring of species and anthropogenic threats, including fieldwork and onboard trials, is essential to assess the effectiveness of mitigation measures and to inform sound conservation policies. Such efforts require both time and high-quality data to yield meaningful results

Digital tools and stakeholder involvement

In today's digital age, new technologies and platforms such as social media, mobile apps, and multistakeholder data collection tools, including digital questionnaires and logbooks, offer expanded opportunities for reporting interactions, collecting sightings, and improving data flow between fishers and researchers. These digital tools facilitate more efficient and accurate data collection, fostering improved collaboration and information sharing among stakeholders.

The TursioNet project in the Pelagos Sanctuary is developing AI-powered acoustic monitoring devices to map dolphin-fishery interactions and train detection algorithms based on echolocation patterns. Croatia's tagging campaign is leveraging social media to encourage fishers to report recaptures. These tools are helping to bridge the gap between science and practice, making conservation efforts more inclusive and responsive.

A key message that resonated throughout the workshop was the importance of establishing a shared space for collaboration. Participants emphasized the need for a common platform to exchange results, methodologies, and data. In response, the GFCM is finalizing the development of a Regional Platform on Vulnerable Species. This platform will allow all actors—scientists, fishers, policymakers, and NGOs—to access, upload, and consult information. It is designed to promote transparency, comparability, and cooperation across the region.

Institutional commitment

Experts shared promising preliminary outcomes on reducing bycatch and mitigating depredation in various fisheries and *métiers*. The workshop also highlighted the strong need to maintain open and continuous dialogue, both within this working group and across wider networks, especially considering that this was the first event of its kind organized under the frameworks of ACCOBAMS and the GFCM.

The workshop reaffirmed the importance of long-term commitment and institutional support. Many of the scientific studies presented have evolved over several years and through multiple phases. The Depredation-3 project in Sicily, for example, has been ongoing for six years and involves multiple organizations working together to develop shared strategies for monitoring and mitigation

The commitment of the FAO through the GFCM was underlined by their technical and financial support, including the funding of five major projects currently being implemented by BirdLife, Çukurova University, Marecamp Association, National Institute of Fisheries Research of Tangier, and WWF Adria. These initiatives are essential not only for understanding and mitigating the interactions between vulnerable marine species and human activities but also for supporting sustainable fisheries and the livelihoods of fishers. Achieving balance between marine conservation and socio-economic sustainability remains a fundamental objective.

The GFCM's commitment to addressing bycatch and depredation caused by marine megafauna has been reinforced through the publication of regional reviews and methodological guidelines, as well as the 2023 endorsement of a Resolution establishing a Regional Plan of Action (GFCM/46/2023/4) to monitor and mitigate the interactions between fisheries and vulnerable species in the Mediterranean and the Black Sea. Within this framework, countries are encouraged to implement concrete actions over the short, medium, and long term, with the continuous support of the GFCM.

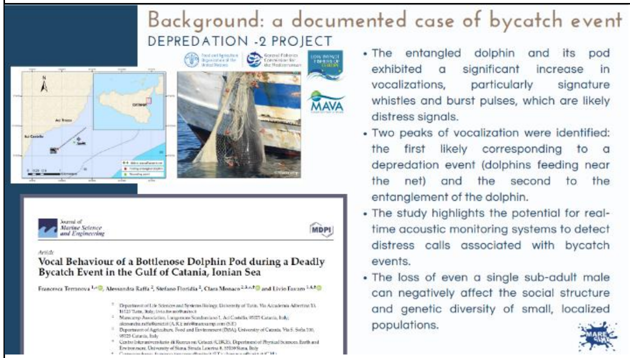
Closure of the meeting

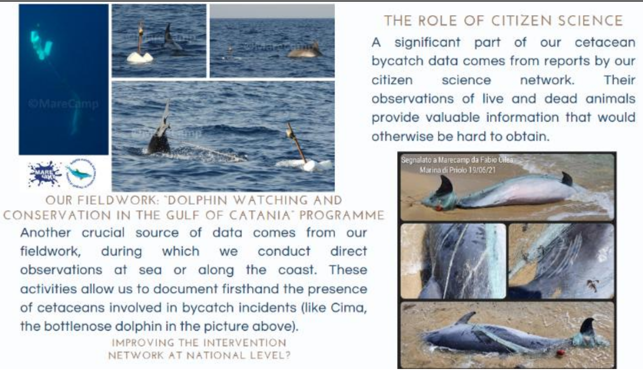
The FAO/GFCM representative concluded that the workshop offered an excellent opportunity for sharing experiences, exploring strategies, and advancing scientific and practical collaboration on one of the most urgent conservation challenges across the ACCOBAMS and GFCM areas. The high level of engagement demonstrated the strong interest and dedication of the various organizations and countries involved.

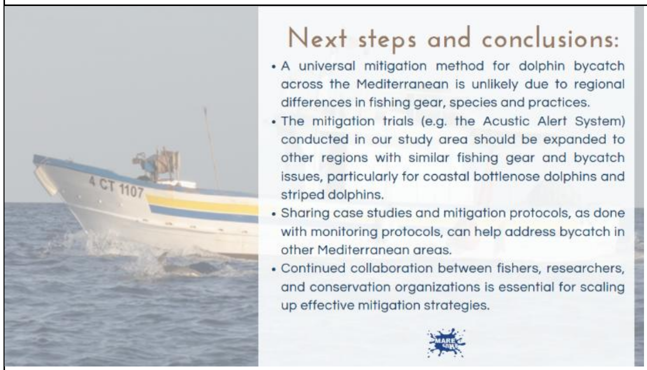
Sincere appreciation is extended to all participants, speakers, and contributors for their ongoing work and valuable insights. Special recognition is given to the FAO project partners and the GFCM for their essential and continuous support, which made the organisation of this event possible.

Continued exchange and collaboration are encouraged to build on the momentum generated by this workshop through future meetings and joint initiatives. The outcomes of this workshop represent a significant step toward the development of harmonised approaches and long-term strategies for mitigating interactions between fisheries and vulnerable marine species within the ACCOBAMS and GFCM areas. Constant engagement from all stakeholders will be essential to translate shared knowledge and recommendations into effective and sustainable actions across the region.

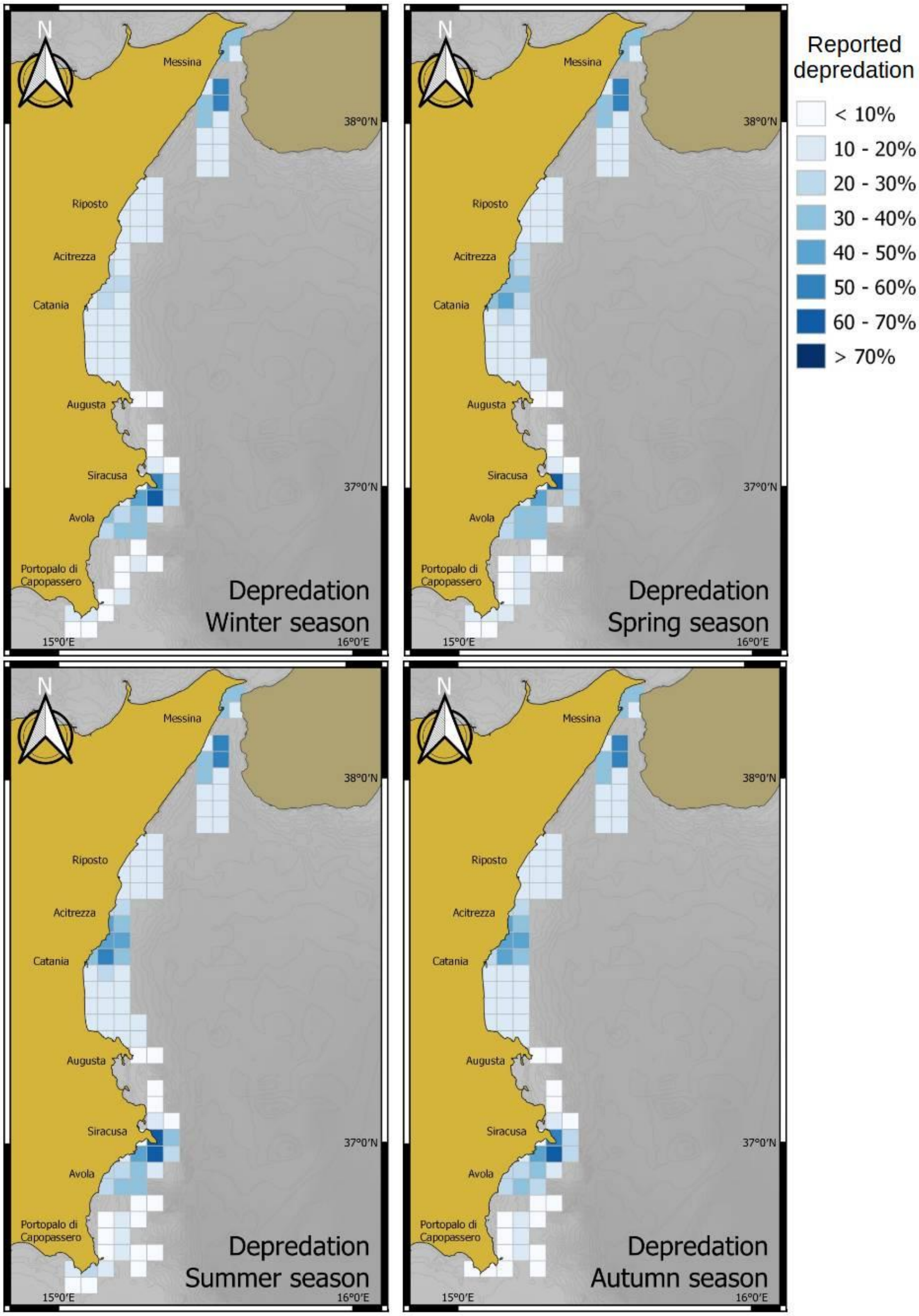
ANNEX XV– Slides presented during the 2nd Meeting of the Joint Bycatch Working Group (JBWG) of ACCOBAMS and ASCOBANS



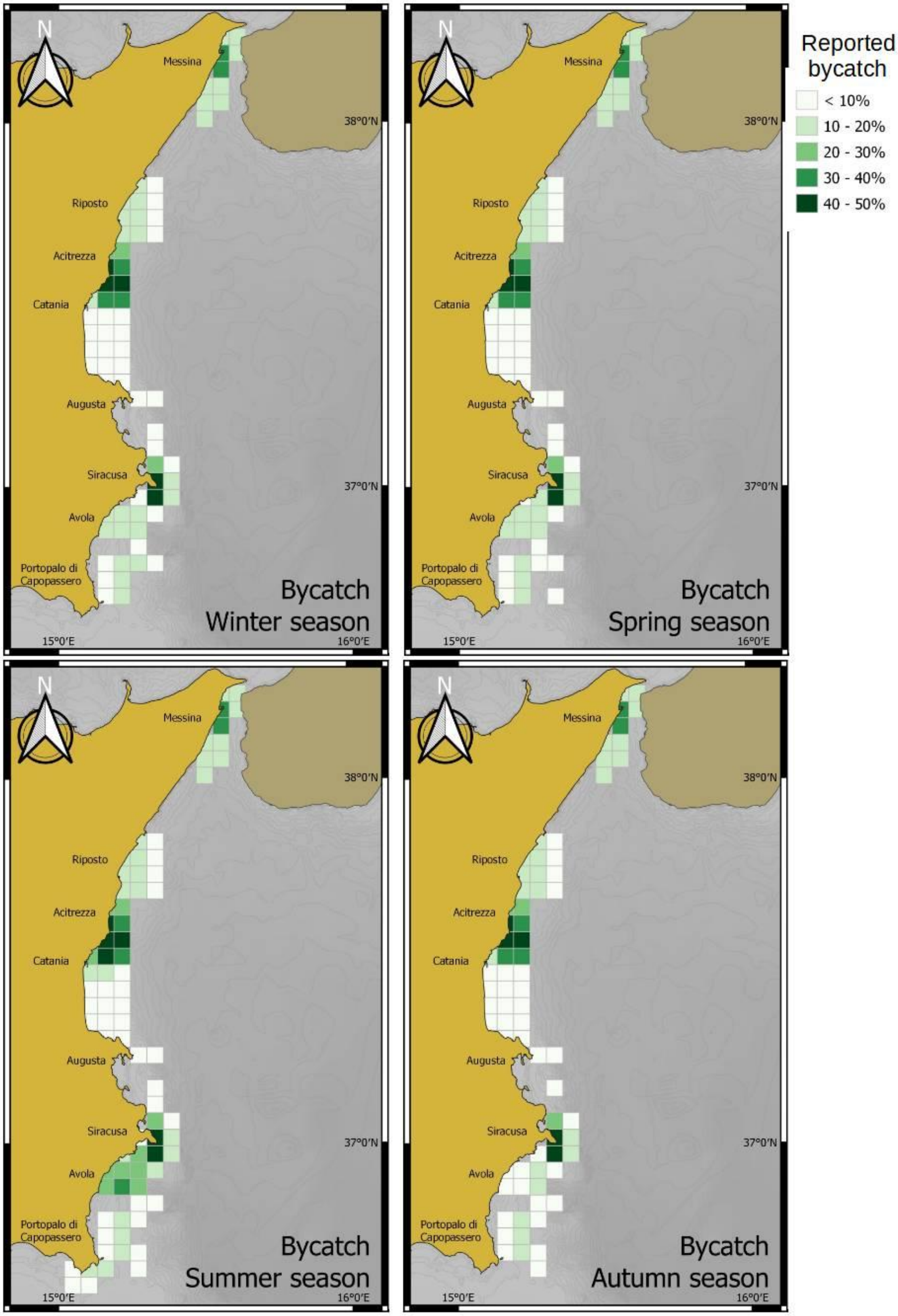




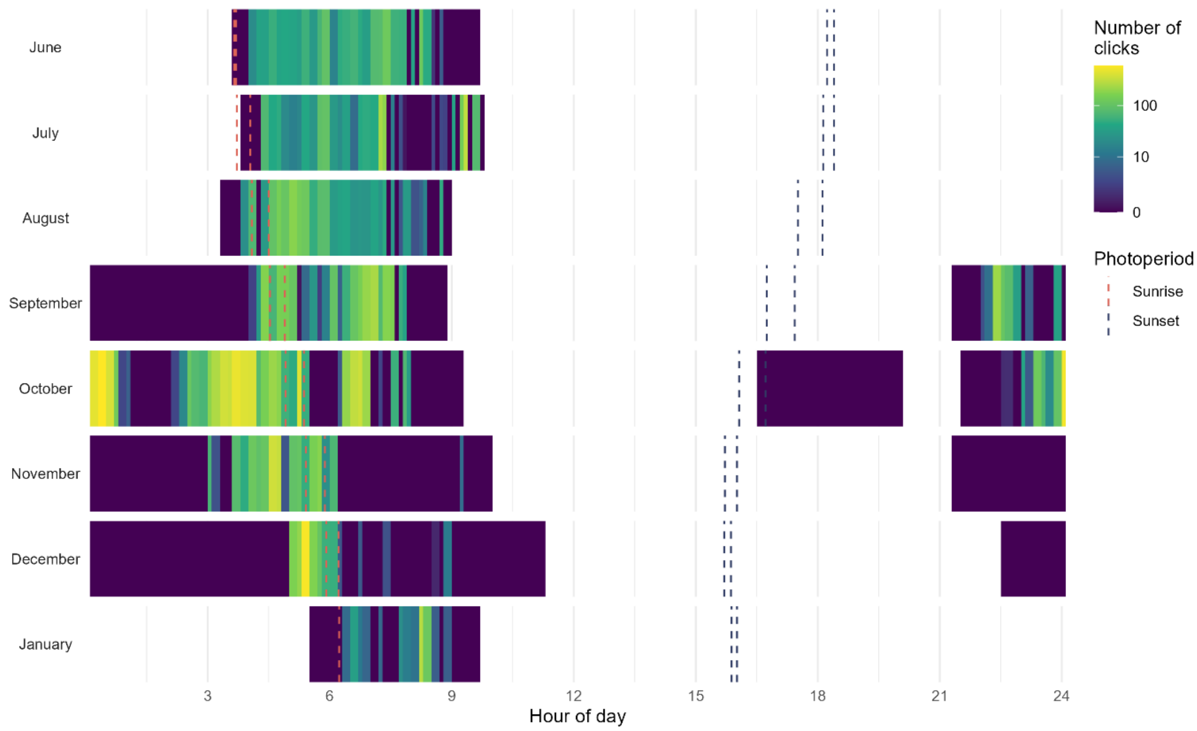
ANNEX XVI– Interviews outputs: Seasonal maps GSA19 –Depredation



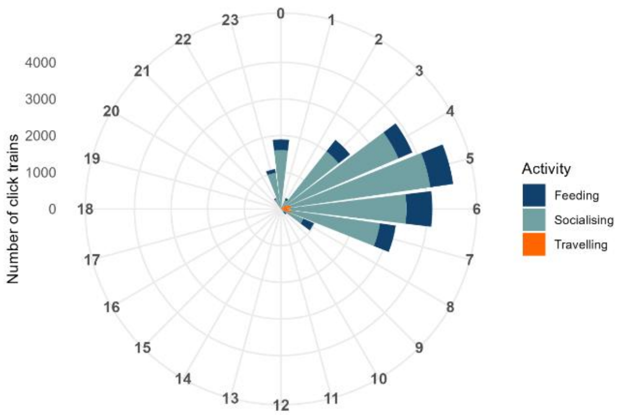
ANNEX XVII– Interviews outputs: Seasonal maps GSA19 –Bycatch

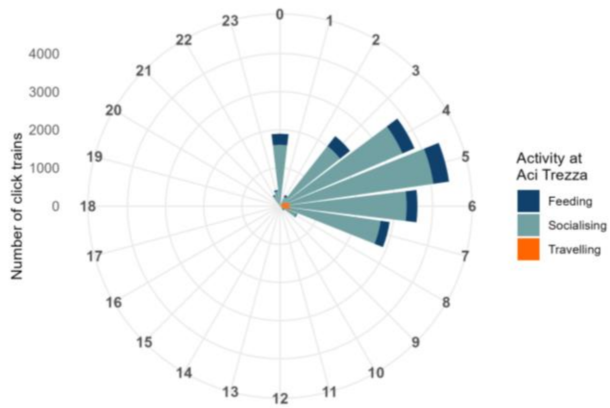


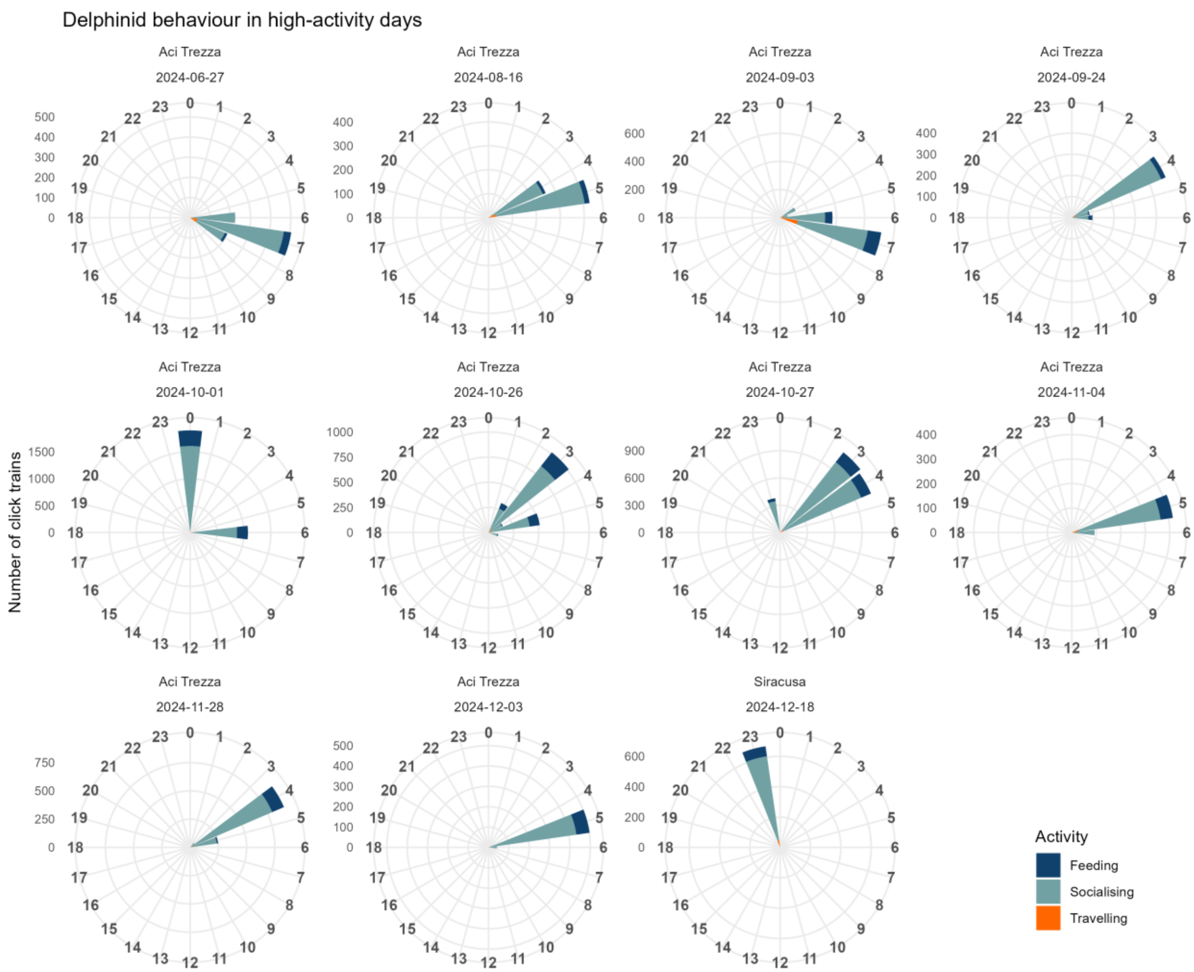
ANNEX XVIII– Daily cycle of dolphin bioacoustic activity



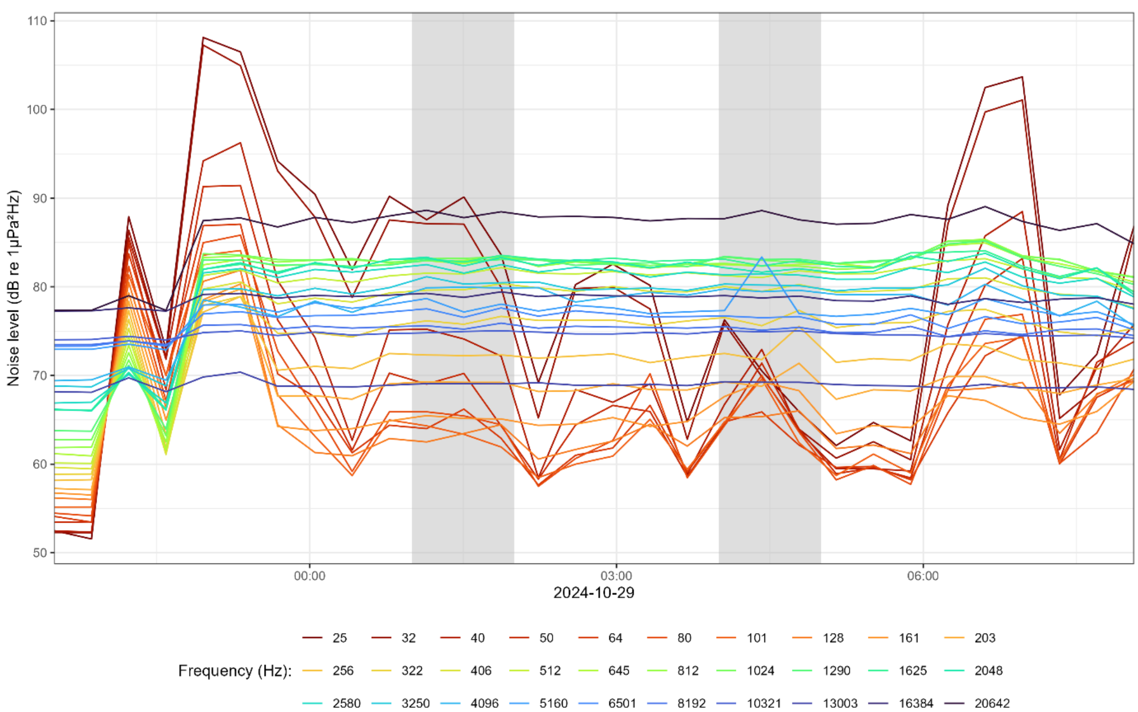
ANNEX XIX – Preliminary hourly behavioural analysis



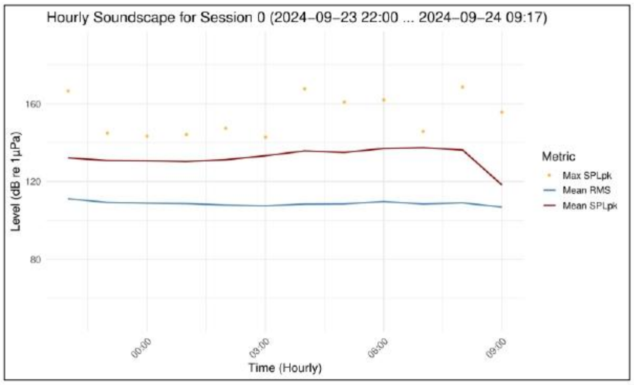


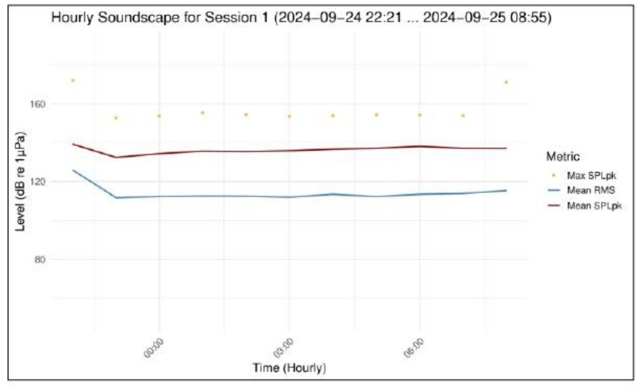


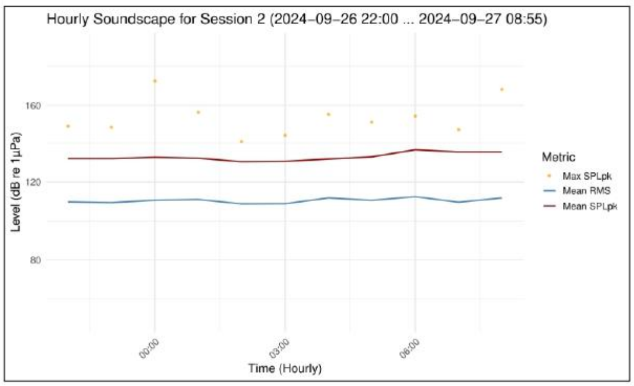
ANNEX XX– Temporal variation of third-octave band noise levels

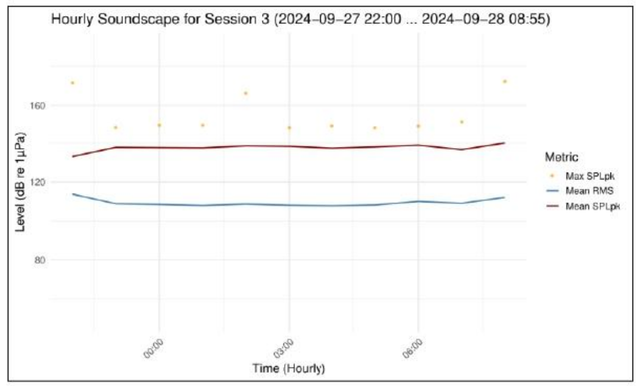


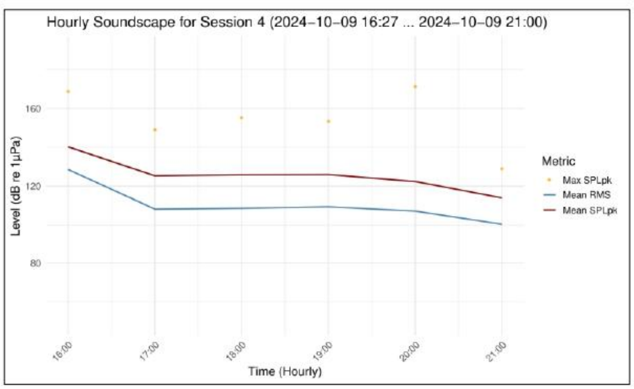
ANNEX XXI– Broadband noise patterns

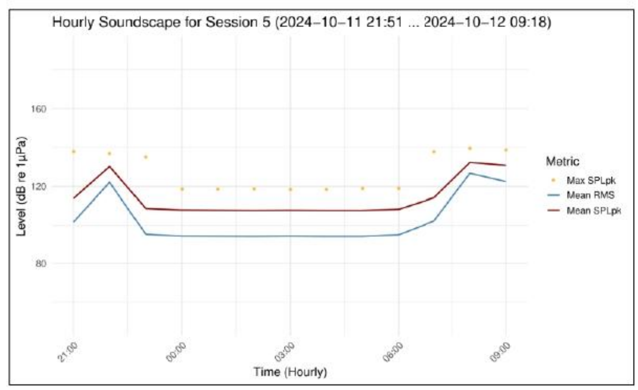


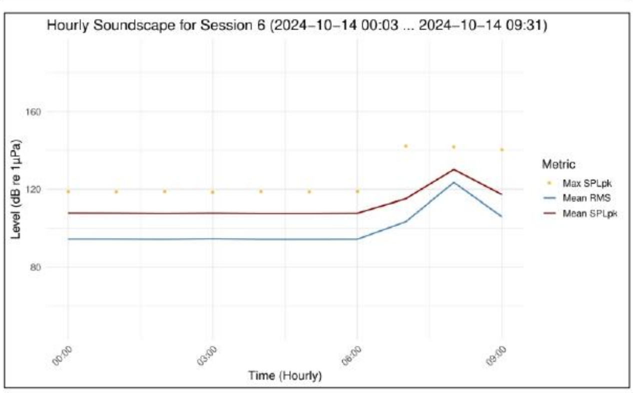


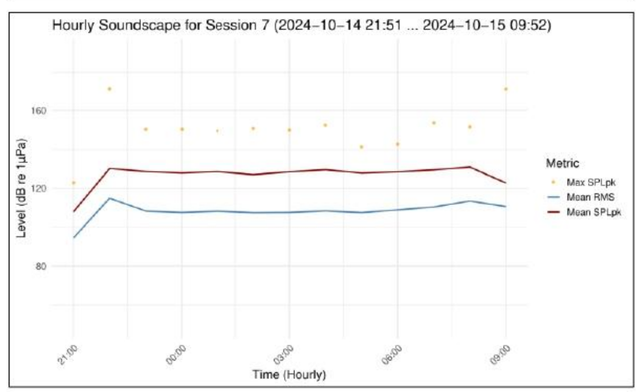


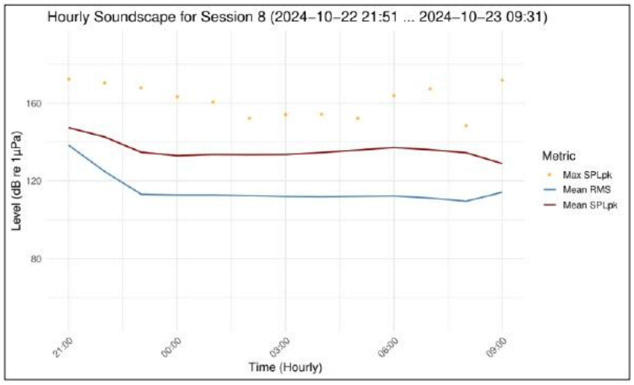








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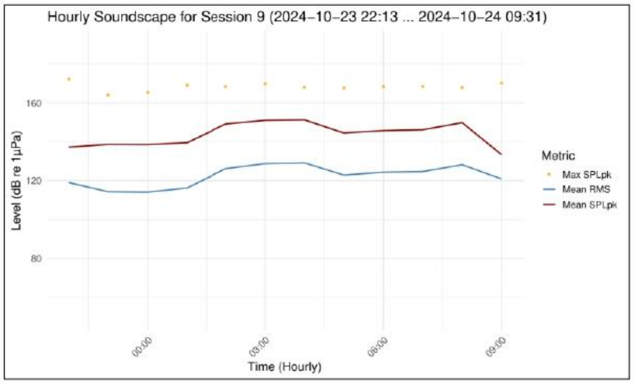
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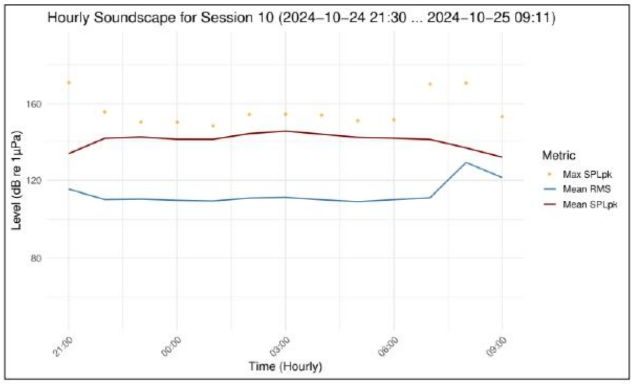
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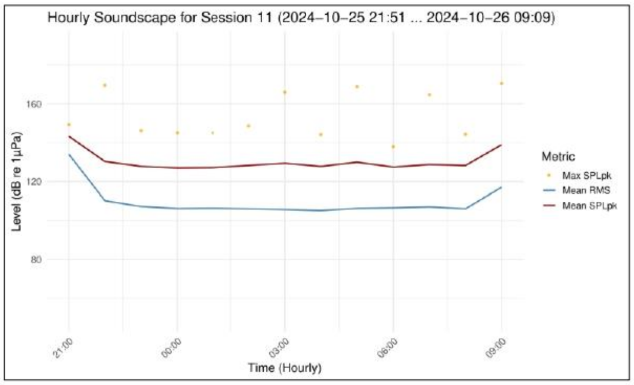
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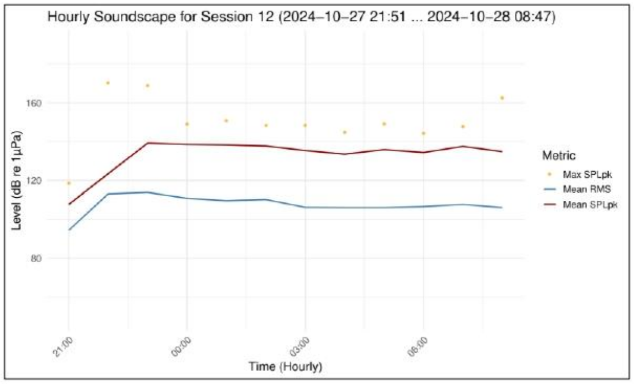
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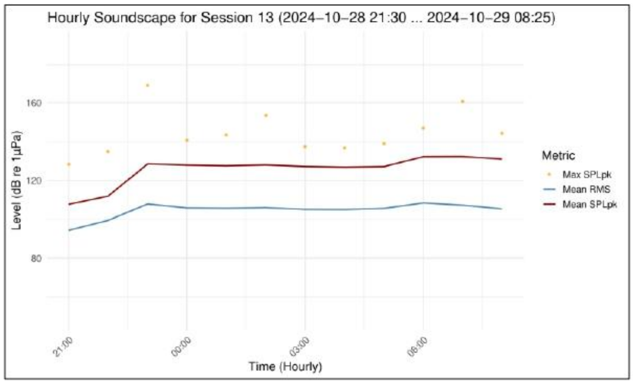
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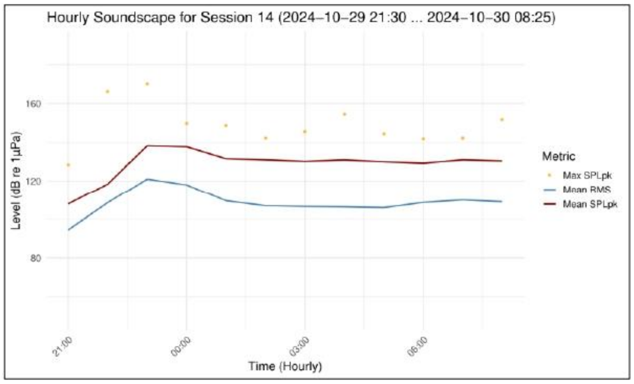
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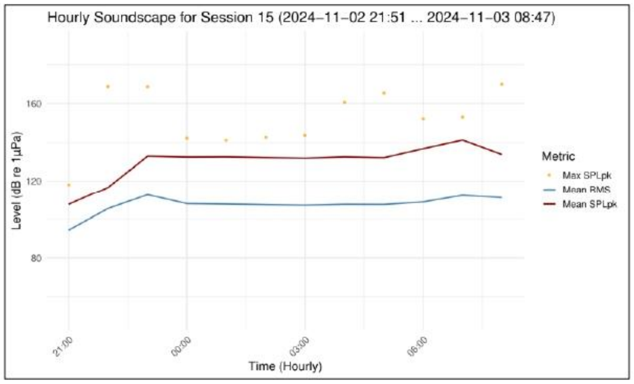
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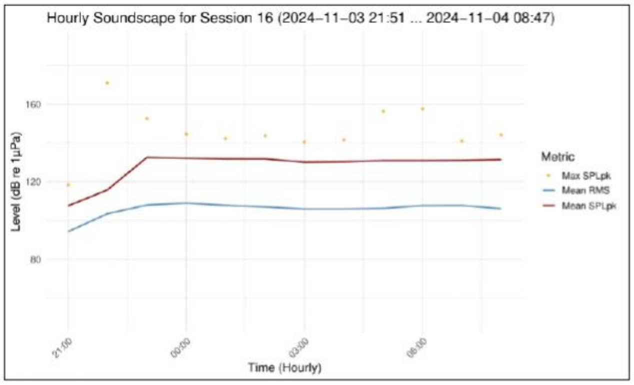

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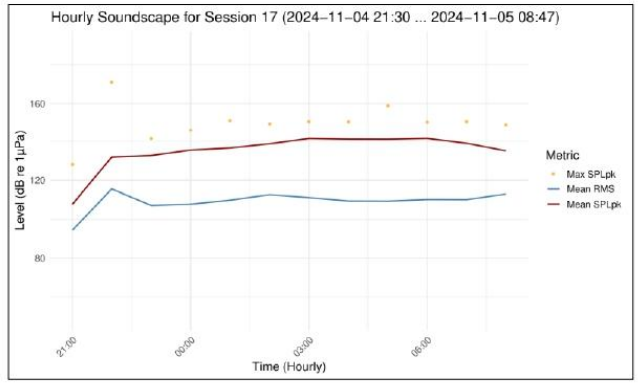

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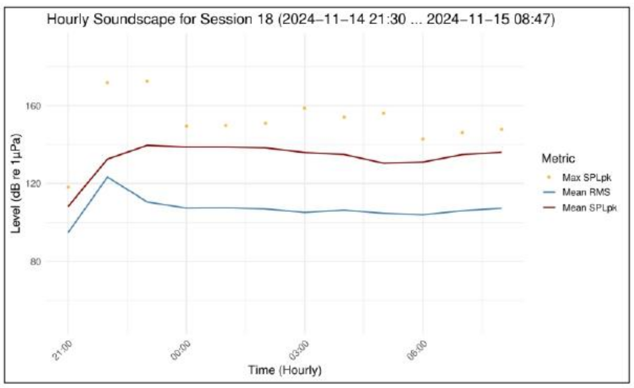

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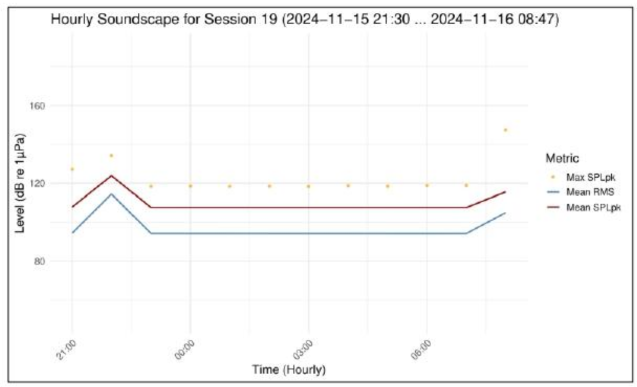

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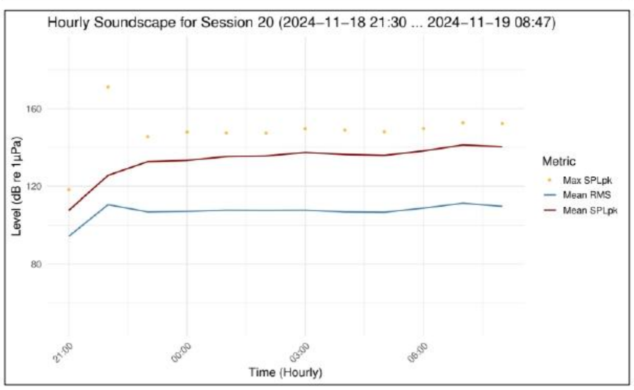

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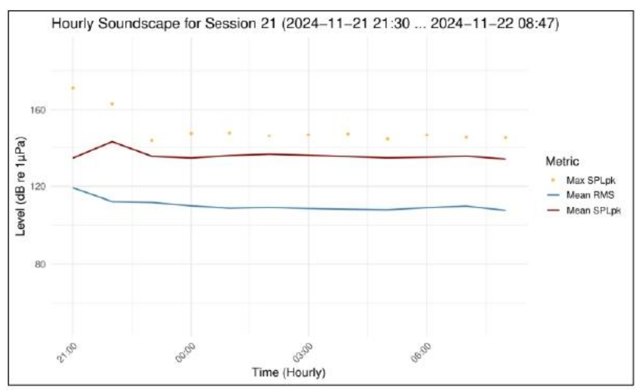

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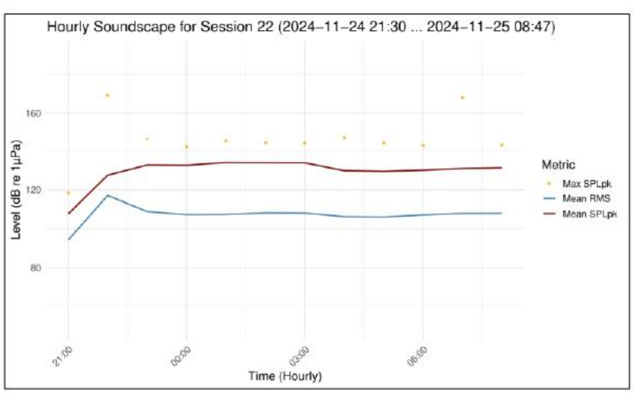

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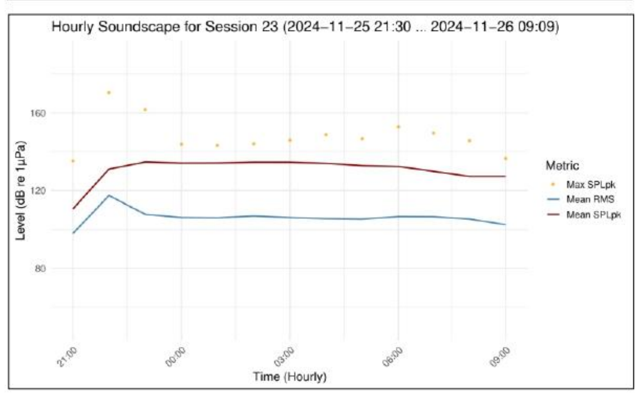

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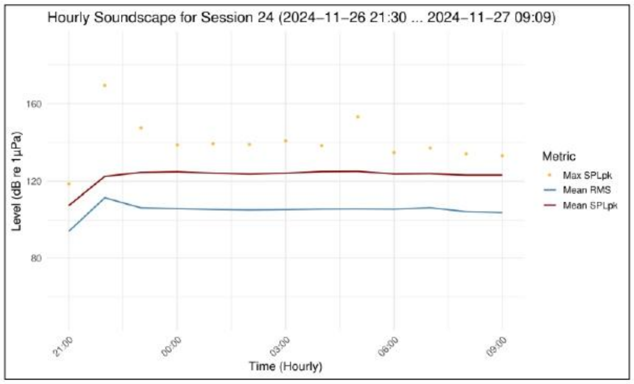
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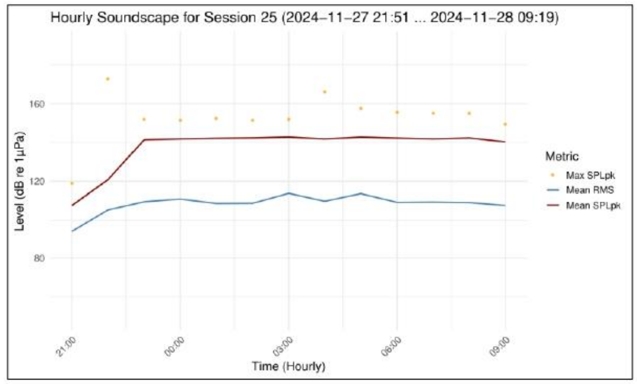
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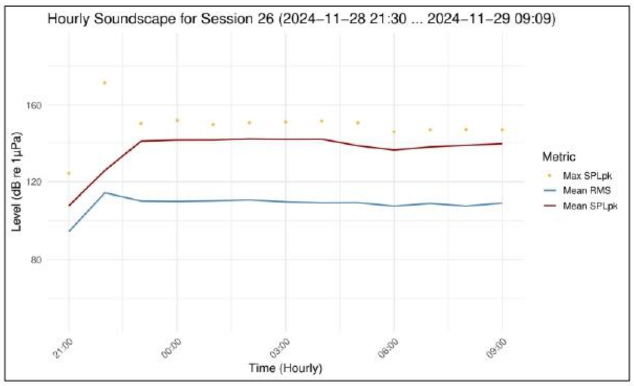
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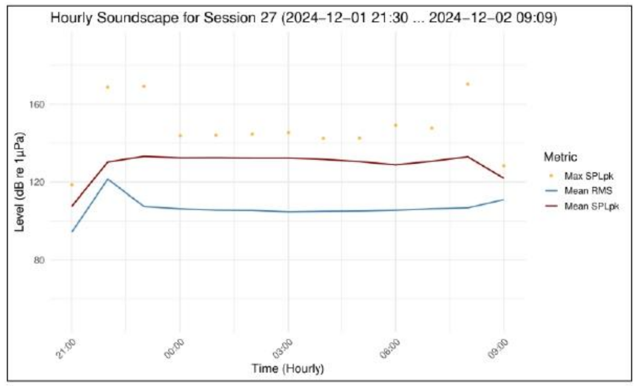
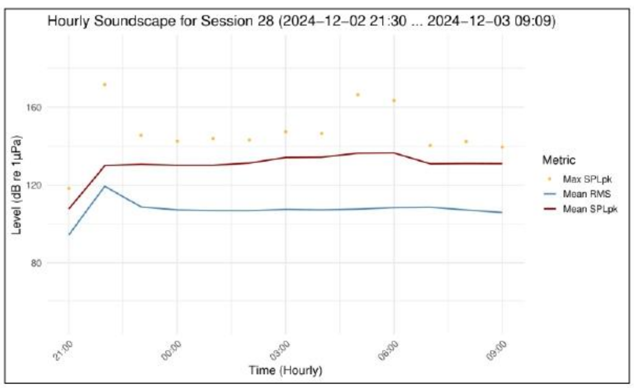
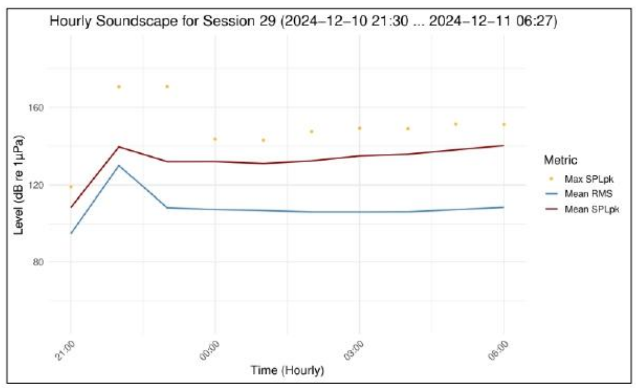
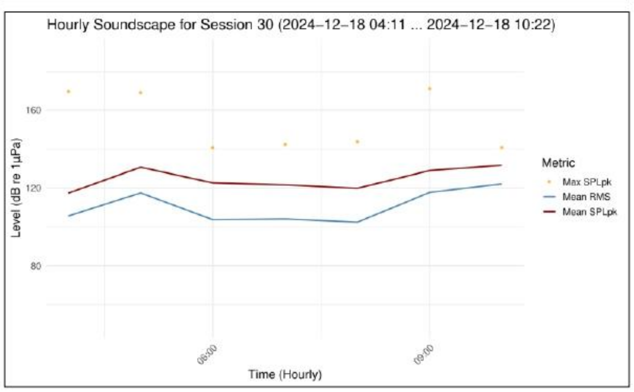
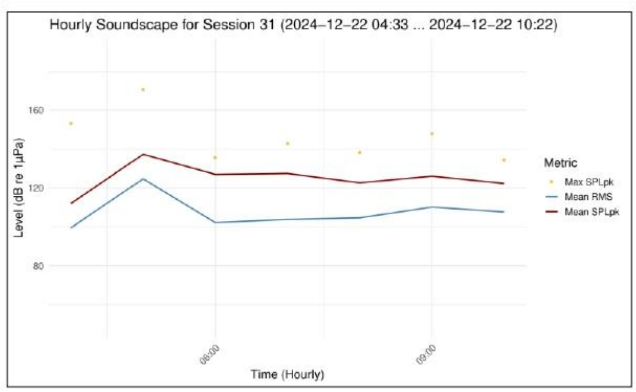
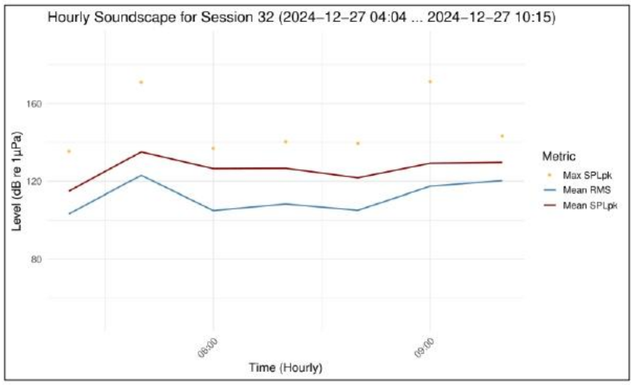

Hourly Soundscape for Session 27 (2024–12–01 21:30 ... 2024–12–02 09:09)
Level (dB re 1µPa)
160
120
80
21:00
00:00
03:00
06:00
09:00
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

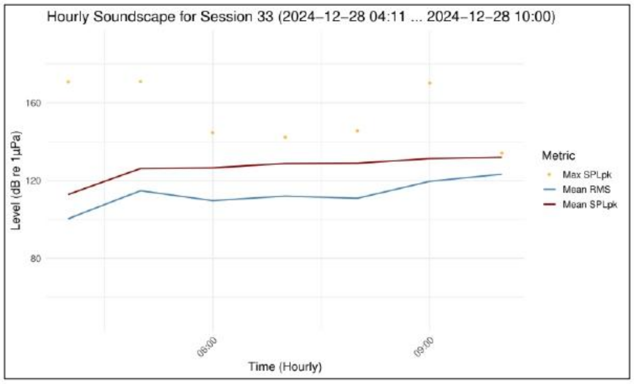

Hourly Soundscape for Session 28 (2024–12–02 21:30 ... 2024–12–03 09:09)
Level (dB re 1µPa)
160
120
80
21:00
00:00
03:00
06:00
09:00
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

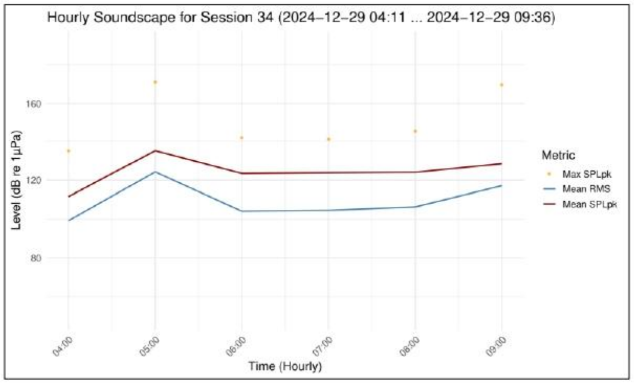

Hourly Soundscape for Session 29 (2024–12–10 21:30 ... 2024–12–11 06:27)
Level (dB re 1µPa)
160
120
80
21:00
00:00
03:00
06:00
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

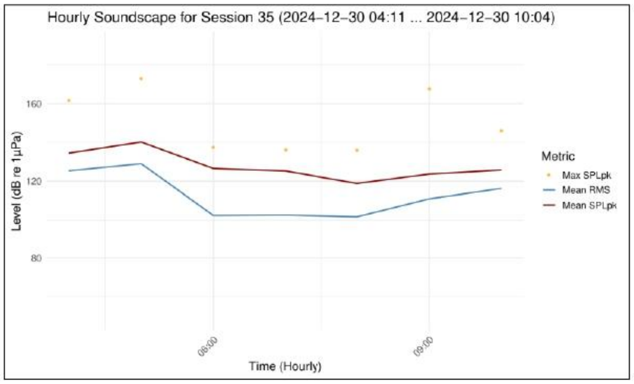

Hourly Soundscape for Session 30 (2024–12–18 04:11 ... 2024–12–18 10:22)
Level (dB re 1µPa)
160
120
80
06:00
09:00
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

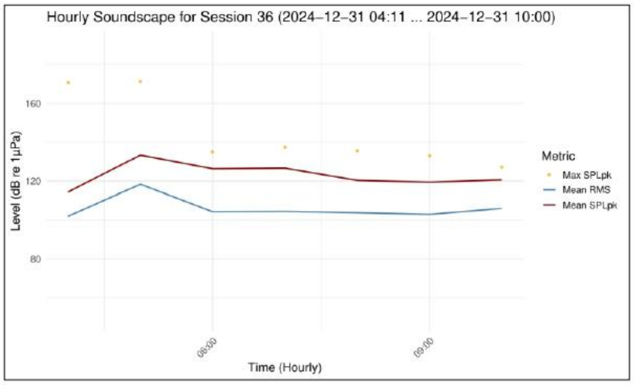

Hourly Soundscape for Session 31 (2024–12–22 04:33 ... 2024–12–22 10:22)
Level (dB re 1µPa)
160
120
80
06:00
09:00
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

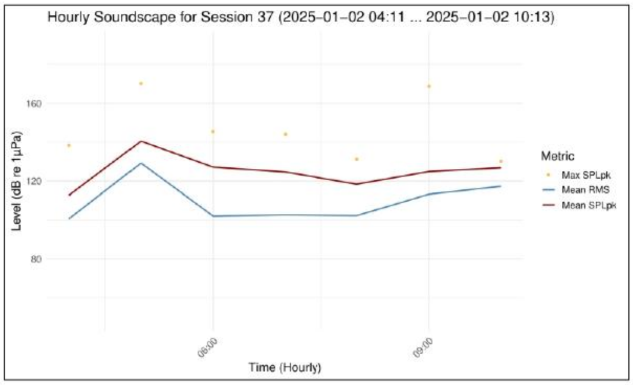

Hourly Soundscape for Session 32 (2024–12–27 04:04 ... 2024–12–27 10:15)
Level (dB re 1μPa)
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

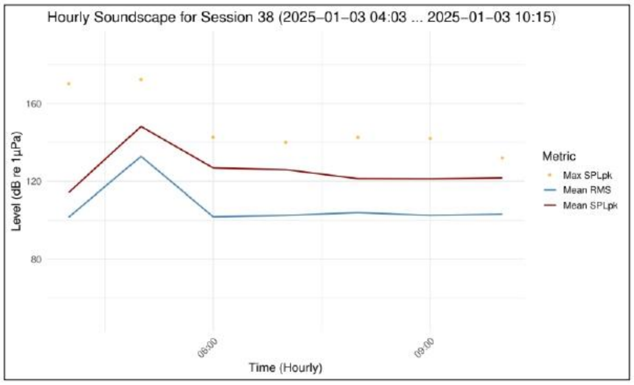

Hourly Soundscape for Session 33 (2024–12–28 04:11 ... 2024–12–28 10:00)
Level (dB re 1μPa)
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

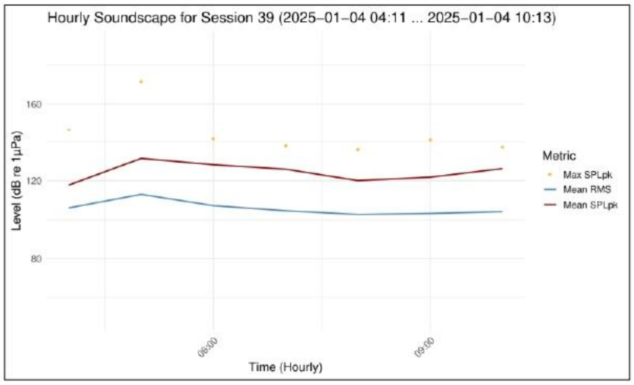

Hourly Soundscape for Session 34 (2024–12–29 04:11 ... 2024–12–29 09:36)
Level (dB re 1μPa)
04:00
05:00
06:00
07:00
08:00
09:00
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

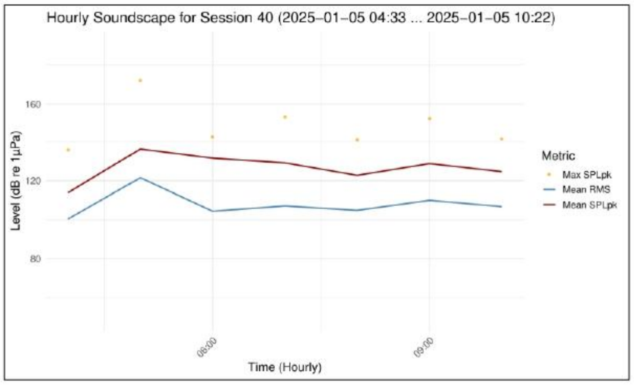

Hourly Soundscape for Session 35 (2024–12–30 04:11 ... 2024–12–30 10:04)
Level (dB re 1μPa)
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

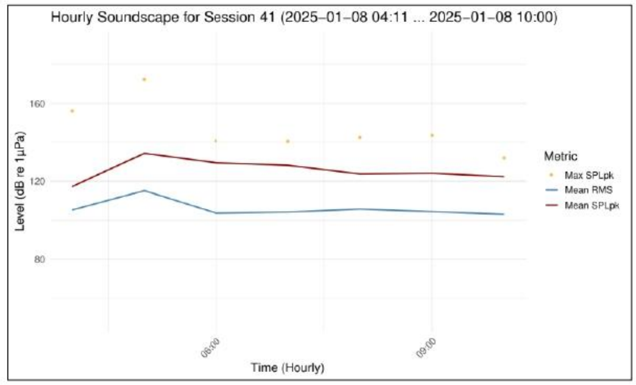

Hourly Soundscape for Session 36 (2024–12–31 04:11 ... 2024–12–31 10:00)
Level (dB re 1μPa)
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

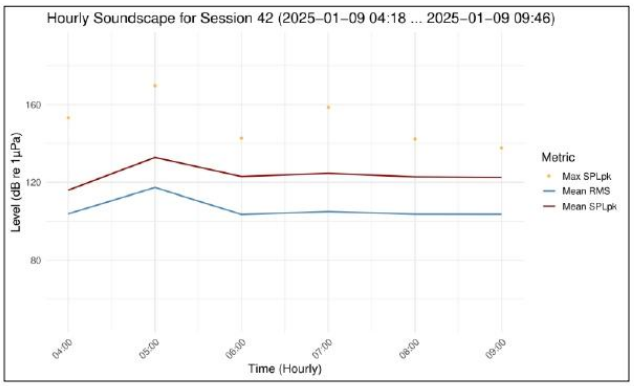

Hourly Soundscape for Session 37 (2025–01–02 04:11 ... 2025–01–02 10:13)
Level (dB re 1μPa)
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

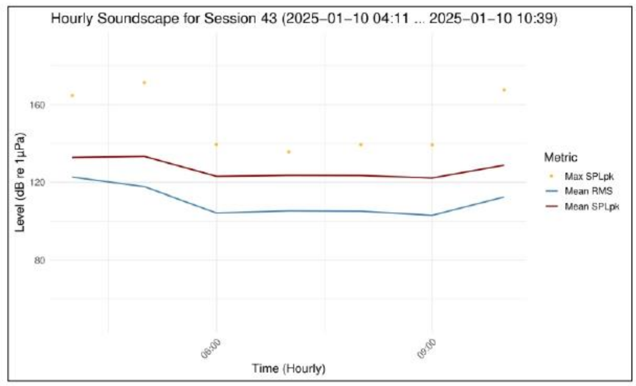

Hourly Soundscape for Session 38 (2025–01–03 04:03 ... 2025–01–03 10:15)
Level (dB re 1μPa)
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

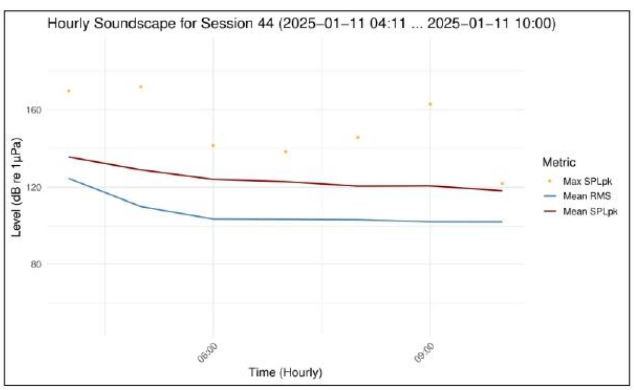

Hourly Soundscape for Session 39 (2025–01–04 04:11 ... 2025–01–04 10:13)
Level (dB re 1μPa)
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk


Hourly Soundscape for Session 40 (2025−01−05 04:33 ... 2025−01−05 10:22)
Level (dB re 1μPa)
160
120
80
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

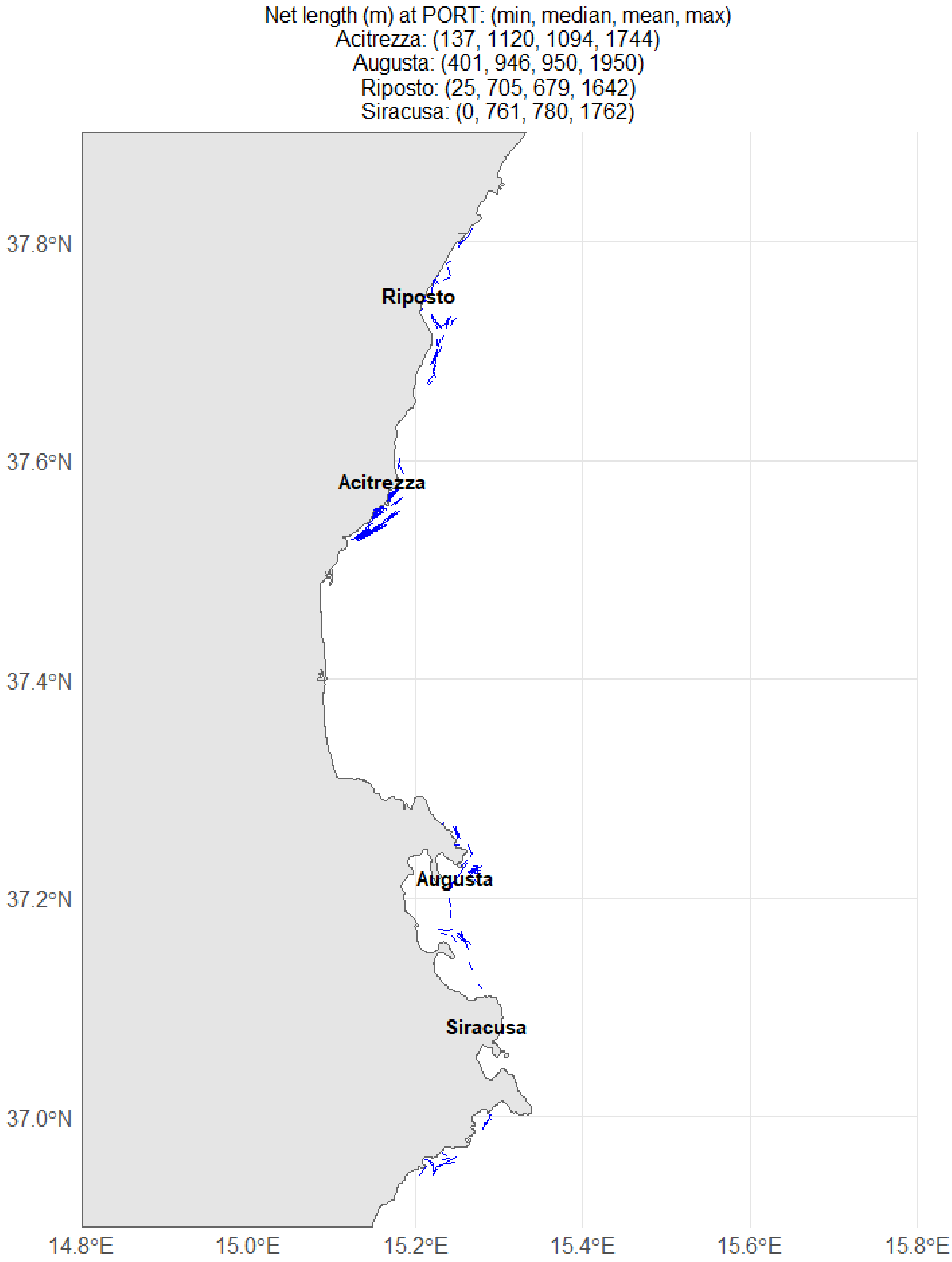

Hourly Soundscape for Session 41 (2025−01−08 04:11 ... 2025−01−08 10:00)
Level (dB re 1μPa)
160
120
80
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

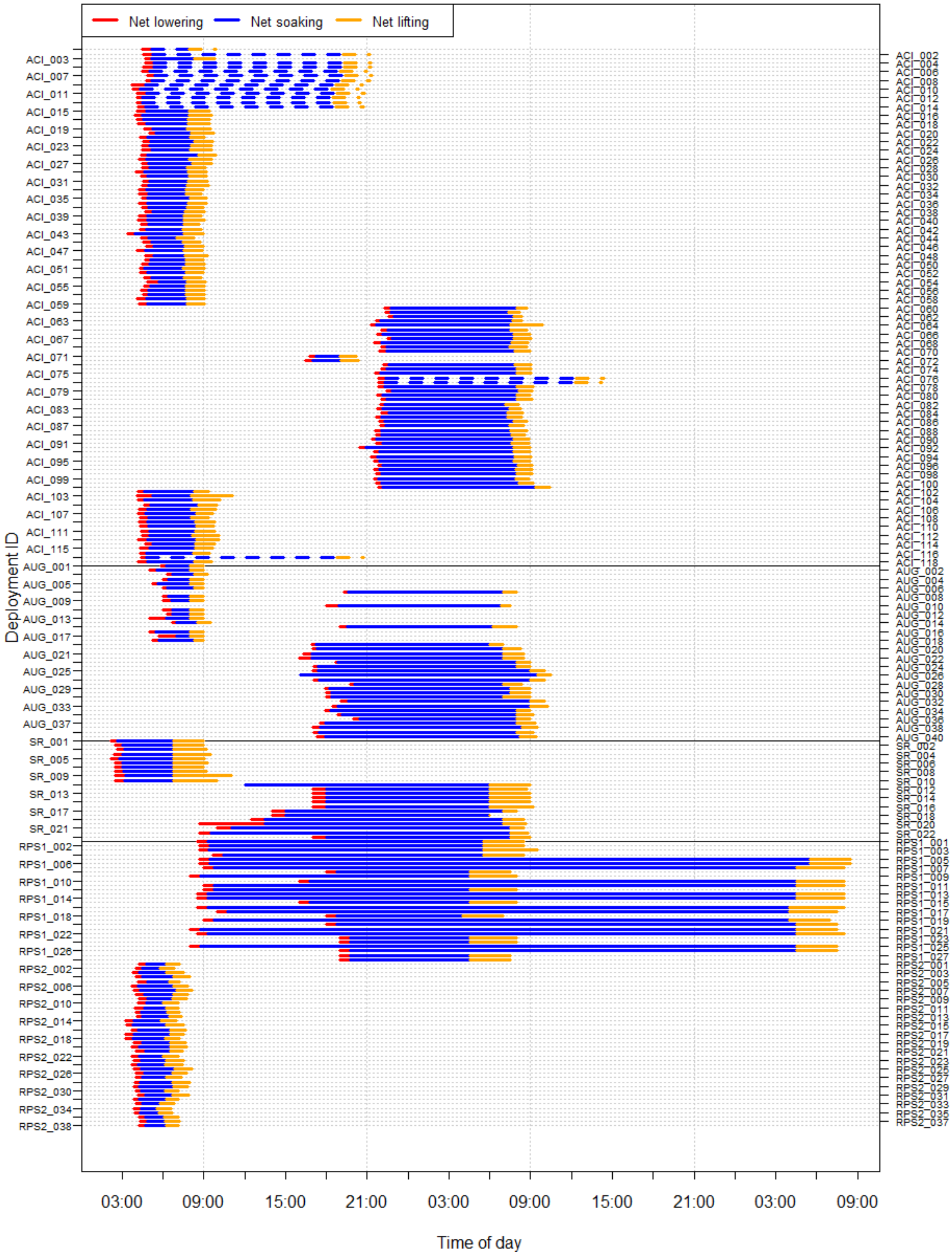

Hourly Soundscape for Session 42 (2025−01−09 04:18 ... 2025−01−09 09:46)
Level (dB re 1μPa)
160
120
80
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk


Hourly Soundscape for Session 43 (2025−01−10 04:11 ... 2025−01−10 10:39)
Level (dB re 1μPa)
160
120
80
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

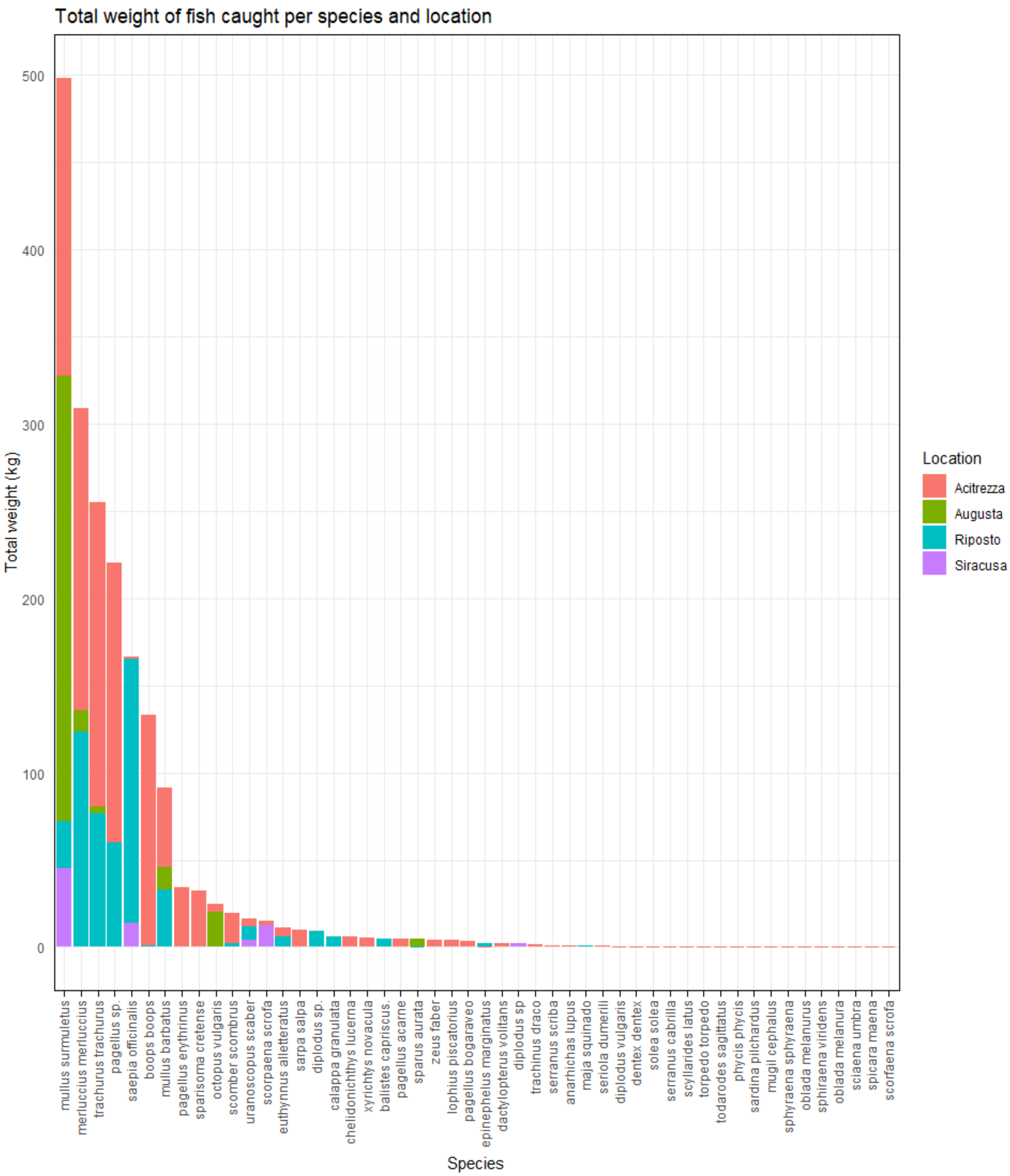

Hourly Soundscape for Session 44 (2025−01−11 04:11 ... 2025−01−11 10:00)
Level (dB re 1μPa)
160
120
80
Time (Hourly)
Metric
Max SPLpk
Mean RMS
Mean SPLpk

ANNEX XXII- Spatial PODs deployment patterns, timing and catch composition

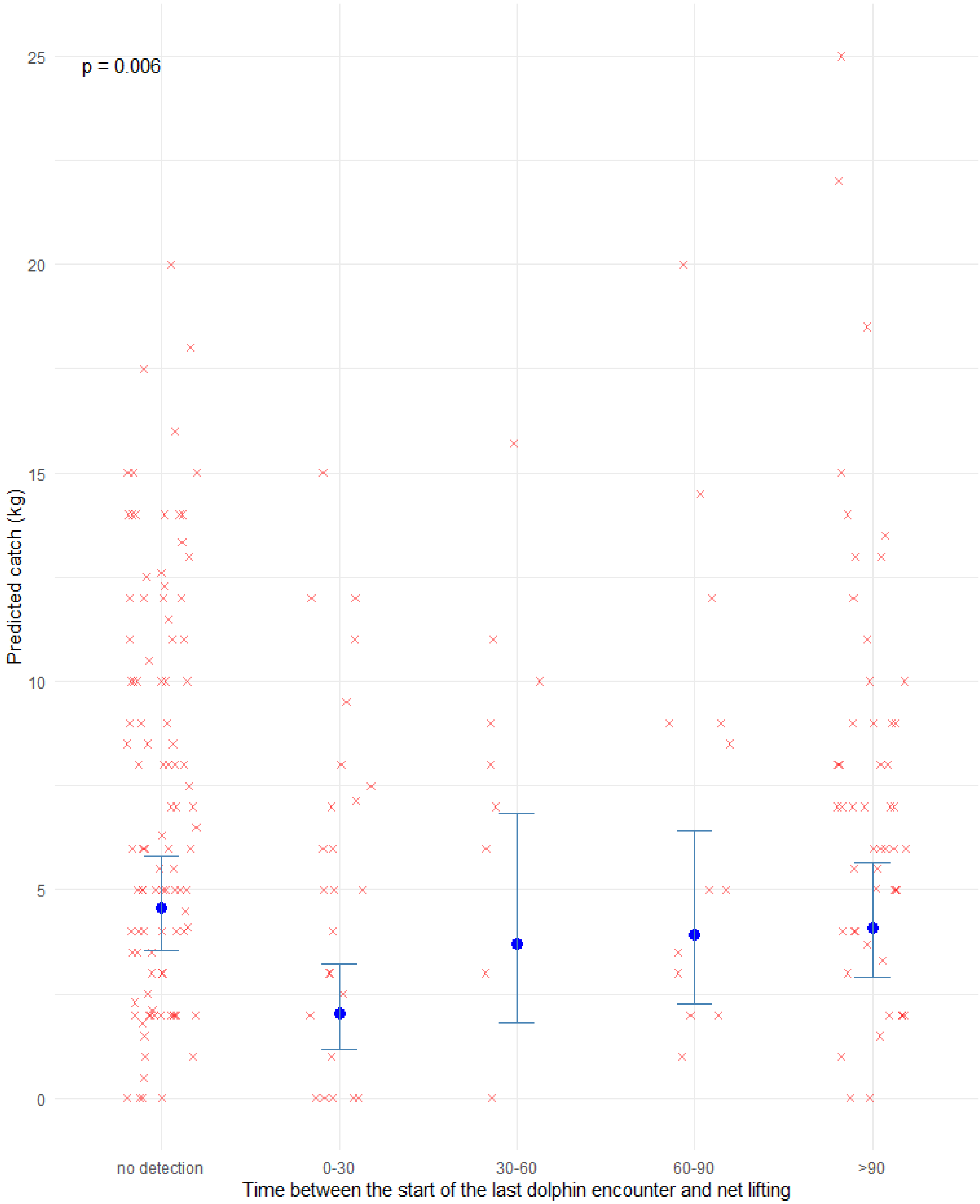


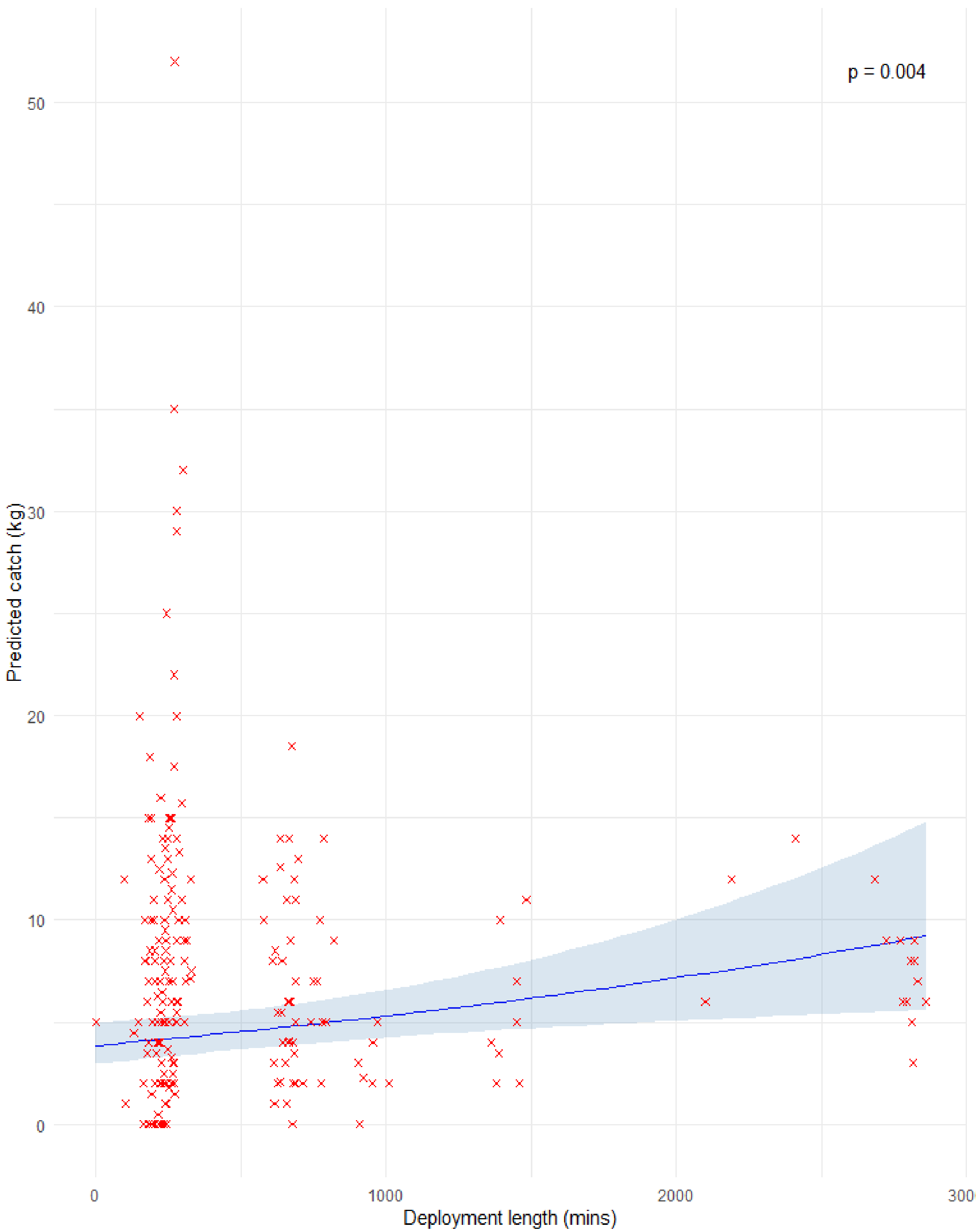


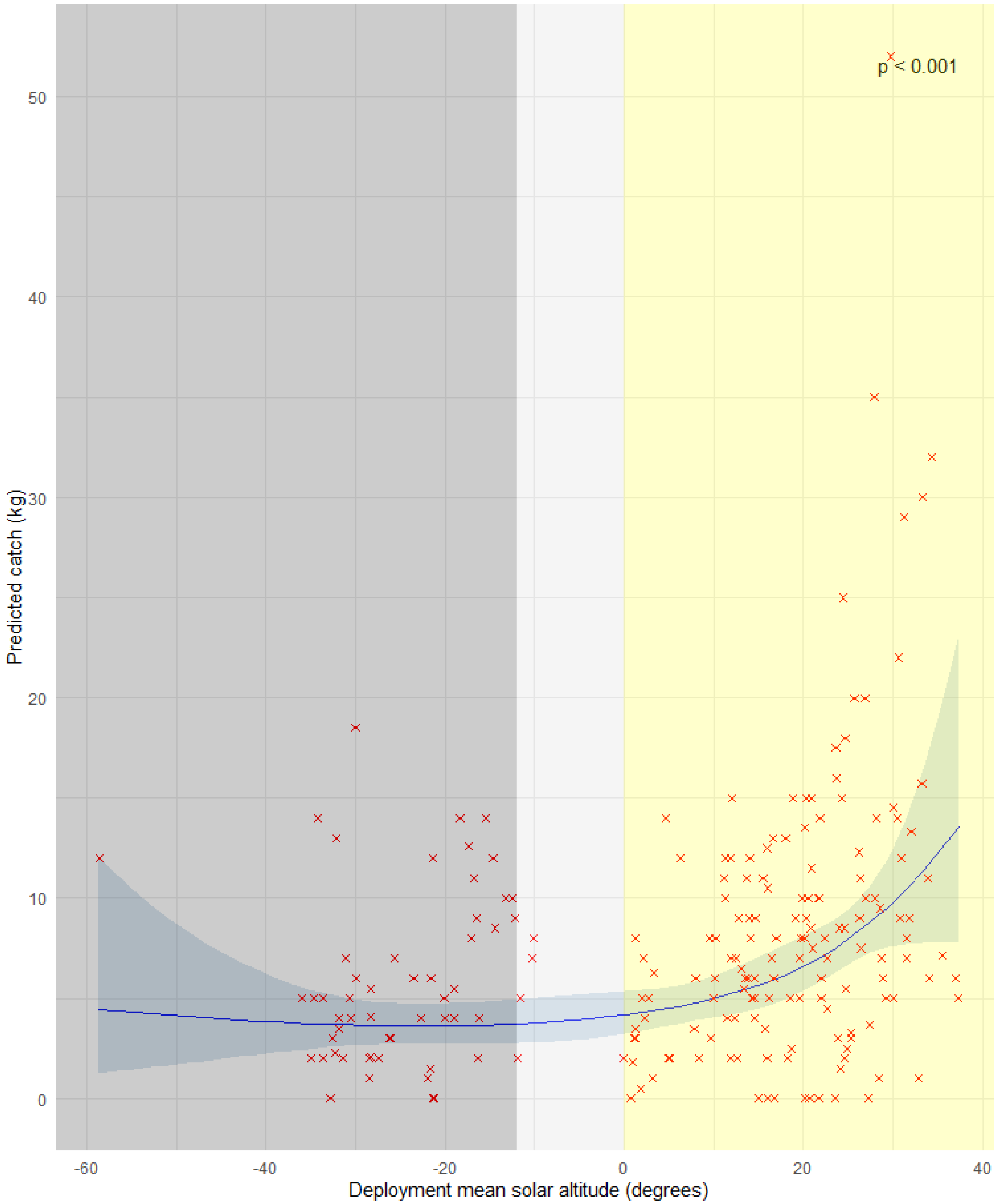
Net lowering
Net soaking
Net lifting
Deployment ID
Time of day
03:00
09:00
15:00
21:00
03:00
09:00
15:00
21:00
03:00
09:00

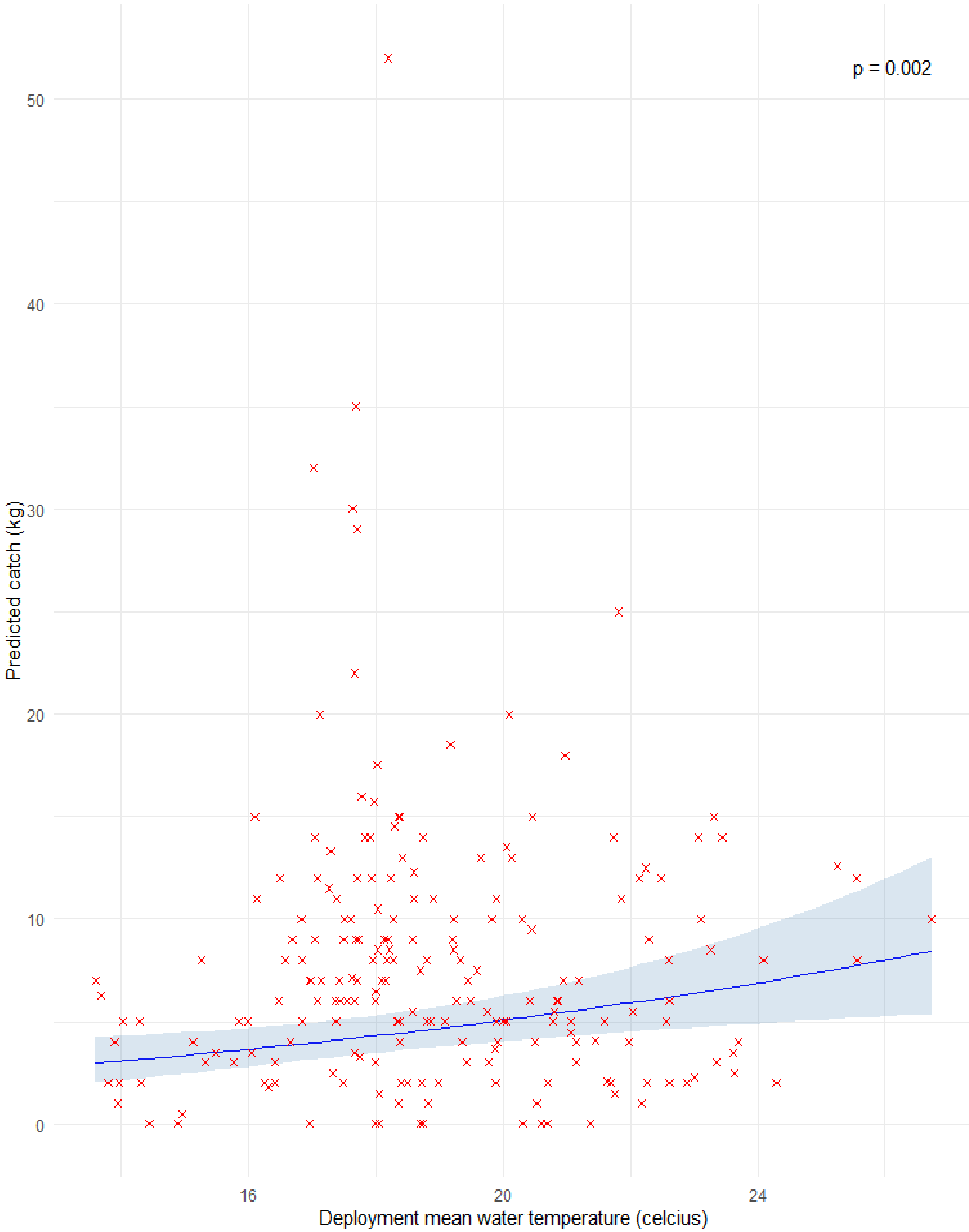


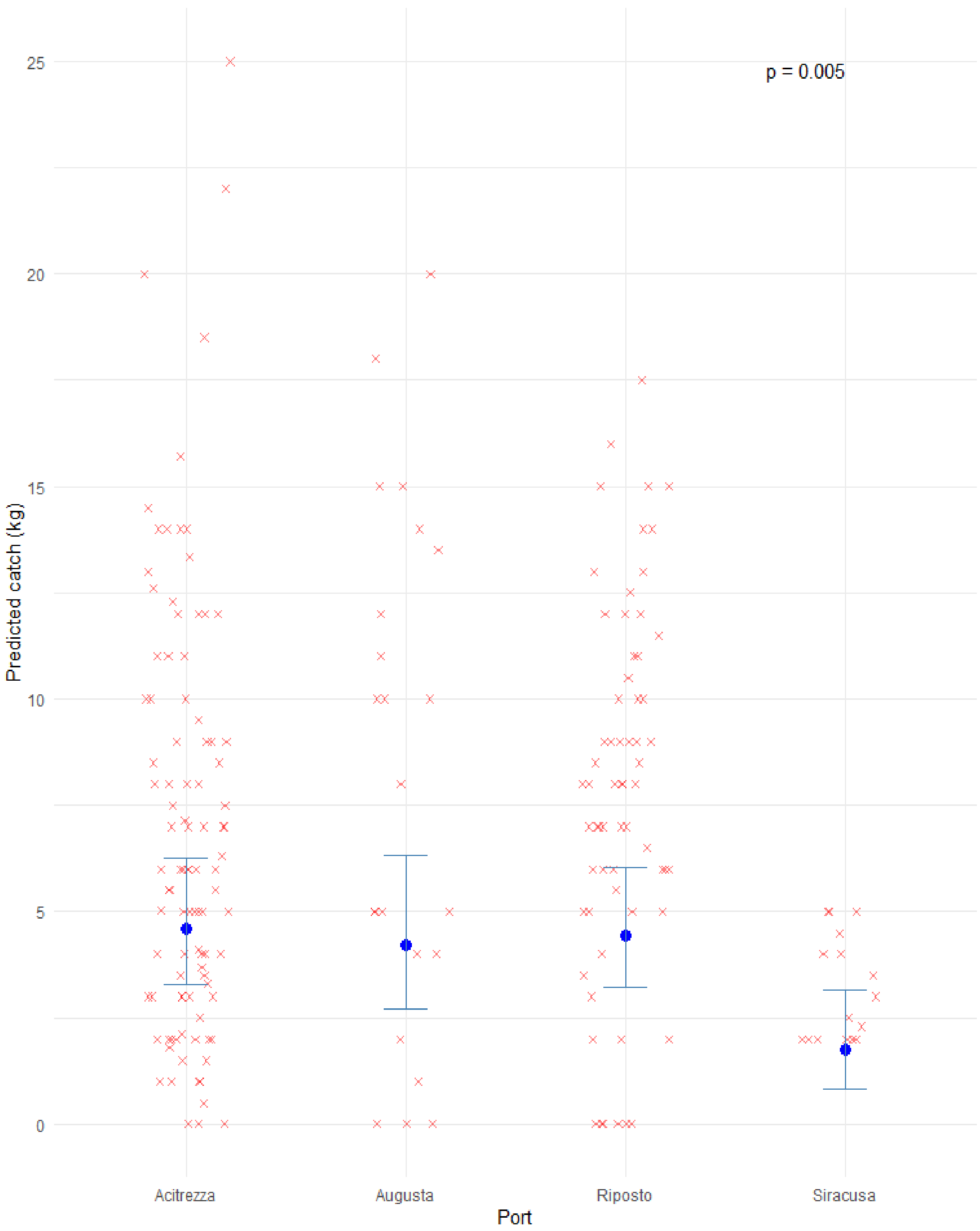
Total weight of fish caught per species and location
Total weight (kg)
500
400
300
200
100
0
Location
Acitrezza
Augusta
Riposto
Siracusa
Species
mullus surmuletus
merluccius merluccius
trachurus trachurus
pagellus sp.
saepia officinalis
boops boops
mullus barbatus
pagellus erythrinus
sparisoma cretense
octopus vulgaris
scomber scombrus
uranoscopus scaber
scorpaena scrofa
euthynnus alletteratus
sarpa salpa
diplodus sp.
calappa granulata
chelidonichthys lucerna
xyrichtys novacula
balistes capriscus.
pagellus acarne
sparus aurata
zeus faber
lophius piscatorius
pagellus bogaraveo
epinephelus marginatus
dactylopterus volitans
diplodus sp
trachinus draco
serranus scriba
anarhichas lupus
maja squinado
seriola dumerili
diplodus vulgaris
dentex dentex
solea solea
serranus cabrilla
scyllarides latus
torpedo torpedo
todarodes sagittatus
phycis phycis
sardina pilchardus
mugil cephalus
sphyraena sphyraena
oblada melanurus
sphiraena viridens
oblada melanura
sciaena umbra
spicara maena
scorfaena scrofa


p = 0.006
25
20
15
10
5
0
Predicted catch (kg)
no detection
0-30
30-60
60-90
>90
Time between the start of the last dolphin encounter and net lifting

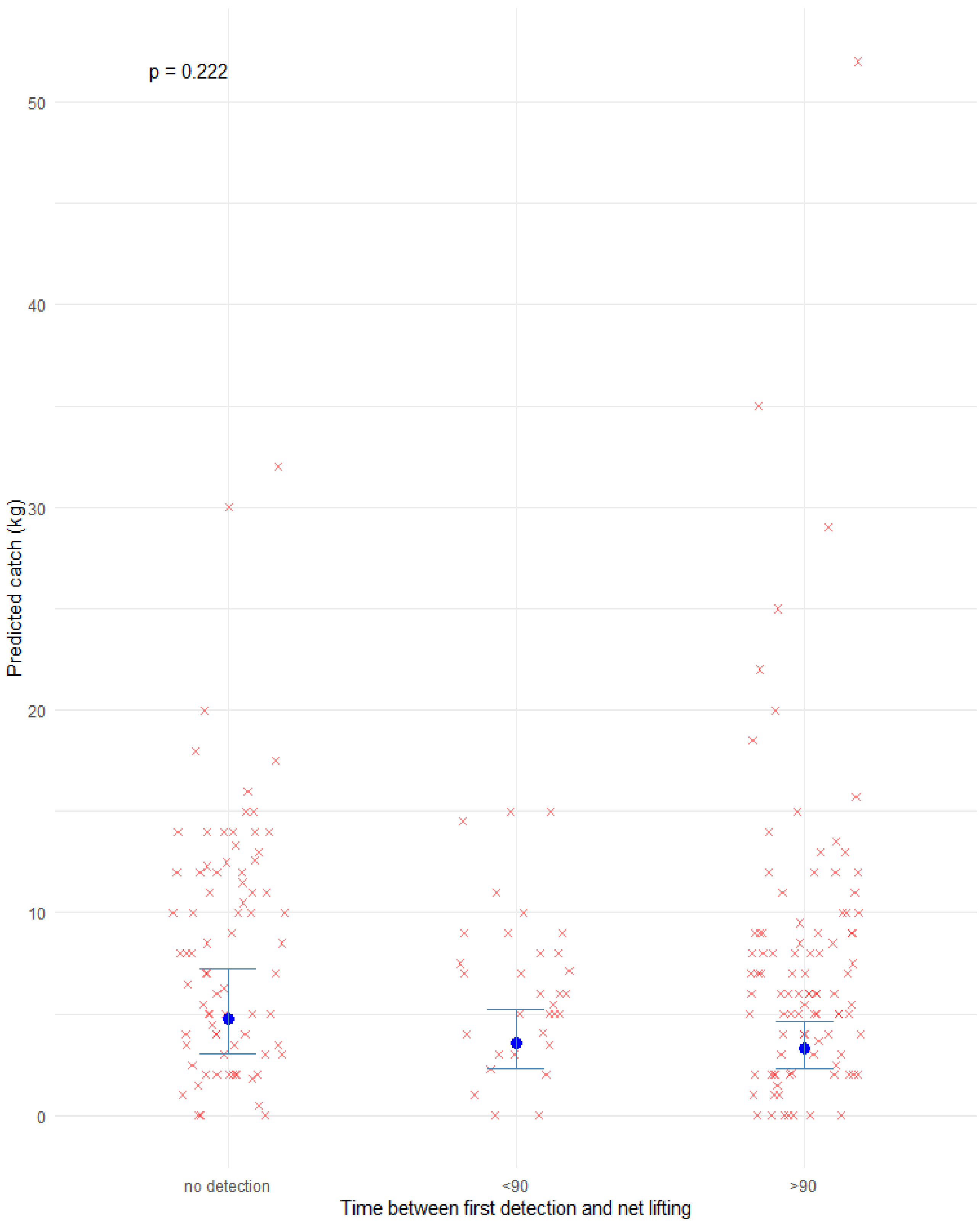

p = 0.004
Predicted catch (kg)
50
40
30
20
10
0
0
1000
2000
300
Deployment length (mins)

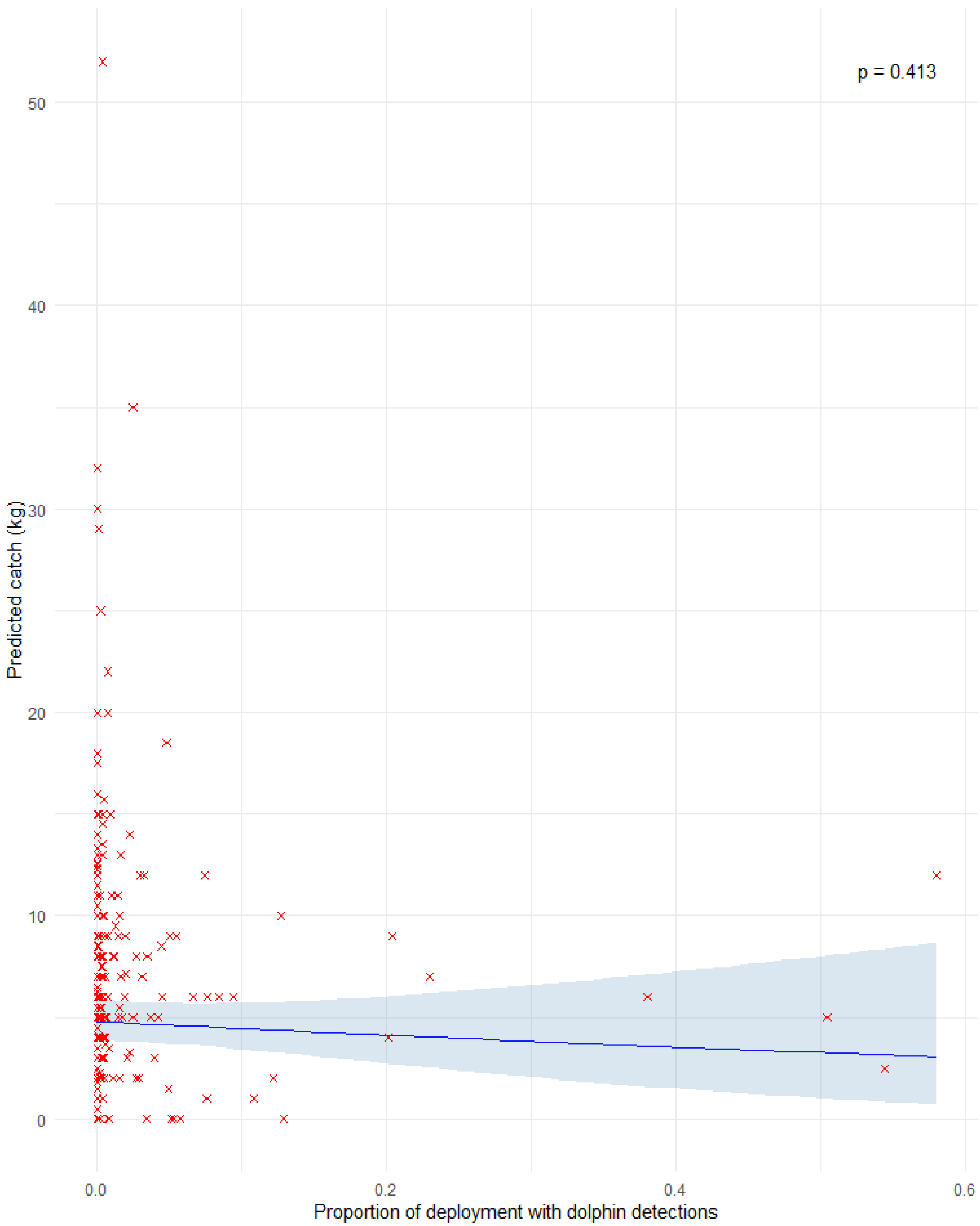

p < 0.001
Predicted catch (kg)
0
10
20
30
40
50
-60
-40
-20
0
20
40
Deployment mean solar altitude (degrees)

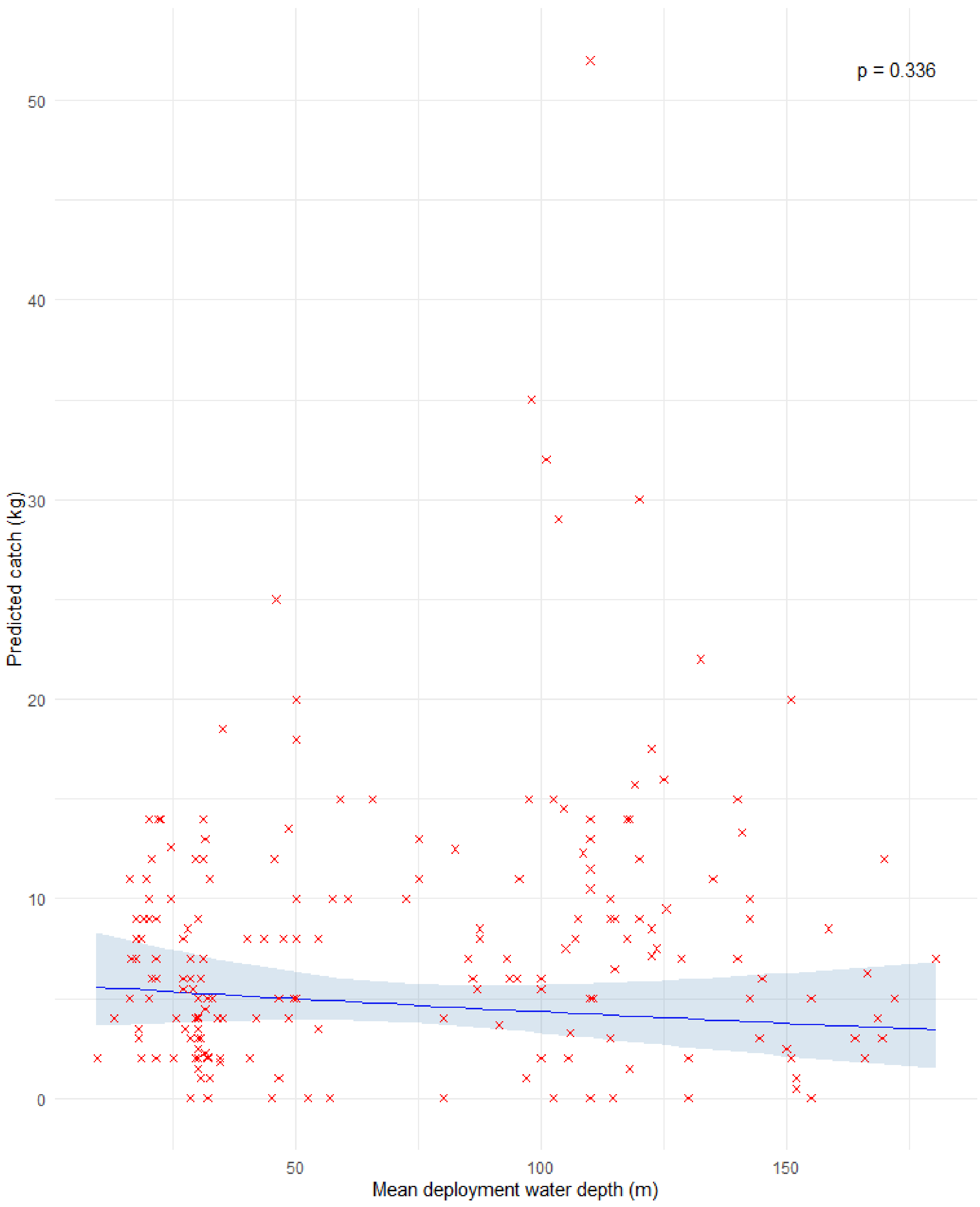

p = 0.002
Predicted catch (kg)
0
10
20
30
40
50
16
20
24
Deployment mean water temperature (celcius)

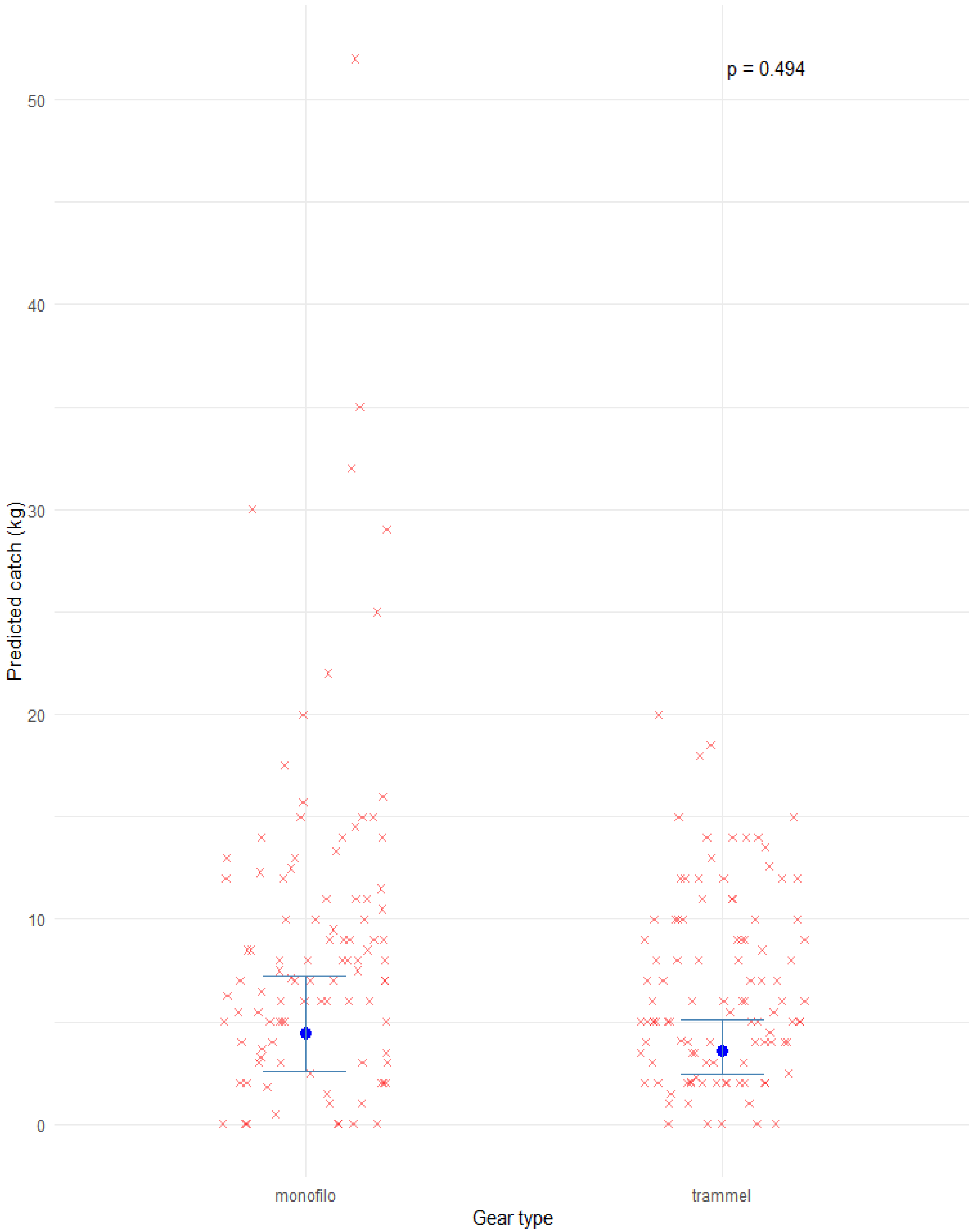


p = 0.005
Predicted catch (kg)
25
20
15
10
5
0
Acitrezza
Augusta
Riposto
Siracusa
Port

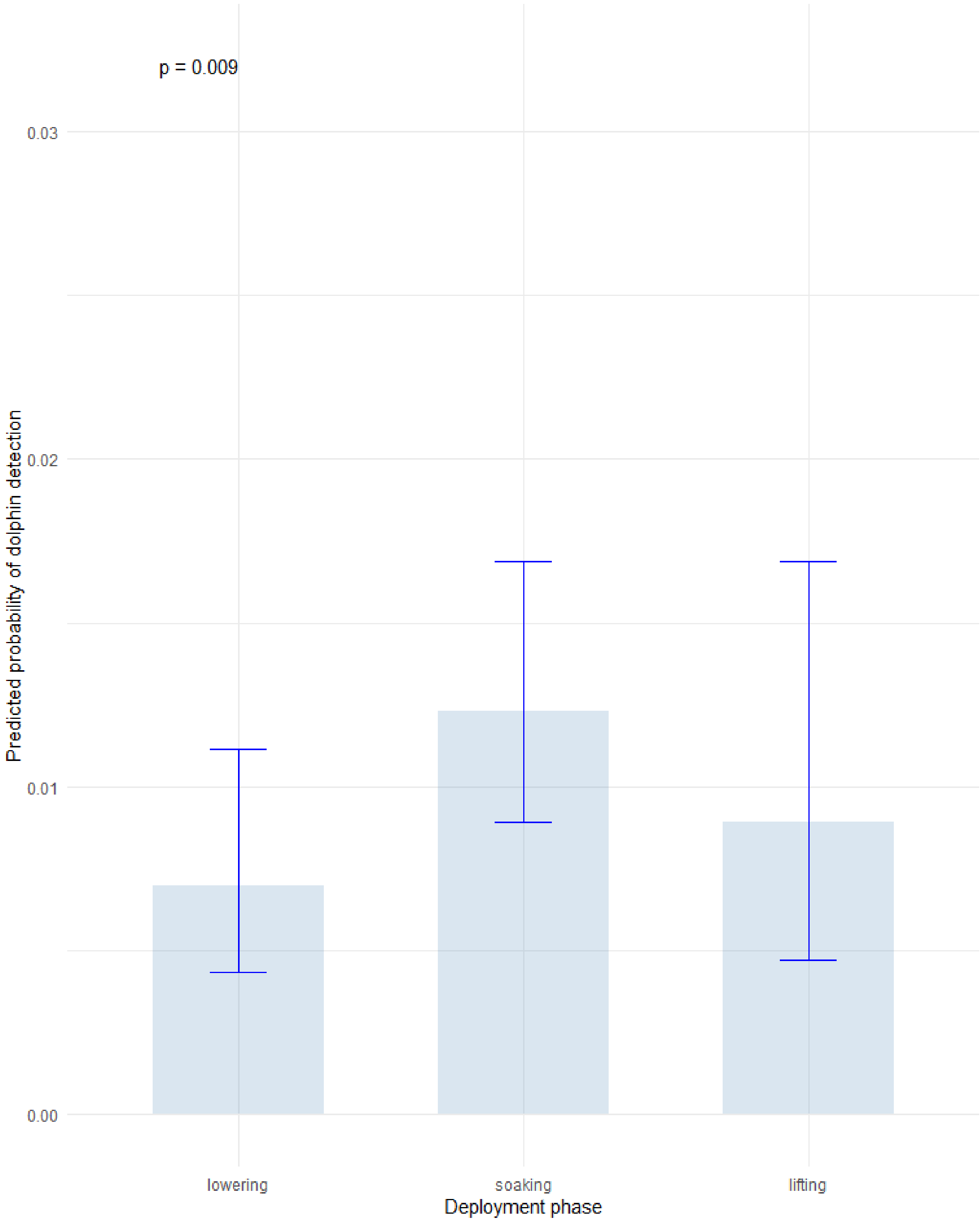

p = 0.222
50
40
30
20
10
0
Predicted catch (kg)
no detection
<90
>90
Time between first detection and net lifting

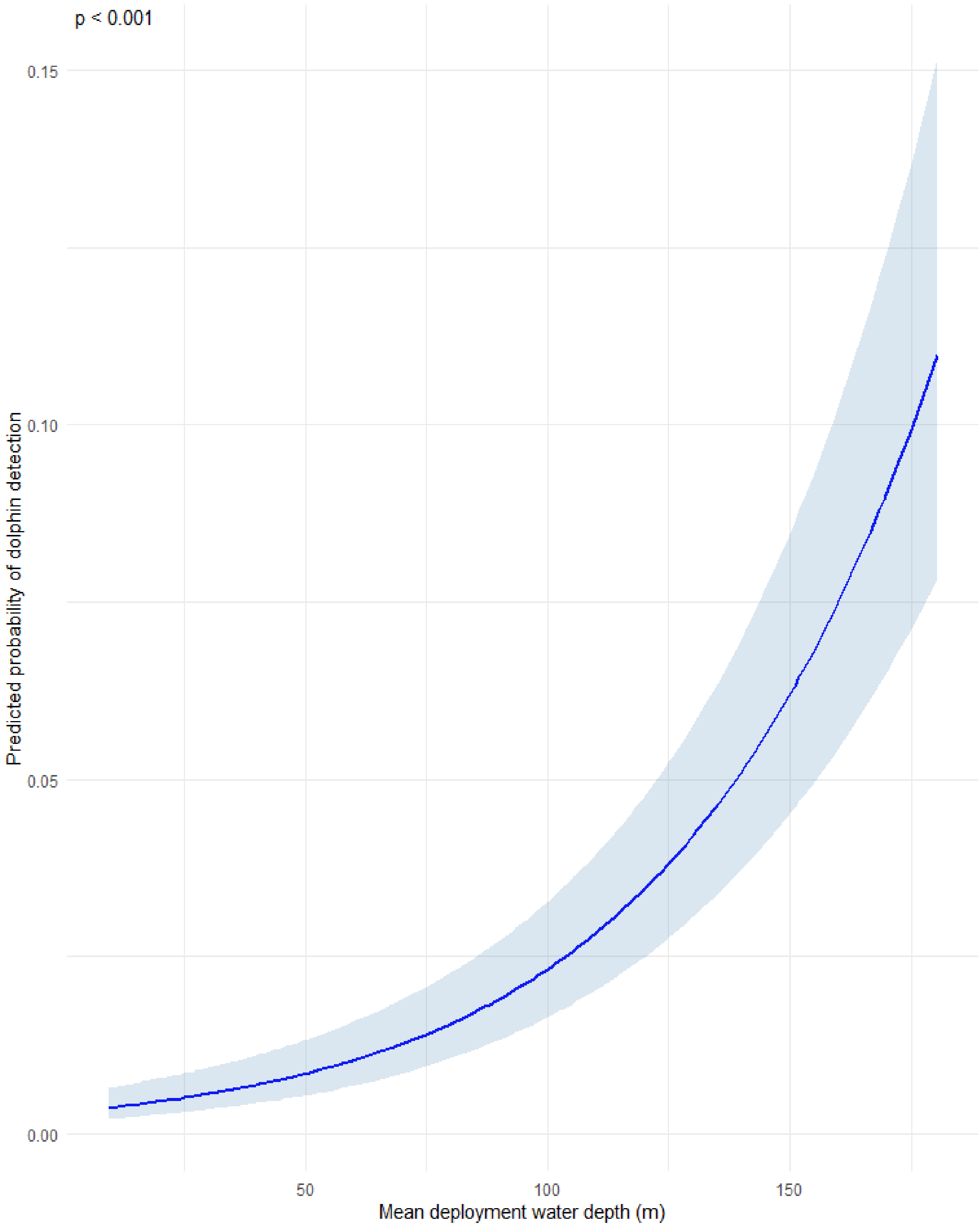

p = 0.413
Predicted catch (kg)
0
10
20
30
40
50
0.0
0.2
0.4
0.6
Proportion of deployment with dolphin detections

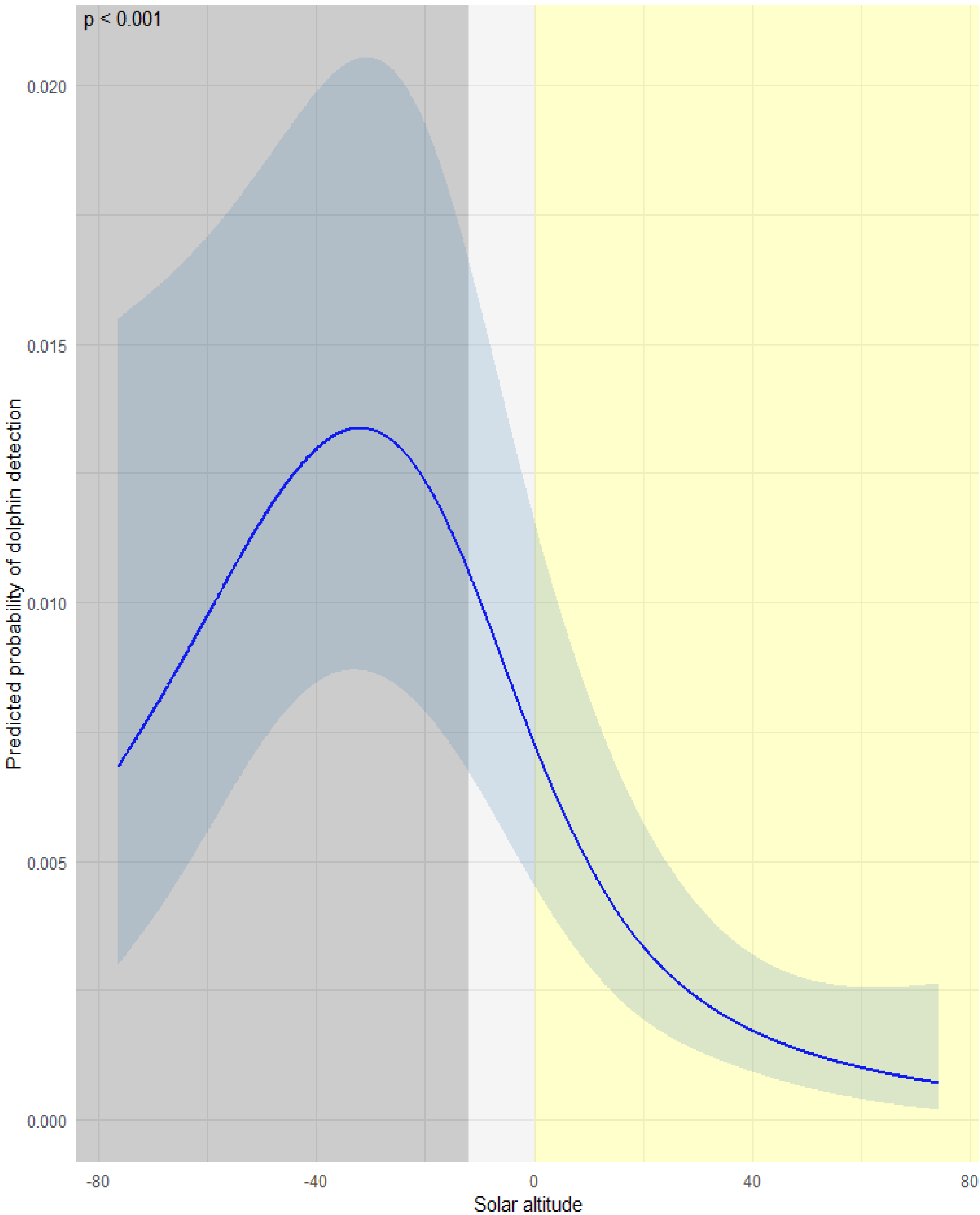

p = 0.336
Predicted catch (kg)
0
10
20
30
40
50
Mean deployment water depth (m)
50
100
150


p = 0.494
50
40
30
20
10
0
Predicted catch (kg)
monofilo
trammel
Gear type

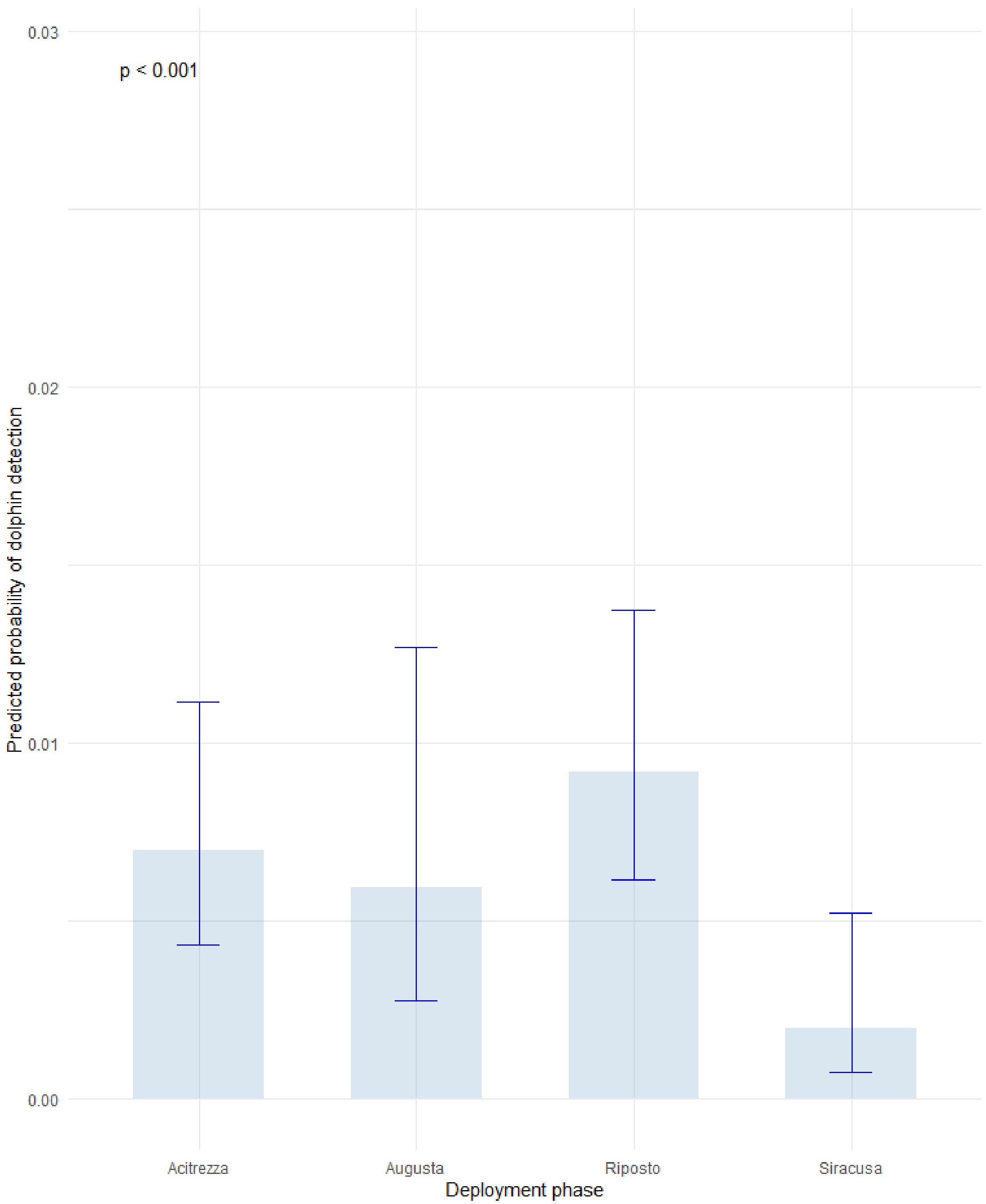
ANNEX XXIV– QUESTION 2 Outputs

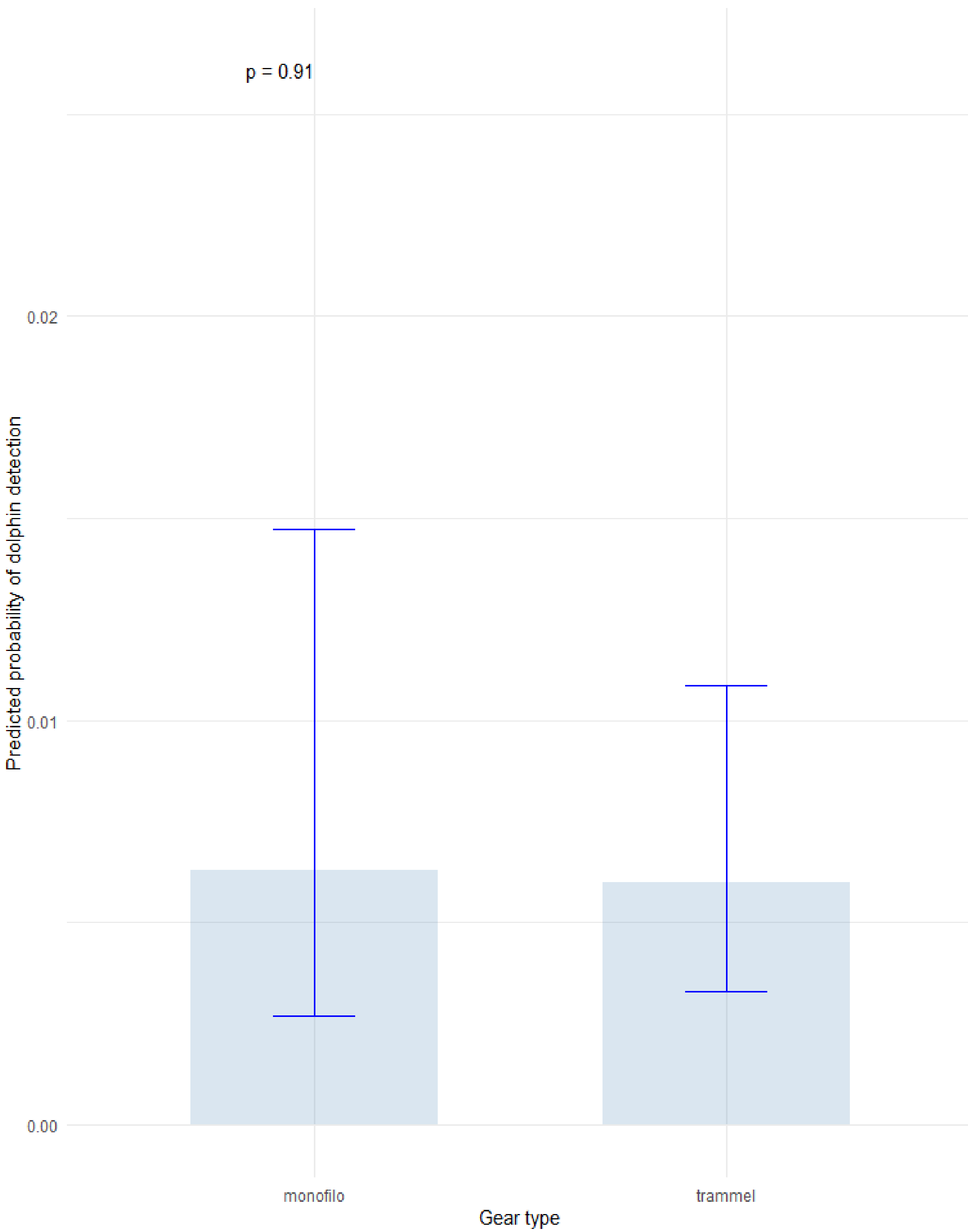


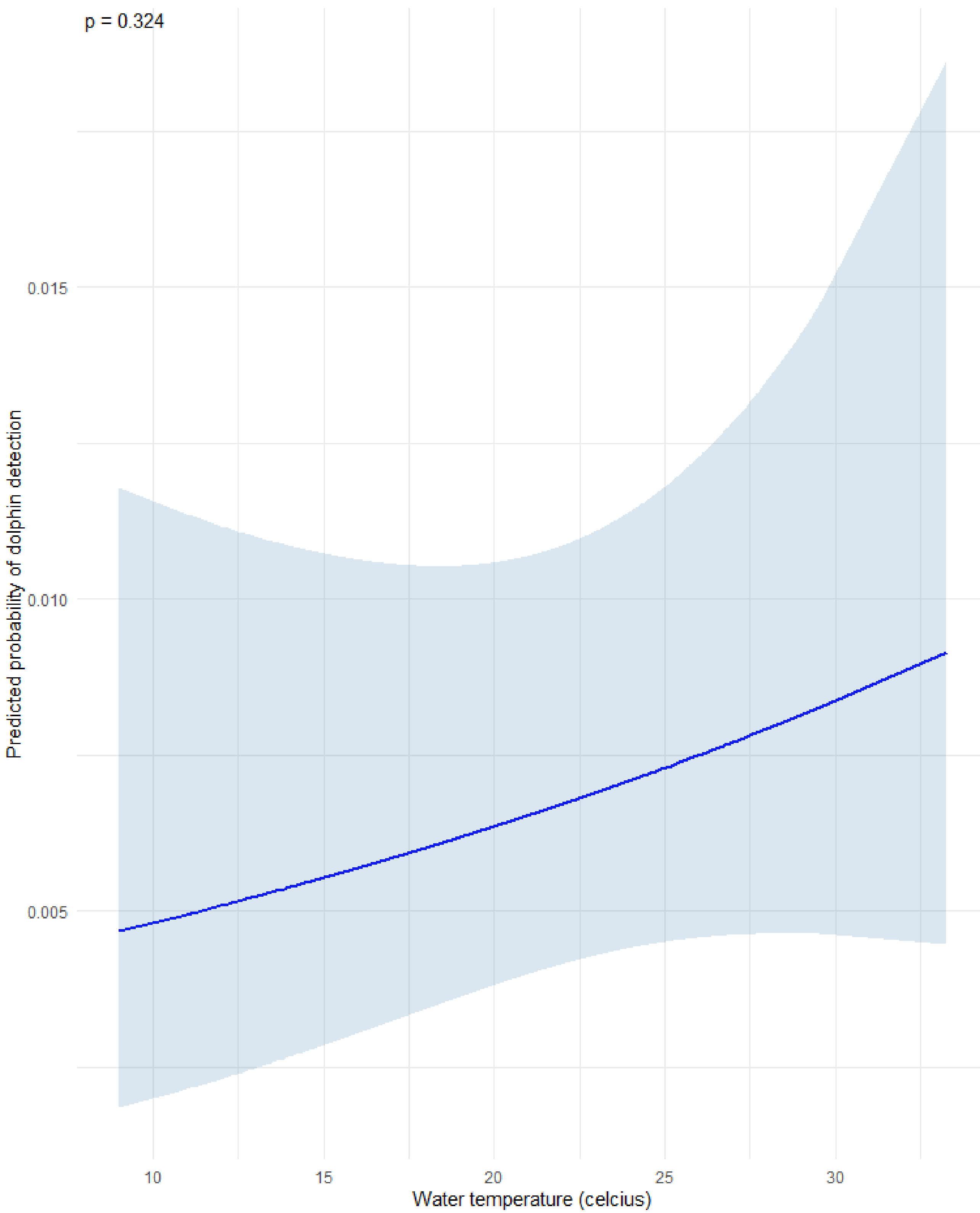

p < 0.001
Predicted probability of dolphin detection
0.15
0.10
0.05
0.00
50
100
150
Mean deployment water depth (m)



p < 0.001
0.020
0.015
0.010
0.005
0.000
Predicted probability of dolphin detection
-80
-40
0
40
80
Solar altitude


0.03
p < 0.001
0.02
0.01
0.00
Predicted probability of dolphin detection
Acitrezza
Augusta
Riposto
Siracusa
Deployment phase


p = 0.91
Predicted probability of dolphin detection
0.02
0.01
0.00
monofilo
trammel
Gear type


p = 0.324
0.015
0.010
0.005
Predicted probability of dolphin detection
10
15
20
25
30
Water temperature (celcius)