PLASMAR

Bases para la planificación sostenible de áreas marinas en la Macaronesia

Activity 2.3.1. Marine monitoring methods needed to apply MSP ecosystem approach

TECHNICAL REPORT

PLASMAR Consortium

PROYECTO COFINANCIADO POR LA UNIÓN EUROPEA
Investigación e Innovación

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1 Introduction

Activity 2.3.1, has as a starting point the results obtained in Activity 2.1.1 *Study 'Finding the balance of Blue Growth Sustainable Development within Ecosystem Approach'* and Activity 2.2.1 *Analyses of data & information availability, current and potential data holders/providers, in the scope of Maritime Spatial Planning*. These activities show the geographic areas and relevant monitoring programs (based on the MSFD indicators) for maritime development, as well as the current data needs.

According to the application form in the framework of the Activity 2.3.1, one of the final planned outputs of the PLASMAR Project is a technical report. The purpose of this report is to present the results obtained. A more detailed description of each of the monitoring methods is made in section 4. Annex.

2 Partners involved

- Gestión del Medio Rural de Canarias, S.A.U. (Activity coordinator),
- Universidad de Las Palmas de Gran Canaria,
- Direção Regional dos Assuntos do Mar,
- Agência Regional para o Desenvolvimento da Investigação, Tecnologia e Inovação
- Secretaria Regional do Ambiente e dos Recursos Naturais.

3 Results

3.1 Monitoring methods

3.1.1 Microplastics

Plastic pollution is affecting marine ecosystems on a global scale. Microplastic particles are of particular concern as, due to their size, they can enter marine food webs. The damage that microplastics can cause, not only physical, due to ingestion, but also the effects of the associated chemical pollutants in marine life, is still unknown. Within PLASMAR project we evaluated the levels of microplastics on beaches, sea surface and fish in the Macaronesian region. In beaches the microplastics present in the tidal line were quantified, in the surface of the sea the floating microplastics were collected with a manta net and the stomach content of Atlantic chub mackerel (*Scomber colias*) was analized. Our results showed that in the north and northeast oriented beaches, maximum abundances of up to 244 gr/m^2 were found in the tidal line. On the sea surface, the maximum values were found at Las Canteras Beach, a semi-enclosed bay, with concentrations of more than one million particles/Km^2. On the other hand, in 78% of the fish studied, microplastics were found in the gastrointestinal content, mainly fibres. According to these results we conclude that Macaronesia is an area highly affected by microplastic contamination and that microplastics are present in the food web. The results of these studies have been published in two articles in the Marine Pollution Bulletin and another two articles are under review. In addition, methods for study microplastics on beach and sea surface were standardized and the methodologies published in common protocols for the Macaronesian region. The methodology developed for separating microplastics from organic matter was published in the Marine Pollution Bulletin.

The information presented here is developed in depth in two technical reports and in three scientific publications >> see Annex 4.

Figure 1. Sampling and analysis methodology for the microplastic monitoring in sandy beaches. Left to right, in both A and B, sample collection and sample treatment to obtain microplastic data of the sandy beaches in two size fraction [largest (1-5 to 5-25mm) and smallest (10µm to 1mm)].

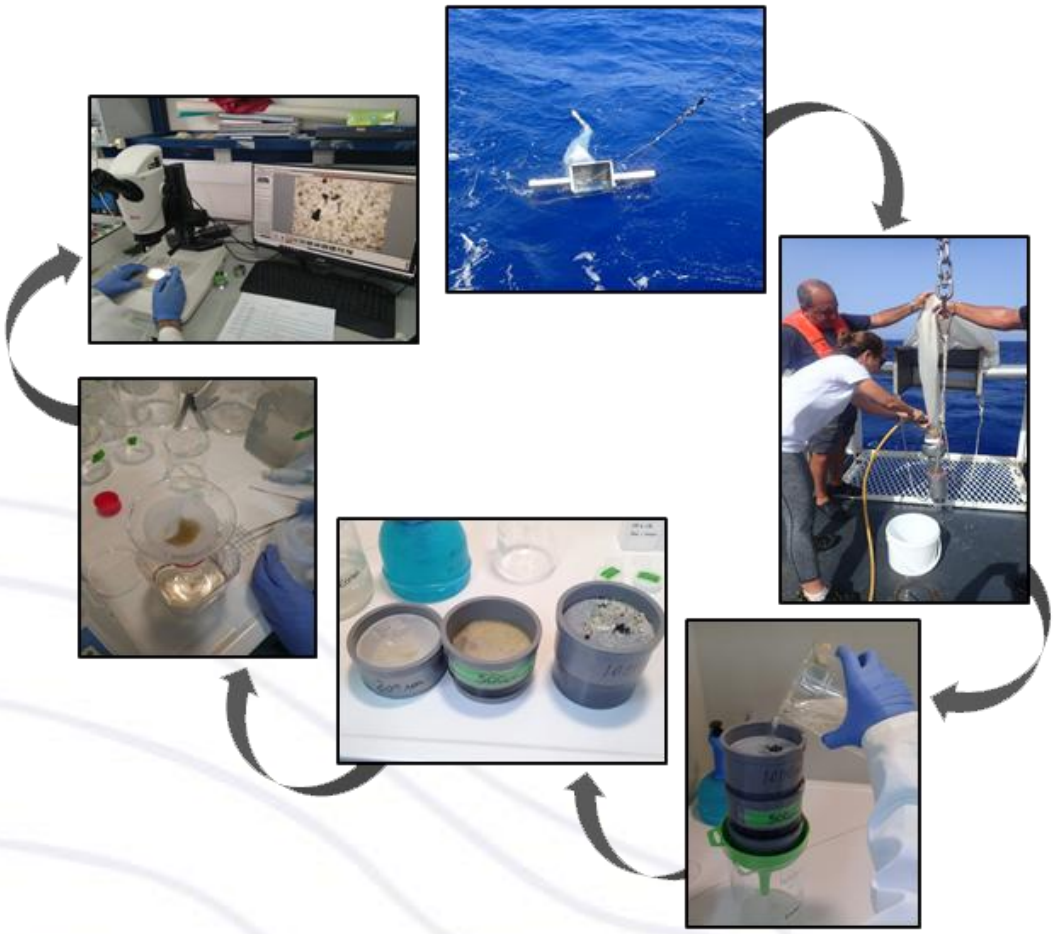

Figure 2. Sampling and analysis methodology for the microplastic monitoring in surface waters. Clockwise, sample collection with the manta net and sample treatment in the laboratory, to obtain microplastic data.

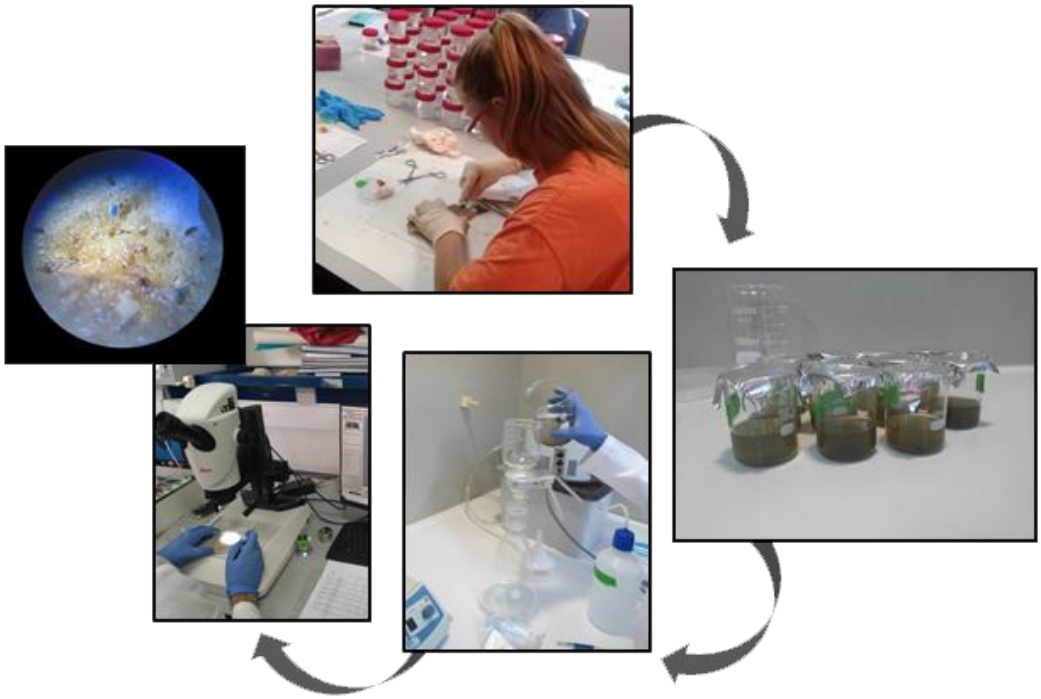

Figure 3. Sampling and analysis methodology for the microplastic monitoring in fish stomach content. Clockwise: dissection step, KOH solution to dissolve organic matter, subsequent filtration, and the microplastic detection and counting.

3.1.2 NIS (Non-Indigenous Species)

The introduction of non-indigenous species (NIS) is actually a common threat to biodiversity in coastal communities, and in the last years the rate has significantly increased. Maritime traffic is currently a vector which more contribute to exchange marine species around the world. Artificial substrates like pontoons or breakwaters provides particularly favorable habitats for many NIS, turning harbors and marinas hotspots to new species arrivals. Within PLASMAR project we compared three different sampling methods in order to identify the optimum one to monitor and detect, with image analyses, new conspicuous species arrival in marinas of Macaronesian region. The three methods were tested in two marinas of Madeira Archipelago: marina Quinta do Lorde (Madeira Island) and marina Porto Santo (Porto Santo Island). The first method consists in the placement of PVC plates (10x10x0.3cm) horizontally in the marina (1m deep) working as an artificial subtract and control system here for the arrival of fouling species; the second method consists in taking photos of the pontoons in the submerged part; and the third method consists in making videos (1min.) also of the submerged part of pontoons. The images obtained from each method were analyzed with a specific software in order to compare the information that each method provides. The preliminary results showed that the video method provides adequate information about abundance and richness of conspicuous species arrivals, and consist in a simple, cheap and fast survey. This new video methodology is now being used at regional scale by monitoring the principal marinas and ports of Canaries, Azores and also Madeira archipelagos. The development and application of a standard and common approach for the detection of NIS in the Macaronesia is a key step in order to unify and give a coordinated response to the European Commission´s Marine Directive in relation with the Descriptor 2.

The information presented here is developed in depth in two technical reports and in three scientific publications >> see Annex 4.

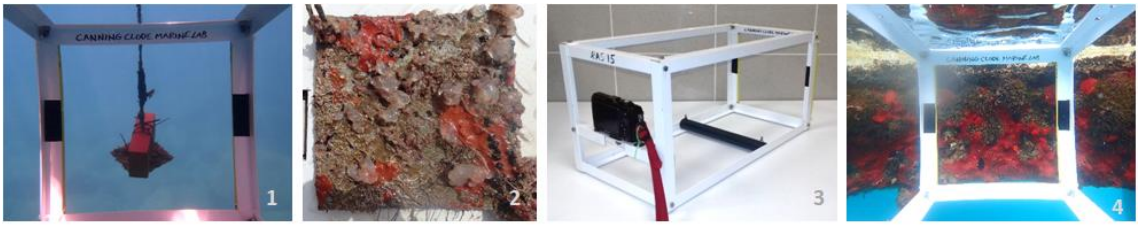

Figure 4. PVC Plates method (photos 1 & 2): PVC Plate deployed in a marina (1), Image obtained with the PVC plate method (2). Photo method (photos 3 & 4): Rapid Assessment Survey to photo method with photo camera (3), Image obtained with the photo method (3).

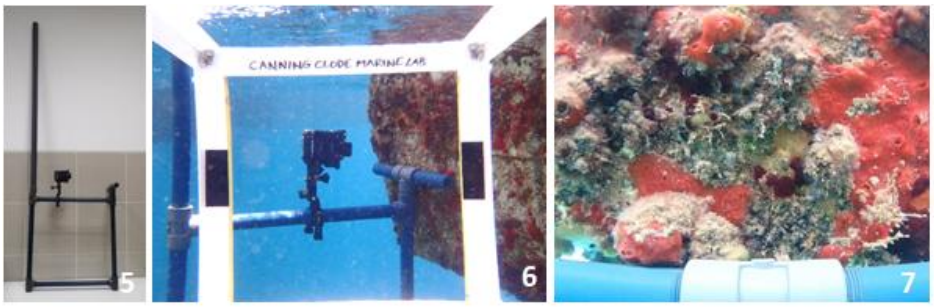

Figure 5. Video method (photos 5-7). Rapid Assessment Survey to video method (5), Rapid Assessment Survey with video camera (6), Image obtained with the video method (7).

3.1.3 Habitat characterization

University Las Palmas de Gran Canaria established basic habitat characterization protocol, for survey using the acoustic tool, Side-Scan Sonar (SSS). The SSS provides digital images of the composition and morphology, differences in materials and texture types of the seafloor. Its application is a useful tool for number of different maritime sector uses, nautical, archaeology, including ecological disciplines, particularly for the identification of habitats and mapping of their backgrounds (e.g. seagrass and seaweeds monitoring). Protocol provides basics on concepts, monitoring method and data processing.

Figure 6. Image of a wreck as an artificial reef, within the Habitat categorization study.

Additionally, spatial information on marine habitats till 50m of depth for Canaries were mapped with monitoring campaigns in period form 2000-2008. *Ecocartogarficos* data sets that are publicly available. Unfortunately, as these surveys were delivered by six different companies, these data sets have different data structure and uncommon habitat classification, including 176 classes. Analysing *Ecocartograficos* we

understood this is a semantical issue that can be resolved with unique system of habitat classification.

That we can work efficiently with *Ecocartograficos* data sets, also update new information delivered by SSS surveys, it is necessary to apply common data structure. We delivered method and tested, how to harmonize data sets on habitats, applying common data structure (INSPIRE data model on *Habitats & Biotopes*) and standardize classification using:

1. European Nature Information System (EUNIS) – 26 habitat classifications;
2. Marine Strategy Framework Directive Classification (MSFD) – 12 habitat classifications;
3. Classification by Inventario Español de Hábitats y Especies Marinos (IEHEM) – 43 classifications,

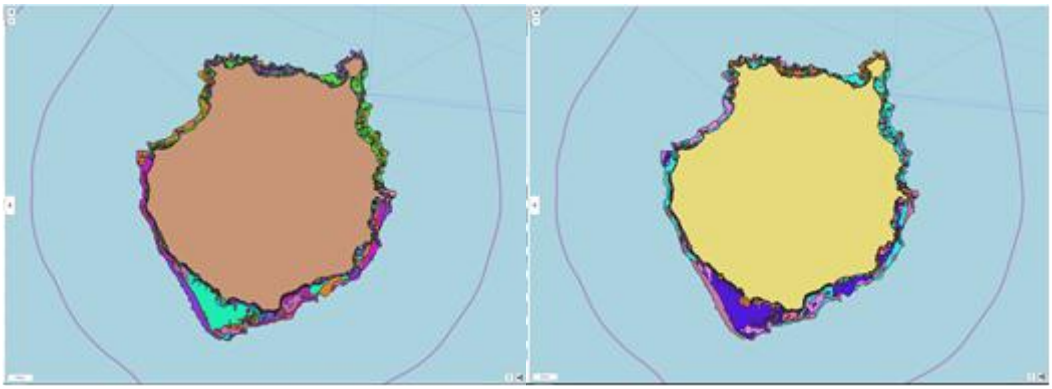

Figure 7. Left: Gran Canaria marine habitats applying 2 different classification systems; righ: Gran Canaria marine habitats applying EUNIS classification system.

3.1.4 Monitoring the subtidal sandy seabed and sand extraction activity in the Azores

Monitoring campaigns, targeting commercial sand extraction in the Azores, followed four methods: i) with nets placed on the suction tube on board of vessels licensed, in order to capture and identify organisms (figure 1); ii) visual surveys on board and on the seafloor for biological characterization of undisturbed bottoms and after pumping, for a qualitative assessment of macro fauna (figure 2); underwater sampling quadrats by SCUBA, with compressed air sucking tube (figure 3) and underwater visual surveys (figure 4). Samples of sediment were characterized (type and granulometry) and the concentration of heavy metals (Hg, Cd, Pb, Cr) were estimated. These methodologies produced complementary results, confirming that it is not possible to study the impact of this activity and the sandy ecosystems through a single approach. It was observed that the sand exploitation affects a group of approximately 15 species of invertebrates and about 4 -5 species of fish. Preliminary estimations indicates that pumping process capture 5 to 10 invertebrates from most of the of invertebrates species present, per m3 of sand extracted, and 1-2 fish for every 10 m3 of sand extracted). According to the underwater monitoring program, there are no major differences between the species richness recorded among exploited and unexploited areas. Regarding mobile fish communities, there were also recorded no differences between these two areas. Finally, it was possible to observe that the seabed depressions formed as a result of the sand extraction remain only for short periods of time; for example, in January 2019 it was no longer possible to find any evidence of the depressions made in October 2018 by the dredging activity in an extraction area (Ribeirinha, Faial island, Azores).

The information about this methodology is developed in a technical report >> see Annex 4.

Figure 7. Sediment and debris collected during the filtration process of the sand extraction tube. The white ball in the image corresponds to a Guinean puffer (*Sphaeroides marmoratus*) @*Imag*DOP.

Figure 8. Visual Inspection on board when the sand filling is complete @*Imag*DOP.

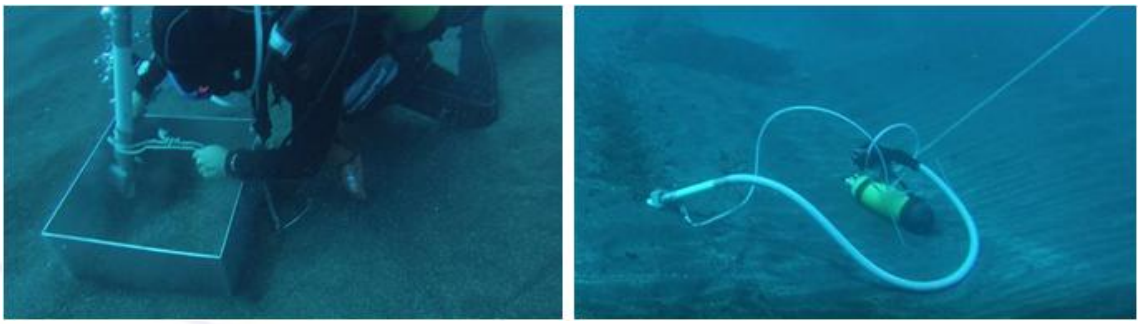

Figure 9. Underwater sampling quadrats by SCUBA. @*Imag*DOP.

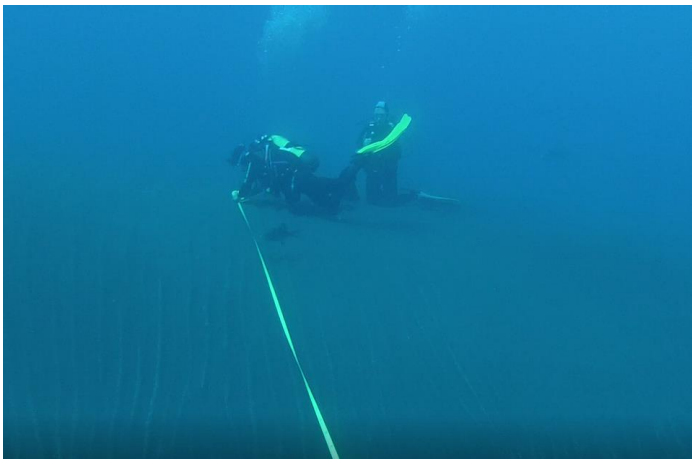

Figure 10. Underwater visual surveys and measurement of extraction cavities. @*Imag*DOP.

Figure 11. Laboratory screening process @*Imag*DOP.

3.1.5 Commercial stocks

Data-poor fisheries are characterised by the uncertainty in the status of the stocks and the nature of fishing in terms of fleet dynamics, which makes it difficult to evaluate the status of stocks, having only basic or no formal assessments. Within PLASMAR project we evaluated some stocks in the three archipelagos to determine if they are within the sustainable biological and exploitation limits. A detailed review of data-poor assessment methods was performed in order to define the best methodology taking into account the particularities of the three archipelagos. Finally, we opted for an optimized catch-only assessment method (OCOM) using reconstructed time series of catch data including professional and recreational fishing as well as discards and subsistence fishing. Our results showed that most of the analyzed stocks are overfished, although in some cases fishing mortality has been reduced. However, these results must be interpreted in a broader context, considering the quality of the data used, the fishing tactics and the uncertainty of the methodology used.

The information about this methodology is developed in a technical report >> see Annex 4.

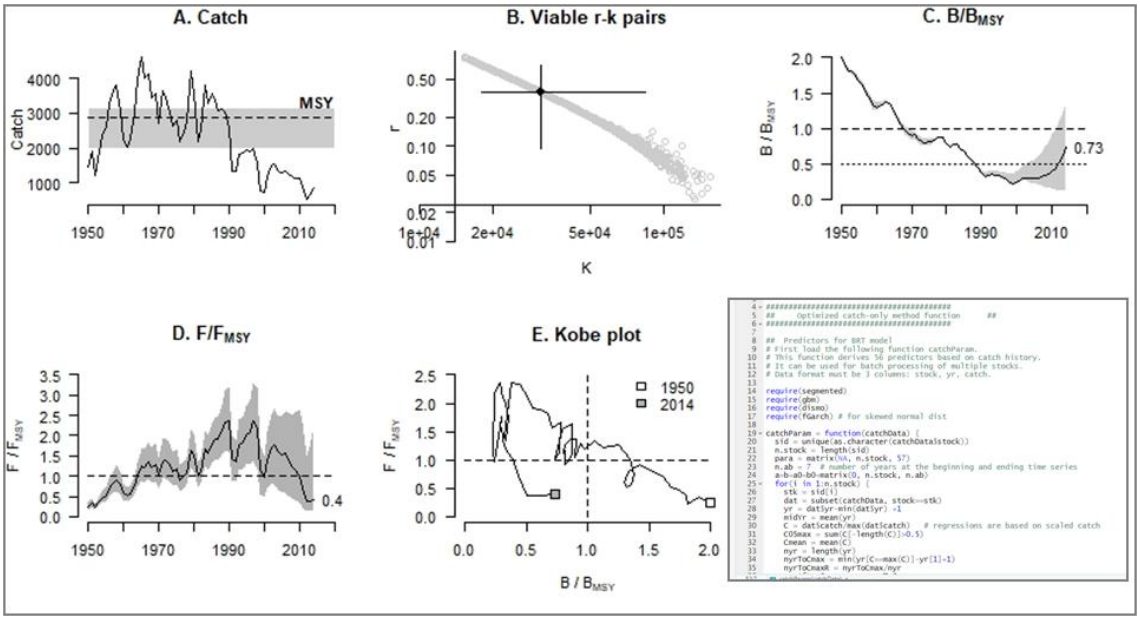

Figure 12. Plot with results obtained with the OCOM methodology (in the small box part of the code used).

3.1.6 Trophic networks

To evaluate the status of the marine ecosystems on Macaronesian region we analyzed their structure and functioning using the software Ecopath with Ecosim. The parameterization to create the ecosystem models is based on satisfying two master equations. The first one describes how the production term for each functional group can be divided: catch (i) + predation (i) + net migration (i) + biomass accumulation (i) + other mortalities (i). The second equation describes the energy balance of each group: Consumption (Qi) = production (Pi) + respiration (Ri) +unassimilated food (Ui). Information about catches and diets is also mandatory. This software also includes a module called Ecospace that provides spatial information about the functional groups included in each model or the fleets and their catches. Face-to-face interviews were conducted to the professional fishermen in the Canary Islands to determine their usual fishing areas and main target species to include this information in the Ecospace module.

The results obtained with the models will be used to evaluate the Descriptor 4 through the use of ecological indicators. Likewise, the models will allow an ecosystem approach to the activities carried out in the marine environment, such as fishing.

The information about this methodology is developed in a technical report >> see Annex 4.

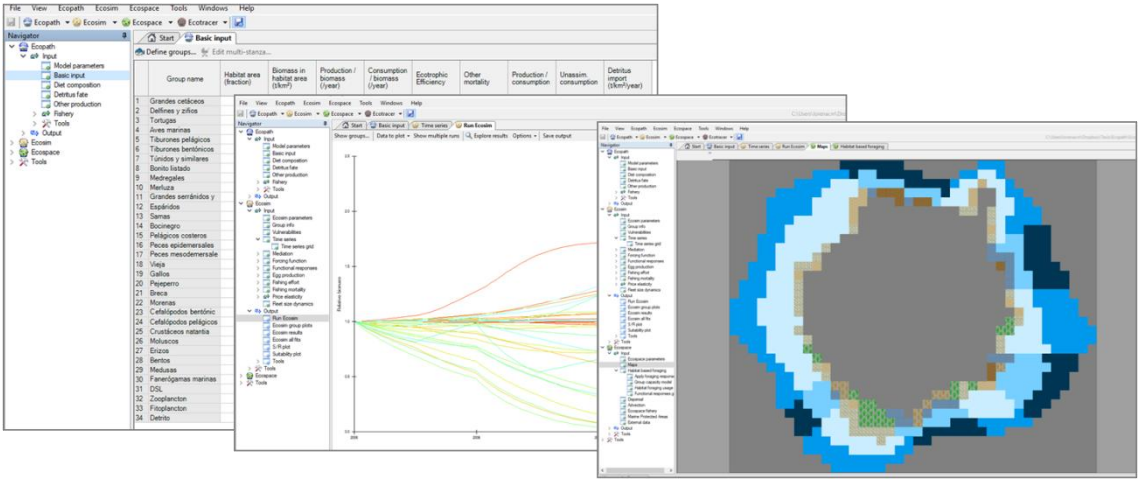

Figure 13. Developing food-web models using the Ecopath with Ecosim (EwE) software.

Figure 14. Survey design and interviews to determine the distribution of the fishing effort

3.2 Increase in marine data area

With six developed/updated monitoring methods and delivered campaigns, idea was to increase or update spatial coverage on benthic habitats, non-indigenous species, commercial species stocks, trophic networks, seabed integrity and marine debris.

Habitat characterization

Data of benthic habitats still in process of analysis, we expect to have this data set available till end of the project. Planned area was surveyed by side scan sonar campaigns (Figure 15), still there is a need to confirm with in-situ campaign composition and morphology, differences in materials and texture types of the seafloor.

Expected data set have an update of the areas, of the East coast of Gran Canaria, in front of the port of Taliarte, Punta de Tufia and Punta de Salineta.

Applying method on INSPIRE standardization and harmonization for the marine habitats, we updated Ecocartograficos data sets delivered for the whole Canary archipelago, including marine coast form 0-50m of depth.

Applying EUNIS common classification, it was possible to integrate harmonized Ecocartograficos with EMODnet data set, covering whole EEZ of Canaries islands (Figure 16).

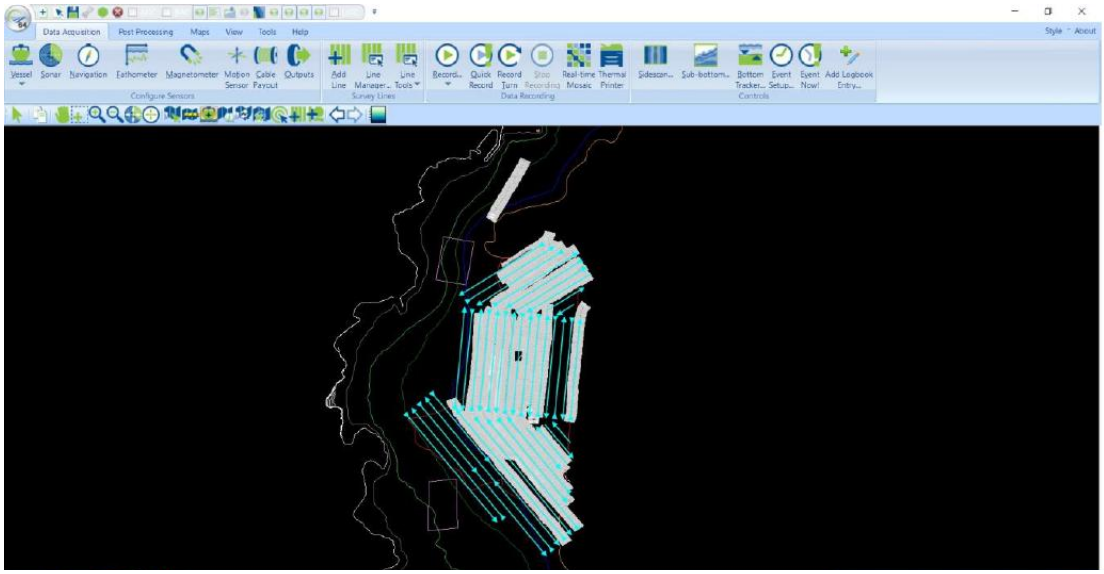

Figure 15. Surveyed area with side scan sonar.

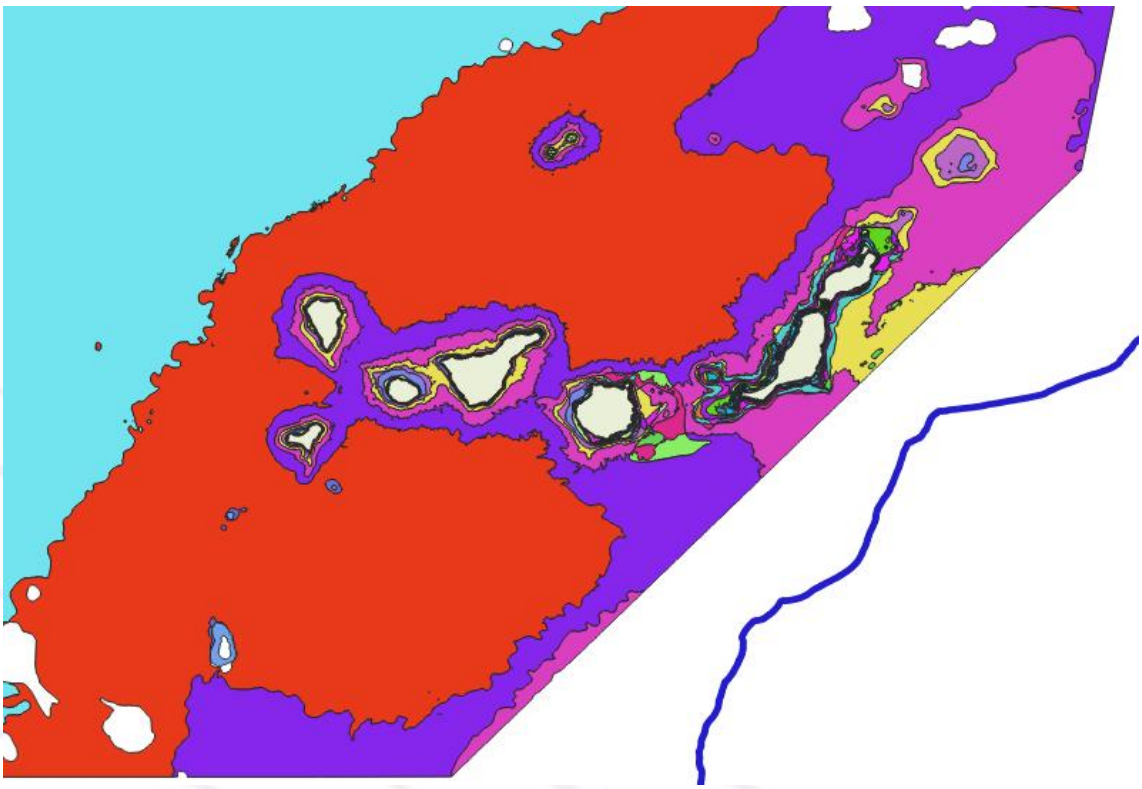

Figure 16. Coverage of habitat data sets with common EUNIS classification

Data on marine debris area covered

A total of 45 neustonic samples were collected during daylight (9:00–14:00 h), 24 in the Canary Islands archipelago, 12 in Madeira and 9 in the Azores in the Macaronesian region. Samples were collected in opportunistic samplings in different periods between 2015 and 2018.

In Madeira archipelago, it was developed the first study to determine the presence of marine litter in coastal areas (Álvarez, Gestoso, Herrera, Riera, & Canning-Clode, 2020). In this study, we compared the quantities, types and colour of the microplastics present in five different sandy beaches in Madeira archipelago, and we also characterized and compared the macrolitter identified in four sampling sites (Figure 17). In addition, we conducted a sea surface sampling in a Macaronesian campaign to determine the quantity of microplastics present. In Madeira, four sampling areas in the southeast coast were surveyed (Figure 18) (Herrera et al., 2020).

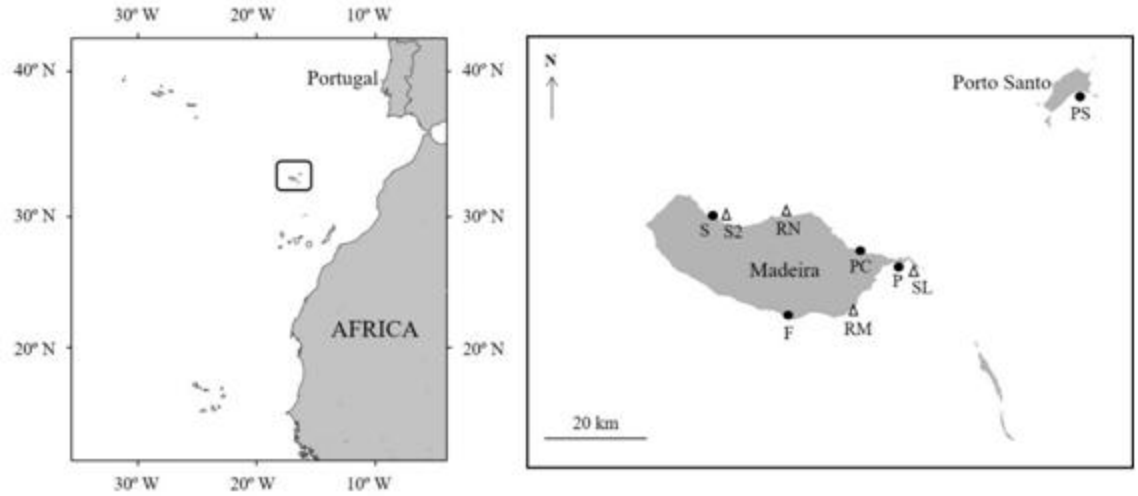

Figure 17. Map of the Madeira Archipelago with the locations of the marine litter sampled sites: Seixal (S), Seixal2 (S2), Rocha do Navio (RN), Porto da Cruz (PC), Prainha (P), São Lourenço (SL), Reis Magos (RM), Formosa (F) and Porto Santo (PS). Macro-litter sampled sites are shown by open triangles and micro- and meso-litter sampled sites are shown by filled circles. (Álvarez et al., 2020)

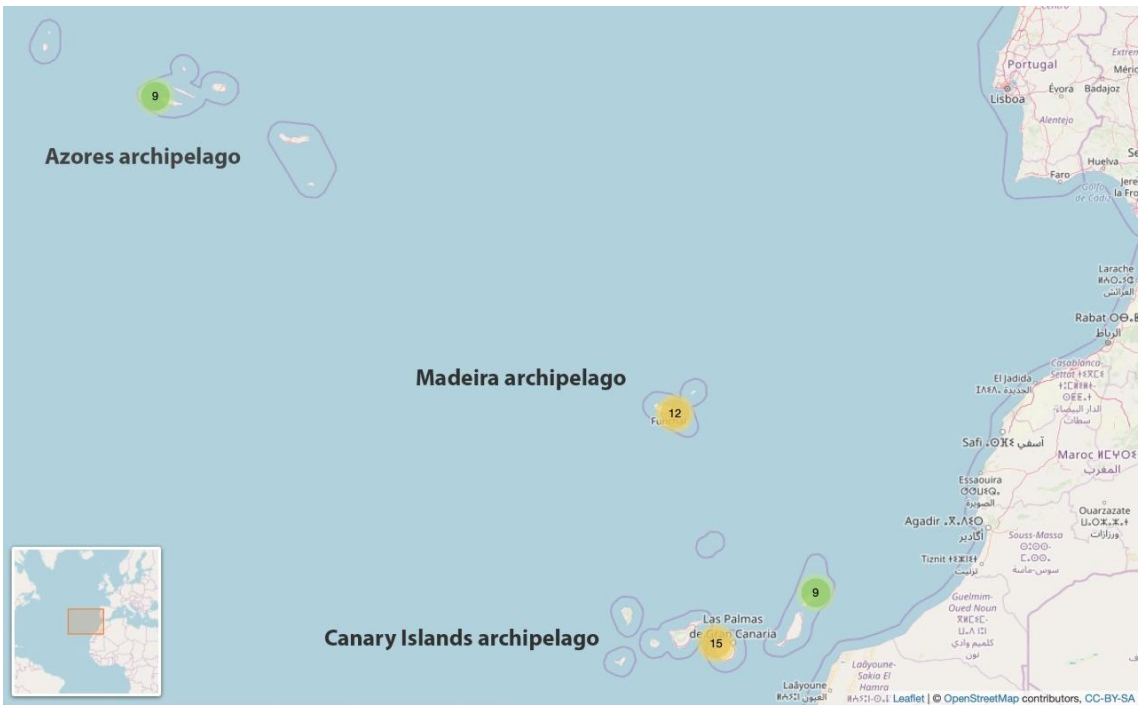

Figure 18. Sampling in Macaronesia.

Data on NIS area covered

The three methods (PVC plates, photo and video) were tested in both marinas, Quinta do Lorde and Porto Santo (Figure 19). The preliminary results showed that video method provides adequate information about abundance and richness of conspicuous non-indigenous species (NIS) arrivals according to the simple, cheap and fast survey of the method (Álvarez, S. et al. (a), in prep).

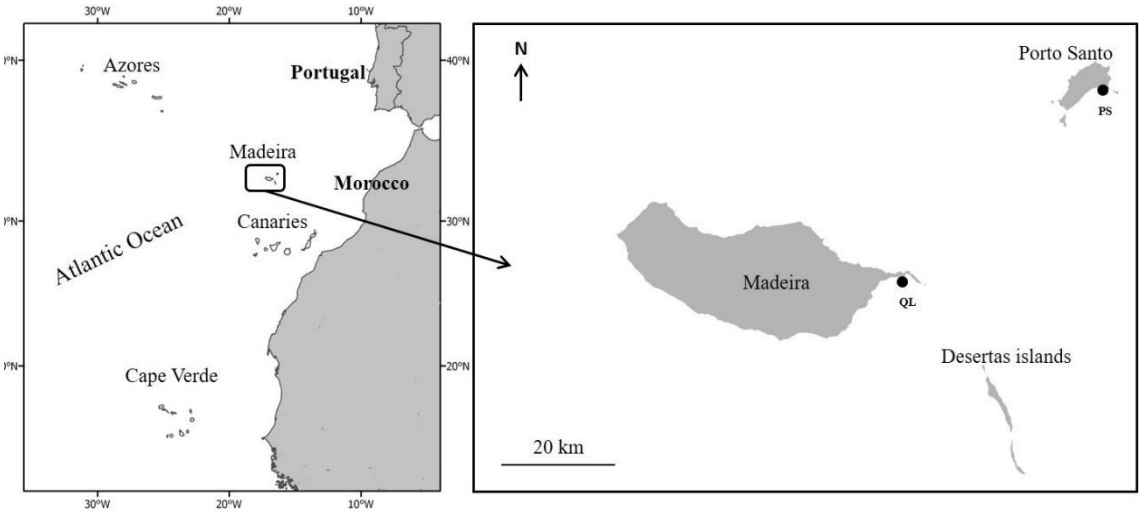

Figure 19. Location of the Quinta do Lorde Marina (QL) and Porto Santo marina (PS).

According to 2.3.2. Activity, It was developed a monitoring campaign in Canary Islands, Azores and Madeira archipelagos using the video methodology, in order to identify the NIS present. A total of 15 marinas were sampled (Figure 20), 6 in Canary Islands (Marina del Sur, Marina Tenerife, Marina de Santa Cruz, Puerto Mogán, Las Palmas and Vela Latina), 4 in Madeira (Calheta, Funchal, Quinta do Lorde and Porto Santo) and 5 in Azores (Marina da Horta, Angra do Heroísmo, Marina Praia Vitória, Marina Vila Franca do Campo and Marina da Ponta Delgada). The results of this monitoring campaign are still not available, the data are being worked (Álvarez, S. et al. (b), in prep).

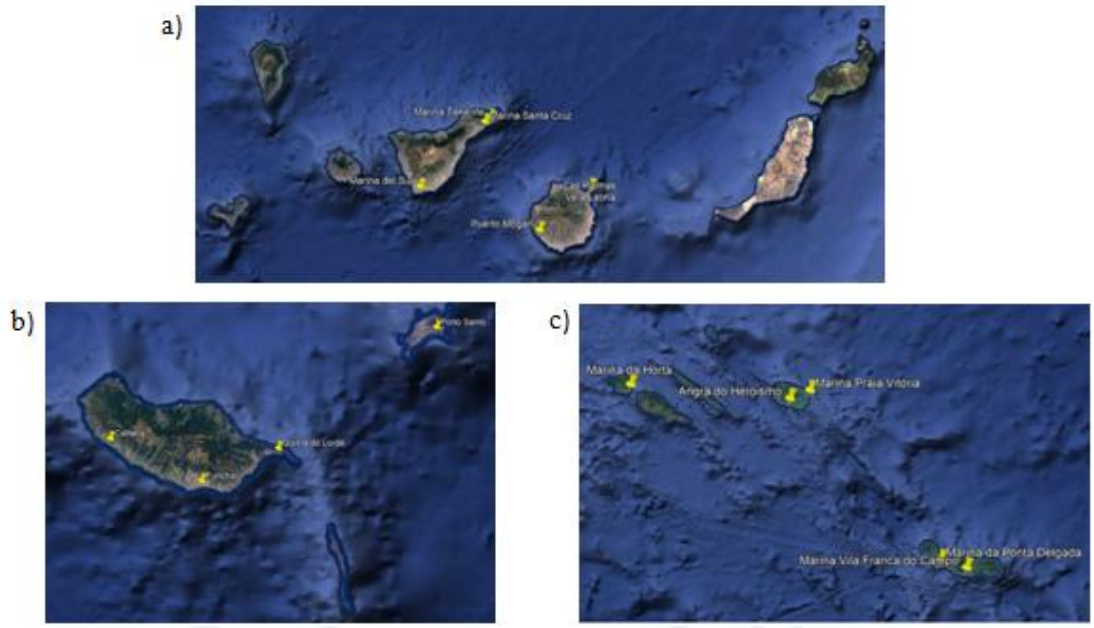

Figure 20. Location of the marinas were the monitoring campaign was developed; a) Canary Islands, b) Madeira archipelago; c) Azores archipelago

Data on stocks and trophic networks area covered, including fisheries survey

To define the spatial fishing effort of the canarian artisanal fleet, we considered the area extending seaward to a distance of 200 nautical miles out from the coastal baseline (about 455.353 km2). Most of the fishermen are active in the waters near the coast, however during the tuna season they can travel long distances; therefore, in these particular cases, information about fishing areas that were outside the limits of the EEZ was also collected (Figure 21).

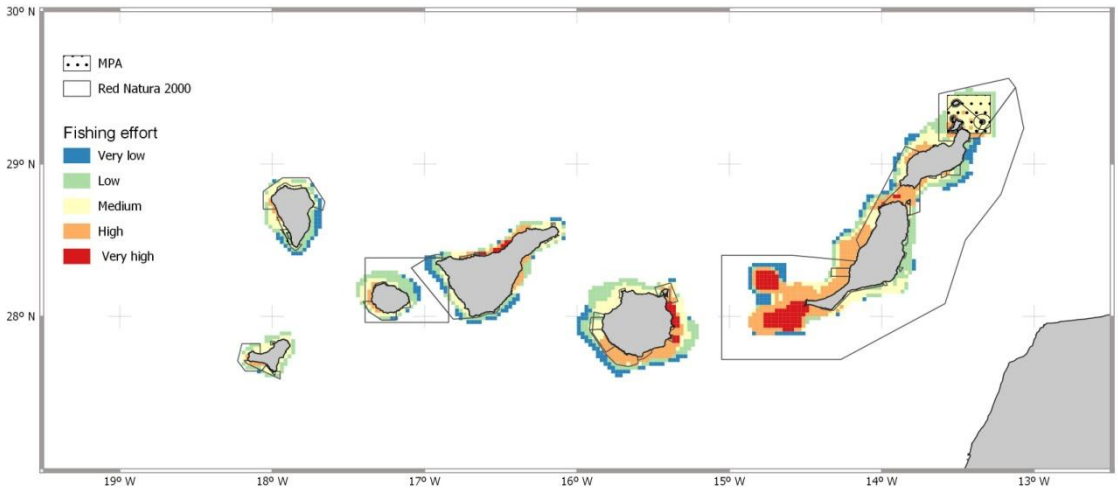

Figure 21. Spatial distribution of the polyvalent fleet (benthodermersal and coastal pelagic fish) expressed as density of vessels per area, assuming annual time frame.

The ecosystem models developed in the Canary archipelago cover an area of approximately 23.752 Km^2. Each area was defined taking into account the most probable distribution of the species based on the available bibliography, as well as the fishing grounds where the fleet operates (Figure 22).

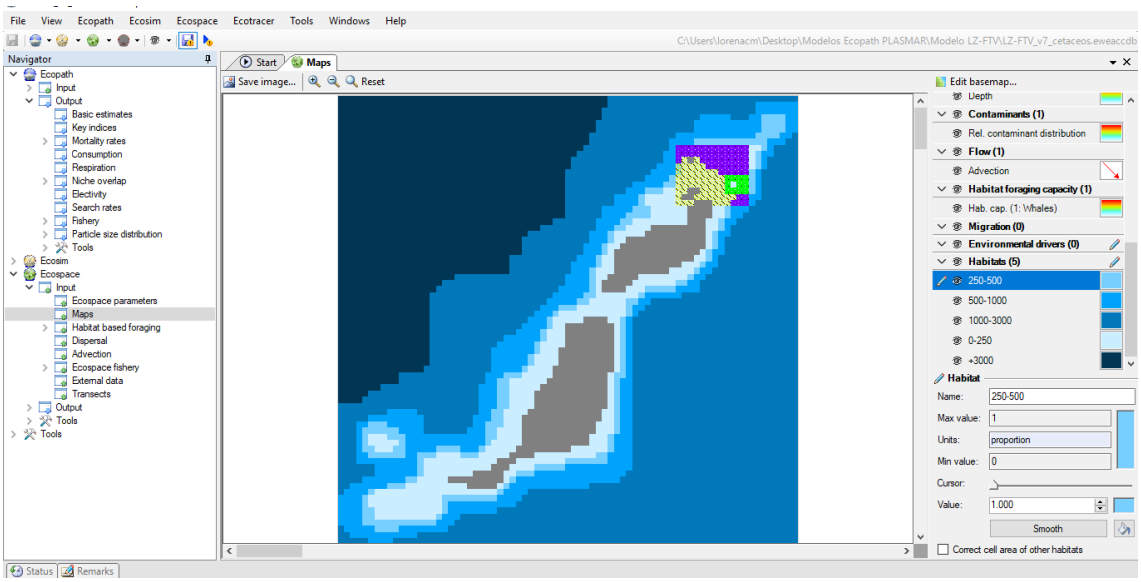

Figure 22. Coverage of the ecosystem model that comprises Lanzarote and Fuerteventura islands

Data on seabed integrity area covered

Campaigns took place in 2019 and focused on the two main sand extraction areas in the archipelago of the Azores, on the island of Faial (Figure 23, left), where most of the work was done and on the island of São Miguel (Figure 23, right). The images and samples collected are being processed and analyzed, consequently results and georeferenced data are not yet available.

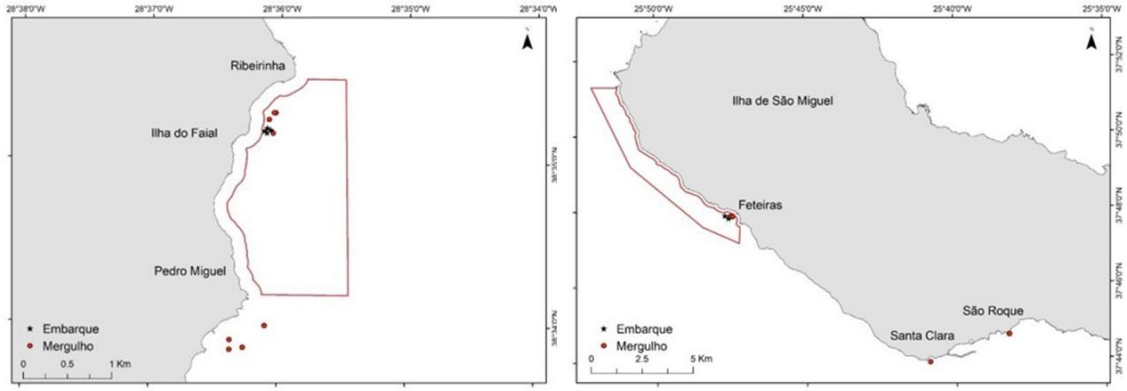

Figure 23. Two main sand straction areas of the Azores.

3.3 Compatible data with INSPIRE

Data sets that are following INSPIRE standards, need to be discoverable, viewable and available for download trough standard network services in the standardized INSPIRE data model. On data infrastructure developed by PLASMAR are publicly available for download data on benthic habitats, trophic networks and commercial stocks.

INSPIRE compliant files are on marine habitats, are discoverable trough metadata catalogues, viewable trough geoportal and can be downloaded trough internet services in the standardized INSPIRE data model *on Habitat and Biotopes*.

More than 200 data sets on commercial fish stocks and trophic guilds are discoverable trough metadata catalogues, viewable trough geoportal and available for download trough internet services. Fisheries data sets delivered with survey are discoverable trough metadata catalogues, viewable trough geoportal and available for download trough internet services.

Data sets delivered with campaigns on marine debris are shared on Mendeley data infrastructure, available for download at: https://data.mendeley.com/datasets/bhjn9xgd47/1

4 Annex

4.1 Microplastics

Technical reports

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- Herrera, A.; Martínez, I.; Gómez, M.; Rapp J.; Raymond E.; Álvarez, S.;Gestoso, I.; Canning-Clode, J. 2019. Sampling and processing microplastics from surface waters. Universidad de Las Palmas de Gran Canaria, Agência regional para o desenvolvimento da investigação, tecnología e inovação. Report prepared as part of PLASMAR Project (co-financied by ERDF as part of POMAC 2014-2020). 22 pp. http://hdl.handle.net/10553/56209

Science (peer reviewed)

- Alicia Herrera, Paloma Garrido-Amador, Ico Martínez, María Dolores Samper, Juan López-Martínez, May Gómez, Theodore T. Packard. Novel methodology to isolate microplastics from vegetal-rich samples. *Marine Pollution Bulletin.* Volume 129, Issue 1, April 2018, Pages 61-69. https://doi.org/10.1016/j.marpolbul.2018.02.015
- A. Herrera, M. Asensio, I. Martínez, A. Santana, T. Packard, M. Gómez. Microplastic and tar pollution on three Canary Islands beaches: An anual study. *Marine Pollution Bulletin.* Volume 129, Issue 2, April 2018, Pages 494-502 https://doi.org/10.1016/j.marpolbul.2017.10.020
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Technical reports

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- Patrício Ramalhosa, Ignacio Gestoso, Bernardo Duarte, Isabel Caçador, João Canning-Clode. Metal pollution affects both native and non-indigenous biofouling recruitment in a subtropical island system. *Marine Pollution Bulletin*. Volume 141, April 2019, Pages 373-386. https://doi.org/10.1016/j.marpolbul.2019.02.072
- Ignacio Gestoso, Eva Cacabelos, Patrício Ramalhosa, João Canning-Clode. 2019. Plasticrusts: A new potential threat in the Anthropocene's rocky shores. Science of The Total Environment, Volume 687, 413-415 pp. https://doi.org/10.1016/j.scitotenv.2019.06.123
- Ferrario J, Gestoso I, Ramalhosa P, Cacabelos E, Duarte B, Caçador I, Canning-Clode J (2020) Marine fouling communities from artificial and natural habitats: comparison of resistance to chemical and physical disturbances. Aquatic Invasions 15(2): 196–216 https://doi.org/10.3391/ai.2020.15.2.01

4.3 Monitoring the subtidal sandy seabed and sand extraction activity in the Azores

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4.4 Commercial stocks

Technical reports

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4.5 Trophic networks

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