BIOMARES project LIFE06/NAT/P/000192

Non-technical report nº1

Alexandra Cunha

Centre for Marine Sciences

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1. The Biomares project

The “Luiz Saldanha” Marine Park is the only marine park in Portugal. Located along the south coast of the Setúbal Peninsula, between the Arrábida mountain range and the north part of Cabo Espichel, it stretches over 38 Km of rocky and cliffy coastline between the Figueirinha and Foz beaches.

There are numerous sheltered bays with sand or pebble bottoms and includes important habitats concerning the Habitat Directive (the Marine Park is included in the Arrábida-Espichel Site) – *Sandbanks which are slightly covered by sea water all the time* – *Reefs* and *Submerged or partially submerged sea caves*.

The park houses more than one thousand species of marine flora and fauna.

Figure 1. Portinho da Arrábida Bay at the Arrábida Marine Park.

2. Threats to conservation in the Arrábida marine park.

The main problems that affected biodiversity in this coast were a high fishing effort, use of destructive fishing gears such as the Portuguese clam dredge (ganchorra), use of scuba diving gear to collect bivalves and intensification of recreative fishing and nautical recreational activities.

Unregulated anchoring with anchors, grapnels and mooring lines and cables dragging over the bottom, rooted up marine vegetation, destroying animals fixed to the seafloor, altering the nature of the sediments and affecting associated fauna and destroying communities growing on rocks and reefs.

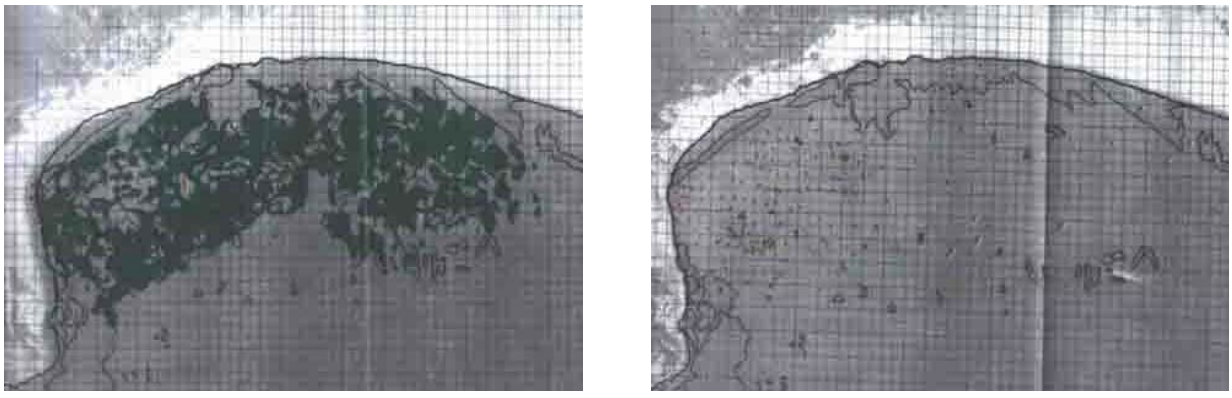

Figure 2. Maps showing seagrass meadow distribution area between 1983 e 2003 (Source ISPA, 2006).

3. The BIOMARES project

The aim of this project is to restore and manage the biodiversity of the Arrábida Marine Park, conciliating economic activities related to fisheries and recreation with environmental protection.

It is coordinated by the Algarve Centre of Marine Sciences and includes partners such as the Consejo Superior de Investigaciones Científicas from Spain, the Instituto da Conservação da Natureza e da Biodiversidade, the Instituto Nacional de Recursos Biológicos and Instituto Superior de Psicologia Aplicada and is co-financed by the LIFE / Nature programme (year 2006) of the European Union and by SECIL – Companhia Geral de Cal e Cimento S.A.

4. The importance of seagrass meadows and its recovery

Seagrass meadows, once abundant in the Arrábida coast, were an important habitat for many species of marine fauna. Molluscs such as cuttlefishes and octopuses, bivalves, crustaceans and adult fishes used seagrass meadows as reproduction sites, while larvae and juveniles of these species would use seagrass meadows as refuge sites against predators. An important function of seagrass meadows is its contribution for the maintenance of water quality and transparency by absorbing excess nutrients in the water. The usually well

developed root system helps retaining sand that, otherwise, would be taken away by currents and thereby helping to diminish coastal erosion.

Seagrass meadows around the world have been disappearing due to many causes arising from human action and are therefore considered vulnerable habitats and in danger of extinction. In the last twenty years, they have also disappeared almost completely from the Arrábida coast and this has consequently impoverished this entire coast from a point of view of fauna and flora and has had significant impacts in the overall production of the region.

Figure 3. Photograph of Portinho da Arrábida (anonymous source), showing the destructive effect of boat moorings and the “ganchorra” gear.

5. Importance of protecting reef habitat.

Rocky substrates that constitute reefs are very important for marine life because they provide a settling substrate for algae and all animals that need a fixed support in order to live such as ascidians, gorgonians and anemones. On the other hand, the structural complexity that they can develop, while forming more exposed areas like slabs and less exposed areas such as hideouts and caves, provides protection against predators during more sensible stages like in larval stages or for reproductive adults.

Most marine animals have difficulties in growing in loose sand and need a fixed support to grow. Therefore, reefs are a privileged location for the development of great diversity and biologic production. Nonetheless, many species associated with reefs are very sensible to human disturbances and require many years to develop. The reef area of this Marine Park is one of the places in Portugal with most marine biodiversity. Despite this, it has suffered many aggressions from commercial fishing with trawl nets, and nautical recreational vessels dropping anchors and grapnels in a disorderly fashion in the park's seafloors. Today, we are attempting to eradicate these actions from the park's area for the preservation of this wealth that belongs to all Europeans.

6. The following actions were conducted during the first year of the Project (2007):

During the four years of implementation, the project involves a set of 26 actions divided into five categories:

Actions A. Are preparatory actions that include some preliminary characterization studies of the area and the development of action plans.

Within this group of actions, Biomares as completed actions A.1, A.2, A.3, and A.6 and has started actions A.4, A.5 and A.7.

Action A.1 was intended to obtain the characteristics of the fishing fleet using the Marine Park area and analyse the evolution of local fisheries on a timescale. This information is very important in terms of management of natural and fisheries resources because only by knowing the fishing effort currently applied in the Park is it possible to adapt the fishing regulations inside the protected area.

The data used were provided by the *Direcção Portuguesa Geral das Pescas e Aquicultura*, and included 60% of the vessels licensed to fish inside the marine protected area (MPA) and refer to the period between 1992 and 2006. The number of licensed vessels has decreased from 112 in 2006, to 89 in 2007 (Table 1). Also, main conclusions of this task indicate that fishing of the majority of species has a seasonal pattern with cycles of abundance and scarcity.

Despite this, data from the analyzed species did not reveal any clear patterns of decline or increase in numbers, except for mullet, red mullet and torpedo rays which show a decrease of landings and for rock-bass, rays and flat-fishes which show an increase of landings at fish auction markets. Nonetheless, these data have limited interpretation because landings were not properly separated and identified at its origin in terms of species but yet in groups of fishes. Furthermore, official statistics do not also include fishing gear used, effort and fishing location. Because there are no environmental data it was also not possible to relate fish catches patterns with environmental variations which are known to strongly influence fluctuations in fish populations. Figure 1 depicts an example of the results from the analysis that researchers develop, in this case it refers to molluscs. The most visible data is the yellow line which shows the fluctuation of abundance of razorshell clam; after two peaks of abundance this species has practically ceased to be commercialized.

Tabela 1. Example of data obtained about the fishing fleet operating inside the marine park.

		2006	2007
Fishing gear	Longline	112	89
	"Toneira" Jigs	99	81
	"Piteira" Jigs	23	20
	Octopus traps	31	28
	Octopus pots	4	0
	Gill nets	21	17
	Trammel nets	31	27
Total licenses		321	262
Total boats		112	89

Fishermen surveys were also included in this task to understand their perception of the existence of a marine park and fisheries resources. Results from the surveys show that fishermen have opinions and know well the regulations and limits of the marine park. They also show that in spite being unhappy about fishing restrictions and the implementation of the marine park, they recognize that restrictions to fishing, fishing gears and vessels used can benefit fisheries resources. There is a general consensus that spearfishing has a strong impact in resources but line and hook fishing should be allowed. When it comes to line and hook recreational fishing answers to the survey become more problematic because they point out the existence of recreative fishermen who fish on a daily basis and sell their fish creating competition with professional fishermen. It should be highlighted that fishermen include pollution as one of the causes of fisheries decline. Figure 4 represents a typical graphic resulting from the analysis of the surveys conducted in 2007.

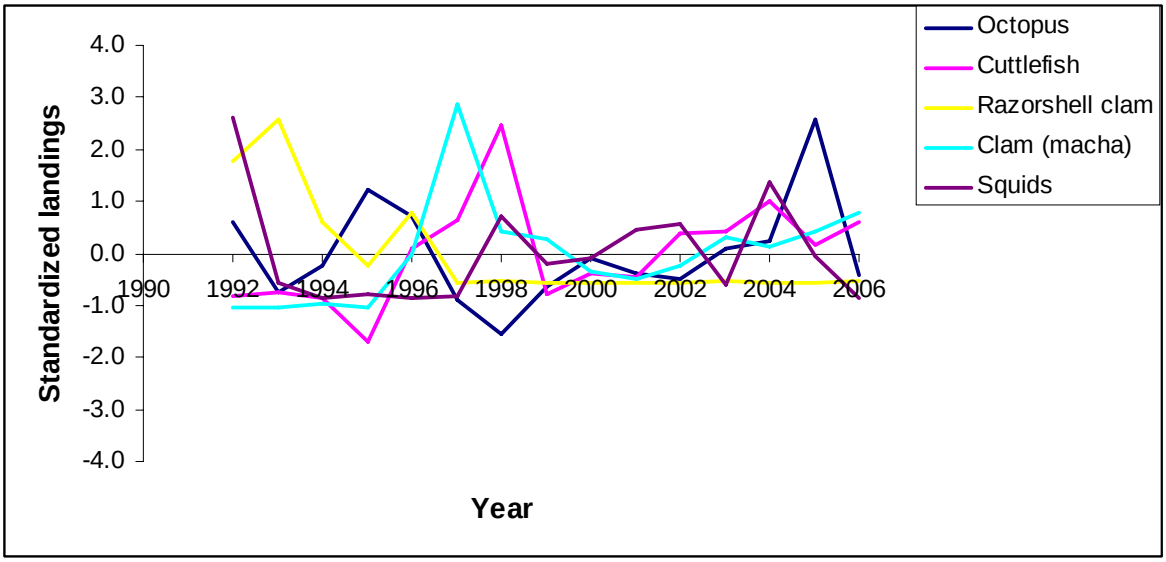

Figure 4. Example of graphics showing the results obtained from the surveys of done at the Sesimbra auction market between 1992 and 2006.

Action A.2 consisted in the development of a mathematic model which provides information to aid decision about the quantity of plants to be transplanted. This mathematic model was developed by Spanish researchers specialized in the study of the growth of marine plants who have made the CSIC (Consejo Superior de Investigación Cientifica) a partner of Biomares. To develop this model the researchers based themselves on previously known horizontal growth and branching rates of the target species. The most evident result was that the two species analysed have very different growth rates, revealing that *Zostera marina* grows much slower than *Cymodocea nodosa*.

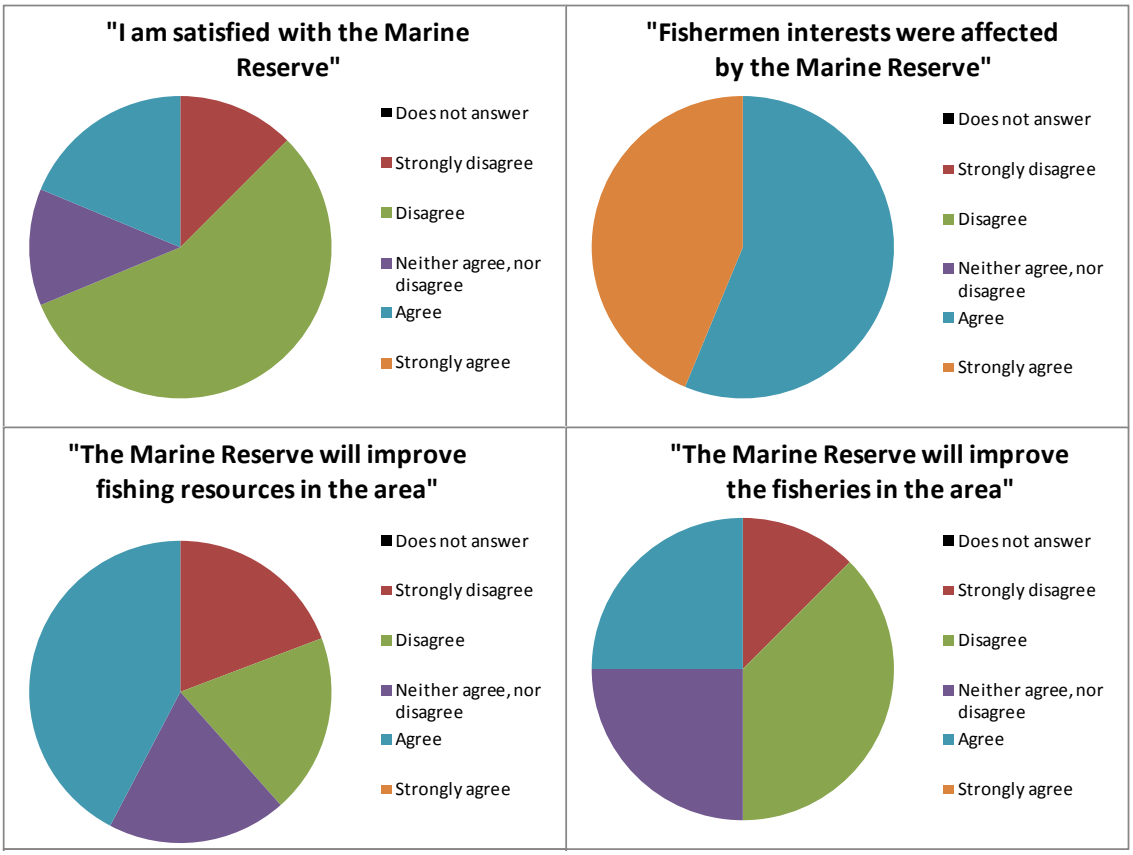

Figure 5. Example of information obtained from fisherman enquiries data. It can be seen that the fisherman although not agreeing with the existence of the

marine park, agree with the idea that the marine reserve will improve fishing resources.

The results show that the number of plants necessary to obtain the area initially proposed in the project in a period of four years is very large and incompatible with the existent logistic capacity. It was suggested to adapt the planting effort to more realistic goals and for a period of five years and also a reassessment (validation) of the model once the actual growth and mortality rates are known after plants are subjected to transplantation (cut and transported to another location as it is).

Action A.3 This action was completed during 2007 and consisted of mapping seagrass meadows recognized as potential donor populations to know their covering area and spatial distribution. During mapping, samples of plants were also collected to characterize populations in terms of genetic diversity.

The estuary of river Sado, the estuary of river Mira and Ria Formosa were visited during this action, conducted between January and June 2007. Various methods were used and depended on the locations' depths and their morphology. Aerial photography was used to identify vegetation patches, surveys were done to local fishermen regarding the existence and location of vegetation patches and sites were visited for verification. This work resulted in a series of digital maps inserted in a geographical information system where existing vegetation patches are identified in each location. Ria Formosa is therefore the location with the largest seagrass meadows area summing a total of 241 hectares, followed by the Sado estuary with 33,1 hectares and river Mira

with 0,5 hectares of sparse vegetation. Presently, there is only one identified patch of one of the species, *Zosteral noltii*, in the Arrábida coast and is very small. During the time of this action several locations were either pointed out by fishermen or identified by aerial photos as indicating previous existence of meadows. In the seventies, a work conducted by students of the course in Biology of the FCL (Faculty of Sciences of the University of Lisbon), under the supervision of Professor Luiz Saldanha, involving sampling of plants and analysis of associated benthic macroinvertebrates made it possible to realize the meadows' extension and faunal wealth at that time (M.J. Gaudêncio e M. Guerra, personnel communication).

Figure 6. Field work for seagrass distribution area assessment.

In some of these places it was still possible to find evidence of meadows (remnants of roots and rhizomes and different sediment type from that around) leading to the conclusion that these meadows have either temporarily ceased to exist or permanently. The results obtained during this action, which point to a rapid decrease of seagrass meadows area in the estuaries of river Sado and river Mira, turned the collection effort to Ria Formosa and it was decided that plants collected from other populations would be used only for the purpose of preserving the heterogeneity of genetic diversity of the transplanted populations.

Action A.4 is a task coordinated and executed by the INRB - IPIMAR.

The goal is to acquire a map of the seafloor of the marine park and surrounding area up to 100 metres depth. The map will represent the main characteristics of the seafloor such as slope, type of superficial sediments and benthic macroinvertebrates populations that inhabit them (Figure 7).

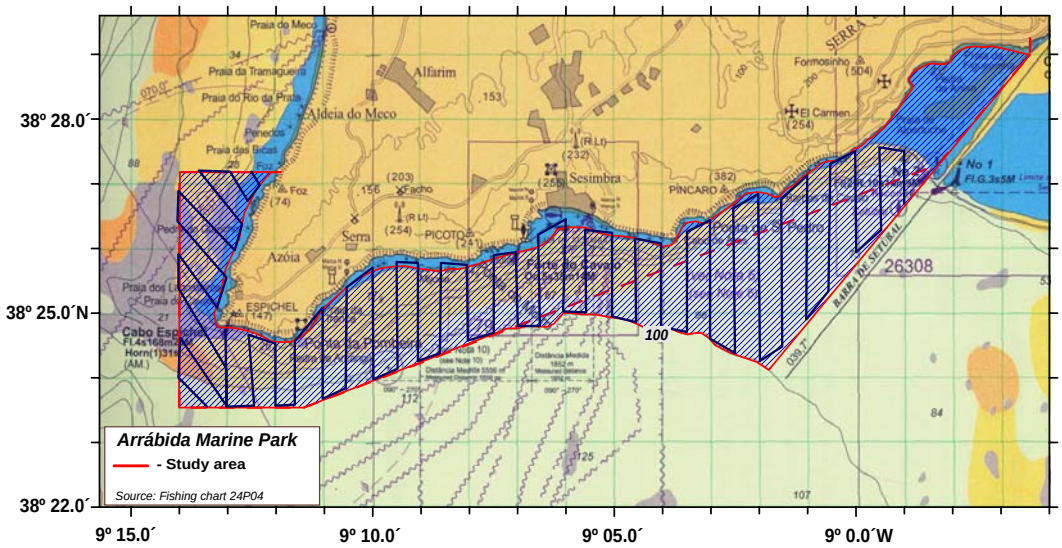

Figure 7. Map showing the area of the marine park area that will be surveyed during the project period.

This information will allow managers, fisheries researchers and fishermen to have a better view of the area and eventually find alternative places to fish. During 2007, the equipment was tested, data were compiled and two sea campaigns were carried out. From these campaigns resulted a three dimensions map from Alpertuche to Sesimbra (Figure 8). The mapped area shows a narrow platform along the coast of the marine park revealing gentle seafloor slopes up to 25 metres depth, dropping rapidly to depths of 50 to 70 metres. The first analysis of collected sediments reveal these to be clean sands, thin to gross in shallower areas (10/20m), with an increase of thin sand as depth increases, to a point where, at 50m, the main sediment type is sandy mud. Numerous animals were found which are typical of these sediments, such as lancelets, polychaetes, annelids, ophiurid echinoderms, bivalve molluscs and small crustaceans.

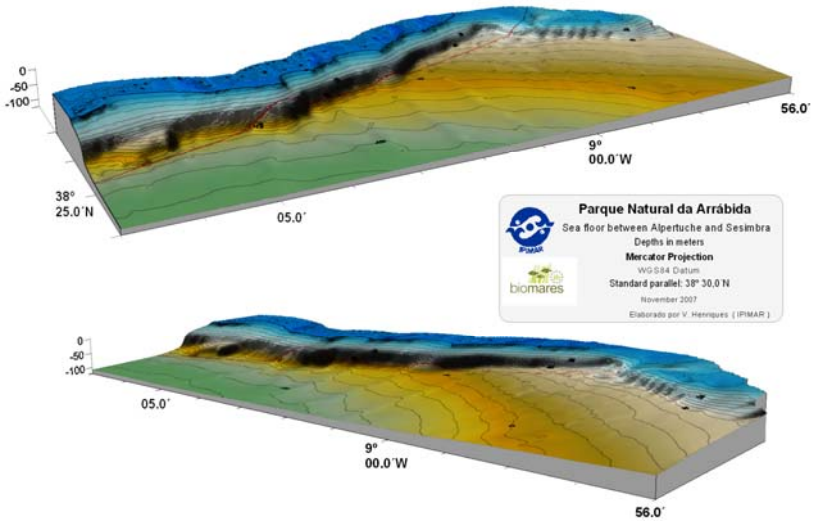

Figure 8. An example of the generated three dimensional map of the Marine Park seafloor.

The goal of action A.5 is to conciliate nautical recreational activities with conservation of marine biodiversity and consists of the installation of special moorings for recreational boats in the marine park area. A floating dock is also planned for Portinho da Arrábida to allow better access for park users.

During 2007, meetings were held with relevant local groups, such as naval clubs, diving companies and other associations to define what are the needs for use and location of mooring buoys. Thirty environmental friendly buoys were placed to test the structures and locations. Surface mooring buoys were connected to mid water buoys with a system of cables and turnbuckles to avoid dragging cables over the seafloor. Moreover, tones of cables were removed from the seafloor in Portinho which were dragging over the seafloor for many years.

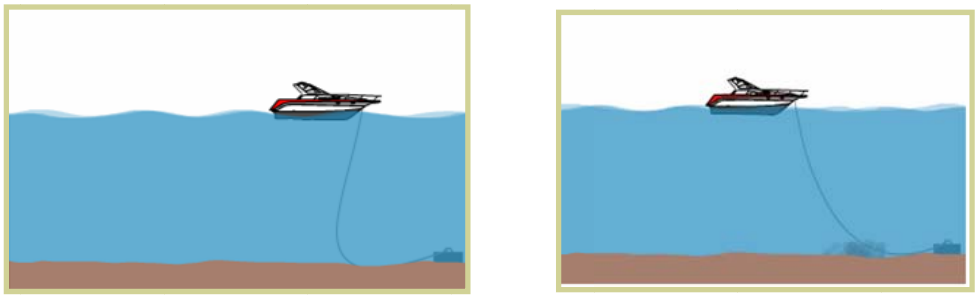

Figure 9. Images showing the cable dragging effects on the sea bottom.

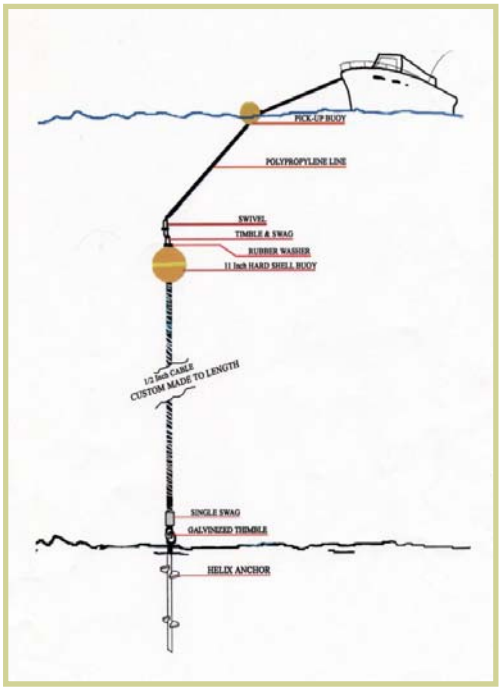

Figure 10. Environmental friendly mooring set up drawing.

Action A.6 was concluded in 2007, and consisted of adapting the Oceanographic Museum to base the Biomares project operational base.

During 2007, sanitary infrastructures were restored; a small laboratory was built to support scientific research as well as a room for diving support and repairs. Besides adapting the diving air compressor and acquiring laboratory equipment, tables, chairs and projection equipment were also obtained in order to receive visitors and organize seminars at the Museum.

Figure 11. Oceanographic museum at the project site.

Actions C. are related with fieldwork actions, such as, for example, the recovery of the seagrass meadows from Portinho da Arrábida. Without doubt, this is one of the most daring actions of the project and it is a great challenge from both a scientific and a logistic point of view.

The objective of this task is to contribute for the reestablishment of seagrass meadows that existed in Portinho da Arrábida not long ago. This task is necessary because this habitat has been destroyed through human action, it is very important from the point of view of fish production, water quality and retaining sand. The intention is to give a chance to this habitat to regenerate through disseminating seeds and planting seagrasses (*Zostera marina*, *Zostera noltii* e *Cymodocea nodosa*), something that would hardly happen without this intervention. During the first year of the project three fieldwork campaigns were conducted to accomplish this task. The first campaign occurred in April, with the presence of the project's consultant, Dr, Mark Fonseca from NOAA, a renowned scientist in the field of recovery of seagrass meadows. During this first campaign, several methods and materials were tested. The second campaign occurred between June and July and its objective was to collect and propagate seeds. For this purpose, weekly trips to Ria Formosa were organized to collect seagrass flowers with seeds in maturation stage which were then transported to Portinho da Arrábida. Flowers were collected by means of scuba diving or simply on foot during low tide. The flowers with maturing seeds were kept in mesh bags in midwater until seeds fell down and spread in the area. In total, 60

bags of flowers were placed with about 1000 flowers each in 24 places in Portinho da Arrábida.

Figure 12. Seed bags set up in the restoration area, *Zostera marina* flower stalk and a *Zostera marina* seed.

The actual transplanting campaign began by the end of August and continued through November. During this period weekly trips were organized to Ria Formosa and plants were collected to set up 375 plantation units. Plants were collected by means of scuba diving and then transported inside isothermal boxes. In Portinho, the plants were taken to a raft built for the purpose and were then tied to iron frames and placed on the seafloor. These plantation units were distributed in 10 plots of seafloor identified with buoys showing the Biomares logo.

Figure 13. Collecting seagrasses in Ria Formosa.

To complement this action, task C.2 consists of studying the germination of seagrass seeds in a controlled environment in order to provide plantlets, grown from seeds, for the recovery of the seagrass ecosystem. This process is not yet fully developed from the technological point of view, but in case it proves to be successful it will imply advantages from the perspective of protecting donor populations and increasing genetic diversity of the regenerated population. During 2007, numerous germination experiments have been carried out in controlled environment (for example, effects of salinity and origin of seeds) with *Zostera noltii* and *Zostera marina* seeds collected in Ria Formosa. Germination experiments have also been conducted in open air in the culturing system of the Biomares project, set at the biologic workstation of the University of Algarve in Ramalhete, Faro. This culturing system, where plants are kept alive for experiments, was built on purpose for this task and consists of an open air structure with ten 540 litres capacity tanks and a semi-closed seawater circulation system.

Figure 14. Transplanting seagrasses in Portinho da Arrábida. Divers carrying a planting unit (plants plus frame) and setting them up on the seafloor. Fish juveniles visiting the restoration site and a sod of *Zostera noltii* (photo bottom right) ready to grow.

Another group of actions are actions D. which are the project's monitoring tasks. These actions are meant to assess the existence of benefits from the project's activities, evaluate the work that has been accomplished and correct problems that arise during the project.

Monitoring tasks are carried out in every area of the marine park and include collection of fish larvae, visual census of flora and fauna by means of scuba diving, experimental fishing with traps and trammel nets, and sampling of seafloor sediment (granulometric composition and associated fauna).

Figure 15. Plant culturing system at Ramalhete, Faro.

The purpose of these activities is to assess the results of the regulations imposed by the marine park. This action is fundamental to obtain objective data for future managers decisions that will allow better management of the regulation of economic activities in the marine park area. During 2007, the locations for visual census were established, 4 stations in Portinho and 9 in the remaining areas of the park, and visual census were carried out in two different occasions (Spring and Autumn). Results reported 52 species, 17% of which

occurred in 80% of the sampled locations. The main species in terms of number were wrasses (10 species), sea-breams (9 species) and gobies, with 8 identified species. Regarding larvae collection task, several materials were tested to determine the best method to accomplish the project's goals. Also, during summer and autumn 2007, two experimental fishing campaigns were realized. In total, 893 and 1139 individuals were caught with traps and trammel nets, respectively. These were then identified and measured, belonging to 32 and 60 species, respectively. Observations indicate the existence of differences between zones; 51 species were recorded inside the total protection zone, 44 species in the partial protection area and only 27 species in the complementary protection zone (common fishing regulations). It should be pointed out that captured individuals were returned to the sea after identification and measuring. Regarding characterization of sediments, samples were collected from 52 locations between 1 and 15 metres depth. Results from analysis carried out in 2007 show clean sediments of various granulometries with predominance of gross sand. The most abundant faunal elements found in analysed samples to present date are bivalve molluscs and polychaeta annelids which represent more than 50% of the fauna that was found. It should be noticed that most of the species found are common in sediments within good ecological conditions.

Concerning monitoring of the plants transplanted to Portinho da Arrábida observations indicate a high mortality rate. Considering that these plants were planted by the end of summer and autumn and then monitored during winter time it would be normal to expect an important decrease in the number of plants alive. In general, during the first year of transplanting, plants undergo an

accentuated decrease of individuals and then recover the following year. Nonetheless, a few threats have been identified which can obstruct the recovery of seagrass meadows; presence of large quantities of a toxic red algae (*Asparagopsis armata*) and strong grazing pressure from herbivorous such as salema and sea-urchins. These threats are being assessed and tests are being carried out to control them.

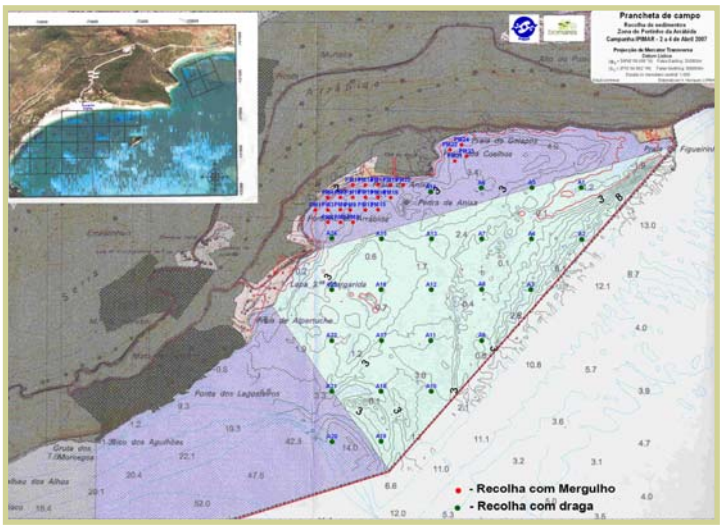

Figure 16. Map of sediment points sampled during the 2007 (Task A.4 campaign.

Figure 17. Divers monitoring seagrasses and a fish larval trap being set up at the sea (Actions D.2 and D.4).

Monitoring of water quality of the Marine Park was also included in this monitoring task to respond to the many questions posed concerning whether there is marine pollution or not. These analyses are bimonthly and started in October 2007. Besides common analysis of water quality, heavy metals are also analysed in mussels to assess whether there is industrial pollution in the Marine Park or not.

Most of the project's work is done using scuba diving. Because scuba diving is an activity that involves risks, the project's coordination has implemented a series of safety measures to minimize diving accidents. At the beginning of each campaign diving safety procedures are recalled in courses and exercises such as basic life support and diver rescue training. Before each dive, a task briefing is given which includes a review of safety procedures. The project has an emergency plan for each working place including steps to be followed in case of a diving accident.

Figure 18. Safety training sessions.

Another important group of tasks (Action E) is dedicated to disseminate information about the project to the public and to create awareness about the loss of biodiversity.

Some of the actions that are planned include activities with local associations and schools, placing information boards, distributing leaflets, creating a webpage and an itinerant exhibition. A permanent exhibition about conservation of biodiversity at the Oceanographic museum, Portinho da Arrábida is also being prepared.

Figure 19. Biomares moving exhibit in the Oceanographic museum.

During 2007, the project's webpage and the general leaflet have been created both in Portuguese and English. The public presentation of the project took place in mid 2007. Information boards have been placed in several locations, pins with the project's logo have been distributed and press and technical notes have been prepared to divulge the project within information channels. From these resulted about 28 articles in newspapers and magazines, 24 references to the project in internet pages and three news in public television. The Biomares project has been presented in several talks and seminars, on a regional, national and international level. In the end of 2007, the project's itinerant exhibition was launched and started its tour at the headquarters of the Portuguese Centre of Underwater Activities.

The project involves approximately 35 people including technicians hired specifically for the tasks, actions coordinator´s, project collaborators, consultants, fishermen, nature guards, students and volunteers.

More information

Project BIOMARES: Centro de Ciências do Mar do Algarve, Universidade do Algarve - Gambelas, 8005-139 Faro, Portugal. Telephone 351 289 800 051.
Email address: acunha@ualg.pt; Website: www.ccmar.ualg.pt/biomares

Parque Marinho Luiz Saldanha – Parque Natural da Arrábida, Praça da República, 2900-578 Setúbal, Portugal. Telephone 351 265 541 140 / 212 189 791
Email address: henriquesm@icnb.pt; Website: www.icnb.pt