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DISTRIBUTION AND ECOLOGICAL CONDITIONS OF *POSIDONIA OCEANICA* (L.) DELILE MEADOWS IN LA MADDALENA NATIONAL PARK (SARDINIA)

Abstract

The La Maddalena Archipelago became National Park in 1996 and together with the southern part of Corsica it forms the Bocche di Bonifacio International Park. Posidonia oceanica *beds widely distributed in the area play an important role in dividing La Maddalena National Park (MNP) into zones with different level of protection in order to manage and coordinate the human activities inside the park. The regression of* P. oceanica *meadows has become generalised around much of theArchipelago coastline.The most common anthropogenic factors in the decline of P. oceanica habitats in near-shore coastal areas are eutrophication and boat anchoring.*

Key-words: Posidonia oceanica*, distribution, La Maddalena National Park, Tyrrhenian Sea.*

Introduction

La Maddalena Archipelago is located in the North-East coast of Sardinia, and consists of seven large islands, with a surface area larger than 100 ha and a high numbers of smaller islets. The surface area of the entire archipelago is about 51 km^2 with 200 km of jagged coast. The seabeds are characterized by wide erosion platforms with a granitic-metamorphic lithology derived from a Paleozoic substratum.

La Maddalena Archipelago became National Park in 1996 and, together with the southern part of Corsica, forms the Bocche di Bonifacio International Park, which represents the first international marine reserve in Europe.

La Maddalena National Park is divided into zones with different levels of protection. Each of these zones has different restrictions related to the exploitation and human use of the marine environment. MA zone is a marine area of high natural interest where the access to tourists is strictly regulated, while the MB is a marine area of high natural interest where the access to tourists is permitted. Finally, a no-take area is present where only scientific research is permitted.

The *Posidonia oceanica* bed is the main biocoenosis of the coastal area, creating an almost continuous belt around the 60 islands of the Archipelago and with the presence also of "rècif-barrières" in shallow waters (Cossu and Gazale, 1997).

The distribution and the structure of the *Posidonia oceanica* beds along the Island have played an important role in dividing La Maddalena National Park into zones.

Materials and methods

From the biocenotic map of the area obtained from previous investigations (Cossu and Gazale, 1997), 82 sampling sites were chosen. In the sampling sites

estimates of *P. oceanica* shoot density was measured in 1600 cm^2 quadrate areas (5 replicates in each site). In each site, 5 orthotropic shoots of *P. oceanica* were collected for the analysis of plant phenology (Giraud, 1977). The shoots were collected 50-100 m apart from each other, and the geographic coordinates were registered with a GPS.

Results

The survey of the area revelaed that *P. oceanica* meadows settle on sandy and rocky substrata down to 38 meters depth and are distributed around the coastal area of the 60 islands of the Archipelago, for a total area of 40 km^2 (Table 1).

Tab. 1 - Distribution of the *P. oceanica* meadows (hectares) in different area of La Maddalena National Park.

meadows (h)	Maddalena, Caprera, S. Stefano	Razzoli, S. Maria, Budelli, Barrettini	Spargi	Bisce	Nibani	Mortorio	Tot.
Rocky beds	42	513	202				757
Sandy beds	1646	433	271	345	99	408	3201
Semi-praires	29	21					50
With *C. proliera*	31						31
Total	1748	967	473	345	99	408	4040

The area of *P. oceanica* in state of degradation is about 50 ha and it is located south of La Maddalena Island near the harbour, near the town and Passo Ceca di Morto, and between Santa Maria and Budelli Islands (Table 1). According to Giraud (1977) the results show that 23.1% are dense meadows (class II), 28.2% are sparse meadows (Class III), considered in a transition state, 38.5% are very sparse meadows (Class IV) which usually refers to meadows that are in regression or in the process of colonizing the environment. And the last 10.2% are semi-prairies (Class V), meadows most prone to regression (Giani, 2001).

This classification, however, it is not correlated to depth, therefore another classification was used (Pergent *et al.,* 1995), where shoot density is related to depth. Fig. 1 shows how shoots density changes with depth in each site, and how the meadows are healthier in the deeper stands; in fact 33% of the meadows that are very disturbed (abnormal density, AD) are mostly located between 1 and 10 meters depth, 20% are disturbed (low density, LD) and 47% are meadows in equilibrium (normal density, ND). The shallow waters are highly frequented by boaters. Several studies have assessed the impact of anchoring on *P. oceanica*, demostrating that there may be a direct adverse effect on meadow cover and shoot density (Porcher, 1984; Francour *et al.,* 1999). Major damage to *P. oceanica* seems to be caused by dragging anchors and scraping anchor chains along the bottom with consequent removal of plants and even pieces of "matte" (Milazzo *et al.*,

2004). In the sampling sites, the anchor impact was highlighted by the presence of chain drills and sandy patches within the *P. oceanica* meadows.

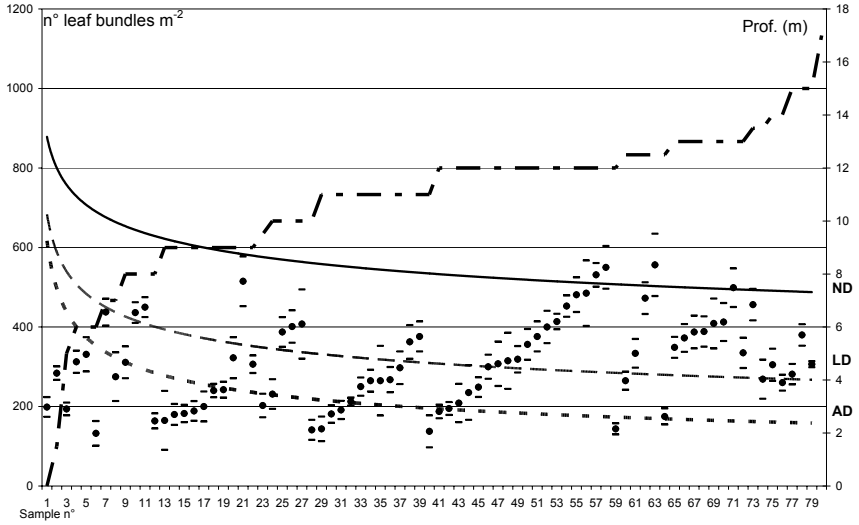

Fig. 1 - Mean shoot densities (•) with their s.d. (=) in relation to depth (— -). AD (- - -) = very disturbed meadows; abnormal density. LD (- - -) = disturbed meadows; low density. ND (–) = meadows in equilibrium; normal density.

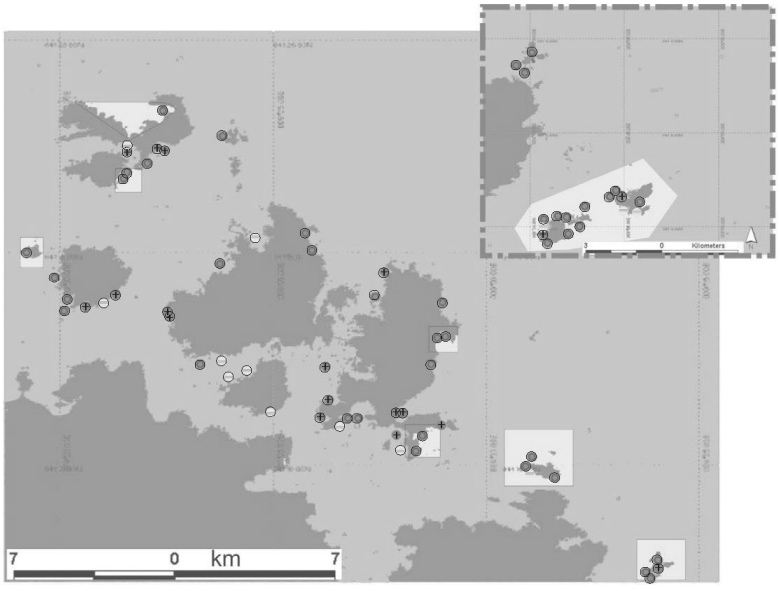

Fig. 2 - Location of the sampling site. (+) = very disturbed meadows; (=) = disturbed meadows; (O) = meadows in equilibrium; clear areas = no-take zones. On the up right there is Mortorio and Mortoriotto Islands, located in the south part of the park.

Fig. 2 represents the overview of the park area and of the *P. oceanica* meadows. The most important meadows in equilibrium, where a high shoot density was found, are inside the no-take zones. There are same exceptions, such as the area in front of the pink beach off Budelli Island. Six years ago this beach became an integral reserve to protect the pink sand (derived from the foraminifer associated to Posidonia, *Miniacina miniacea*). Recent studies (Ragazzola *et al*., 2005) show how the *P. oceanica* meadow is still in a regression state, and the shoot density data show lower values compared to the calculation made during a previous study in 1999-2000 (Giani, 2001). The small islands of Soffi, Mortorio and Mortoriotto, located in the southern part of the park, have some *Posidonia* meadows in a degraded state. As recorded in front of the pink beach, signs of chain drill in the seabed and sandy patches were discovered, despite the fact that the Ente Parco created a buoy camp.

Conclusion

The major cause of the *P. oceanica* regression in La Maddalena National Park comes from dragging anchors and scraping anchor chains of recreational boats. The shallow water area near the town of La Maddalena shows a *Posidonietum* affected by the urban activities (eutrophication) and the ferries transit. In order to contain the damage in protected areas, some different strategies can be proposed: the identification of sandy areas where the boat anchoring can be permitted, the creation of new buoy camps in the area of high boat frequency, and the implementation of a self regulatory approach based on educating and informing boaters on the respect of *Posidonia* meadows and on the correct anchor type to use.

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