

# CONSERVATION AND RESTORATION OF CYSTOSEIRA FORESTS IN THE MEDITERRANEAN SEA: THE ROLE OF MARINE PROTECTED AREAS

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## Abstract

In the Mediterranean Sea *Cystoseira* forests are locally threatened due to several impacts. The low dispersal capacity of most *Cystoseira* species makes the natural recovery unlikely. The restoration of *Cystoseira* forests can represent a valuable solution and is recommended where the historical presence is recorded and the impacts that led to its loss are no longer acting (a reasoned forestation could be considered also where historical data are not available). MPAs may play a paramount role in the conservation of *Cystoseira* forests, guaranteeing protection from several impacts and representing the source of propagules for the restoration of lost or degraded forests outside their borders. MPAs where *Cystoseira* forests are lacking due to past impacts should be considered as priority experimental sites for artificial forestation.

*Keywords: Marine parks, Phytobenthos, Conservation, Restoration, North-Western Mediterranean*

Large brown seaweeds play the role of engineer species in shallow waters of temperate and cold waters. In the Mediterranean Sea, marine forests are mainly originated by Fucales of the genus *Cystoseira* that play an important functional role in sustaining complex food webs and maintaining a high biodiversity. As many other large brown seaweeds worldwide, *Cystoseira* forests are regressing due to several impacts, among which a decrease in water quality, coastline overbuilding and the proliferation of herbivores, sometimes an indirect effect of overfishing [1, 2]. Six Mediterranean species of *Cystoseira* are listed in the Annex I of the Bern Convention, and the Mediterranean Action Plan, adopted within the framework of the Barcelona Convention, identifies the conservation of all but one *Cystoseira* species as a priority.

The low dispersal capacity of most *Cystoseira* species makes the natural recovery unlikely, so that artificial reforestation can represent an extremely valuable solution for lost forests [3, 4]. Large brown seaweeds restoration has been already explored worldwide but only few studies have been carried out in the Mediterranean Sea on *Cystoseira* species (*C. amentacea* var. *stricta*, *C. barbata*, *C. compressa*). These experiments gave encouraging results, thanks to the highly-efficient reproductive strategy characteristic of the Fucales order. Negative effects of grazing have been observed in several cases, suggesting that, at least in a first phase of artificial reforestation, grazers should be controlled.

The restoration of *Cystoseira* forests is particularly recommended where the historical presence is recorded and the impacts that led to its loss are no longer acting in the area. Nevertheless, forestation could be considered also at sites where the previous distribution cannot be documented, but seems likely based on the local and regional environmental characteristics. Also existing man-made structures may be considered for forestation, whenever the biotic and abiotic environmental factors are compatible, as this would enhance the ecological value of these artificial substrata without compromising their engineering function.

Although pristine *Cystoseira* forests can be found in MPAs, this is not a general rule: several MPAs lack *Cystoseira* forests, while healthy dense forests can still be found in non-protected, but naturally isolated and lowly impacted sites [5]. MPAs can play a paramount role for the conservation of these forests, as they guarantee protection from various human impacts (e.g. overfishing, urbanization) and can reduce others through an integrated management with adjacent areas. Healthy forests in MPAs may represent also an important source of propagules for restoration of lost or degraded forests outside their borders. MPAs lacking *Cystoseira* forests may offer priority experimental sites to identify the factors facilitating the conservation and restoration of damaged forests.

The protection of existing forests should be coupled to regular monitoring programs in order to promptly highlight potential threats and early signs of regression. An ecosystem-based management applied to a network of MPAs with long-term monitoring programs and restoration actions, where necessary, is probably the best perspective for *Cystoseira* forests preservation in the Mediterranean Sea.

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Mediterranean marine forests formed by *Cystoseira* species

## Cystoseira forests loss have been recorded in several areas

Cormaci & Furnari 1999  
Mangialajo et al., 2008  
Perkol-Finkel & Airoidi, 2010  
Serio et al. 2006  
Thibaut et al. 2005  
Vukovic 1982



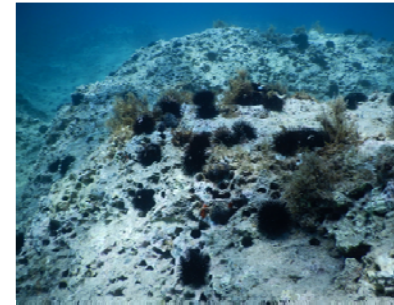
## Major causes of loss

### Coastline urbanization

(Habitat destruction, decreased water quality; increased sedimentation; barrier for connectivity)

### Unregulated / illegal fishery

(i.e. overfishing of sparids; date-mussel harvesting)  
Direct and indirect effects  
(destruction; proliferation of herbivores)



High reproductive potential but **low dispersal ability:**

### NATURAL RECOVERY UNLIKELY

especially when forests are degraded/lost on wide areas

## ECOLOGICAL RESTORATION

First experiments encouraging

(Falace et al., 2006; Susini et al., 2007; Perkol-Finkel and Airoidi 2010; Perkol Finkel et al., 2012)



## Many forests remain unprotected

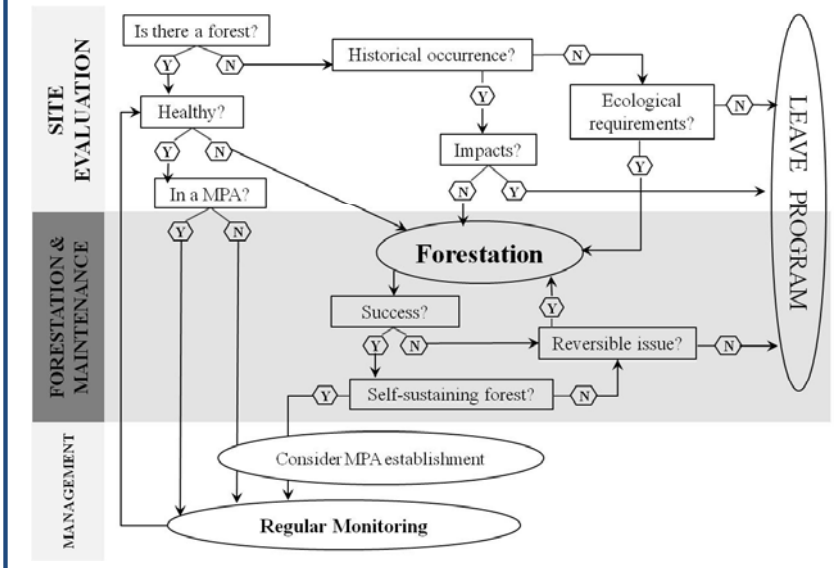
### Which role can play MPAs in the conservation of *Cystoseira* forests?

Better protection from (some) impacts

source of propagules

preferential sites for reforestation

## Flow-chart for the conservation (and reasoned restoration) of *Cystoseira* forests



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### MINI-REVIEW

Conservation and restoration of marine forests in the Mediterranean Sea and the potential role of marine protected areas

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Conservation and recovery of marine forests are possible, raising awareness of the importance of *Cystoseira* species, reducing impacts and, whenever necessary, adopting restoration actions