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ABANDONED FISHING GEARS IMPACT ON CORALLIGENOUS REEFS OF CAPO CARBONARA MARINE PROTECTED AREA

IMPATTO DEGLI ATTREZZI DA PESCA ABBANDONATI SUI REEF CORALLIGENI DELL'AREA MARINA PROTETTA CAPO CARBONARA

Abstract *- Fishing gears can cause several damages on coralligenous reefs not only during fishing activities, but also when they are lost on the seafloor. The removal of abandoned fishing gears (AFG) is debated: this may cause further damage on marine habitats. With the aim of assessing the impact of AFG removal on coralligenous in the Capo Carbonara Marine Protected Area (MPA), five sites were monitored considering impact stations and control stations. The BACI (Before-After/Control-Impact) sampling design was used to compare the ecological status of coralligenous before and after the AFG removal by applying the COARSE index (Coralligenous Assessment by Reef Scape Estimate). A reduction of ecological status was observed only in the impact stations of two sites. Gorgonians, bryozoans and erect algae were the most affected species by the action of AFG, the removal of which is recommended when it is done in a way that does not create further damages.*

Key-words*: fishing activities, coralligenous, ecological status, BACI approach, Tyrrhenian Sea.*

Introduction – One of the most serious treats to coralligenous reefs are fishing gears, such as trawling nets and longlines, which can cause several damages both during fishing activities, but also when they are lost on the sea bottom and abandoned (Enrichetti *et al*., 2021). Coralligenous species may become entangled in nets, be smothered or mechanically damaged. Specifically, encrusting species of the basal layer suffer due to the nets covering them, and increased turbidity and sediment accumulation (Clark & Koslow, 2007), while erect species of the intermediate and upper layers may be broken, overturned, or abraded reaching out to tissue necrosis and subsequent epibionts overgrown (Ferrigno *et al.,* 2021). Further damage may also occur during the removal of Abandoned Fishing Gears (AFG), especially if it is done long time after the abandonment on the bottom: all the species grown on AFG are obviously removed with them. Little is known about the recovery capacity of coralligenous in response to the impact from fishing gears (Ferrigno *et al.,* 2021). However, the slow growth rates of the most abundant and structuring coralligenous species suggest a reduced ability of this habitat to recover after extensive mechanical damage (Piazzi *et al.*, 2012). Important information on the impact of the AFG removal and on the recovery capacity of coralligenous can be obtained by monitoring this habitat over time after the removal of them. In this work, the ecological status of Capo Carbonara Marine Protected Area (MPA) coralligenous reefs affected by AFG was compared through time to nearby unaffected assemblages.

Materials and methods – To assess the impact of AFG removal on coralligenous reefs in the Capo Carbonara MPA, five sites were surveyed. At each of the five sites, two condition were considered: an impact station with AFG and a control station without, located at a distance of about 5 m from each other. All the five sites were firstly surveyed before the removal of AFG in July 2022 (i.e., the before period), and then resurveyed after the removal of AFG in September 2022 (i.e., the after period). At each station, three replicated visual surveys were carried out, at depths between 30-40 m, for a total of 30 replicates of approximately 2 m^2 each. Data were collected following the STAR protocol (STAndaRdized coralligenous evaluation procedure; Piazzi et al., 2019) and by applying the COARSE index (Coralligenous Assessment by Reef Scape Estimate; Gatti et al. 2015) for the assessment of coralligenous ecological status. The BACI (Before-After/Control-Impact) sampling design was used to compare the ecological status before and after the AFG removal in both control and impact stations.

Results – Application of the COARSE index revealed an overall good ecological status of the Capo Carbonara coralligenous reefs in almost all the sites and stations (impact and control) investigated (Tab. 1). Punta la Guardia was the only site where a moderate ecological status was recorded in all the stations (both impact and control) and in both periods (before and after). After the removal of AFG, a reduction of the ecological status of coralligenous, from good to moderate, was observed only in the impact stations of the two sites Punta Karalis and Santa Caterina (Tab. 1).
Despite the general good ecological status observed in the coralligenous habitat, different results were obtained when analysing the three coralligenous layers separately. The basal layer, in the before period, showed a high ecological status in two out of the ten stations monitored, a good ecological status in seven stations and a moderate status in one station. In this layer, no reduction of the ecological status was observed after the removal of AFG (Tab. 1). The intermediate layer, in the before period, exhibited a high ecological status in three out of the ten stations investigated, in four other stations it showed a good ecological status, and in three stations a moderate ecological status. After the removal of AFG a reduction from a high/good ecological status to a moderate was observed in three impact stations. On the contrary, no changes were observed in the control stations (Tab. 1). Finally, the upper layer, in the before period, showed a high ecological status in two out of the ten stations monitored, in six other stations it showed a good ecological status, and in two other stations a moderate ecological status. After the removal of AFG, a reduction in the ecological status from high to good and from good to moderate was observed in the impact stations of two sites (Tab. 1).

Conclusions – One of the purpose of the Italian EAMPA (Environmental Accounting in Marine Protected Areas) project (started in 2014) is to investigate the different anthropogenic pressures impacting the coralligenous habitat. A protocol was developed to assess damages on natural capital of this habitat caused by fishing activities. Since little is known about the recovery capacity of coralligenous species in response to impact from fishing gears (Ferrigno *et al*., 2021) main phases of the protocol are devoted to acquire information about this topic. Important knowledge on the resilience of coralligenous to this pressure can be obtained by conducting monitoring over time after the removal of AFG.

With the aim of assessing the impact of AFG removal on the coralligenous of the Capo Carbonara MPA, an approach based on the comparison of its ecological status before and after the removal was adopted. The application of the COARSE index showed an overall good ecological status of the coralligenous habitat in the before period, with the only exception of reefs at Punta la Guardia, where coralligenous had a moderate ecological status. A reduction from good to moderate ecological status was observed for two out of the five sites after the removal of AFG. This could be due to organisms that quickly overgrow on AFG (e.g., encrusting and erect bryozoans, encrusting corallines, erect algae, *Peyssonnelia* spp.) that increase the specific richness in a given habitat, as it happens with artificial substrates (Ostalé-Valriberas *et al*., 2018), but that are inevitably removed together with the AFG. Of course, this does not mean that AFG increases the biodiversity of a given area: while AFG provides artificial substrates for species that may cover them, they obviously smother and lead to death of many organisms that are covered or entangled.
Prior to the removal of the AFG, the basal layer of coralligenous at Capo Carbonara showed a good ecological status almost in all the sites monitored, and in both control and impact stations. The species inhabiting this layer (mainly encrusting species, such as algae, bryozoans, and sponges) are less sensitive to mechanical damages than the erect species of the intermediate and the upper layers. No changes in the ecological status were, in fact, observed in this layer after the AFG removal.

Tab. 1 - Scores of the COARSE index used to define the overall ecological status of corallingenous (and its three layers) in the five sites monitored at Capo Carbonara MPA. Colours represent the different levels of ecological status: blue=high, green=good, yellow=moderate.
Valori dell'indice COARSE utilizzato per definire lo stato ecologico del coralligeno (e dei tre strati di cui è composto) nei cinque siti monitorati nell'AMP Capo Carbonara. I colori rappresentano il diverso livello di stato ecologico: blu=alto, verde=buono, giallo=moderato.

SITES	CONTROL		IMPACT	
	Before	After	Before	After
CB	2.28	2.28	2.22	1.97
PK	2.33	2.24	2.23	**1.50**
PG	1.71	1.61	1.72	1.55
SC	2.17	2.14	2.12	**1.79**
SM	1.90	1.86	2.09	2.09

Capo Boi	CONTROL		IMPACT	
	Before	After	Before	After
Basal	1.82	1.82	2.61	2.49
Intermediate	2.62	2.62	1.59	1.59
Upper	2.41	2.41	2.47	**1.82**

Punta Karalis	CONTROL		IMPACT	
	Before	After	Before	After
Basal	2.59	2.60	2.07	1.98
Intermediate	2.11	1.82	2.62	**1.26**
Upper	2.29	2.29	2.00	**1.26**

Punta la Guardia	CONTROL		IMPACT	
	Before	After	Before	After
Basal	1.86	1.86	1.77	1.68
Intermediate	1.67	1.39	1.82	**1.39**
Upper	1.59	1.59	1.59	1.71

Santa Caterina	CONTROL		IMPACT	
	Before	After	Before	After
Basal	1.80	1.80	1.86	1.80
Intermediate	2.62	2.62	2.20	**1.57**
Upper	2.08	2.08	2.29	2.00

Secca di Mezzo	CONTROL		IMPACT	
	Before	After	Before	After
Basal	1.82	1.83	1.88	1.88
Intermediate	1.59	1.59	2.11	2.11
Upper	2.29	2.15	2.29	2.29

In the before period, the intermediate layer showed the most heterogeneity of the ecological status among the five sites. Moreover, the greatest changes after the removal of AFG were observed in this layer. A reduction in the ecological status from high/good to moderate was observed for four out of the five impact stations. This is also confirmed by the fact that, in the retrieved AFG, the most abundant entangled species were bryozoans, filamentous algae and *Osmundaria pelagosae* (Schiffner) K.W.Nam, which characterise the intermediate layer of the coralligenous habitat.
For what concerns the upper layer a high and good ecological status of the coralligenous reefs was observed, apart for Punta la Guardia where it was moderate. After the removal of AFG, a reduction to a moderate ecological status in the impact stations was observed in the sites Capo Boi and Punta Karalis, probably due to the loss of *Eunicella cavolini* (Koch, 1887) and *Eunicella singularis* (Esper, 1791) found entangled in the retrieved AFG. Because of their three-dimensional shape, the gorgonians characterising the upper layer of coralligenous are among the most sensitive organisms to the impact of AFG, which makes them easily entangled (Giusti *et al.,* 2019).
The removal of AFG is nowadays still controversial. Although some changes were observed in the ecological status of the coralligenous of Capo Carbonara MPA after the AFG removal. These were mainly due to fast-growing species that probably colonized the AFG after they were abandoned. In addition to its natural value, coralligenous habitat also has an aesthetic and economic value, as it represents an attractive for divers. The maintenance of the seascape integrity, which also includes the cleaning of AFG, must be widely considered in the conservation activities of any MPA. However, the removal of AFG should be recommended only after careful evaluation and, where appropriate, carried out by qualified operators and in a manner that does not create further damage to sessile communities.

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