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IMPACT OF DREDGING ON MACROBENTHIC ASSEMBLAGES IN A NORTHERN ADRIATIC COASTAL LAGOON

IMPATTO DEL DRAGAGGIO SUI POPOLAMENTI MACROBENTONICI IN UNA LAGUNA COSTIERA NORD ADRIATICA

Abstract - *The effects of channel dredging on the invertebrate assemblages were investigated in the coastal lagoon Pialassa Baiona (northern Adriatic Sea). Despite the extent of the intervention, no clear effects on the assemblages and sediment properties were detected neither in the channels nor in the ponds. This could be due to the high spatial/temporal heterogeneity that can hide the direct/indirect effects of the dredging.*

Key-words: *benthos, lagoons, dredging, ecosystem disturbance, northern Adriatic Sea.*

Introduction - Coastal lagoons are ephemeral habitats, whose conservation requires direct human interventions. To prevent siltation and to maintain the hydrodynamics features of the lagoonal system, often the inner channels must be dredged. Dredging activities have three principal effects on benthic assemblages: i) reduction of species and abundances due to the removal of individuals with the sediment, ii) alteration of the sediment properties, iii) resuspension of fine sediment and the associated nutrients, organic matter and pollutants, which can lead to eutrophication, hypoxic events and increasing toxicity even in the adjacent areas (Quigley and Hall, 1999 and references therein). The aims of the present study is to asses the effects of channel dredging performed in the period October 2004 - August 2005 on the invertebrate macrobenthic assemblages in both channels and ponds in a northern Adriatic coastal lagoon (Guerra *et al.*, 2007).

Materials and methods - This study was carried out in the coastal lagoon Pialassa Baiona, a northern Adriatic eutrophic intertidal lagoon (Ponti *et al.*, 2005). Artificial embankments divide the lagoon into several semi-enclosed shallow water ponds interconnected by channels. The lagoon is affected by chemical and thermal pollution coming from urban and industrial treatment plants and two thermo-electric power plants located along the southern edge. Sediments are contaminated by heavy metals, mainly mercury (Trombini *et al.*, 2003), and polycyclic aromatic hydrocarbon (Fabbri *et al.*, 2003). The sampling design was selected according to a before-after control-impact (BACI; Underwood, 1994) approach (Fig. 1). Three impacted sites were located in the dredged channel (labelled BAC 1, BAC 3 and BAC 5) and three in the adjacent ponds (POL 1, POL 3 and VEN 5); three non-impacted sites were located in a channel (TBF 1, TBF 3 and TBF 4) and in a pond (RIS 1, RIS 2, RIS 3) not influenced by dredging operations. Three replicated samples of the benthic assemblages were collected with a Wildco® box corer at each site before (September, 2004) and after (September, 2005) the dredging operations. Differences in species abundances and species diversity indices were analysed by ANOVA, while assemblage multivariate pattern were tested by PERMANOVA after square root transformation and using Bray-Cutis similarity, in accordance to the experimental design: Impact (Im, 2 levels I/C fixed), Time (Ti, 2 level B/A fixed), Habitat (Ha, 2 levels Ch/Po fixed), and Site (Si, 3 levels, nested in ImXHa).

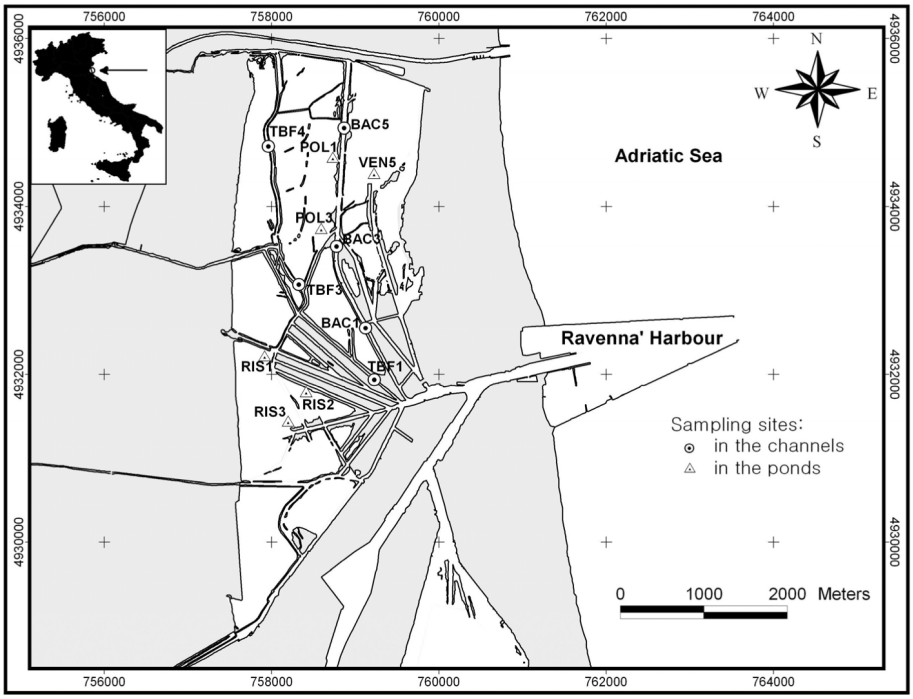

Fig. 1 - Map of Pialassa Baiona lagoon, showing sampling sites located in channels (circles), and ponds (triangles) (geographic grid UTM 32T, ED50).

Mappa della laguna Pialassa Baiona in cui sono riportati i siti di campionamento nei canali (cerchi) e nei chiari (triangoli) (reticolo geografico UTM 32T, RD50).

Results - A total of 96 taxa of macrobenthic invertebrates were recorded. Overall, the most abundant taxa were the polychaetes *Streblospio shrubsolii* and *Capitella capitata*, the larvae of the midge *Chironomus salinarius*, the amphipod *Corophium insidiosum*, the oligochaetes Tubificidae and the gastropod *Hydrobia ventrosa*. Invertebrate assemblage multivariate patterns showed high variability both in space and time (TiXSi(ImXHa) $p<0.001$). Although this high heterogeneity, assemblages clearly differed among habitats (channel and pond). Some temporal trends could be also recognized both in impacted and control channels and ponds (Fig. 2). However, no significant difference undoubtedly related to the dredging operations was found (ImXTiXHa and ImXTi $p>0.05$).

The most abundant taxa showed high heterogeneity in space and time (TiXSi(ImXHa) $p<0.01$) but even if some general trends could be recognised, no significant difference definitely related to the dredging operations was found (ImXTiXHa and ImXTi $p>0.05$). In particular *Capitella capitata* was initially significantly more abundant in the ponds but after the dredging its density was reduced reaching values similar to those found in the channels, both close and far from the dredging area. In contrast the abundance of *Corophium insidiosum* increased after the dredging in several sites located in the ponds, both close and far from the dredged channel. On average abundance of *Hydrobia ventrosa*, which is practically absent in the channels, decreased in the control pond, while abundance of *Streblospio shrubsolii* increased in the impacted channel and decreased in the control one after the dredging. However,

these differences were not statistically significant. Similar results were obtained for the species diversity indices, as well as for some sediment features such as the organic carbon content (loss on ignition) and mud (grain size <63 μm).

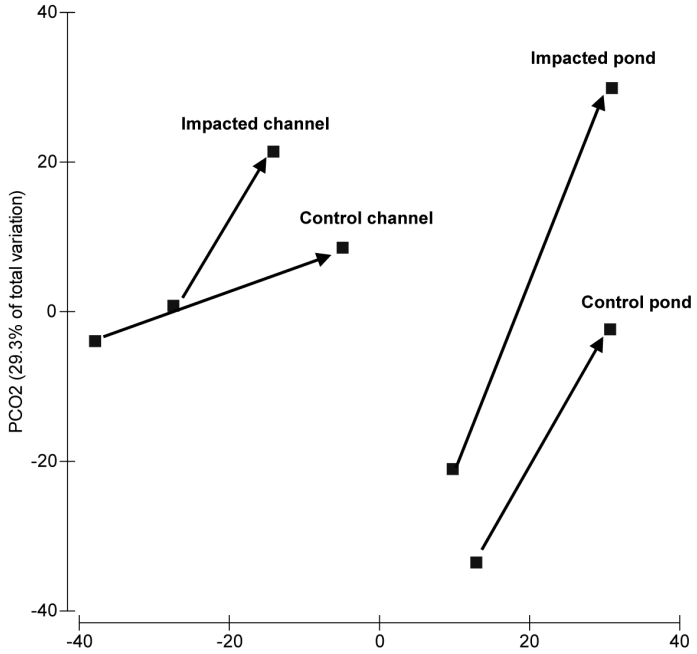

Fig. 2 - Principal coordinate analysis (PCO) showing different temporal paths (before and after) in impacted and control channels and ponds. Each point represented the centroid of the observed similarities.

Analisi delle coordinate principali (PCO) riportante i differenti percorsi temporali (prima e dopo) nei canali e nei chiari di impatto e controllo. Ciascun punto rappresenta il centroide delle similarità osservate.

Conclusions - Invertebrate benthic community living in the study lagoon are affected by several disturbances, including summertime dystrophic events that have significant effects on the assemblages structure and dynamics (Ponti and Abbiati, 2004). Channels dredging operations could drastically reduce both species richness and biomass with direct effect also on the secondary production (Ponti *et al.*, 2007). The effects of the dredging operation could be extended to the surrounding areas for hundreds of meters (Quigley and Hall, 1999).

The dredging operations monitored in this study affected most of the main channel of the lagoon and lasted nearly one year. Despite the extent of the intervention, no clear effects on the benthic assemblages and in the sediment properties were detected neither in the channels nor in the ponds. This could be due to the high spatial heterogeneity and temporal variation that characterise the studied environment and can hide the effects directly and/or indirectly related to the dredging. Moreover, since the dredging operation lasted long time with frequent suspension, the physical disturbance could have affected the impacted sites in different times. In this case, the disturbance could be not considered a single and univocal event; therefore each site should be considered individually.

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