IMPACTS OF MAINTENANCE CHANNEL DREDGING IN A NORTHERN ADRIATIC COASTAL LAGOON. I: EFFECTS ON SEDIMENT PROPERTIES, CONTAMINATION AND TOXICITY

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Introduction

Coastal lagoons are ephemeral habitats whose conservation requires direct human intervention, including maintenance dredging of the inner channels. The aim of the present study was to assess the **effects of channel dredging**, carried out between October 2004 and August 2005, on sediment chemistry and toxicity, both in channels and adjacent ponds in the **northern Adriatic lagoon Pialassa Baiona**. The lagoon includes shallow water ponds of brackish water crossed by a network of artificial channels dug since 1850. From 1958 to 1976 Pialassa Baiona was heavily impacted by industrial pollution. Mercury, polycyclic aromatic hydrocarbons, and synthetic polymers were among the most important pollutants which nowadays contaminate the sedimentary compartment (Trombini et al., 2003). The expected **positive effect** was an increase in water circulation and oxygenation; possible **negative impacts** were uncovering of more contaminated sediments and resuspension of fine sediment, associated nutrients, organic matter and pollutants. Effects on the macrobenthic fauna are reported in an oral presentation at this conference.

Figure 1. Aerial view of Pialassa Baiona.

Field sampling & laboratory analysis

The **sampling design** was selected according to a modified beyond before-after control-impact (BACI; Underwood, 1994) approach (**Fig. 2**). Three **putatively impacted sites** were located in the dredged Baccarini channel **(labelled BAC 1, BAC 3 and BAC 5)** and three in the adjacent ponds **(POL 1, POL 3 and VEN 5)**; three **control (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.

Four replicated sediment samples were collected with a Wildco® box corer (sampling area of 0.0225 m^2) at each site **before** (September, 2004) and **after** (September, 2005) the dredging operations. Top 5-cm layers were taken for sediments analysis, chemical and biological tests.

The apparent **Redox Potential Discontinuity** (RPD) was measured as depth of boundary between the light aerobic near-surface sediment and the underlying black hypoxic or anoxic sediment. Sediment **particle size distribution** was measured as dry weight percentage after wet sieving (0.250 and 0.063 mm mesh). Sediment **organic content** was determined as percentage loss of weight on ignition (LOI) at 500°C for 8 hours (King et al., 1998). Sediments for **trace metals** analysis (Cd, Cu, Cr, Ni, Pb) were measured with graphite furnace atomic adsorption spectroscopy (GFAAS). Total **mercury** was determined by cold vapour atomic absorption spectrometry (CVAAS) (Fabbri et al., 2001).

Sediment **toxicity tests** included bioluminescence inhibition with ***Vibrio fisheri*** (Microtox®) and 10-d survival of the amphipod ***Corophium insidiosum***.

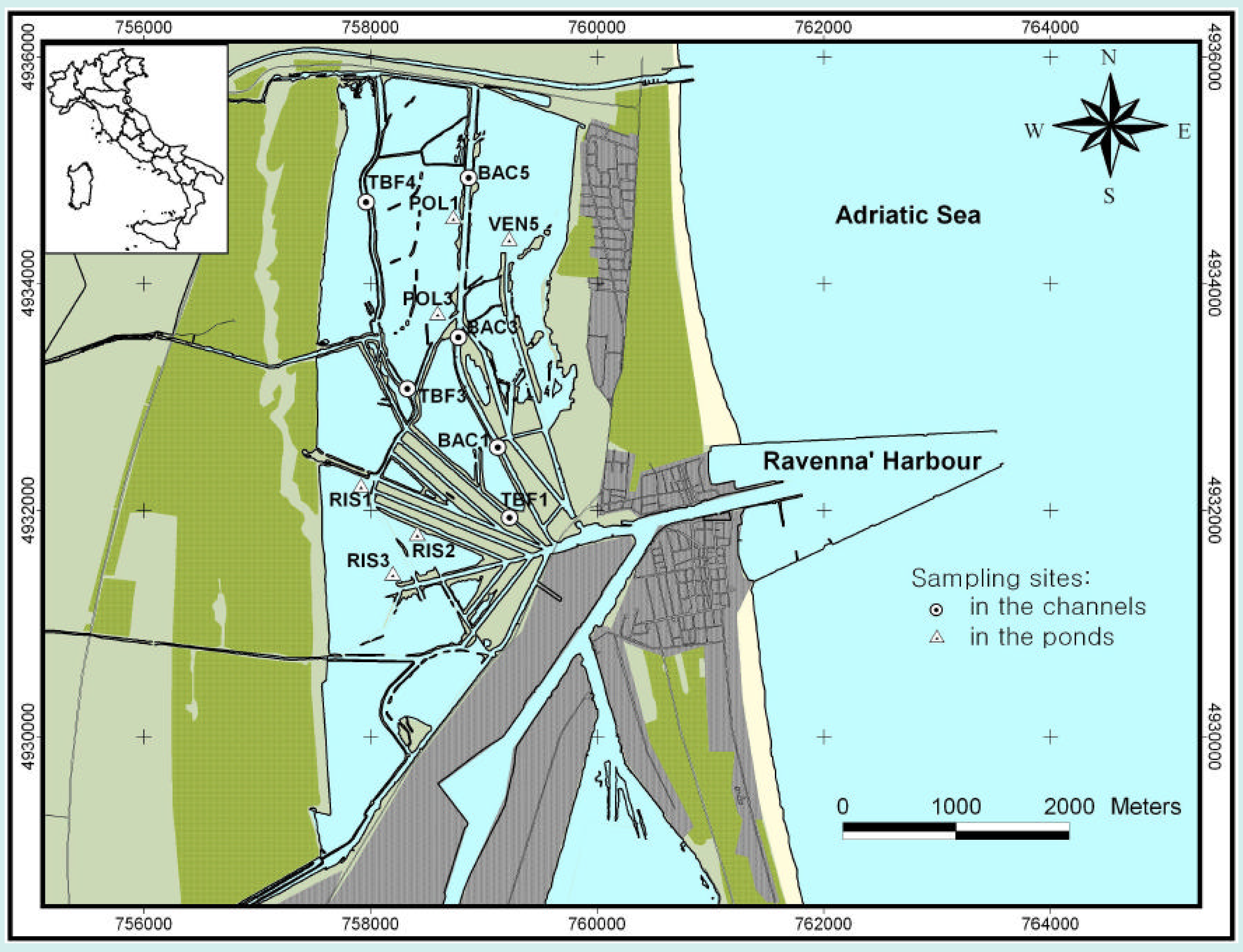

Figure 2. Sampling sites located in channels (circles) and ponds (triangles) (UTM 32T, European Datum 1950).

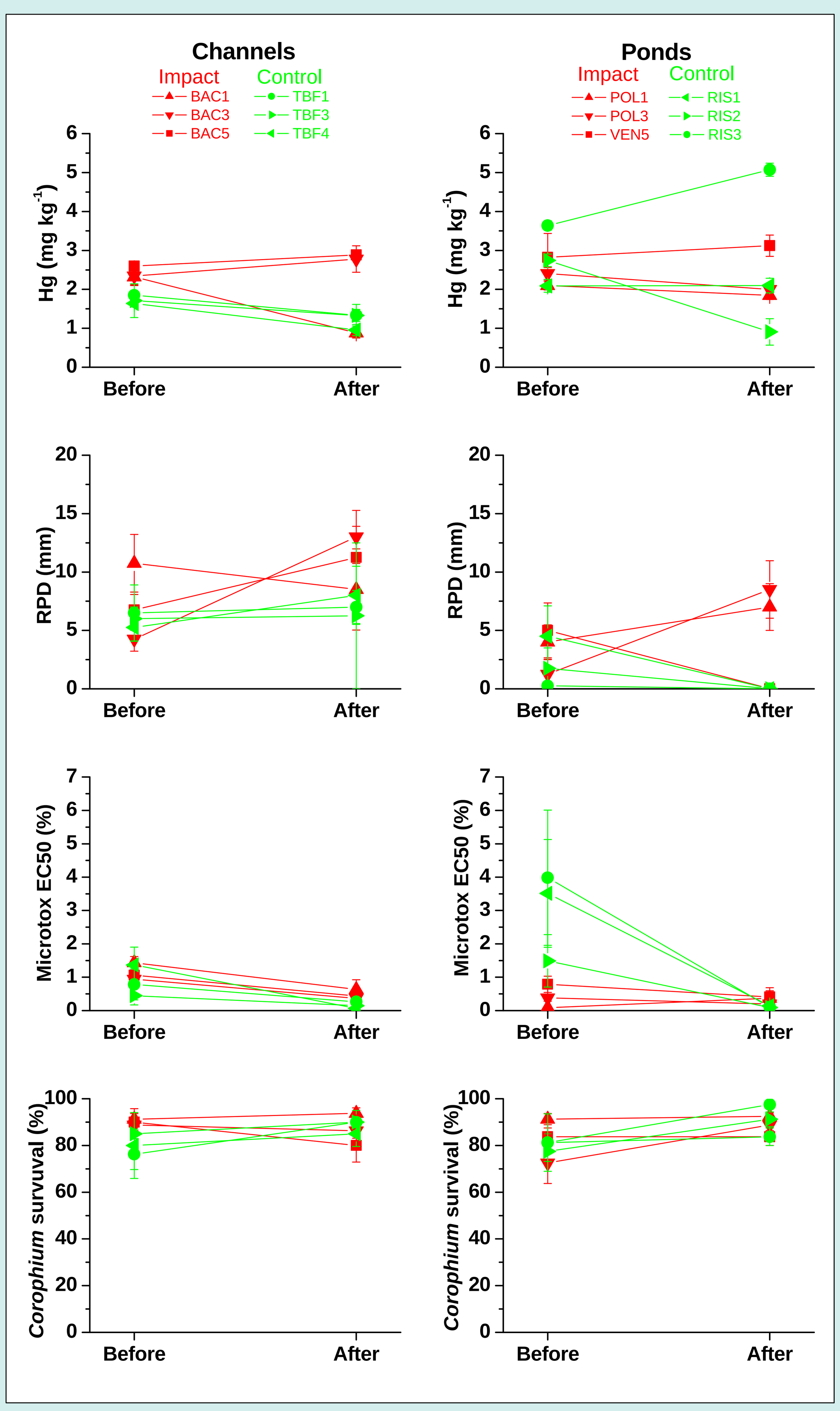

Figure 3. Plots of sediment characteristics, trace metal content, and toxicity in channel and pond sites before and after dredging operations.

Data analysis

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 putatively impacted site** was separately compared with **the three control sites** from the same habitat (channel or pond).

Results were analysed by **asymmetrical ANOVA**, according to beyond BACI principles. Factors considered are: **time** (**T**: before Vs. after) and **site** (**S**). If an event (in this case the dredging) has an actual impact, the **putatively impacted sites** (influenced by the dredging) change over time differently from **control sites** (not influenced). This difference can be detected as a significant **TxS interaction**. In particular, interaction is partitioned in two component: **among controls** (**TxCs**), and **impact Vs controls** (**TxI**). The latter, if significant, indicates that an actual impact has occurred.

Availability of resources dictated that sampling was performed in only one date before and one date after the dredging. Admittedly, this is a major drawback in comparison to a strict beyond BACI design, where replicated dates before and replicate dates after are sampled.

Results & discussion

Mercury slightly decreased in all the control channel sites (TBF1, TBF2, TBF3), while a more pronounced decrease was observed in one impact channel site (BAC1), causing a significant TxI interaction. In the other two impact channel sites (BAC3, BAC5) a slight increase was observed, although TxI interaction was not significant. This indicates that sediments exposed after dredging were equally or less contaminated than removed sediments. The presence of a significant TxCs interaction among control pond sites (RIS1, RIS2, RIS3), prevented the detection of a significant TxI interaction; However mercury concentration did not notably change in impact pond sites (POL1, POL3, VEN5).

Oxygenation of sediments, measured as depth of redox potential discontinuity, apparently increased in BAC3 and BAC5, although TxI was not significant, due to high within site variability. RPD decreased in control pond sites and in VEN5, while increased in POL1 and POL3, with significant TxI. This suggests that dredging increased water circulation and oxygenation of sediments in some of the impact sites, as opposed to a general tendency of the lagoon ponds toward less oxygenated sediments.

The only relevant change in sediment toxicity was observed in control pond sites, where Microtox® EC50 decreased (i.e. toxicity increased). This increase in sediment toxicity was not observed in impact pond sites. As a result TxI is significant for all the impact pond sites. This could be considered as a positive effect of dredging, possibly related to the increased oxygenation of bottom sediments.

The high spatial heterogeneity and temporal variation that characterise Pialassa Baiona, as well as most of the transitional waters, make difficult to discriminate environmental effects of any particular event. However our data support the conclusion than no severe damage has occurred as a consequence of dredging and suggest that some improvement to water circulation and oxygenation of sediments was obtained.

References

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