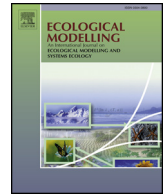




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Trophic web structure and ecosystem attributes of a temperate coastal lagoon (Ria de Aveiro, Portugal)



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ABSTRACT

A high quality data collection has been carried out between 2004 and 2014 to develop the first trophic ECOPATH model for the functioning of the sub and intertidal zones of Ria de Aveiro. This schematic representation allows the characterization of the most important compartments of biomass and flows of energy representing the functioning of the ecosystem, and can be used in the fields of decision-making and management. The model considered 26 functional groups from primary producers to top-predators and two different fisheries (artisanal and leisure), and showed that Ria de Aveiro is a dynamic ecosystem dominated by a high biomass of primary producers, where the transference of energy among compartments is, to a large extent, accomplished through the detritus path. The model also provides several ecological indicators on the state of maturity of the ecosystem, showing that Ria de Aveiro is in an intermediate state of maturity with a relatively complex food web and resilience to environmental changes. As discussed, this state of maturity is probably determined by human action pervading the system to advance in the expectable ecological succession of a coastal lagoon. These aspects, together with indicators of elevated fishing pressure and predation within the system, underline the necessity of controlling illegal extraction activities and monitoring the biomass of the main functional groups of the system, especially top predators, in order to keep the functioning of the ecosystem of Ria de Aveiro in its current condition.

1. Introduction

Coastal lagoons are among the most productive aquatic ecosystems, supporting a large reservoir of organic matter, and a large diversity of habitats that offer optimal niches for numerous aquatic species (Villanueva et al., 2006). Ria de Aveiro is a shallow multi-branch lagoon system situated in the north-west coast of Portugal (40°38'N–08°45'W, Fig. 1). It comprises an area between 66 and 83 km² in low and high spring tides respectively and is connected to the ocean

by a single inlet (Valentim et al., 2013). The climate of the region is maritime-temperate, with seasonal strong rains and mild temperatures during the whole year. The hydrology of Ria de Aveiro is essentially dominated by tidal forcing, with the Vouga and Antuã Rivers accounting for about 80% of the freshwater discharge into the lagoon (average flows between 2–29 m³ s⁻¹; Dias et al., 1999). Tides are semidiurnal with an average range of 2.1 m and varying between 1–3 m in extreme neap and spring conditions (Dias et al., 2000). From the conservationist point of view, Ria de Aveiro is the most important

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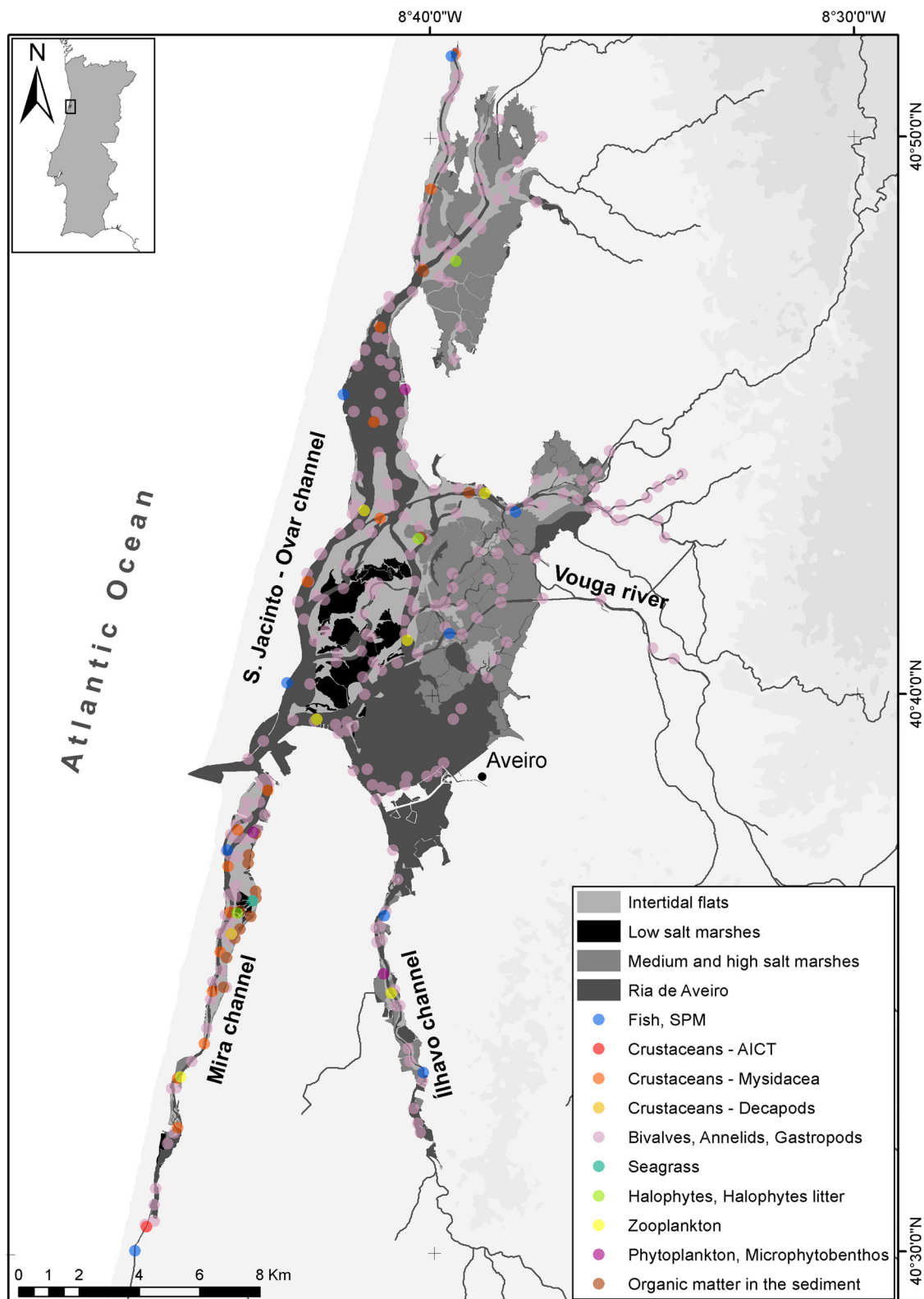


Fig. 1. Map and situation in Portugal of Ria de Aveiro, showing the sampling points of the different functional groups.

coastal system of Portugal, hosting very diverse biotopes with biological importance, such as salt marshes (Sousa et al., 2017a), seagrass meadows of *Zostera noltei* (Azevedo et al., 2013; Sousa et al., 2017b), and dune systems (Lopes et al., 2007). The lagoon constitutes also an important stopover and wintering site for migrating birds, and hosts breeding populations of emblematic species such as the little tern

(*Sternula albifrons*) and the Kentish plover (*Charadrius alexandrinus*) (Castro et al., 2006), being classified as a Site of Community Importance (SCI; European Commission Habitats Directive, 2018) within the framework of the Natura 2000 network of protected areas. On the other hand, the diversity of human-modified habitats is high, with salt-production areas, extensive aquaculture ponds and small agriculture

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