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Assessing habitat specific fish assemblages in estuaries along the Portuguese coast

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ABSTRACT

Estuaries consist of a complex mosaic of many distinctive habitat types. Each one may perform several vital functions in the functioning of the whole system and although its value is often based on species density patterns, functional relationships between them also need to be examined. Spatial patterns of estuarine habitat use by fish assemblages were determined within and among nine estuarine systems along the Portuguese coast. Fish sampling surveys were conducted in May and July 2006, covering the full estuarine gradient. All the different habitat types were sampled in each estuarine system with a beam trawl. Estuarine habitats were mapped with GIS and habitat specific associated fish assemblages were described based on several community descriptors, namely richness (S), evenness (J'), and diversity (H') and on an ecological and feeding guilds classification. A canonical correspondence analysis was performed to evaluate the relationship between estuarine habitats and fish assemblages in this set of estuaries. The intertidal and subtidal soft substratum habitats corresponded to the largest areas in all the estuaries and presented higher number of species. Nevertheless the highest mean density of fish was registered at the salt marsh habitat, which occupies smaller areas within each estuary. The fact that small vegetated habitats like salt marsh and seagrass supported high densities of fish may be an indication of the important role these habitats play in the whole system functioning. Differences in fish assemblage structure were found with latitude and between habitats amongst and within estuaries. Some of the fish species were found to be particularly associated with certain habitat types, which might indicate that each estuarine habitat may be related with specific fish assemblages regardless the estuary. The present work provides valuable information for management by identifying the most important habitats for species conservation and predicting the possible effects of habitat disturbance or destruction, namely by climate change and anthropogenic pressures.

1. Introduction

Estuaries consist of a complex mixture of many distinctive habitat types that do not exist in isolation (Pihl et al., 2002) and can typically contain mangrove forests, salt marshes, seagrass meadows, oyster reefs and non-vegetated areas. Losses of these habitats have the potential to affect local ecology and fisheries, as it is widely accepted that estuaries provide habitat for numerous fish and invertebrates species, many of which are economically important (Connolly, 1994; Jenkins et al., 1997).

Within an estuary, the selection of a specific habitat by fishes may be related to its availability and structural complexity, prey and predator abundance, physical transport processes and local environmental conditions (Blaber and Blaber, 1980). The value of estuarine habitats is often assessed on the density of fish associated with these habitats as density reflects recruitment, mortality, and emigration (Minello et al., 2003).

Recent investigations over larger spatial scales have found both intra- and inter-estuarine differences in fish abundances in different habitat types (Elliott and Hemingway, 2002). Many studies have compared the ecology of non-vegetated and vegetated habitats in estuarine environments (Sogard and Able, 1991; Sheridan, 1992). Vegetated areas typically support higher values of species richness and higher densities of fish and invertebrates than adjacent non-vegetated areas, regardless the type of vegetation studied (Connolly, 1994; Gray et al., 1996). Non-vegetated habitats may support higher densities of particular species (Castellanos and Rozas, 2001), indicating that although loss of vegetated habitats (such as seagrass, salt marsh or mangroves) will probably result in reduced overall densities of fish and invertebrates, some species may be unaffected (Bloomfield and Gillanders, 2005).

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Previous studies have also found differences in fish assemblages associated with different habitats, despite their seasonal and variable nature (Gray et al., 1996; Nagelkerken et al., 2000). Although particular species occur in higher numbers in certain habitats resulting in distinct assemblages, an organism's preference and subsequent selection of habitat may change over time (Castellanos and Rozas, 2001; Bloomfield and Gillanders, 2005).

Studies on multiple habitat comparisons are scarce and most have compared vegetated and non-vegetated habitats (Sheridan, 1992; Rozas and Minello, 1998; Castellanos and Rozas, 2001). Nagelkerken et al. (2000) compared six habitats, but they used visual censuses along belt transects, which are not appropriate for estuarine habitats.

While these density patterns provide insight as to the habitat value, functional relationships also need to be examined (Stuntz et al., 2002). For most estuarine species, the functional role of different habitats and the links between them are not well known (Miller and Skilleter, 2006). Species' distribution in relation to their habitat can provide initial insights into the types of ecological processes that regulate estuarine populations and assemblages (Pihl et al., 2002). Understanding whether and how communities differ in or shift among these habitats is important for predicting consequences of habitat loss and environmental degradation for biodiversity and ecosystem functioning (Connolly et al., 2005).

Estuaries along the Portuguese coast play an acknowledged role as nursery areas for several commercially important fish species (Cabral, 2000; Cabral and Costa, 2001; Costa et al., 2002; Cabral et al., 2007; Leitão et al., 2007; Pombo et al., 2007). Some systems have been studied for several years (Costa and Cabral, 1999) while others have seldom been studied even in terms of their fish assemblages. The zoogeographic importance of this area has long been recognized, representing the transition between north-eastern Atlantic warm-temperate and cold-temperate regions (Briggs, 1974). Consequently, several species are found in sympatry in this geographical area, which constitutes an interesting and unique ecological context (Cabral et al., 2007).

The present study aims to assess the value of several estuarine habitats within and among nine estuarine systems along the Portuguese coast by determining spatial patterns of habitat use by fish assemblages. The evidence of common links between similar habitats in different estuaries and species' ecological guilds will also be analyzed.

2. Material and methods

2.1. Study area

Nine estuarine systems along the Portuguese coast were considered in this study (Fig. 1). Geomorphologic and hydrologic characteristics differ considerably according to estuarine system (Table 1). The Tejo and the Sado estuaries are much larger than the others. The Mira estuary is the smallest, covering an area of ca. 5 km^2. Ria de Aveiro and Ria Formosa are shallow coastal lagoon systems with large intertidal areas. Mean depth varies between 1 and 6 m, which indicates that shallow areas predominate in all

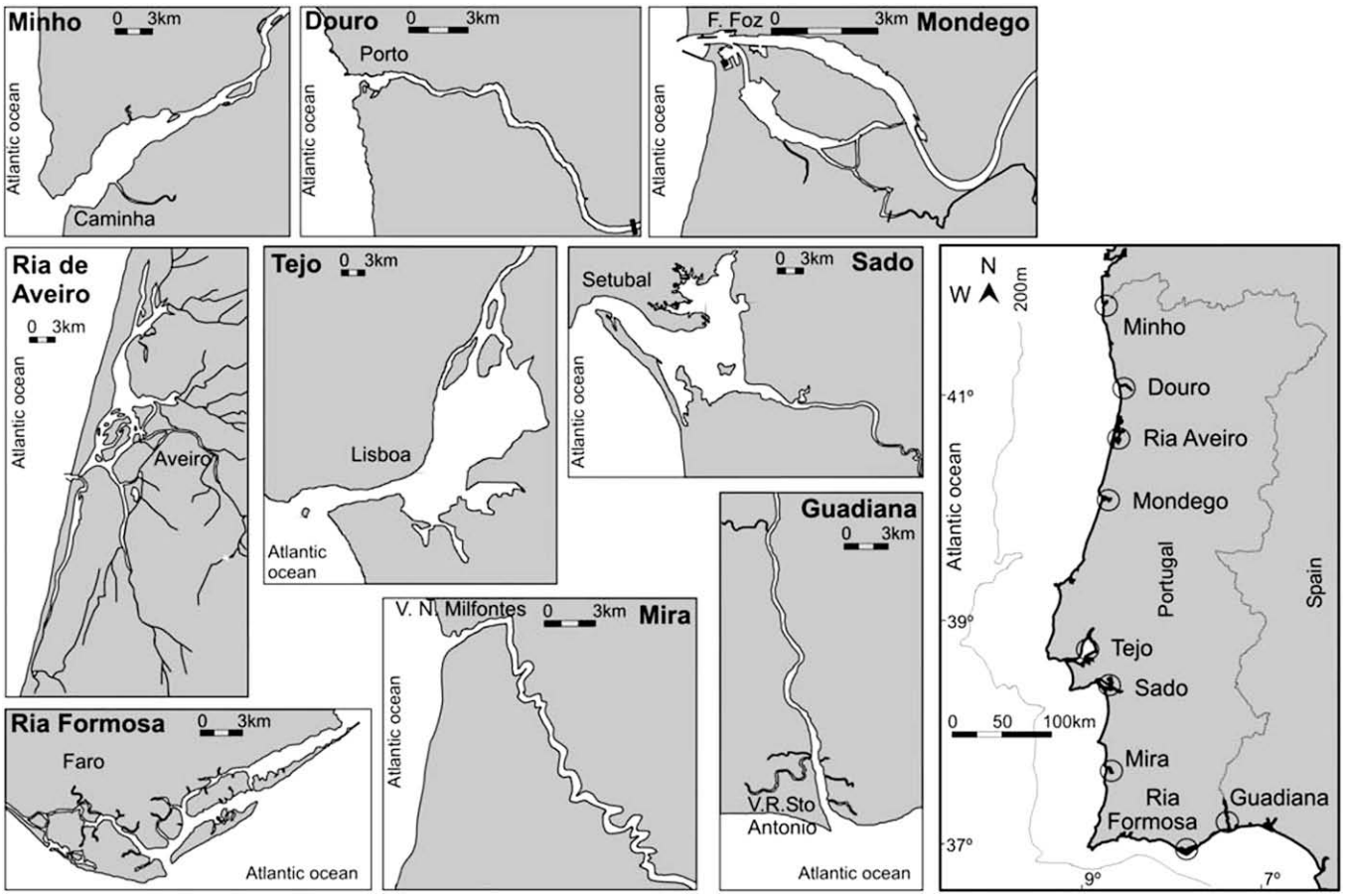

Fig. 1. Estuarine systems sampled in the Portuguese coast.