Estuarine, Coastal and Shelf Science 83 (2009) 602–612

Contents lists available at ScienceDirect

Estuarine, Coastal and Shelf Science

journal homepage: www.elsevier.com/locate/ecss

Composition, structural characteristics and temporal patterns of fish assemblages in non-tidal Mediterranean lagoons: A case study

S. Maci*, A. Basset

Department of Biological and Environmental Sciences and Technologies, University of Salento, Prov.le Lecce-Monteroni, Ecotekne Centre, Lecce 73100, Italy

ARTICLE INFO

Article history:
Received 5 March 2009
Accepted 11 May 2009
Available online 20 May 2009

Keywords:
fish fauna
ecosystem type
community structure
coastal lagoon
temporal patterns
Mediterranean Sea
Italy
Acquatina

ABSTRACT

The importance of transitional water ecosystems as nursery habitats and feeding grounds for fish species is well-known. Detailed studies of colonization patterns of fish guilds in response to biotic and abiotic drivers are however unevenly distributed among ecosystem types. We address here the temporal variability of fish assemblages in small non-tidal lagoons in the Mediterranean basin. The study was carried out at the Acquatina lagoon (Lecce, Italy) where four stations, situated in two habitat types along a confinement gradient, were sampled twice per month for one year with fyke nets. Forty-five taxa ranging across 20 families were collected, with the most abundant species, *Atherina boyeri*, accounting for more than 95% of total abundance. Pooling all species together (excluding sand smelt), the structural features of the assemblage, relative abundance of families, and abundance of individual species all showed significant temporal patterns. Mean abundance peaked in Summer and Autumn and fell in Winter, whereas taxonomic richness and diversity were highest in Summer and lowest in Spring. Within the fish assemblage, multivariate ordination showed temporal segregation of species belonging to the same family or genus and expected to be functionally similar, suggesting that they avoid competition for space and resources by timing inward migration and peak occurrence differently. Of the environmental driving forces, which also showed temporal patterns of variation, salinity was the main factor affecting the distribution of individuals and species. The catch of young individuals of several marine species confirmed the role of this small lagoon as a nursery and feeding area, and emphasized the need for further studies.

1. Introduction

Transitional water ecosystems represent an interface between freshwaters and the marine environment. These ecotones are characterized by highly variable and unpredictable chemical-physical conditions, and can be colonized only by organisms physiologically or behaviourally able to cope with their intrinsic selectivity (Guelorget and Perthuisot, 1983; McLusky and Elliott, 2004; Basset et al., 2008). Even so, these systems provide suitable habitats for a huge array of species, from invertebrates to fish and birds, providing them with feeding resources, nesting sites, shelter from predation, and an environment for juvenile growth and survival (Kjerfve, 1994).

Transitional water ecosystems are known to function as nursery areas for fish juveniles, i.e. habitats whose contribution to the production of individuals that recruit to adult populations is greater, on average, than other habitats in which juveniles occur, either on a per-unit-area basis (Beck et al., 2001) or in terms of the whole-habitat contribution (Dahlgren et al., 2006). Such ecosystems are inhabited by a diverse ichthyofauna, with some resident species spending their entire lives in them, and others using sub-habitats as nursery grounds in their earlier life stages and returning to the sea when they reach a certain body size or sexual maturity (Whitfield, 1999).

When determining nursery areas in transitional waters, it is useful to take into account the effects of scale, complexity and connectivity, identify the crucial resources and processes supporting juveniles and quantify their contribution to future generations (Sheaves et al., 2006). Particular attention should be paid to the temporal scale of observation, because patterns of fish distribution depend on micro-scale factors such as diel cycles and tidal regime (Hampel et al., 2003) as well as larger-scale factors such as lunar phases, seasonal changes (and consequently species' life histories) (Rountree and Able, 2007) and finally inter-annual climatic oscillations and global warming (Poizat et al., 2004; Roessig et al., 2004). Observed patterns of co-occurrence are also known to be related to functional or phylogenetic affinities between species, and can thus give insights into the prevailing mechanisms of community

* Corresponding author.
E-mail address: stefano.maci@unisalento.it (S. Maci).

0272-7714/$ – see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.ecss.2009.05.007

organization, helping us to discriminate between processes linked to environmental filters and those associated with biotic interaction between species (Mouillot et al., 2007).

It is important to recognize and describe patterns of habitat colonization and use by fish fauna, to answer ecological questions, to understand the role of transitional waters as a source of harvestable resources and to gain knowledge that can be useful for managing natural capital and regulating human activities. (Beck et al., 2001; Elliott and Hemingway, 2002). Patterns are influenced by the abiotic properties of the environment, as well as by resource availability, intra and inter-specific interactions and species' life histories (Whitfield, 1999). The chemical–physical parameters (oxygen, salinity, temperature, nutrients, turbidity) (Blaber and Blaber, 1980; Marshall and Elliott, 1998), hydrological characteristics (tide, current direction and velocity, water residence time) (Joyeux, 1999) and morphometric factors (dimensions, depth, confinement, inlet configuration) (Pérez-Ruzafa et al., 2007; Franco et al., 2008b) of an ecosystem affect colonization rates from the sea and filter the functional attributes of individuals and species which successfully settle, grow and reproduce.

These abiotic features have also been shown to be as major factors affecting overall biotic variability in transitional water ecosystems, and are now considered when defining transitional water ecosystem types (sensu WFD, 2000/60/EC). Besides salinity (Battaglia, 1959), confinement (Guelorget and Perthuisot, 1983) and tidal regime (Elliott and McLusky, 2002 and citations therein), surface area has also been proposed as a niche dimension co-determining differences between ecosystems in terms of habitat structure, abiotic properties and abundance and distribution of organisms (Basset et al., 2006).

Knowledge of nursery areas, and more generally the use of transitional water ecosystems by fish assemblages, is unevenly distributed across ecosystem types. Until now, most studies in Europe have focused on estuarine macrotidal ecosystems such as estuaries (Costa, 1988; Elliott and Dewailly, 1995; Marshall and Elliott, 1998; Thiel and Potter, 2001; Maes et al., 2005; Martinho et al., 2007; Selleslagh and Amara, 2008), mud flats or salt marshes (Cattrijsse et al., 1994; Laffaille et al., 2000; Mathieson et al., 2000; Jovanovic et al., 2007) located on the coasts of the Atlantic Ocean and the North Sea. In most cases these papers looked at the influence of tidal regime, turbidity, sediment granulometry and seasonal fluctuations of abiotic conditions on patterns of taxonomic and functional composition, abundance and spatial distribution of fish fauna.

Concerning the Mediterranean Sea, in the last few decades some authors have studied fish assemblages in coastal systems or system-complexes such as lagoons, river deltas and coastal lakes. Most of the work has been carried out in the western Mediterranean on Spanish, French and Italian coastal systems (Hervé and Bruslé, 1980, 1981; Mazzola et al., 1990; Mariani, 2001; Dumay et al., 2004; Pérez-Ruzafa et al., 2004, 2007; Poizat et al., 2004; Franco et al., 2008b). Few papers have been published reporting data and ecological information on the fish assemblages of southern and eastern Mediterranean brackish ecosystems (Rowntree, 1984; Rossi, 1986; Koutrakis et al., 2005; Akin et al., 2005; Franco et al., 2006; Matić-Skoko et al., 2005, 2007). Moreover, the majority of these studies covered medium-to-large size ecosystems, while little is known about the fish assemblages of small non-tidal lagoons which, however, are a major ecosystem type in the Mediterranean. Few quantitative data are available on the role of these lagoons as habitats for fish species or on recruitment periods and seasonal patterns of colonization.

The aims of this study were to: 1) characterize and describe, on an annual scale, the fish fauna colonizing a small Mediterranean transitional water ecosystem, 2) evaluate the influence of seasonal environmental fluctuations on the structural properties of the community and on single species' abundance patterns, especially migrant and commercially important ones, 3) identify temporal patterns of species co-occurrence, focusing on their functional and phylogenetic closeness, in order to investigate the importance of abiotic constraints and competitive interactions in shaping community structure and organization. The study was carried out in the small non-tidal lagoon of Acquatina (Lecce – Italy), which has been owned by the University of Salento since 1986 and is used for experimental activities.

2. Materials and methods

2.1. Study area

In the typology of Mediterranean lagoons (Basset et al., 2006), Acquatina (Lecce – Italy) is a small non-tidal lagoon with artificial embankments, located on the Adriatic side of the Salento peninsula, about 13 km from the city of Lecce. It has a surface area of 0.45 km^2, an average depth of 1.2 m and a maximum depth of 2 m. The basin is long, narrow and branching in shape and is oriented along a NW–SE axis, parallel to the Adriatic sea, from which it is separated by a narrow line of dunes (Fig. 1).

The lagoon is linked to the sea by two channels; in the northern part is the mouth of Giammatteo canal, almost always closed by accumulations of sand and *Posidonia oceanica* detritus, and in the southern part is the main canal, which between 2002 and 2004 was embanked and equipped with a sluice. Marine influence is currently more important than in the past, when the current main inlet was frequently silted up and connection with the sea was guaranteed only in proximity to the Giammatteo canal and another 500-m-long canal linked to a small harbour, now constantly kept closed with a sluice.

The main freshwater input is a lateral ramification of the Giammatteo canal, fed by precipitation and ground water. The relatively shallow depth, very limited tidal regime, scarce and

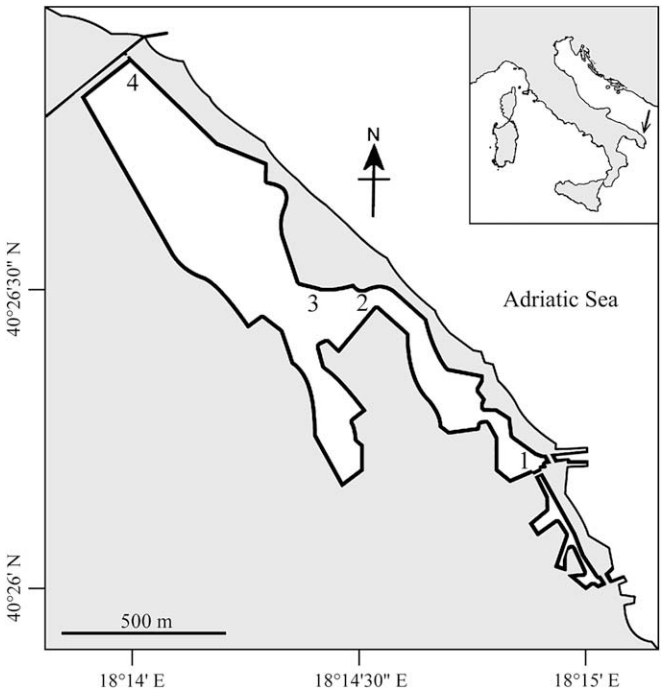

Fig. 1. Acquatina lagoon showing sampling stations. Vegetated habitat, stations 2 and 3; unvegetated habitat, stations 1 and 4.