Spatial Distribution Modelling of Juvenile Common Pandora (*Pagellus erythrinus* Linnaeus, 1758) in Relation to Habitat in the Shallow Waters of Gökçeada Using GIS

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Abstract. The distribution of juvenile *Pagellus erythrinus* (Linnaeus, 1758) species was studied by the abundance, density and habitat preferences in the shallow waters of Gökçeada. Fish samples were obtained in experimental beach seine and beam trawl surveys carried out between 2013 June to 2014 May in the shallow waters of Gökçeada. To understand the habitat preferences of the species, sediment samples were collected and sediment composition was determined by grain size distribution analysis. The spatial distribution of juvenile *Pagellus erythrinus* species in relation to the habitat structure was estimated and modelled using Geographic Information System (GIS) and geostatistical tools. It was observed that juvenile *Pagellus erythrinus* species prefer the rocky areas which in 5-10 m water depth in the shallow waters of Gökçeada.

Keywords: Distribution, Juvenile, *Pagellus erythrinus*, Modelling, Gökçeada, GIS.

1 Introduction

Fish species which belong to the Sparidae family are important marine resources that play an important role in demersal fish community (Gomes et al., 2001) for fisheries and they are widespread in the Mediterranean Sea (Gordoa and Moli, 1997). Common pandora (*Pagellus erythrinus* Linnaeus, 1758) is a demersal species (Fischer et al., 1987) occurring to 220 m water depth (Russel, 2014) and the juvenile individuals are common near to the coastline (Ardizzone and Messina, 1983, Papaconstantiou et al., 1988) and has high commercial value in the Mediterranean coasts and distributes along the coasts of the central eastern and northeastern Atlantic

Proceedings of the 7th International Conference on Information and Communication Technologies in Agriculture, Food and Environment (HAICTA 2015), Kavala, Greece, 17-20 September, 2015.

Ocean (Bauchot and Hureau, 1986; Sanches, 1991) and the Mediterranean Sea (Bauchot, 1987). Some various aspects of the common pandora such as biology, feeding ecology, distribution, life history and fisheries have been previously studied (Zei and Zupanovic, 1961; Hashem and Gassim, 1981; Ardizzone and Messina, 1983; Ünsal, 1984; Andaloro and Giarritta, 1985; Girardin and Quignard, 1985; Papaconstantinou et al., 1988; Livadas, 1989; Mytilineou, 1989; Santos et al., 1995; Gonçalves et al 1997; Özaydın, 1997; Pajuelo and Lorenzo, 1998; Benli et al., 2001; Somarakis and Machias, 2002; Hoşsucu and Türker, 2003; Abecasis et al., 2008; Coelho et al., 2010; Fanelli et al., 2011). It can be found in various bottoms such as rock, gravel, sand and mud (Russel, 2014). Habitat preference of a species may change spatially and temporally for each life stages of the fishes (Crec'hriou et al., 2008). The relationship between environment and species can change because of the several factors (i.e. fish behavior, oceanographic characteristics). To understand how they can be affected, the habitat mapping offers a chance (Koubbi et al., 2006).

In this study we aimed to determine habitat preferences and to model the spatial distribution of juvenile *Pagellus erythrinus* species. Surveys were conducted in the shallow waters of Gökçeada Island (the northern Aegean Sea, Turkey). We combined geostatistical tools and GIS to model the spatial distribution of juvenile fish species in relation to the habitat structure.

2 Material and Methods

2.1 Study Area

Gökçeada was located in the northern Aegean Sea between 25°65' – 26°05' E and 40°05'–40°25' N (Fig. 1). The study area encompasses the shallow waters of Gökçeada between 0-20 m water depths.

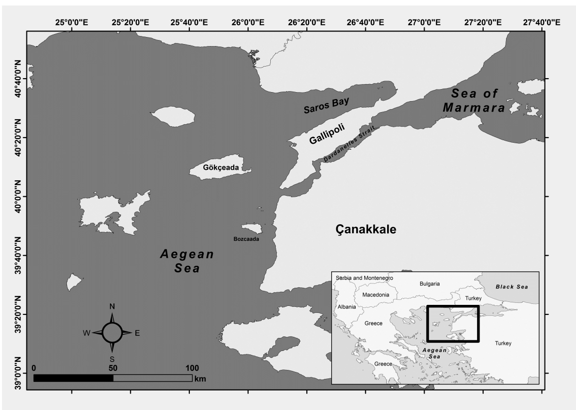

Fig. 1. The study area.

2.2 Sampling and Data Collection

Fish Sampling

Fish samples were collected in experimental beach seine and beam trawl surveys carried out in 6 different stations and 3 different water depth (0-2 m, 5-10 m and 10-20 m) between 2013 June to 2014 May in the shallow waters of Gökçeada (Fig. 2).

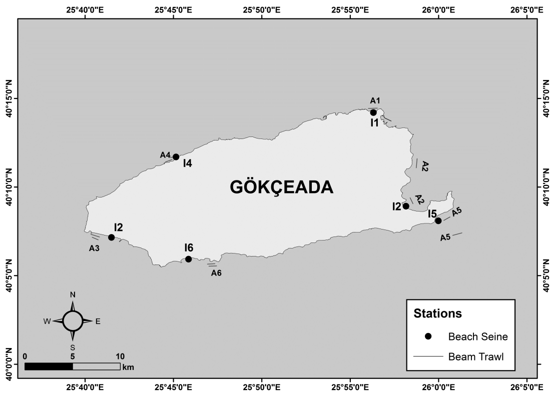

Fig. 2. Fish sampling stations (*A: Beam Trawl; I: Beach Seine*)

Sediment Sampling

Sediment samples were collected with a 0.1 m^2 van Veen grab at the sampling stations (Fig. 3). The collections of grabs in the stations were stored in sealed plastic bags until the analysis. Then sediment samples were dried at 105°C for 24 hours in an oven (Yee et al., 1992). Granulometry analysis was conducted for determining the sediment grain size and quantity. Data were analyzed for the characterization of the bottom sediment as the percentages of gravel, sand and mud (Folk, 1954).

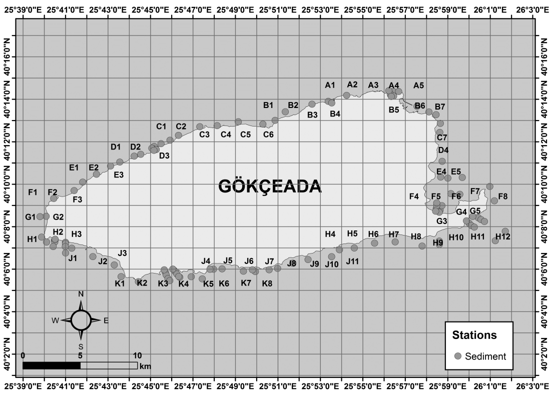

Fig. 3. Sediment sampling stations (Study area was divided into the grids which 1x1 min latitude and longitude and the grids were labelled from the North to the South alphabetically and from the West to the East numerically).

3 Results

The habitat structure was classified and modelled in the shallow waters of Gökçeada Island (Fig. 4). GIS and geostatistical tools were used to model species potential distribution in relation to habitat.

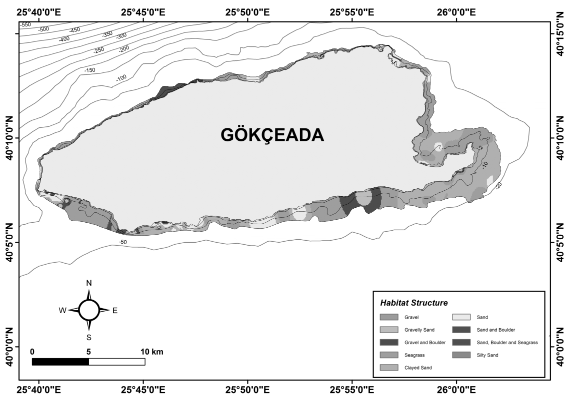

Fig. 4. The habitat structure in the shallow waters of Gökçeada Island.

The distribution and density of juvenile common pandora species were estimated considering the water depth and also modelled. The density of juvenile common pandora fish species was predicted as 2794.67 fish/km^2, 29757.39 fish/km^2, and

13022.74 fish/km^2 for 0-2 m, 5-10 m and 10-20 m water depth, respectively (Fig. 5). The density was found the highest in 5-10 m water depth, and the lowest in 0-2 m water depth. It is observed that juvenile common pandora species prefer the rocky areas in 5-10 m water depth. Also the species were observed in rocky areas and seagrass beds in 10-20 m and rarely sandy areas in 0-2 m water depth in Gökçeada shallow waters.

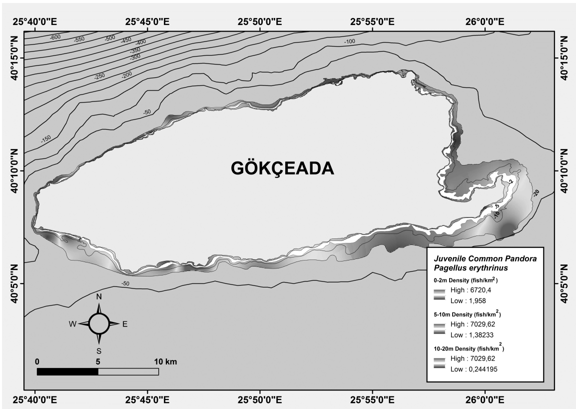

Fig. 5. The density and spatial distribution of juvenile common pandora on suitable habitats

4 Discussion

Habitat structure is one of the key issues that describe the changeability of Mediterranean fish assemblages (García-Charton and Pérez-Ruzafa, 2001; García-Charton et al., 2004). Bauchot ve Hureau (1990) notified that *Pagellus erythrinus* lives in the rocky, sandy, muddy bottoms and seagrass beds in 0-150 m water depth. The results of this study showed that the juvenile common pandora species occur in the shallow waters and prefer the rocky areas, seagrass beds and rarely sandy bottoms in the shallow waters of Gökçeada Island. This species would prefer these habitats for feeding, sheltering and nursery grounds in the shallow waters due to those waters are warmer than the deeper, are very rich in terms of food and the juvenile species are vulnerable during early life stages. Also, it is high commercially valuable fish species in this area.

Shallow waters are important areas for juvenile fish species in terms of recruitment and fisheries management. (Gibson et al., 1996; Harris and Cyrus, 1996; Nash and Santos, 1998; Layman, 2000; Polte et al., 2005). Most of fish species use these areas during early life periods for sheltering, feeding and nursery area. Beck et al. (2001) stated that a nursery habitat must support further additives to the adult recruitment about density, growth, survival of juveniles and movements to the other adult habitats. The assessment of species distributions and habitats is one of the essential elements to develop comprehensible marine strategies (European Commission, 2010). GIS makes available new approaches for the more data processing with the integration and management of fishing survey data. Main existence areas of the species can be determined by the integration of fishing survey data with bathymetry (Valavanis et al., 2004). To ensure sustainable recruits and maintain the spawning stock, technical measures such as regulations of fishing gears and methods or area and time restrictions would be required. Pajuelo and Lorenzo (1998) recommended to apply the regulations of fishing gears and methods for ensuring that species is not targeted through the short spawning period. Also, monitoring the population should be continued (Russel, 2014).

5 Conclusion

This study provides new information on the spatial and bathymetric distribution of *P. erythrinus* in the Aegean Sea, eastern Mediterranean Sea. The spatial distribution, abundance and density of *P. erythrinus* was mapped to show possible distribution of juvenile species on suitable habitats. The bathymetric pattern of abundance and density showed a decrease at 0-2 m water depth. The density was found the highest in 5-10 m water depth. It is observed that juvenile common pandora species prefer the rocky areas in 5-10 m water depth in the shallow waters of Gökçeada Island.

Acknowledgments. This research was supported by TUBITAK (The Scientific and Technical Research Council of Turkey) (Project no: 112Y062). The authors would thank to project team who support in the field study.

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