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Seagrass fish assemblages in the Namhae Island, Korea: The influences of seagrass vegetation and biomass

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ABSTRACT

Seagrass habitats are highly productive areas that support vegetative habitats and provide shelter for various marine animals. In seagrass beds, vegetation patterns are important factors that control faunal assemblage structure. In this study, we surveyed fish assemblage structures in *Zostera marina* beds and in adjacent unvegetated habitats to assess the influences of seagrass vegetation and biomass on fish assemblage structures. In total, fifty-four fish species belonging to 30 families were collected using a small beam trawl at both seagrass beds and unvegetated habitats from two different areas off the coast of Namhae Island, South Korea. The dominant fish species in seagrass beds were *Sebastes inermis* and *Rudarius ercodes*, whereas *Acanthogobius flavimanus* and *Takifugu niphobles* were the most abundant fish species in unvegetated habitats. The number of species, their abundance, and the diversity of fish assemblages varied greatly by habitat type, study site, and season. Abundance peaked in seagrass beds and during the spring, and were lowest catch rate in unvegetated habitats and during the winter months. Multivariate analyses revealed that habitat type, site, and season affected the structure of fish assemblages. Seagrass vegetation supported higher densities and greater fish species richness, but not species diversity. Among the dominant species, *Lateolabrax japonicus*, *Sebastes schlegelii*, *Syngnathus schlegeli*, and *Rudarius ercodes* characterized the fish assemblages in seagrass beds, with the former two more abundant under conditions of higher seagrass biomass. Gobiid species were significantly correlated with unvegetated habitats.

1. Introduction

Zostera marina (eelgrass), the most common seagrass species in temperate coastal areas of Western Pacific, provides living space and shelter for many marine animals (Klumpp et al., 1989; Huh and Kwak, 1997; Connolly et al., 1999; Hemminga and Duarte, 2000). Many fish and crustacean species use seagrass beds as feeding and nursery grounds, including several commercial and recreational fishes (Nelson, 1981; Edgar and Shaw, 1995; Huh and Kwak, 1997; Huh and An, 1997; Guidetti and Bussotti, 2000), because of their high structural complexity, providing refuge from predators (Blaber et al., 1995; Rozas and Minello, 1998; Beyst et al., 2002; Nagelkerken et al., 2002). Previous studies of faunal assemblages in seagrass habitats have shown that vegetated seagrass meadows have a consistently higher diversity and abundance of vertebrates and invertebrates than other coastal habitats (Orth et al., 1984; Polte and Asmus, 2006). Due to their ecological importance, seagrass habitats have been ranked among the most valuable ecosystems in the marine environment (Costanza et al., 1997; Short et al., 2007).

Several studies have compared the diversity, abundance, and distribution of fish assemblages associated with seagrass beds with that from non-vegetated habitats. Guidetti (2000) indicated that differences in fish assemblages in the Adriatic Sea were mainly due to the temporal and fish size differences of several fish species, suggesting different habitat preferences. Bloomfield and Gillanders (2005) reported that, although seagrass and non-vegetated assemblages in southern Australia were similar, the loss of vegetated habitats could result in the loss of species richness and abundance. More recently, Riberio et al. (2012) showed that seagrasses support a greater number of species and greater diversity, whereas unvegetated habitats supported greater numbers of fish but fewer species. Large seagrass beds often contribute to the presence of greater diversity and abundance of fish in adjacent non-vegetated habitats (Jelbart et al., 2007; Mazumder et al., 2006) because several fishes are more likely to move from unvegetated habitats to adjacent vegetated ones (Irlandi and Crawford, 1997). Comparative studies have shown that fish assemblages associated with seagrasses and assemblages in unvegetated habitats within shallow intertidal areas are structurally different, with unvegetated habitats dominated by

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fewer species.

Large seagrass beds are found along the shoreline of Namhae Island, South Korea, which provide habitat for a variety of invertebrates and small fish (Huh and Kwak, 1997). A number of studies have demonstrated the importance of eelgrass beds as habitats for juvenile fish and decapod crustaceans (e.g. Lee et al., 2000; Kwak et al., 2006; Kwak et al., 2014). Although some ecological studies on fish in eelgrass beds have been conducted at Namhae Island, their focus was limited to fish production (Kwak et al., 2009; Kim et al., 2013; Kim et al., 2014), fish feeding habits (Huh et al., 2008; Huh et al., 2014), and seahorse reproduction (Park and Kwak, 2015). Kwak et al. (2009) reported eelgrass beds were superior in *Acanthogobius flavimanus* production than unvegetated tidal flats. Several studies have been performed on the effects of eelgrass beds on seasonal variations in species composition and abundance in southern Korean waters (e.g. Huh and Kwak, 1997). In a similar study, fish assemblages in eelgrass beds and unvegetated habitats in Jindong Bay were contrasted (Kwak et al., 2006). However, the factors determining variation in fish community structures when comparing vegetated and non-vegetated habitats were proven difficult to unravel.

In this study, we compared fish assemblages in seagrass beds and unvegetated habitats in two different locations to investigate the influences of seagrass on fish assemblages. Our specific objectives were to 1) compare species richness, abundance, and diversity among habitats; 2) associate differences in assemblage structures with changes in habitat type, study site, and season; and 3) examine relationships between seagrass biomass and fish abundance. Results from this study will contribute to a greater understanding of the dynamics between habitat complexity and the structure of fish assemblages.

2. Materials and methods

2.1. Study area

Investigations were conducted in Dongdae Bay (site A, northern part) and Aenggang Bay (site B, southern part) of Namhae Island, South Korea (Fig. 1). Site A faced inland and was surrounded by diverse geographic features, whereas site B was exposed to open ocean, facilitating seawater circulation. The seagrass beds of the study area form subtidal bands (2.7–3.3 km in width) along the shoreline in shallow water (< 5 m). In the study area, the seagrass beds at both sites were dominated by *Zostera marina*.

2.2. Sampling

Fish samples were collected monthly throughout 2005 by beam trawl (5 m × 3 m, 1.9-cm mesh wing and body, 0.6-cm mesh liner). Four 6-min tows per sampling were carried out during the day in seagrass beds and in unvegetated habitats. The estimated coverage area was 180 m^2 at each sampling event. Fish abundance was expressed as the number of individuals per 100 m^2. Although this method may be destructive to seagrass beds, beam trawl survey is also useful to estimate actual densities of benthic marine organisms in seagrass habitats (Coles, 1986). Immediately after capture, individual fish were preserved in 5% formalin with seawater and later transferred to 70% ethanol for long-term storage. In the laboratory, specimens were identified to the species, and standard length (SL, ± 1.0 mm) and weight (± 1.0 g) were measured. For each species, three functional groups were categorized as pelagic (P), semi-benthic (S) or benthic (B) according to where they inhabit the surface, inside or bottom of the seagrass bed (Hori et al., 2009).

Surface water temperature (by thermometer) and salinity (via salinometer) were monitored monthly at each sampling occasion. Seagrass biomass was estimated by collecting all plant matter enclosed in a 0.01 m^2 quadrat. Plants collections were dried at 80 °C for 24 h and weighed to the nearest gram. Seagrass biomass was expressed as dry weight per square meter (g dwt/m^2; Kwak and Klumpp, 2004).

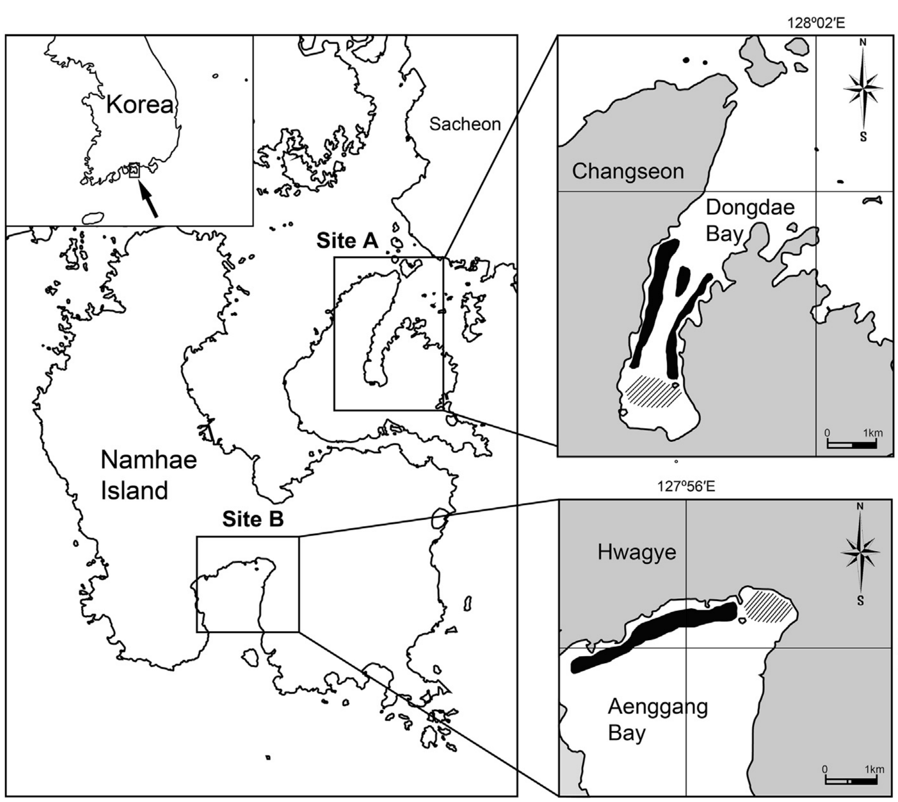

Fig. 1. Location of study areas in Namhae Island, South Korea. Black area = seagrass bed, oblique area = unvegetated area.

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