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# Fish utilization of a salt marsh intertidal creek in the Yangtze River estuary, China

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**Abstract**

The structure and temporal variations of the fish community in salt marshes of Chinese estuaries are poorly understood. Fish utilization of a salt marsh intertidal creek in the Yangtze River estuary was studied based on quarterly sampling surveys in July and November, 2004, and February and May, 2005. Fishes were collected by consecutive day and night samplings using fyke nets during the ebbing spring tides. A total of 25,010 individuals were caught during the study. 17 families and 33 species were documented, and the most species-rich family was Gobiidae. Three species, *Synechogobius ommaturus*, *Chelon haematocheilus* and *Lateolabrax maculatus* together comprised 95.65% of the total catch, which were also the most important commercial fishery species in the Yangtze River estuary. The fish community was dominated by juvenile individuals of estuarine resident species. Time of year significantly affected fish use of salt marshes, but no significant effects of diel periodicity on the fish community were found except for fish sampling in July. These findings indicate that salt marshes in the Yangtze River estuary may play important nursery roles for fish community.


*Keywords:* fish community; temporal variation; diel; salt marsh; creek; habitats

## 1. Introduction

Salt marshes are generally considered to be important fish nursery habitats (Kneib, 1997; Beck et al., 2001; Cattrijsse and Hampel, 2006). A great number of juvenile fishes use these habitats as feeding grounds and refugia from predation (Boesch and Turner, 1984). The utilization of salt marshes by juvenile estuarine resident and marine transient fishes has been reported from North America (Cain and Dean, 1976; Weinstein, 1979; Rountree and Able, 1992; Desmond et al., 2000; Rozas and Zimmerman, 2000; Able et al., 2001), Europe (Cattrijsse et al., 1994; Mathieson et al., 2000; Salgado et al., 2004; Veiga et al., 2006), Australia (Morton et al., 1987; Connolly et al., 1997; Thomas and Connolly, 2001) and Africa (Le Quesne, 2000; Paterson and Whitfield, 2000, 2003). However, according to our knowledge, no study has been conducted to explore fish diversity patterns in salt marshes and their creeks from Asia.

The dominance of a few species is a general feature in fish communities of salt marshes and their creeks (Kneib, 1997). Seasonal utilizations of these habitats by fishes are commonly observed patterns (Rountree and Able, 1992; Cattrijsse et al., 1994; Salgado et al., 2004). Effects of diel periodicity on species richness and abundance of fish communities in salt marsh ecosystems have also been reported (Rountree and Able, 1993; Hampel et al., 2003). However, the nature and causes of seasonal and diel changes in fish communities may vary among different salt marshes.

In the Yangtze River estuary, coastal wetlands have experienced rapid progradations with a total seaward movement of more than 10 km during the 1950s–1990s (Yang et al., 2001). This rapid land expansion has stimulated continuous

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reclamations, which have converted over 500 km$^2$ intertidal wetlands into agriculture lands during the last 50 years (Yang et al., 2005a). In recent years, the sediment discharge rate has decreased rapidly due to the construction of the Three Gorges Dam and other dams in the Yangtze River basin (Yang et al., 2005b). Consequently, the drastic recession of coastal wetlands in the Yangtze River estuary could be expected (Yang et al., 2006). At present, there are still about 213 km$^2$ salt marshes with well-developed creek systems in the estuary (Huang et al., 2005). Previous faunal studies in salt marshes of the Yangtze River estuary have focused on detecting the effects of land reclamation and *Spartina alterniflora* invasions on meiofauna, macrofauna and birds (e.g., Wu et al., 2002; Ma et al., 2004; Chen et al., 2005; Wu et al., 2005). A full recognition of the value of these habitats for sustaining biodiversity is critical for the implement of management strategies for salt marsh ecosystems in the strongly human-disturbed Yangtze River estuary.

In this study, we investigated the fish use of salt marshes in the Yangtze River estuary for the first time. The specific goals of this work were to study the structure and temporal variations of fish community in a salt marsh intertidal creek of the estuary.

## 2. Materials and methods

### 2.1. Study sites

This study was carried out in the Shanghai Jiuduansha Wetland National Nature Reserve (31°03′–31°17′ N, 121°46′–122°15′ E) located at the Yangtze River estuary in eastern China (Fig. 1), which is a relatively undisturbed salt marsh ecosystem in the estuary. The area of the nature reserve is 135.1 km$^2$, of which about 35.67 km$^2$ is salt marshes dominated respectively by two native species, *Scirpus mariqueter* (14.40 km$^2$) and *Phragmites australis* (13.58 km$^2$), and one invasive species, *Spartina alterniflora* (7.69 km$^2$) (Huang et al., 2005). No vegetations are distributed in the salt marsh creeks. The estuary is characterized by the Asian monsoon climate, with dry periods from November to April, and wet periods from May to October. Annual mean temperature and annual mean precipitation of the islands are 15.7 °C and 1145 mm per year. Average water temperature and salinity are 13.1 °C and 9.95 in spring (March–May), 25.7 °C and 9.91 in summer (June–August), 20.5 °C and 10.25 in autumn (September–November), and 7.0 °C and 16.61 in winter (December–February) (Chen, 2003). The intertidal zones are flooded by semi-diurnal meso-tides with a pronounced neap-spring inequality, and the tidal amplitude is from 2.45 m to 4.96 m (mean tidal range 2.75 m) (Chen, 2003). Like European salt marsh ecosystems (Cattrijsse et al., 1994; Laffaille et al., 2000; Veiga et al., 2006), the entire vegetated surface of salt marshes in the Yangtze River estuary is only inundated during high spring tides.

### 2.2. Sampling design

All fish samples were collected from seven sampling sites (A–G) with average intervals of 200 m in a salt marsh intertidal creek (Fig. 1). The total length of the creek is about 2000 m. The width of the creek at the sampling sites varies from 16 m to 51 m, and the water depth at high tide from 1.6 m to 3 m which was measured as the depth from the surface of water to the bottom of the creek. Global position system (GPS) was used to ensure the consistency of site location in different sampling seasons. Quarterly fish samplings were taken during the spring tide periods on 23–25 July and 17–19 November 2004, 25–27 February and 19–21 May 2005. Fishes were sampled using seven fyke nets (4 mm mesh size) which have been used to sample fish assemblages of salt marsh creeks in previous studies (Cattrijsse et al., 1994; Salgado et al., 2004). Each fyke net was 8 m long with an opening of 1 × 1 m. Two 8 m long × 1 m high wings (4 mm mesh size) were stretched in front of the mouth of the fyke net in order to enlarge the sampling areas. At each sampling site, the fyke net was set in the middle of the creek (not blocked the creek) and faced the outgoing ebb currents to sample fish leaving the creek with the ebb. On each sampling month, fishes were collected over there consecutive tidal cycles including three day ebb tides and three night ebb tides, and the sampling intervals within these tidal cycles were about 12 h. Here, we define a tidal cycle as a tidal day, i.e., a period which includes two complete flood and ebb tides in the Yangtze River estuary. For each of the consecutive tidal cycles, we sampled fish in all seven sampling sites. For each sampling, fish were collected only once from high tide until the creek was completely drained. So, a total of 168 fish samplings using fyke nets were conducted during the study. Day and night tides were defined as those in which the flood occurred primarily during day or night, respectively (McIvor and Odum, 1986; Rountree and Able, 1993). All fish were preserved in 10% formalin seawater solutions in situ. In the laboratory, all fish were counted and identified to species. Nomenclature follows Fishbase (Froese and Pauly, 2006) except one species *Lateolabrax japonicus* which has been recently revised as *Lateolabrax maculatus* (Zhao et al., 2005). The wet weight of fish individuals was measured to the nearest 0.1 g after removal of excess water. To analyze functional structure of fish community, species were simply classified into two ecological guilds: estuarine residents (R) and estuarine transient species (T).

### 2.3. Data analyses

A randomized block design with two blocking factors was used. The first blocking factor was diel periodicity (day and night), and the second blocking factor was time of year (February, May, July and November). In order to minimize the issue of pseudo-replications, all of the fish captured on a given ebb tide at the seven locations within the creek were pooled into a single composite sample, which was expressed as the catch per unit effort (CPUE). So, a total of 24 observations were used in the data analysis. The effects of time of year and diel periodicity on fish assemblages were analyzed by two-way analysis of variance (ANOVA). Multiple comparisons were performed using Least Square Differences (LSD) tests. Differences were regarded as significant when