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# Habitat use, movement, and growth of young-of-the-year *Fundulus* spp. in southern New Jersey salt marshes: Comparisons based on tag/recapture

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**Abstract**

We examined habitat use, movement, and growth of young-of-the-year (YOY) *Fundulus heteroclitus* and *Fundulus luciae* with a tag/recapture experiment in tide-dominated salt marshes to determine if movements from *Spartina* marsh surface can account for the occurrence of larger, older individuals in other habitats. Evaluation of the tagging techniques in laboratory experiments with YOY *F. heteroclitus* (15–35 mm TL) found that coded wire tags were retained at least up to 77 days. The high rates of recapture in the field also indicate that the tagging approach generally worked well. Of a total of 5748 YOY *F. heteroclitus* (14–40 mm TL) and 133 YOY *F. luciae* (17–40 mm TL) tagged, 56.0% and 74.4% were recaptured, respectively. Most (44%) YOY *F. heteroclitus* recaptured occurred at or near (0–5 m) the release site, but some were captured up to 299 m away up to 166 days after tagging. By comparison, movement of *F. luciae* was very limited, with 99% of recaptures occurring at the exact site of release after up to 66 days at liberty. These different movement patterns by YOY *Fundulus* indicate that species-specific behavior plays an important role in habitat selection. In addition, it appears that dispersal of YOY *F. heteroclitus* can help to explain the occurrence of larger individuals of this species in *Phragmites*-dominated marshes even though there is little evidence of use of this habitat by small YOY.


*Keywords:* Fish; *Fundulus*; Growth; Habitat; Movement; *Phragmites*; Salt marsh; Young-of-the-year

## 1. Introduction

*Fundulus* spp. are among the most important fishes of salt marshes along the east coast of North America (Able and Fahay, 1998; Collette and Klein-MacPhee, 2002) because they are important predators (Kneib and Stiven, 1982) and prey (Kneib, 1982) in these productive ecosystems. As a result, they are important components of the trophic relay (Kneib, 1986, 1997; Tupper and Able, 2000; Nemerson and Able, 2003) in the shallow portions of estuaries. An emphasis on these salt marsh fishes is especially relevant because marshes are being eliminated (Valiela et al., 2004), altered (Weinstein and Balletto, 1999; Burdick and Konisky, 2003; Lathrop et al., 2003), created (Minello et al., 1994) and restored (Thayer, 1992; Weinstein et al., 2001; Zedler, 2001) yet we do not know what factors are influencing the population dynamics in natural marshes let alone those being altered by all or some of the above.

Prior studies of *Fundulus* spp. have focused on the large juveniles and adults with emphasis on habitat use (Kneib and Wagner, 1994), movement (Fritz et al.,

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1975; Lotrich, 1975; Teo and Able, 2003), and growth (Kneib and Stiven, 1978; Kneib, 1993) of the dominant species in salt marshes, *Fundulus heteroclitus*. Fewer studies have emphasized *Fundulus luciae*, in part, because this small, cryptic species has often been misidentified or unreported. The most useful summaries for this species have determined aspects of the life history and habitat use (Byrne, 1978; Kneib and Stiven, 1978; Able and Fahay, 1998). There have been relatively few comparative studies on the young-of-the-year (YOY) of these two species with the exception of some mentioned above, extensive work in Georgia salt marshes (Kneib, 1984, 1993, 1997), and those that are directed to an understanding of *Fundulus* response to the invasion of salt marshes by *Phragmites* in the northeastern US (Able and Hagan, 2000, 2003; Able et al., 2003).

We examined movements of YOY *F. heteroclitus* and *F. luciae* to compare habitat use, movements and growth of these two species. In addition, we determined if movements of YOY *F. heteroclitus* from *Spartina* salt marshes could account for the relative high abundance of this species observed in *Phragmites* marshes (Able et al., 2003; Hunter et al., in press).

## 2. Methods and materials

### 2.1. Study area

The marshes at Hog Islands in the Mullica River in southern New Jersey (Fig. 1) have two attributes that make them excellent study locations. First, there are extensive aerial photographs of the region, dating back to 1932, and two decades of data on the distribution of *Spartina* marshes and the timing and extent of the *Phragmites* invasion (Ferren et al., 1981; Windham, 1995; Windham and Lathrop, 1999). Second, the study locations are in an estuary where there are few other impacts (Psuty et al., 1993; Kennish, 2004) to confound the interpretation of natural habitat use.

Two specific study sites were chosen; one on Hog Islands (site C) and the other on marshes adjacent to Hog Islands on the mainland (site F; Fig. 1). The specific habitats on sites C and F were marsh pool, intertidal creek, subtidal creek, and marsh edge. Marsh pools were distinct pools of standing water on the marsh surface which were only available for fish immigration/emigration at high tide when the surrounding marsh surface flooded with semidiurnal tides or during storms. Intertidal creeks included creeks that drained at low tide, although many of these creeks had standing water pools (depth range = 0.05–0.4 m) at low tide because of shallow sills at the creek mouths. Subtidal creek habitat (only available at site C) was defined as creeks with a permanent water connection to the Mullica River during all tide stages. Marsh edge included mostly subtidal areas adjacent to the marsh surface; however, some locations were relatively shallow and typically exposed at low tide. In previous years, in the vicinity of these study sites, vegetation was dominated by *Spartina alterniflora*, with *Spartina patens*, *S. cynosuroides*, *Amaranthus cannabinus* and *Scirpus americanus* present in small amounts, which is typical for natural marshes in the area (Able and Hagan, 2000, 2003). However, along the transect of wire mesh trap sites (see below), approximately 300 m upstream and downstream from tag and release sites, there were patches (5–140 m of marsh edge) consisting of monocultures of *Phragmites australis* at both sites (Fig. 1).

### 2.2. Sampling and tag/recapture techniques

Sampling for fishes occurred from the end of June through December 2002 with wire mesh traps (3 mm bar mesh with a 20 mm diameter opening) and weirs (2.0 m × 1.5 m × 1.5 m, with 5.0 m × 1.5 m wings, 3.0 mm bar mesh) in specific habitat types (Table 1). *F. heteroclitus* and *F. luciae* were identified (Byrne, 1978; Hardy, 1978; Able and Fahay, 1998) counted and measured to nearest 1 mm total length (TL). Tagging of some of these captured fish occurred from 25 June to 28 August 2002. Young-of-the-year *F. heteroclitus* (15–40 mm TL) and *F. luciae* (17–40 mm TL) were tagged with coded wire tags (1.1 mm long × 0.28 mm diameter, Northwest Marine Technology Inc., Jefferts et al., 1963) using etched needles (diameter = 0.47 mm) on a hand-held coded wire tag injector. This technique has been previously used in Delaware Bay marshes on larger (20–100 mm TL) *F. heteroclitus* (Teo and Able, 2003). Several standing water pools within intertidal creeks served as tag and release sites at site F ($n = 2$ of 5 tag-and-release sites) and site C ($n = 1$ of 1). The remaining tagging sites at site F ($n = 3$ of 5) were marsh pools. After tagging, fish were monitored for at least 2 h. After all mortalities (6.8% of 6306 individuals initially tagged) were removed, fish were released back in the sites from which they were initially captured. During the first 2 weeks, there was intensive tagging with no recapture effort. Thereafter, tagging occurred every other week through the end of August while the recapture effort occurred weekly from 8 July to 24