Undergraduates through the Boston University Marine Program and also by the Plum Island Sound LTER Program. We thank Simon Panall, João Feliciano Salgado, Susan Oleszko, Jaimie Champagne, Nate Tsao, Marc McDonnell, Jeff Hughes, and Jesse Young for their help.

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Influence of Marsh Flooding on the Abundance and Growth of *Fundulus heteroclitus* in Salt Marsh Creeks

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Like many other estuarine fish and crustaceans, *Fundulus heteroclitus* (mummichog) regularly makes use of the marsh as a foraging area, nursery habitat, and refuge from predators. Mummichogs are known to follow flooding tides onto the intertidal marsh to forage (1, 2). Through this behavior, they provide an important trophic link between salt marsh and open estuary (3). Previous research indicates that access to the intertidal flooded marsh has significant effects on the growth rate of *F. heteroclitus.* Weisberg and Lotrich (4) showed that foraging exclusively on subtidal food sources was not sufficient to support normal growth rates of mummichogs. Javonillo *et al.* (5) found that mummichogs denied access to the marsh had lower growth rates than those that were allowed entrée to the marsh surface. Both of these studies employed caging techniques on a relatively small scale. Our goal was to examine the importance of marsh flooding to mummichog growth and abundance in a natural environment without enclosures.

Tidal creek flooding onto the marsh determines the vegetation in the area surrounding the creek. *Spartina alterniflora* grows on the marsh adjacent to the creek that floods on every high tide, whereas *S. patens* grows on the higher marsh that floods less frequently. We measured the length from the creek edge to the transition between *S. alterniflora* and *S. patens* at increments along the creek. The mean of these measurements multiplied by the length of the creek was considered the area of marsh accessible to mummichogs at high tides. This area is equivalent to the area of marsh adjacent to the creek covered by *S. alterniflora.* A comparison of the regularly flooded area in the 5 tidal creeks that were part of our study is shown in Figure 1a.

We measured the abundance and growth of *F. heteroclitus* in tidal salt marsh creeks of the Rowley River in the Plum Island Estuary in northeastern Massachusetts (42°44′ N × 70°50′ W). Over 6 weeks, catch-per-unit-effort (CPUE) was measured three times in each of five salt marsh creeks. Ten minnow traps (6.35-mm mesh), spaced evenly in the primary tidal creeks, were set at high tide and retrieved about 5 h later during low tide. In two of the creeks, we measured growth of mummichog young-of-the-year, the life stage in which the most dramatic growth occurs. Four times during the 6 weeks (first three times coincided with CPUE measurements, plus one additional growth measurement), the total lengths of between 275 and 1000 fish from each creek were measured, and length-frequency histograms were constructed. Probability paper was used, according to the method described by Harding (6), to identify the young-of-the-year cohort from the length-frequency histograms. Mean values from each set of measurements were plotted to evaluate growth.

Catch-per-unit-effort measurements indicated that mummichogs tended to be more abundant in creeks with greater areas of frequently flooded marsh (correlation coefficient = 0.83, $P = 0.09$) (Fig. 1b). This relationship suggests that creeks with increased marsh flooding are able to support a larger population of mummichogs by providing greater regularly flooded areas for foraging, or that creeks with increased flooding offer greater refuge from predation. Mummichogs that follow the high tide onto the marsh surface become more exposed to predation by shorebirds, but they gain protection from predation by larger fish, the more likely predator. Although the creeks are very similar, properties other than regularly flooded area—including dimensions, water volume, temperature regime, productivity, and food availability—may affect the abundance of mummichogs in a creek.

The pattern of growth was the same for young-of-the-year mummichogs in Sweeney Creek and Club Head Creek (Fig. 1c). However, the mean total length values of mummichogs from Sweeney Creek were significantly greater than mean total length measurements from Club Head Creek (Complete Randomized Block ANOVA $P < 0.05$). Though statistically significant, the very small mean difference between measurements of 1.25 mm is unlikely to be of ecological significance, especially since the pattern of growth did not differ between the creeks. Unlike in

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enclosure experiments in which mummichogs were denied access to the marsh (4, 5), all fish in our study could access the marsh, though the extent of this access differed among creeks. Thus, because the lower marsh is accessible at every high tide, differences in regularly flooded accessible marsh area may not be great enough to cause a large difference in mummichog growth.

This work was funded by NSF Research Experience for Undergraduates through the Boston University Marine Program and the Plum Island Sound Long-term Ecological Research Program. We thank Simon Panall, Nate Tsao, Marc McDonnell, Susan Oleszko, João Salgado, Jaimie Champagne, and Jeff Hughes for their help with the project.

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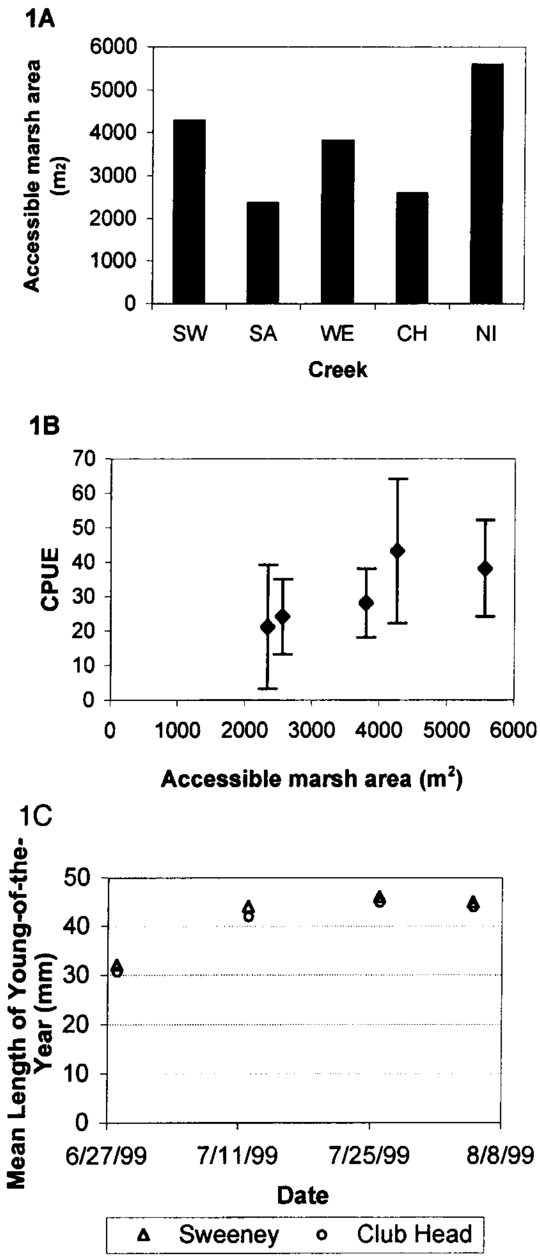

Figure 1. *(A) Regularly flooded accessible marsh area (m^2) by tidal creek, ordered from upstream to downstream: SW, Sweeney Creek; SA, Sand Creek; WE, West Creek; CL, Club Head Creek; and NE, Nelson Island Creek. (B) Mean catch-per-unit-effort (number of fish ± 1 standard error) plotted against regularly flooded accessible marsh area (m^2). (C) Mean total length measurements (mm ± 1 standard error, standard errors all < 0.1) at Sweeney Creek and Club Head Creek plotted against date of measurement.*

Reference: *Biol. Bull.* **197:** 300–302. (October 1999)

Decline of a Horseshoe Crab Population on Cape Cod

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The American horseshoe crab, *Limulus polyphemus,* inhabits coastal estuaries of North America from Northern Maine to Florida, as well as the region around the Yucatan peninsula. Delaware Bay contains the largest known population, but surveys of the New Jersey beaches that border the Delaware Bay show a decline of about 50% in the spawning population since 1990 (ref. 1 and B. L. Swan, pers. comm.). Trawl surveys of Delaware Bay from 1990 to 1997 yielded a 74% decline in crabs caught per tow (2). These declines do not appear to be isolated events; the populations of crabs spawning on the beaches of Cape Cod have also declined. We report here the results of a longitudinal study of the spawning population at Mashnee Dike, Bourne, Cape Cod, Massachusetts. In