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Nekton density patterns and hurricane recovery in submerged aquatic vegetation, and along non-vegetated natural and created edge habitats

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ABSTRACT

We compared nekton habitat value of submerged aquatic vegetation, flooded non-vegetated natural and man-made edge habitats in mesohaline interior marsh areas in southwest Louisiana using a 1-m^2 throw trap and 3-mm bag seine. When present, SAV habitats supported close to 4 times greater densities and higher species richness of nekton as compared to either natural or man-made edge habitats, which supported similar densities to one another. Three species of concern (bayou killifish, diamond killifish, chain pipefish) were targeted in the analysis, and two of the three were collected almost entirely in SAV habitat. During the course of the study, Hurricanes Ike and Gustav passed directly over the study sites in September 2008. Subsequent analyses indicated significant reductions in resident nekton density 1-mo post hurricanes, and only limited recovery 13-mo post-hurricane. Possible alteration of environmental characteristics such as scouring of SAV habitat, deposition of sediment over SAV, edge erosion and marsh loss, and extended high salinities may explain these lasting impacts.

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1. Introduction

Debate over the relative value of dominant shallow-water estuarine habitat types in support of nekton productivity remains a central issue affecting fisheries management and coastal restoration. Estuaries are composed of an assortment of shallow-water habitat types (i.e., salt marsh, oyster reefs, submerged aquatic vegetation, non-vegetated bottom), many of which have been identified as extremely productive areas that support dense populations of nekton (e.g., Weinstein, 1979; Boesch and Turner, 1984; Kneib, 1997; Minello, 1999; Minello et al., 2003; Shervette and Gelwick, 2008; Stunz et al., 2010). In the northern Gulf of Mexico, extensive coastal marsh loss affects both the amount and location of all of the shallow-water habitat types. Within this changing landscape, efforts to protect, enhance and restore habitat further affect the distribution of habitat types across the coast. For management and restoration of these habitats, the relative value of these changing and created habitats is of increasing importance given the scale of coastal restoration in the northern Gulf of Mexico.

Interhabitat comparisons are critically important in helping to define conservation priorities, but results are rarely comparable between studies, and parameters of interest vary depending on the management question of interest. For example, at the species level, Minello (1999) examined data from over 20 studies taken from six habitat types in Texas and Louisiana and concluded that each of the six habitat types was of highest relative importance for at least one species. At the community level, studies often rank relative value of habitats based on the tenet that high animal densities indicate high quality or preferred habitat, and while conclusions vary, they tend to rank habitats providing structure (i.e., submerged aquatic vegetation, oyster reefs) above those without structure (i.e., non-vegetated bottom) (Baltz et al., 1993; Rozas and Minello, 1998; Plunket and La Peyre, 2005; Shervette and Gelwick, 2008; Stunz et al., 2010).

Mixed within this diverse assortment of shallow-water habitat types are man-made or enhanced habitats. There remains much uncertainty as to how well these restored or created habitats function in comparison to their natural counterparts. For nekton in particular, conclusions differ as to the equivalency of these created habitats with some study results suggesting equivalency based on density, abundance, biomass, or growth of nekton, and some finding that the created habitats fail to provide equivalent services at the time each study was conducted (Minello and Webb, 1997; Minello, 2000; Rozas and Minello, 2001a,b; Bush Thom et al., 2004; La Peyre et al., 2007; Zeug et al., 2007; Llewellyn and La Peyre, 2010). Given the substantial investment of effort and money in restoration, enhancement and creation of habitats,

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relative interhabitat comparisons that include both "natural" and man-made habitats are essential in determining relative habitat values and helping set conservation priorities (Beck et al., 2001).

In southwest Louisiana, numerous management and restoration projects target the enhancement of SAV beds and the creation of marsh edge (LCPRA, 2007). However, few published studies have compared nekton assemblage between SAV beds, natural and man-made marsh edge habitats to identify priorities for either protection or restoration. We use the term "natural" to refer to habitats that were not intentionally created by humans; "man-made" edges are those created through terracing projects in marshes, or levees. Specific objectives of our study were to quantify and compare nekton assemblages among naturally occurring submerged aquatic vegetation beds, natural marsh edges and man-made marsh edge (<1 m on the water side of the water−marsh interface composed of flooded mud-bottom) in southwest Louisiana using multiple measures including nekton density, abundance, biomass, assemblage composition, and abundance of three listed species of concern (*Syngnathus louisianae, Fundulus pulvereus, Adinia xenica*) (Lester et al., 2005). We also examined if these observed patterns varied seasonally. Furthermore, Hurricanes Ike and Gustav impacted our sites during the study which allowed us to compare habitat recovery and nekton assemblage 12-mo pre, 1-mo post and 13-mo post-hurricane.

2. Methods

2.1. Study area

Sites were selected at three study units, two located at Rockefeller State Wildlife Refuge (RWR; 29°40′30″N, 92°48′45″W) and one located at Sabine National Wildlife Refuge (SWR; 29°54′N, 93°32′W) in southwest Louisiana (Fig. 1). All sites are brackish water with long-term salinity ranging between 8 and 15 (LOCPR, 2011). Site 1 is located in Unit 4 of RWR, which is a 2,400-ha impoundment managed via two variable-crest flap-gated structures. The area is dominated by saltmeadow cordgrass *Spartina patens* marsh (Flynn et al., 1999). *Ruppia maritima*, *Potamogeton pusilus*, and *Myriophyllum spicatum* occur in this area (Chabreck, 1970; Gossman, 2005). Site 2 is located in Unit 5 of RWR, which is a 1,982 ha impoundment directly south of Unit 4. The area is composed of *S. patens* dominated marsh. Levees are constructed around 3 sides of the impoundment, while the southern end is a broad beach rim at the Gulf of Mexico. *R. maritima* and *P. pusilus* occur in this unit (Chabreck, 1970; Gossman, 2005). Site 3 is located in SWR, south of Hog Island Gully and along the western edge of Lake Calcasieu. The marsh is dominated by *Spartina alterniflora*. The area includes terraces built in 1990. Several species of SAV are reported in the shallow water areas (*R. maritima, Halodule wrightii, Thalassia testudinum)* (LDNR, 1993).

2.2. Sampling design

The three study sites were sampled using a stratified random sampling design. Within each study site, triplicate sample sites were randomly selected within each of the three pre-identified habitat types (SAV, natural edge, man-made edge). Sample sites were a minimum of 500 m from one another, and SAV sites were a minimum of 100 m from a shoreline edge of any kind. Samples were taken in June and October 2007, January, March, June, and October 2008 and October 2009. The 2009 sampling was added because our sites experienced a direct hit from both Hurricanes Gustav and Ike on Sept. 1 and Sept 13, 2008 respectively. October 2008 sampling was 1 month post-hurricane while October 2009 sampling occurred 13

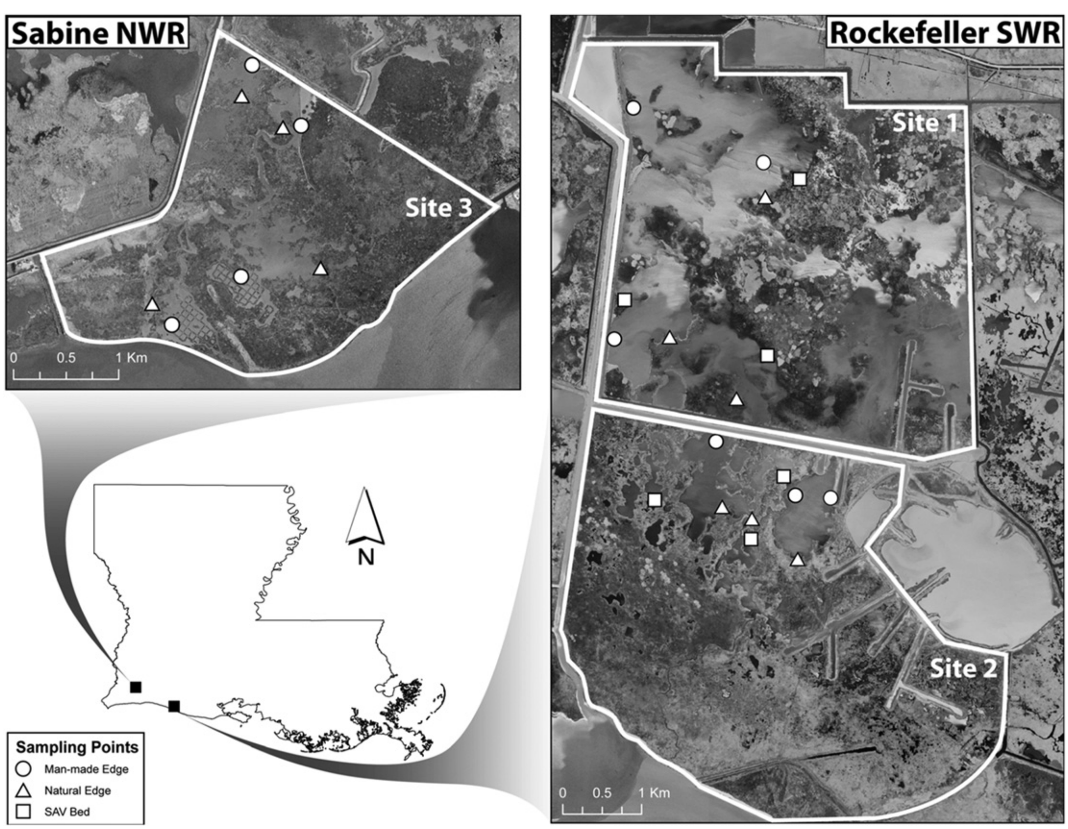

Fig. 1. Study site locations in southwest Louisiana. All study sites were located in interior mesohaline marsh. Study sites 1 and 2 were both located at Rockefeller State Wildlife Refuge. Study site 3 was located at Sabine National Wildlife Refuge.