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A a : Annual production of vegetation is an important indicator of various ecosystem processes in coastal marshes; many factors, both biotic and abiotic, can influence production of aboveground biomass. Using a 14-year data set, we evaluated the relative influence of 38 biotic and abiotic factors on annual aboveground biomass of an intermediate coastal marsh on the upper Gulf Coast of Texas. We used visual obstruction (VO) measurements as a surrogate variable in a prediction model to estimate available aboveground biomass in the marsh. Available biomass was greatest (3.34 kg/m^2) when sampling site was flooded. Plant growth form, type of animal present, and composition of the ground cover influenced biomass of the marsh. Presence of insects was related to biomass (regression beta weight 5 0.28), uniquely accounting for 7.6% of the incremental variance in biomass. The presence of moderate amounts of litter was also related to available biomass (beta weight 5 0.86). Soil capping had little or no influence on aboveground biomass. Implementing standard protocols for long-term vegetation monitoring can be cost and time intensive. Our results suggest quantitative measurement of VO and qualitative observation of few variables (standing water, insects, and litter) measured annually can yield a reasonable assessment of aboveground biomass of intermediate coastal marshes.

: aboveground biomass, growth form, insects, intermediate coastal marsh, litter, soil capping, visual obstruction (VO) measurement

INTRODUCTION

Many biotic and abiotic factors can alter the structure and function of wetland plant communities by influencing the extant community composition, growth, nutrient acquisition, and productivity. Evaluating the relative influence of factors that affect production of aboveground biomass in coastal wetlands is important for wetland ecologists and managers because macrophytes are the main source of organic matter that supports various trophic structures in these systems (Teal 1962, Odum and Heald 1975). For example, canopy structure and distribution of herbaceous species in tidal freshwater swamps are primarily determined by the flooding regime (Rheinhardt 1992). Increased levels of sedimentation and flooding have been shown to reduce seedling emergence in freshwater wetlands (Peterson and Baldwin 2004). Bhattacharjee et,er that secne3 555albvaO)4wrertedthat4eextendedflooding4etorprbud

most important abiotic factors regulating production of vegetation biomass (Ungar 1998). However,

Pers.) (United States Fish and Wildlife Service, unpublished data), which is typical for intermediate marsh habitats found in mesohaline

biomass (kg/m^2) (Biomass 5 20.177 + 0.057 * VO, r^2 5 0.69, P 5 0.005, n 5 9). The use of VO measurement to predict biomass has been used widely as an effective and nondestructive means to estimate annual production (Vermier and Gillen 2001, Whitbeck and Grace 2006), and the effectiveness and ease of estimation makes VO measurements useful for wildlife managers to estimate biomass as a means of assessing habitat condition.

Data Analysis

We used a two-factor analysis of variance to test for differences in productivity among years and between sampling periods with or without standing

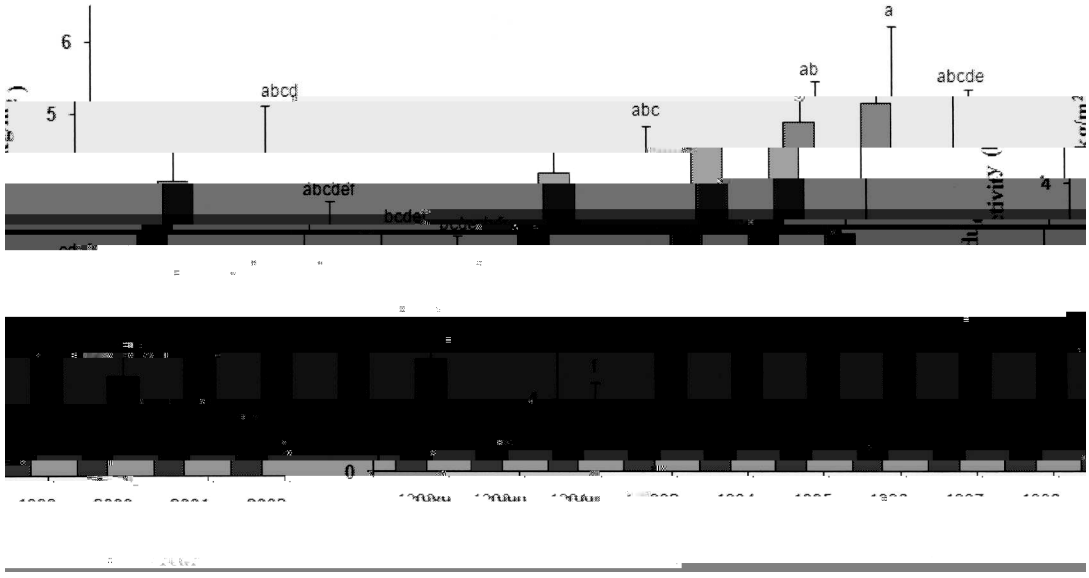

Figure 3. Mean biomass (kg/m^2) of vegetation samples conducted annually from 1989 to 2002, in an intermediate coastal marsh at East Bay Bayou, Anahuac National Wildlife Refuge, Texas. Year 1993 was not used due to loss of data. Years represented by the same lowercase letter were not different (P . 0.05). Bars represent standard errors.

attributed to the favorable growing conditions for plants adapted to marsh hydrology. Water stress (i.e., drought) in wetland plants has been known to reduce overall biomass (Froend and McComb 1994, Hudon et al. 2000, Wilcox 2004). Haukos and Smith (2006) reported that under slight water stress, some wetland plants redistributed resources by increasing seed production against vegetative development. Further, results of a recent study by Touchette et al. (2007) on drought tolerance in wetland plants, suggest that drought periods as short as 14 days are sufficient to reduce productivity significantly. Thus, in our study, water stress might have led to reduced morphological development and altered resource allocation in the marsh plant community during years with no standing water.

Year-end biomass of the marsh was related to plant growth form, type of animal present, and composition of the ground cover. Biomass was greatest in areas where plants exhibited a normal pattern of growth (abundant seed production, good tillering, or branching, and absence of any old or

Table 1. Different environmental categories and their corresponding factors[1] that were used to predict aboveground vegetation biomass in an intermediate coastal marsh at East Bay Bayou, Anahuac National Wildlife Refuge, Texas from 1989–2002.

Category	Variable(s)	t	P

dead branches). Typically, brush exhibited stout appearance and often had several dead branches contributing little towards VO measurement. Similarly, overgrazed plots were characterized by grasses that were short and had more lateral than vertical branches; any associated shrubs had a heavily hedged appearance. These structural characteristics were associated with low VO measurements and indicative of reduced levels of available biomass.

Ground cover had a direct influence on available aboveground biomass of the marsh. Bare ground reflected lack of vegetation, whereas increased ground cover by litter resulted in greater productiv-