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Aquatic macroinvertebrates associated with *Schoenoplectus* litter in a constructed wetland in California (USA)

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ABSTRACT

Culm processing characteristics were associated with differences in invertebrate density in a study of invertebrates and senesced culm packs in a constructed treatment wetland. Invertebrate abundance differed by location within the wetland and there were differences between the two study years that appeared to be related to water quality and condition of culm material. Open areas in the wetland appeared to be critical in providing dissolved oxygen (DO) and food (plankton) to the important invertebrate culm processor, *Glyptotendipes*. As culm packs aged, invertebrate assemblages became less diverse and eventually supported mostly tubificid worms and leeches. It appears from this study that wetland design is vital to processing of plant material and that designs that encourage production and maintenance of high DO's will encourage microbial and invertebrate processing of material.

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1. Introduction

Emergent plants are often integral elements of treatment wetlands. Plants sequester nutrients and other constituents and also act as filters for removal of suspended solids (Verhoeven and Meuleman, 1999). Plant litter accumulation and decomposition are also important wetland functions, with a balance between these components needed to sustain wetland productivity (Magee, 1993). These functions may be especially significant in constructed wetlands, where excessive litter accumulation can hinder nitrogen cycling, consume oxygen, and increase mosquito habitat (e.g., Thullen et al., 2005). Management of constructed wetland plant biomass is frequently necessary to improve treatment reliability. Treatment wetlands occasionally need to be taken off-line when biomass from senescent plants builds up to the point where treatment is compromised. Physical removal of litter can be costly in manpower and equipment, while natural processes may be too slow or unreliable for management purposes.

Litter decomposition typically occurs in steps which progress sequentially from leaching and microbial colonization to processing by invertebrates (e.g., shredders). While the importance of these processes has been recognized, little information is available on decomposition of macrophytes in wetland systems (e.g., Varga, 2001; but see Chimney and Pietro, 2006), and especially in constructed wetlands. Information on decomposition and conditions needed to encourage invertebrate decomposers could aid in improving constructed

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wetland reliability and also decrease costs, especially those associated with facility downtime.

It is unclear how critical invertebrates are to the breakdown process in wetlands (e.g., Polunin, 1984), with some reporting no effect of macroinvertebrates on vegetation breakdown rates in wetlands (Menéndez et al., 2004). In general, however, it is suggested that shredders are not important elements of material processing in wetlands (Wissinger, 1999). In some cases the wetland environment may not be suitable for invertebrate production and microbes may account for the vast majority of litter weight loss (Magee, 1993). A few studies (Alvarez et al., 2001), however, have indicated major positive impacts of invertebrate shredders to wetland litter processing rates and modeling exercises have indicated that the addition of plant matter can have large impacts on wetland macroinvertebrate (including shredders) standing crop (Spieles and Mitsch, 2003). Specific wetland design attributes may be important for encouraging invertebrate colonization of constructed wetlands. Wetland designs that focus on invertebrate biodiversity are rare (Hannsson et al., 2005) with limited information on constructed wetlands and associated invertebrate communities available (e.g., Nelson et al., 2000). To our knowledge there are no papers on macroinvertebrates related to culm processing in constructed wetlands.

This study of macroinvertebrates associated with decomposing bulrush (*Schoenoplectus* spp. culms) took place at a constructed wetland used for treating ammonia-dominated secondary effluent. The study was designed to describe how culm pack macroinvertebrates varied with water depth, gradients of physical and chemical constituents, plant material species, and temporally (different years). Information from this study on microbial versus invertebrate processing in the wetland has been previously reported (Thullen et al., 2005). Culm decomposition rates associated with these packs are reported in Thullen et al. (2008). Our objective was to use this information to make recommendations for wetland designs that might allow for more efficient breakdown of culm material in constructed wetlands.

2. Study location

The 9.9 ha wetland was constructed in 1994 at the Hemet/San Jacinto Regional Wastewater Reclamation Facility located about 135 km southeast of Los Angeles, California, USA. There have been numerous reports concerning operations at this site and details are reported in Sartoris et al. (2000), Smith et al. (2000), Thullen et al. (2002), Andersen et al. (2003), and Thullen et al. (2005). Several inlets introduce water into the site which is shaped somewhat like a hand (Fig. 1). The site was drained and senescent emergent vegetation and detritus burned in July 2002. Interior planting areas were reconfigured into vegetation bands with more open water in the fall, 2002 and then re-watered in May 2003.

3. Methods

Sampling sites were situated at six locations: three sites in the inlet marshes and three sites in the outlet marshes (Fig. 1). The study was divided into Period I (June 2003–February 2004) and Period II (June 2004–February 2005). Standing dead culms of *Schoenoplectus californicus* (California bulrush) and *Schoenoplectus acutus* (hardstem bulrush) were collected in October 2002 for use in Period I. Culms were air-dried to a constant mass and approximately 20 g placed in packs (20 cm × 20 cm) made of polypropylene mesh (mesh opening = 1 cm). Culm packs were attached to tee posts using stainless steel wire at the six locations within the wetland and at two depths (surface and bottom, ca. 50 cm deep). Replicate samples (one at each inlet versus outlet/depth combination per date) were collected periodically [after 2 months (August), 4 months (October), 6 months (December), and 8 months (February)]. Fine-mesh packs (300-μm mesh) filled with 20 g of culm material were

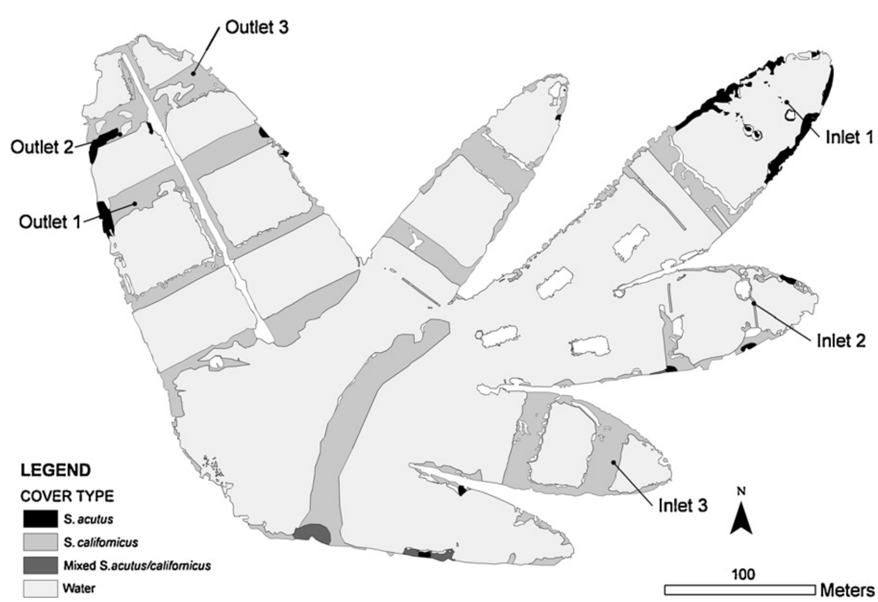

Fig. 1 – Location of sampling sites within the Hemet/San Jacinto Demonstration Wetland. Darker gray areas within the wetland indicate bands of vegetation with lighter areas associated with open water. Rectangular areas are loafing areas for waterfowl.