EFFECTS OF HYDRAULIC MANIPULATION ON HABITAT AVAILABILITY FOR MIGRATORY SHOREBIRDS IN AN AUSTRALIAN COASTAL WETLAND

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Coastal wetlands provide a range of ecosystem services including primary production, flood attenuation, storm surge protection, groundwater recharge and filtering of surface flows (Mitsch and Gosselink 2000; Wolanski et al. 2004). They also provide habitat for migratory shorebirds, which feed primarily on benthic invertebrates in intertidal mudflats. During high tide, when intertidal mudflats are submerged, many species of migratory shorebird roost in salt marsh and tidal pools as close as possible to their primary feeding grounds (Geering 1995). In Australian estuaries, salt marsh is often squeezed between landward encroachment of mangrove forest and urban/industrial development of foreshore land (Adam 2002; Saintilan and Williams 2000; Wolanski et al. 2004). Efforts to maintain and rehabilitate shorebird habitat, including salt marsh, are hampered by an incomplete understanding of the complex ecological processes that govern estuarine habitat distribution (Boumans et al. 1997; Rodríguez et al. 2004).

This study focuses on a rehabilitated wetland in the Hunter estuary, NSW, Australia, which is an important migratory shorebird roost site. Estuarine habitats include mangrove forest, salt marsh, mudflat and tidal pools. The area is hydraulically complex, with a number of culverts and roads that compartmentalise flow. In 1995, two 500 mm culverts were removed from one of the two inlets to the study area to improve tidal flushing. This paper investigates the effect of hydraulic manipulation on topography, suspended solids, hydraulics and migratory shorebird roost habitat availability in the compartment immediately upstream of the removed culverts, where tidal range is unattenuated, and a compartment deeper in the wetland with an attenuated tidal range.

Data collection involved topographic survey by differential global positioning system (DGPS); habitat distribution mapping by aerial photography, DGPS and randomly located nested quadrats; water level monitoring using pressure transducers; flow field measurement by acoustic Doppler velocimeters; and gravimetric analysis of total suspended solids.

Habitat in both the unattenuated and attenuated compartments show the same sequence of zonation: mudflat occurs at low elevation, followed up the topographic gradient by mangrove, salt marsh and pasture. The effect of tidal attenuation due to hydraulic control is to shift vegetation at the upper end of the topographic gradient (pasture and salt marsh) downslope due to the lower tidal range, whilst at the lower end of the topographic gradient, mangrove and mudflat vegetation is shifted upslope due to the increased hydroperiod.

Prior to removal of culverts at the mouth of Fish Fry Creek in 1995, both compartments showed similar patterns of habitat zonation, which were driven by an attenuated tidal range and extended hydroperiod. After culvert removal, a semi-diurnal (M2) mesotidal regime with a range of ~1.6 m was reintroduced to the unattenuated compartment, which effected rapid and dramatic changes in vegetation and topography: shallow tidal pools fringed with salt marsh were replaced by extensive areas of mangrove forest with developed tidal channels.

The unattenuated compartment exhibits elevated mean velocity (ū) and turbulent kinetic energy (*k*), which leads to increased entrainment of bed sediments, lowering of bed elevation and increased export of sediment. In the attenuated compartment, the low ū and *k* do not supply sufficient energy for entrainment of bed sediments, creating an environment that favours sediment deposition and marsh accretion; however, the high density of mangrove stems and pneumatophores in the unattenuated compartment promotes sediment deposition prior to its transport deeper into the wetland.

In the attenuated compartment, hydraulic controls maintain permanent tidal pools with a microtidal range (~0.3 m) that drive an ebb-dominated tidal asymmetry, with short, strong ebb currents and longer, weaker flood currents. Habitat change following culvert removal was initially slower; however, the increased tidal range and flow velocity in the unattenuated compartment are gradually eroding tidal channels between the two compartments, which appears to be altering hydraulic conditions sufficiently to allow mangrove encroachment deeper into the wetland. It is anticipated that, without intervention, much of the salt marsh in the study area will be converted to mangroves by this process.

The landward incursion of mangroves into salt marsh is a key threat to the roost habitat of migratory shorebirds. Where there is insufficient space for landward migration of estuarine vegetation, such as in the study area, the resulting vegetation community distribution may not meet the conservation outcomes envisaged by wetland managers. Hard engineering works have a role to play in maintaining preferred estuarine wetland habitat in areas where landward migration is constrained by topography or land use. These hydraulic controls provide an opportunity to manipulate tidal flow to meet management criteria; however, detailed baseline topographic and hydraulic survey is necessary, as well as hydrodynamic modelling of alternative management scenarios and careful consideration of the sediment flux required to facilitate salt marsh accretion at rates in excess of marsh subsidence and sea level rise.

Keywords: ecohydraulics, estuarine wetlands, migratory shorebirds, coastal development; management

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