Plant Harvesting from a Constructed Wetland: Nutrient Removal and Plant Attributes

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ABSTRACT

The capacity for wetlands to function as sinks for nutrients has been widely exploited to treat a variety of wastewaters. Much debate has centred on the contribution to nutrient storage via acquisition and assimilation, by aquatic macrophytes to the overall sink capacity of constructed wetlands. This study investigated the nutrient storage and removal potential of four aquatic macrophyte species (*Bolboschoenus medianus, Phragmites australis, Triglochin procerum* and *Typha domingensis*) at the Willunga constructed wetland system, South Australia.

The macrophytes at Willunga had large above ground biomass and high tissue nutrient concentrations compared with maximum values in other studies. The storage capacity for nitrogen and phosphorus of two species not commonly used in constructed wetlands (*Triglochin procerum* and *Bolboschoenus medianus*) were 70.7 g N m^{-2} 6.8 g P m^{-2} respectively. These were significantly higher than the values recorded for species commonly used in constructed wetlands (*Typha domingensis* and *Phragmites australis*). In addition, *Triglochin* maintained a high tissue nutrient concentration throughout the year (29.1 – 36.6 mg N g^{-1} dwt; 3.6 – 4.8 mg P g^{-1} dwt), whereas the tissue nutrient concentrations for *Bolboschoenus* and *Phragmites* were low during winter senescence.

A comparative study was undertaken to determine the influence of single versus multiple harvest on the removal of nutrients. Generally, potential nutrient removal was higher under multiple regimes than single regimes for *Bolboschoenus, Triglochin* and *Typha*. Multiple harvests of *Phragmites* did not remove greater quantities of nitrogen and phosphorus due of poor regrowth after harvesting.

The range of parameters measured at the Willunga system was used to construct a simple predictive computer model which calculated nutrient removal via harvesting as a percentage of total annual nutrient load. Under the current plant densities, nutrient loading and wetland area, a single harvest of all above ground plant material during late summer (February) would only remove 6.1% of annual N load and 2.2% of annual P load. A multiple harvest regime (harvest in November followed by a harvest in February) would increase the removal to 8.7% N and 3.3% P. The model was used to make nutrient removal predictions under a variety of hypothetical wetland configurations.

Other ecological aspects were investigated for the four species (*Typha* and *Triglochin* in particular) in both field and controlled conditions. This included investigations into the implications of the contrasting rhizome extension strategies observed at the Willunga system for *Triglochin* and *Typha*. Also a controlled pond based experiment demonstrated that location of nutrient supply (sediment versus water nutrient addition) had little influence on total above ground biomass, however differences in storage capacity resulted from variation in nutrient concentration of that above ground biomass. Another pond based experiment investigated the resulting biomass and growth performance for *Triglochin* and *Typha* when grown in a replacement series design.

Overall, it was concluded that wetland design and management were crucial to nutrient storage and removal by aquatic plants. Appreciation of plant responses to environmental factors such as nutrient addition regime and water depth, was integral to an understanding of the processes which optimise nutrient removal from wetlands via aquatic plants.