Livestock-Generated Nitrogen Exports from a Pastoral Wetland

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When wetlands are disturbed by cattle, pulses of contaminants may be released. We studied nitrogen exports from a small pastoral wetland (1725 m²) in the Lake Taupo Catchment, New Zealand, to which cattle and sheep had periodic access. Flow, turbidity, and water quality samples were collected at the wetland outlet over 2 yr. Turbidity was used to trigger sampling during livestock grazing and as a surrogate for organic N (OrgN) and total N (TN) in flux estimation. The wetland flowed throughout the study (median 0.285 L s⁻¹) and was baseflow dominated (73%) but responded to rainfall (peak storm flow 166 L s⁻¹). Organic N was the dominant N form exported (median OrgN:TN ratio 0.86). During cattle grazing periods, concentrations and fluxes of all forms of nitrogen at the outlet were elevated compared with storm and baseflow conditions during nongrazed periods. The TN fluxes were nine times greater when cattle grazed the wetland (306 g d⁻¹) than under nongrazed baseflow conditions (32 g d⁻¹). Cattle grazing occurred 9% of the time but accounted for 34% of TN export over 11 mo. Excluding cattle from small wetlands is likely to have immediate water quality benefits.

Disturbance of pastoral wetlands by livestock can entrain organic substrate, resulting in pulses of slurry entering streams. While the impacts of livestock (e.g., sheep, cattle, and deer) grazing on riparian zones, streams, and water quality have been widely investigated, the research on wetlands has an ecological rather than physical focus (e.g., Menard et al., 2002; Jansen and Healey, 2003; Foote and Hornung, 2005).

Pastoral wetlands occur at the heads and along the sides of streams. They may also be known as seeps, flushes, valley bottom, or riparian wetlands. They are mainly fed by subsurface flow that re-emerges via springs and seeps, and their saturation status may range between temporary dryness and permanent saturation. Pastoral wetlands are numerous on many New Zealand farms and have been widely viewed by farmers as a suitable water supply for stock. Pastoral wetlands are often small (10–5000 m²) and consequently they are rarely identified in regional wetland inventories or managed any differently from surrounding pasture. Although they are individually small, they may represent a large part of headwater catchments and their direct connection with the stream network makes them a potential source of agricultural pollutants.

Wetlands can provide suitable conditions for deposition of particulate N and biogeochemical processing of dissolved N. The dominant nitrogen processes are (i) denitrification of nitrate by organic, anaerobic soils; (ii) uptake of ammonium and nitrate by aquatic plants; (iii) settling of particulates; (iv) adsorption of fine particulates onto the surfaces of plants and detritus, and (v) mineralization of particulate organics to release ammonium and nitrate. Nitrogen can be lost from wetlands as inorganic N (mineral N, nitrate N, nitrite N, ammonium N) or organic N (particulate OrgN, dissolved OrgN), and the relative losses of each form will vary under baseflow, stormflow, and disturbed conditions. Short- and longer-term studies suggest that nitrate removal by pastoral wetlands under baseflow conditions can exceed 75% (Cooper, 1990; Downes et al., 1996; Rutherford and Nguyen, 2004). Lower removal rates are expected during events or when channels occur in the wetlands, resulting in a significant fraction of water and nutrient bypassing the soil matrix (Burns and Nguyen, 2002; Nguyen et al., 1999). Nguyen et al. (1999) found that while small wetlands can be sediment sinks during low flows, fine sediment and particulate organics

Abbreviations: AEP, annual exceedance probabilities; NTU, nephelometric turbidity units; OrgN, organic nitrogen; PN, particulate nitrogen; SU, stocking unit; TN, total nitrogen.