APPENDIX J
STREAMSIDE VEGETATION NUTRIENT FILTERING FUNCTION

Approaches for allocations to riparian function depend upon riparian filtering and uptake of nutrients. Developed for restored riparian function follows the percent reduction approach, an EPA suggested alternative to traditional load analyses. This approach shows considerable promise in developing allocations as research in other parts of the country provides evidence that allocation of a percent reduction of nitrogen and phosphorus to riparian buffers is a feasible tactic. In a review of the efficacy of buffers in removing nitrogen and phosphorus, numerous investigators have demonstrated marked reductions in delivery of nitrogen and phosphorus to surface waters (Wenger 1999). This included nutrients transported by surface run off and through groundwater.

Grass buffers provide an effective means of filtering phosphorus and nitrogen from surface runoff, preventing delivery to streams. Thirty-foot wide grass buffers removed up to 79% of phosphorus, and 74% of nitrogen from overland flow (**Table 1**). The tendency for an increase in nutrient removal with increased buffer width suggests additional decreases are possible with wider buffers. Note that these buffers were trapping runoff from Concentrated Animal Feeding Operations (CAFOs), which have a greater potential to contribute nutrients than rangeland due to the greater stocking rates. A reasonable assumption is that buffers in rangeland may be capable of filtering a higher proportion of the load because the loading is less likely to exceed the buffer's potential filtering capacity compared to buffers treating contributions from a feedlot.

Table 1: Removal of total phosphorus and total nitrogen from surface runoff by grass buffers (modified from Wenger 1999).

	Total P Removal		**Total N Removal**	
Study	**15 ft buffer**	**30 ft buffer**	**15 ft buffer**	**30 ft buffer**
Dillaha et al. 1988	71.5%	58%	67%	74%
Dillaha et al. 1989	61%	79%	54%	73%
Magette et al. 1987	41%	53%	17%	51%
Magette et al. 1989	18%	46%	0%	48%

In addition to removing nutrients in surface runoff, buffers supporting shrubs are effective at removing nutrients from subsurface flows, particularly nitrate. A review of studies investigating the efficiency of riparian buffers of varying width found percent removal of nitrate of between 75 and 99%, with buffers between 50 and 200 ft in width (Wenger 1999). In contrast to relations between buffer width and filtering of surface runoff, no clear correlation was apparent between buffer width and extent of nitrogen removal from sub-surface flows.

An investigation of the extent of nitrogen removal from surface and subsurface flows within a 50-meter (164 ft) buffer demonstrates the efficiency of riparian buffers at removal of various forms of nitrogen (Peterjohn and Correll 1985). In this investigation, nitrate was present in slightly higher concentrations in groundwater than surface runoff (**Table 2**). Other forms of nitrogen (exchangeable ammonium [NH_4^+] and particulate organic nitrogen) varied between surface and subsurface flow with particulate organic nitrogen being greatest in surface flows by several orders of magnitude. Treatment of both surface and subsurface flows through the 50-meter buffer resulted in a marked reduction of nitrate, the largest nitrogen fraction from subsurface flows, and the second largest from surface flows. In contrast, concentrations of other forms of nitrogen increased after exposure to the buffer. These constituents rose as much as six fold; however, these still comprised a relatively small proportion of the overall nitrogen load, leaving a substantial net decrease in nitrogen loading from exposure to a riparian buffer.

Table 2: Nitrogen reductions in surface and subsurface flows through a 50-meter riparian buffer (Peterjohn and Correll 1985, as presented in Wenger 1999).

		Nitrate (mg/L) (Percent Change)	***Exchangeable NH_4^+ (mg/L)***	***Particulate Organic N (mg/L)***
Surface Runoff	Initial	4.45	0.402	19.5
	Final	0.91 (-79%)	0.087 (-78%)	2.67 (-86%)
Subsurface Transect 1	Initial	7.40	0.075	0.207
	Final	0.764 (-90%)	0.274 (+ 365%)	0.267 (+ 129%)
Subsurface Transect 2	Initial	6.76	0.074	0.146
	Final	0.101 (-99%)	0.441 (+596%)	0.243 (+ 166%)

Applying the principles of measurable reductions of nitrogen and phosphorus in riparian buffers in developing allocations has promise, although several matters need attention. One issue is the relative permanence of the nutrient removal, which differs between nitrogen and phosphorus. Nitrogen removed by riparian forests has two potential fates, incorporation into plant tissue, and denitrification where plants and microbes release nitrogen as gas to the atmosphere. These factors result in permanent or long-term removal of nitrogen from the aquatic system. In contrast, riparian buffers are short-term sinks for phosphorus. Its fate in riparian buffers include uptake by vegetation, adsorption onto soil or organic matter, or release into the stream or groundwater (Lowrance et al. 1998). Once phosphorus saturates the riparian area, the excess is exported as soluble phosphate. Therefore, the riparian buffer will be less efficient at the removal of phosphorus over the long term if grazing and/or fire is not managed to reduce climax conditions while assuring riparian area health.

Literature Cited

Lowrance, R., R. Todd, J. Fail, O. Hendrickson, R. Leonard, and L. Assmussen. 1984. Riparian forests as nutrient filters in agricultural watersheds. Bioscience 34: 374-377.

Peterjohn, W.T. and D.L. Correll. 1984. Nutrient dynamics in an agricultural watershed: observations on the role of a riparian forest Ecology 65:1466-1475.

Wenger, S. 1999. A review of the scientific literature on riparian buffer width, extent, and vegetation. Office of Public Service and Outreach, Institute of Ecology, University of Georgia, Athens, GA.