# Technical Note – Forest

## North Carolina

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### WATER QUALITY BENEFITS FROM MANAGEMENT OF RIPARIAN FOREST BUFFERS

Water quality benefits of riparian forest buffers are well documented in scientific literature. Those benefits include serving as sediment traps and as denitrification zones. Researchers from Georgia (Vellidis et al. 1994) found that "…riparian forest ecosystems are (also) excellent nutrient sinks (that) buffer the nutrient discharge from surrounding agroecosystems." Vellidis et al.(1994) continued to say "…nutrient uptake and removal by soil and vegetation in the mature riparian forest ecosystem prevented agricultural upland outputs from reaching stream channels. The riparian ecosystem can serve as both a short- and long-term nutrient filter **and sink** if above-ground vegetative biomass is periodically harvested to ensure a net uptake of nutrients." (emphasis added) Thus trees in zone 2 – the zone behind that needed for streambank stability, shade, and woody debris production – should be harvested periodically to remove nutrients from the site, as woody tissue, if maximum water quality benefits are to be attained.

Denitrification and phosphorus trapping rates are well documented, but the amount of nutrients (particularly N and P) that accumulate in woody tissue and can be exported as logs is less well known.

A review of a number of research papers and contact with several experts in the fields of water quality and forest fertilization revealed the following facts:

- "Upon mineralization, N and P may be reimmobilized, taken up by vegetation, adsorbed, or leached, in that order of priority…." (Altier et al. 1993)
- "Nitrate and NH4+ are equally subject to plant uptake." (Altier et al. 1993)
- "Only the labile (unstable) P pool is available for incorporation into microbial biomass and plant uptake." (Altier et al. 1993)
- "Some estimates indicate that 25% of the N removed by the streamside forest is assimilated in tree growth which may be stored for extended periods of time in woody tissue and possibly removed as logs or other forest products." (United States Department of Agriculture 1991)
- Nutrient budgets customarily include both inputs and outputs, including harvest. (Lowrance et al. 1985)

Forest buffer strips can reach a nutrient saturation and lose their nutrient filter capacity as they reach maturity (Omernick et al. 1981). Theoretically, ecosystems at the "climax" stage of succession exhibit no net annual production or net nutrient uptake (Vitousek and Reiners 1975). Lowrance et al. (1983) stated that "…the nutrient filter capacity of southeastern riparian forests depends on proper management by the land owner/manager. Periodic selective harvesting of bottomland tree species can keep the riparian zone in an earlier successional stage, allowing nutrient accumulation in woody biomass to continue."

The following table, prepared by NRCS Agroforester James L. Robinson (1991), provides specific nutrient uptake rates:

**Annual Aboveground Nutrient Accretion Rates by Site for Riparian Woody Plants**
**(kg./ha./yr.)**

| Site | Nitrogen | | | Phosphorus | | |
|---|---|---|---|---|---|---|
| | Kg./ha. | Lb./acre | 23% reduction lb./acre | Kg./ha. | lb/acre | 23% reduction lb./acre |
| 2 (Test) | 97.6 | 87.1 | 67.5 | 6.9 | 6.2 | 4.8 |
| 4 (Test) | 34.6 | 30.9 | 23.8 | 4.1 | 3.7 | 2.8 |
| 5 (Test) | 36.9 | 32.9 | 25.3 | 1.9 | 1.7 | 1.3 |
| 3 (Reference) | 49.8 | 44.3 | 34.3 | 3.6 | 3.2 | 2.5 |
| 6 (Reference) | 40.0 | 35.7 | 27.5 | 2.4 | 2.14 | 1.6 |
| Mean, Test | 56.4 | | | 4.3 | | |
| Mean, Reference | 44.9 | | | 3.0 | | |
| Mean, Overall | 51.8 | 46.2 | 35.6 | 3.8 | 3.4 | 2.6 |

The 23% reduction in the above table is included to account for the fact that branches would contain higher concentrations of N than the bole, and might not be removed by harvesting.

“While the total pounds per acre (of P) seem small, it should be remembered that water is often very sensitive to phosphorus input. Concentrations as low as 0.02 PPM cause eutrophication.” (Robinson 1991)

To summarize, one could expect that, on average, 35.6 lbs/ac N and 2.6 lbs/ac P are trapped within woody tissue annually. Multiplying the annual rate of nutrient accretion by the number of years within the cutting (regeneration) cycle would give a good estimate of total nutrients that could be prevented from reaching flowing streams over time, if zone 2 of the riparian forest buffer is properly managed. If short rotation forestry were practiced, especially with removal of leaves, the nutrient removal rate would be “…far greater than for conventional forest harvests.” (Heilman and Norby 1998) Failure to harvest trees that have reached maturity within zone 2 could allow the above amounts of N and P to reach flowing streams as water pollutants.

## REFERENCES CITED


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