# Managing Vegetation in Upland Forested Filter Zones to Enhance Removal of Sediments and Nutrients from Agricultural Runoff

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*The results of this research by Franklin et al. were presented at WRRI's Annual Conference last March and were the subject of a news story released by WRRI prior to the conference. Since that time, Dr. Franklin has had scores of inquiries about the research. Since interest seems to be very high, we invited the researchers to prepare an article describing their study.*

Over the last decade our research has demonstrated the effectiveness of upland forested field-edge filter zones in removing sediment and nutrients from agricultural run-off from cultivated fields. One of the most effective ways to increase effectiveness of the these zones is to use trenched level spreaders (Franklin *et al.* 2000, Verchot *et al.* 1998). We have recently begun to study vegetation management in forested filter zones to find the combination of cover types best suited to remove or cause the removal of sediments and nutrients. A key point to keep in mind is that about 80% of all sediments and nutrients are delivered to receiving waters by a few major storms each year. So, if your filter zone cannot handle the "gully washers", it cannot do the job. For example, grassed filter zones have two major shortcomings:

1. They do not have adequate infiltration capacity to handle large storms, and
2. They do not have hard, vertical, physical structure to significantly reduce the velocity of large volumes of rushing storm water.

Evidence of this can be seen after a big rain when the grass has been laid down flat by rushing water.

Mature forested stands with closed canopy have a similar shortcoming in that they typically have very little ground vegetation (vertical structure) because sunlight does not penetrate to the forest floor. So how could we promote ground vegetation which would physically slow the flow of rushing storm water as it leaves an agricultural field loaded with sediments and nutrients? We had an idea!

Clear cuts come back naturally in a very dense ground cover of herbs, shrubs, vines and tree saplings which creates an ideal matrix to reduce the velocity of storm flow. We had two watersheds which had been fully instrumented for ten years. One was quite adequate to handle sediments and nutrients from its field area, while the other was only marginally adequate to inadequate due to shallow soils and smaller ratio of effective filter area to field area. We had considered clear cutting this zone to see if we could increase its effectiveness. While we considered, Hurricane Fran delivered a micro-burst that surgically felled almost every tree in the zone. Miraculously, very little damage was done to structures and instrumentation.

We saw and seized upon an opportunity! With financial support from the NC Department of Agriculture, we hired a crane and some loggers to remove the downed trees without machine traffic over the small filter zone. Then we used the crane to pull the stumps upright to simulate a normal clear cut. We were between studies on the site, so the filter zone stabilized for two growing seasons. During the third and fourth growing seasons, in conjunction with another study, we had a chance to compare the effectiveness of this filter zone with 3- and 4-year old vegetation versus a mature mixed pine-hardwood stand which had been there before the hurricane.

Results demonstrated the overwhelming superiority of the dense regrowth following a clear cut over the mature mixed pine-hardwood forest, as the table on the right shows.

Detention of sediments was improved while detention of nutrients was dramatically improved. Actually, during the period of the clear cut study, the forested filter zone had detained sediment at the rate of 79%, up until the last storm of the study in December, 2000. That storm delivered more sediment to the forested filter zone than the sum of all sediment delivered between April, 1999 and December, 2000. During the December storm, the grassed filter zone, above the forested filter zone, actually exported a large amount of sediment to the forested filter zone, and the forested zone detained only 36% of received sediment during that one storm which brought the overall weighted average down by about 25 points. The December storm illustrated the important points already stated:

1. Grassed zones alone are not adequate to handle large storms.
2. A very few major storms deliver most of the sediments and nutrients to receiving waters each year.
3. If your filter zones cannot handle the big events, they are not doing much good.

This study clearly indicated that clear cutting of a mature forest and allowing it to be replaced with natural regrowth dramatically increased the effectiveness of a marginally effective upland forested filter zone.

How can these results be applied?

First we need to clarify some terminology. The forested filter zone in this study was a non-riparian (not within 50 feet of receiving waters) upland zone; therefore, management of the vegetation was not restricted even though it was in the Tar-Pamlico Basin. If a portion of a

Table 1. Amount of sediments and nutrients retained in the forested filter zone expressed as a percentage of the amount entering the zone, with a mature mixed pine-hard forest versus a recently clear cut forest

| | Mature Forest 1989-1995 | Clear Cut Forest 1999-2000 |
|---|---|---|
| | % | % |
| Sediment | 40 | 53 |
| Ammoniacal Nitrogen | 41 | 66 |
| Nitrate Nitrogen | 14 | 57 |
| Soluble Phosphate | 25 | 72 |
| Total Phosphorus | 14 | 68 |

field-side forested filter zone happens to be within 50 feet of a Tar-Pamlico or Neuse River Basin jurisdictional stream, then the management of vegetation in all or part of the zone comes under the rules governing management of vegetation within these jurisdictional zones[2]. If a field-side filter zone is a forested wetland which otherwise qualifies for silvicultural management under federal guidelines, then clear or partial cutting may be management alternatives.

Farmers may prefer to clear cut field-side filter zones to reduce field shading and competition for nutrients by tall trees. These results indicated that this practice would not be expected to impair capacity of the zone to cleanse runoff, and might improve it. Logging practices which minimize soil compaction and surface disturbance should be used. An alternative to clear cutting, which would also be expected to improve the filtration capacity of a deficient zone, would be a partial cut to leave about 50% crown cover. This would allow sunlight to reach the soil surface and promote growth of ground vegetation. Wildlife habitat would also be improved for many species.

Maintenance of the ground vegetation under both alternatives and maintenance of partial crown cover would require periodic treatments. Prescribed fire or mowing might be used to maintain the ground cover, while additional partial cutting would maintain an open crown structure. If a filter zone were clear cut or storm damaged to the extent of removing most of the overstory, saplings could be selected and left to develop another stand, which should also be maintained at about 50% crown coverage.

Franklin, E. Carlyle, James D. Gregory, Dennis W. Hazel, John E. Parsons. 2000. *Management of forested filter zones for dispersion and treatment of agricultural runoff.* Report No. 312 of the Water Resources Research Institute of The University of North Carolina.

Verchot, Louis V., E. Carlyle Franklin, J. Wendell Gilliam. 1998. "Effect of agricultural runoff dispersion on nitrate reduction in forested filter zones." *Soil Sci. Soc. Amer. J.* 62(6):1719-1724.

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[2] For Neuse Buffer Rules:<http://h2o.enr.state.nc.us:80/nps/2b-0233.pdf> For Tar-Pamlico Buffer Rules: <http://h2o.enr.state.nc.us:80/nps/Buff0259-RRC2-00.pdf