Chapter 6

Factors Influencing Adoption

Forested riparian buffers have been recognized for their ability to improve water quality, provide fish and wildlife habitat, and to reduce the costs to communities of water treatment, flooding, and dredging. However, plans to restore forested stream buffers on private lands has been controversial. Private citizens, policy makers, and resource professionals alike are asking: Who will pay? How do we account for individual needs and circumstances? How do we set goals and standards that are flexible and fair to all?

This chapter will examine some of the issues surrounding the adoption of riparian forest buffers on private lands and highlight policies which may be used to implement them.

Adoption of agricultural conservation practices

While the issue of riparian forest buffer restoration is new in many parts of the country, farmers have been involved in the adoption of other types of conservation practices for years. Like restoring riparian buffers, these conservation programs are, for the most part, voluntary. Many studies have been made to determine the factors influencing the adoption of such programs. They have found:

_ *Farmers have positive attitudes toward protecting the environment.* A 1986-87 survey of farmers in Virginia and Iowa found that a majority of the farmers had positive attitudes toward protecting the environment and attached a high priority to protecting water quality and preventing soil erosion (Norris and Batie 1987). A large majority of the farmers surveyed were concerned with the potential effects of agricultural chemicals on ground water in their area, considered the issue serious, and believed that more research and possibly stricter regulation of the use of agricultural chemicals was needed.

Another survey made of Virginia farmers in the mid-1980s measured the attitudes of participants in Virginia's Filter Strip Program (Dillaha et al. 1986). A majority of the farmers indicated that they participated in the program so that they could reduce soil erosion and improve water quality. Other reasons cited were economic considerations (such as the availability of state cost-share, for extra hay production, etc.) and enhancing wildlife habitat.

A 1990 poll of farm operators in Iowa found that even though almost two-thirds reported some damage or loss to crops due to wildlife, 81% felt that the presence of wildlife was important to them, and 69% agreed that wildlife have as much right to exist on the land as they did. Many enjoyed fishing, birdwatching, hunting, or photographing wildlife. Others said that wildlife provided enjoyment just "from knowing they exist" (Lasley and Kettner 1990).

_ *Farmers believe that they should be free to manage their land as they wish.* The same 1990 Iowa poll found that 58% of these farmers felt that individuals should be allowed to use their own property without outside interference (Lasley and Kettner 1990). Likewise, a 1986 survey of Ohio farmers found that farmers believe they should have absolute rights to the farm land they own, although they should not be free to abuse the land (Napier et al. 1988).

_ *Economic circumstances strongly influence management decisions.* Farmers face increasingly uncertain economic circumstances: costs of equipment, land, labor, and management are increasing; government support programs are decreasing; and new competition exists in

international markets. Farmers are concerned about their ability to pay off debts and remain in business, and realize that they must maintain flexibility and preserve their management options for their land in the long-term.

Some economists have argued that soil erosion and runoff from agricultural lands occur because farmers are behaving in a rational, predictable manner (Libby 1985). Farmers must make a living farming, maintain stability in their business, and respond to needs in the market. They have no economic incentive to bear the cost of producing benefits for others (for example, improved water quality), particularly if they feel that their actions will make little significant difference in solving the larger problem.

Therefore, voluntary adoption of a conservation practice depends to a large degree on how well it maintains farm profitability, or at least not decrease profitability significantly. Practices that are profitable, simple to implement, and compatible with existing machinery and operations are more likely to be implemented (Nowak and Korsching 1983, Marra and Zering 1996).

_ Farmers are strongly motivated by individual characteristics and values. A number of studies have examined the relationship between an individual's personal beliefs and their adoption of conservation practices. Researchers in Florida found that individuals with stronger views about the use of nonrenewable resources, preserving the integrity of renewable resources, and taking responsibility toward others were more likely to implement conservation efforts on their lands than other farmers (Lynne et al. 1988). Individuals with a strong belief in technology and profit maximization displayed less effort. Likewise, other studies have found that farmers who believe that "one has a moral obligation to maintain the land for future generations" were more likely to adopt conservation measures than those who believe "they have an inviolate, God-given right to use the land as they please" (Nowak and Korsching 1983).

Changing patterns of land ownership may also have implications in the adoption of conservation practices. Today, agricultural lands are often owned by individuals who lease the land to others for agricultural production. In some cases, the landowner may still live on the farm or in the vicinity, but in other cases farms are owned by individuals who live far away in urban areas, and who may have little or no farm experience (Constance et al. 1995). Although it is the renter, rather than the owner who often makes most farm management decisions, renters are less likely to employ conservation practices, and are less likely to benefit directly from economic incentives associated with conservation programs.

There may also be differences in attitudes between full-time farmers and part-time farmers. In Maryland, full-time farmers were less likely to have plans to develop riparian buffers than part-time farmers, partly because full-time farmers had a larger financial stake in the operation (Hagan 1996). Part-time farmers were more interested in amenities such as fisheries, wildlife, and aesthetics. Likewise, Olmstead and McCurdy (1989) found that the majority of landowners in Illinois who had planted trees under the Conservation Reserve Program (CRP) owned farms less than 100 acres in size.

Adoption of riparian buffers

Several recent studies have dealt specifically with the establishment of forested riparian buffers on agricultural lands.

_ Maryland's Buffer Incentive Program. A recent study of Maryland's riparian landowners compared the characteristics of those who had established riparian forest buffers

through Maryland's Buffer Incentive Program and landowners who did not participate in the program (Hagan 1996). The Buffer Incentive Program (BIP) is a cost-share program initiated in 1992 by the Maryland Department of Natural Resources to encourage landowners to install forested buffers along streambanks. This study found that the typical BIP participant was more educated (two-thirds had at least a college degree), younger, and had less farm management experience than landowners not in the program. Aesthetic factors and an interest in fish and wildlife were also important to these individuals. Participants also had much less at stake financially when they converted their riparian lands; 55% earned less than $1,000 from the farm, while another 27% earned only $1,000 to $19,999. Participating farms were generally small; nearly a third were 20 acres or less.

Non-participants, on the other hand, were more likely to be individuals who were full-time farmers, farmed larger areas, and derived much or most of their income from the farm. Reasons given for not participating in the BIP included: concern about the impact of current and future land laws; plantings were required at a busy, inconvenient time of year; too much time was required to maintain the buffer; and previous experiences with government programs. The study also suggested that many non-participating farmers would prefer to install grass buffers rather than forested buffers.

Hagan (1996) suggested several reasons participating landowners were willing to take part in the program: their opportunity cost of taking land out of production was much lower than for active farmers, these farmers were less concerned about possible hidden costs of having a buffer (such as increased wildlife damage to crops), they were less concerned that creating a buffer would eventually result in further regulatory problems (such as losing "farmable wetland" status), and these farmers may be more interested in on-site amenities generated by the buffer (such as the return of trout) than full-time farmers.

During public meetings in Maryland, the agricultural community expressed concerns that public benefits of riparian buffers such as wildlife and aesthetics will be forced on them at the expense of farm operational priorities (US EPA Chesapeake Bay Program 1995). Farmers were concerned about the loss of productive land and farm income, and expressed belief that once riparian lands are planted in trees, additional regulations would be enacted to prevent their use. Some individuals expressed fears that the riparian forest could revert to wetlands or attract endangered species, making them subject to additional regulations. The introduction of pests, such as deer and noxious weeds onto the property was also an important issue.

Urban/suburban landowners had similar concerns. They were concerned about private property rights, wildlife damage, and invasion of exotic and endangered species. Buffer appearance, home security, public access, liability, and responsibilities for maintenance were also mentioned.

_ Conservation Reserve Program. In 1989, farmers in Fayette County, IL were surveyed to determine their willingness to retire riparian lands through the Conservation Reserve Program (CRP) (Lant 1991). Those surveyed showed little interest in establishing trees or restoring wetland conditions in riparian areas. In fact, a requirement for tree planting on riparian lands would have likely reduced enrollment to below 10% of all eligible lands. Increasing the contract period to 20 years to allow for the development of stands of bottomland hardwood trees would have cut enrollments in half. Likewise, temporary plugging of drainage ditches and tiles in order to reestablish wetland conditions would have reduced enrollment.

However, farmers were more willing to create grass filter strips, particularly if haying or grazing were allowed on these areas. Interest in the filter strip program also increased as annual rental rates were higher - at $20/acre/year, less than 6% of the eligible land would be enrolled in filter strips, but at $200/acre/year, over 83% of the land would be enrolled.

Individuals who were interested in the CRP program cited soil conservation, water quality improvement, wildlife habitat enhancement, and economic motivation as their primary motivating factors. On the other hand, farmers who indicated that they would not enroll in CRP said that they could earn more by producing on the eligible land, they were hesitant to be tied to a fixed payment for 10 years, or they wished to avoid the program's rules and regulations.

Similarly, a 1993 nationwide survey of CRP participants conducted by the Soil and Water Conservation Society found only about 12% of all respondents were willing to plant trees, although slightly more (16%) were willing to plant trees with a 10-year extension (Nowak and Schnepf 1994). On the other hand, half said they were willing to plant a different vegetative cover for wildlife habitat if the government provided cost-sharing for these plantings. More than half of those surveyed said economics would be the single most important factor in their decision to either keep their CRP acres in cover or return them to crop production. Only 14% cited conservation as the most important factor.

Norris and Shabman (1988) suggested that tree plantings may be of little interest to farmers because landowners are generally unwilling to incur the costs of investments from which they may not realize the profit. Therefore, waiting for a tree stand to develop is less desirable than crops which produce income annually. Furthermore, farmers see tree plantings as reducing their flexibility for future land use, and a drain on time, labor, and financial resources. Most individuals prefer immediate returns to those for which they have to wait.

Conclusions

While farmers may be concerned about soil erosion, water quality, and the environment, this concern does not always translate into the adoption of conservation practices. Farmers must also produce a product, meet their debt obligations, and maintain future profitability. Establishing woody vegetation on riparian lands currently provides little economic value to most agricultural operations, but at the same time, buffer establishment requires time and money, and reduces future options for that land. Therefore, it is not surprising that forested buffer establishment has been met with some resistance by the agricultural community. Although landowners want to be good stewards of the land, they must also meet their financial obligations and preserve their options for the future.

A Riparian Forest Buffer Policy for the Chesapeake Bay Watershed

At a Chesapeake Bay riparian buffer workshop held in 1994, participants discussed their concerns for implementing a riparian forest buffer policy. They made many useful suggestions. Those representing the agriculture community believed:

- The policy should be based on sound scientific research and should be voluntary.
- It should take a "whole-farm" approach that is flexible and allows for site-specific design.
- Federal and state policies, and the work of their agencies, should be coordinated and consistent as to establishment and maintenance requirements.
- Farmers should be provided educational, technical, and financial assistance, and compensated for loss of agricultural production.
- Markets should be developed for products which may be produced in buffer areas.
- The buffer initiative should target specific areas of the watershed which have been identified through a resource inventory.

The urban/suburban discussion groups echoed many of these concerns and made additional suggestions:

- The policy should clearly set program priorities and objectives at the beginning, stating up front what the program is expected to achieve and specific about where efforts should be applied.
- Alternatives to forested buffers should be explored, and the buffer policy should allow for new innovations.
- The support of local governments and the need for their input into the policy-making process was emphasized.
- Strong support should be provided for public education on the benefits and management of riparian areas in urban areas.
- Some support for regulation to ensure participation was indicated by this group.

From: US EPA Chesapeake Bay Program. 1995. Riparian forest buffers: restoring and managing a vital Chesapeake resource. Proceedings of a conference October 5-6, 1994, Ellicott City, MD. US EPA -903-R-95-008.

Policy options

In the past, many types of federal and state programs have been used to encourage conservation on private lands. They may be classified in three general categories: volunteerism, economic incentives and disincentives, and regulation.

Voluntary programs

Persuading individuals to voluntarily adopt conservation practices can be a complex and challenging task for conservation agencies. Harrington et al. (1985) identified conditions which must be met for voluntary programs to succeed. Among these were: 1) individuals must agree that the goals of the program are worthy, and that their action will advance the goal; 2) noncompliance must be observable, in order to create social pressure for compliance; and 3) the cost of the program should not greatly exceed its private benefits.

- ***Education***. A landowner's perception of a problem is one of the most important factors related to the adoption of conservation practices (Ervin and Erwin 1982). This may be especially true when dealing with water quality issues.

For example, a 1990 Iowa poll of farm operators found that farmers were more likely to perceive that environmental problems had become worse at the national (50%) or state (34%) level than in their own communities (22%) or on their own farms (8%) (Lasley and Kettner 1990). These results were similar to those of earlier reports, both national and regional (Napier et al. 1988, Steiner 1990). For example, a 1986 survey of Maryland farmers found that they recognized that water quality problems exist, but felt that they were caused by someone else (Lichtenberg and Lessley 1992). Throughout the state, farmers believed that there were only slight problems with water quality at the farm level, slight to moderate problems at the local level, but definite problems at the state level. While water quality problems were most prevalent in the principal agricultural regions of the state, farmers in these areas were less concerned about water quality than farmers in more urban areas of the state.

In the case of riparian areas, many landowners don't always even recognize that they own riparian lands. A 1995 survey of riparian landowners in Maryland found that farm owners often reported that they did not own riparian land. Streams which were most overlooked were small ephemeral streams, or those greatly altered by drainage or channelization (Hagan 1996).

Even once a problem is recognized, landowners may feel the problem is simply beyond their scope of effort. For example, Alexander (1994) argues that farmers are more concerned with using the land to support themselves rather than "how to keep an entire ecosystem operating smoothly". Nor are farmers interested in bearing the cost of ambiguous, long-term goals (Nowak 1987). Therefore, a successful riparian restoration program must demonstrate some benefit to local streams, communities, or to the farm itself.

- ***Technical assistance.*** Many technical assistance programs have been developed by governmental agencies and nonprofit organizations to assist landowners in installing conservation practices. Technical assistance can be particularly important when programs are first introduced and when conservation practices are complex or unfamiliar. In addition, many private firms exist which specialize in environmental restoration and mitigation.

Few studies have been made to measure the effect of technical assistance on landowner behavior. However, studies made of forest landowners suggest that those who worked with a professional forester were more likely to regenerate stands after harvest than landowners who did not get assistance (Alig et al. 1990).

Ohio TREES program

The Ohio Department of Natural Resources TREES (Tree Resource Establishment and Enhancement Service) program offers a "turn-key" landowner assistance programs to owners of riparian lands. The program is managed by the Top of Ohio Resource Conservation and Development Council who contracts with local vendors to provide tree planting, shelters, mowing, and maintenance on riparian lands. Landowners can pay a flat fee to the Council for a 3-year planting and maintenance contract, or may contract for only some services (planting, shelters, mowing, maintenance). State and federal cost-share receipts may be applied toward the cost of installing and maintaining the buffer.

The Ohio TREES program successfully meets some of the obstacles landowners may face when they wish to install riparian buffers, such as time constraints, labor needs, and lack of expertise.

From: Ohio Division of Forestry. TREES - the tree resource establishment and enhancement service. Top of Ohio RC&D. Urbana, OH.

Economic incentives and disincentives

Economic incentives include cost-share programs, land retirement, subsidy payments, and tax incentives. Economic disincentives such as taxes, fines, and environmental bonds may also be effective policies. Another alternative, cross-compliance, requires producers to fully comply with certain conditions before they are eligible to receive financial assistance such as cost-share, subsidy payments, federal loans, or crop insurance.

- Cost share. There are a number of federal cost-share programs which may be applied to restoring forested riparian areas. In addition, many states offer their own programs.

Landowner response to cost-share programs has been mixed. One recent U. S. Forest Service review found that the availability of cost-share was a very significant factor in forest tree planting. They estimated that 70%-80% of tree planting occurred with government assistance, and concluded that the effects of cost-share were additive - that is, cost-share programs served as a catalyst for landowners to plant additional trees (Alig et al. 1990). However, another study found that cost-share funds were of limited value in actually convincing landowners to become involved in a particular program. This survey of nonindustrial private forest landowners in Tennessee found that it was the attitude of the landowner toward the goals of the program, rather than the availability of cost-share itself, that was the best indicator of landowner participation (Bell et al. 1994). Landowners who had a negative attitude regarding the goals of the program would probably not participate, no matter what cost-share amount was offered. On the other hand, landowners with strong positive attitudes were likely to participate in conservation activities whether funds were available or not.

A study of farmers in Virginia's Piedmont region found that the receipt of cost-share was not important to the farmer, leading the authors to suggest that in this particular case, the limits

on cost-sharing were too low (the average cost share assistance received in this study was $150, while the average conservation expenditure was $1,900) (Norris and Batie 1987). This study cautions against the tendency to spread limited program funding among a large number of participants.

Another survey of Virginia farmers in the mid-1980s measured the attitudes of participants in Virginia's Filter Strip Program. When asked if they would install new vegetative filter strips without cost-share funds, 40% said no and 27% were unsure. However, farmers believed the vegetative filter strip cost-share program should continue, that the use of wildlife plantings should be encouraged, and that more education was needed to make people more aware of the program (Dillaha et al. 1986).

Red tape, design requirements, and lengthy application processes also discourage some individuals, particularly small or part-time farmers, from participating in cost-share programs (Hagan 1996).

- ***Land retirement.*** Land retirement programs such as the Conservation Reserve Program and the Wetland Reserve Program have been used successfully by the USDA Natural Resource Conservation Service to "set aside" lands in their conservation efforts. Landowners may also voluntarily retire lands by enrolling them in a conservation easement. A 1990 survey of CRP participants indicated that about 27% would consider selling a conservation easement to the government, 39% rejected the idea outright, and 34% were unsure.

- ***Tax incentives.*** Tax incentives have been used for years to encourage landowners to reforest cutover timberlands and to reduce tax burdens on agricultural and forested lands. Tax incentives may include a reduction of federal and state income taxes or local property taxes. A recent survey of forest landowners in the Pacific Northwest found that federal tax relief could be a powerful incentive to encourage landowners to restrict harvesting in riparian areas. Fifty percent of landowners surveyed indicated that they would forego harvesting within 2000 feet of a riparian area if given a 10-year reduction in federal income taxes (Johnson et al. 1997).

- ***Subsidy payment.*** Subsidies are payments made to a landowner to encourage a particular behavior, for example, the adoption of a conservation practice, and can take the form of cash, guaranteed prices, tax exemptions, insurance or low interest loans (Harrington et al. 1985).

- ***Economic Disincentives.*** While economic incentives have generally been applied to voluntary conservation programs, it is possible to create economic disincentives to encourage the same behavior. Although disincentives have not been used to encourage forested buffer establishment, it is possible (though likely unpopular) that such disincentives could induce landowners to plant forested riparian buffers.

Economic disincentives may take the form of pollution taxes, fines, liability payments, or environmental bonds, and have been used primarily to control point-sources of water pollution. Taxes and fines work by charging the producer for pollution discharges or for failure to implement a certain practice. Environmental bonds may be issued to a farm for a specified sum of money, and refunded at a future date only if certain management practices are installed (Malik et al. 1994).

Several economists have examined the potential impacts of different policy options on farming operations and water quality, and agree that water quality can be significantly improved without losses to farm profitability, and in some cases without high costs to taxpayers or farmers

(Seale et al. 1985, Contant et al. 1993) . Their models indicate that while greatest improvements to water quality are gained through high levels of taxation, there is a large cost to farmers. Smaller gains in water quality may be realized through other approaches - at less cost to farmers, but higher costs to taxpayers.

Regulation

Past efforts to control nonpoint source pollution have relied almost exclusively on voluntary compliance and financial incentives. However, as lawmakers and the general public become increasingly frustrated with the lack of progress in reducing nonpoint source pollution, regulatory approaches to meeting water quality goals are gaining wider interest.

Many studies in recent years find that the public is becoming increasingly concerned about soil erosion and water quality problems that result from agricultural practices. In 1986, a nationwide survey of U.S. citizens found that almost 40% supported applying penalties to farms that failed to adopt needed conservation practices (Molnar and Duffy 1987). A similar survey conducted in 1992 found a majority agreed that most farmers take good care of the soil, but also indicated that "laws regulating excess soil erosion are badly needed". Citizens also agreed that "farmers who do not adopt the needed soil conservation practices should be fined" (Jordan and Elnagheeb 1992).

A recent survey of residents of eastern North Carolina found the majority of residents believed the government was doing too little to control agricultural pollution from cropland and livestock production, and just over half agreed that government regulations to control water pollution were more important than landowners' rights to use the land as they saw fit (Hoban and Clifford 1994).

However, a regulatory approach to nonpoint source pollution does not necessarily result in the greatest improvement to water quality, and can be expensive to implement and monitor. A comparison of Virginia's voluntary approach and Maryland's regulatory approach to control forestry nonpoint source pollution suggests that the voluntary approach results in the same level of water quality improvement, but at a significantly lower cost to both the landowner and to the state forestry agency (Hawks et al. 1993).

Regulation of nonpoint source pollution in Virginia

The Commonwealth of Virginia has passed three major pieces of legislation during the past decade to encourage communities and individuals to voluntarily protect water resources. These include the Chesapeake Bay Preservation Act, the Water Quality Law, and the Agricultural Stewardship Act. These Acts give citizens the primary responsibility for protecting the State's waters during agricultural and forestry activities and urban development. Citizens are allowed great flexibility in how they will prevent pollution; however, if water pollution does occur, the State may take corrective actions and levy fines. In addition, state agencies have been charged with providing technical and financial assistance to help citizens meet water quality objectives.

Chesapeake Bay Preservation Act. The 1988 Virginia General Assembly passed the Chesapeake Bay Preservation Act, which requires local governments in the Tidewater Region (roughly the eastern 1/3 of the state) to incorporate water quality protection into their zoning ordinances and comprehensive plans. One result of this law is most jurisdictions in the region now require 100 foot vegetative buffers bordering sensitive environments such as tributary streams and wetlands (however, most allow buffer widths to be reduced to 25 feet on agricultural lands where an approved Soil & Water Quality Conservation Plan is in place or 50 feet on building lots where a wide buffer would render the lot unbuildable). Fines of up to $5,000 per day may be levied against anyone who violates local regulations (Crogan 1994, Lipman 1995).

Forest Water Quality Law. The Forest Water Quality Law was enacted in 1993 to protect the waters of the state from nonpoint source pollution during silvicultural activities. The law requires forest landowners or operators to notify the State Forester of a commercial timber harvest at least three days prior to the beginning of the harvest and encourages them to voluntarily implement forestry Best Management Practices during harvest operations. The law gives the State Forester the authority to issue special orders to anyone who is causing pollution to cease all silvicultural activities until corrective measures have been implemented (pollution is defined as "alteration of the physical, chemical, or biological properties of any state waters resulting from sediment discharge"). Violators may be fined up to $5,000 per day until the problem is corrected. However, special orders will not be issued where acceptable Best Management Practices have been incorporated but have failed due to unusual weather activity (Lipman 1995, VA DOF 1997a).

Agricultural Stewardship Act. In 1996, the Virginia General Assembly passed the Agricultural Stewardship Act to prevent pollution of the state's waters from agricultural activities. Under this Act, farmers are encouraged to implement voluntary conservation measures to correct water quality problems on their lands. However, the Act gives the Commissioner of Agriculture the authority to investigate any complaint that an agricultural activity is creating pollution (pollution is defined as "any alteration of the physical, chemical or biological properties of any state waters resulting from sedimentation, nutrients, or toxins"). If the complaint is founded, the farmer is required to develop and begin implementing a plan to correct the problem within six months. If the farmer fails to carry out the plan, the Commissioner may enter the land and implement the measures. The farmer will be held responsible for all costs, and can be subject to a fine of up to $5,000 for each day the violation occurs (Virginia Department of Agriculture and Consumer Services 1998).

Funding of riparian forest buffer programs

Riparian forest buffer programs are funded through a variety of federal, state, and local programs, as well as a variety of nonprofit organizations such as The Nature Conservancy, Trout Unlimited, Ducks Unlimited, and others. King et al. (1997) suggests that funds could also be generated from wetland mitigation banking, watershed restoration funds received as compensation for natural resource damages (for example, from oil spills), and from point-nonpoint source pollution trading. Point-nonpoint trading works by allowing the sources of point source pollution (for example, water treatment plants, industrial operations, etc.) to fund nonpoint source pollution control projects, rather than installing additional point controls themselves.

When funds and resources are limited, it may be most cost effective to target efforts to specific areas of the watershed than to support efforts across a larger area (Duda and Johnson 1985, Libby 1985, Pritchard et al. 1993). As outlined by King et al. (1997), this may be particularly true for riparian restoration because:

_ not all buffers will provide the same range of benefits. The effectiveness of the buffer will depend on site characteristics, land use, stream characteristics, and the degree to which buffers exist elsewhere along the stream.

_ not all stream buffers will be restored. The voluntary nature of the program suggests that landowners who are not interested will not create riparian buffers on their property. If streams within the watershed are for the most part protected by buffers, occasional interruptions in the stream buffer may not be significant. Conversely, installing short sections of riparian buffers along streams that are mostly unbuffered may provide limited benefits.

_ riparian buffers must be part of a larger sediment and erosion control plan. The buffer is only a “last line of defense”. On agricultural lands, BMPs must be in place to reduce erosion from highly erodible lands, to reduce nutrient and pesticide inputs, and to handle animal manure. In urban areas, storm water drainage systems often bypass buffers and discharge directly into the streams. Likewise, buffers can do little to reduce the force of runoff created by large areas of impervious surfaces. In these situations, the effectiveness of the buffer is limited.

Chapter 7

Resources for Virginia Landowners

While forested buffers can provide many benefits to society, the cost of establishing and maintaining these buffers can be significant to the individual landowner. To help Virginia's landowners in their restoration efforts, the agencies of the Commonwealth have agreed to work with individuals and communities in their efforts to restore streamside lands by providing education, technical assistance and funding. They are joined in this effort by federal agencies and many non-profit conservation organizations.

Costs to landowners

Costs are incurred both in establishing and maintaining the buffer, as well as the revenues lost as long as those lands are out of production.

Installation. Costs of installation may include fencing, site preparation, the cost of plant materials, tree protectors, weed control, and in some cases, alternate watering sources for livestock and stream crossings (Table 7.1). The Natural Resources Conservation Service estimates the average cost of installing a 50 foot wide buffer of mixed hardwoods and warm season grasses in Virginia would be approximately $155 per acre, or $394 if the landowner chooses to install seedling protectors (USDA NRCS 1997). Costs of site preparation will vary widely depending on the vegetation present, but may include $54 per acre for herbicide treatment, $34 per acre to disk the area, and $8 per acre to bush hog the area. Annual maintenance costs include costs of replacing seedlings that have died, plus $16 per acre to mow the area, or as much as $54 per acre to treat with an herbicide. Fencing, stream crossings, and alternate watering sites for cattle will increase the cost significantly.

Opportunity costs. Besides the costs of buffer establishment and maintenance, there are additional costs incurred by the landowner. They include loss of income from land that is out of production, personal "utility" loss (for example, loss of view or access), and in some cases, reduced income from developing the land in the future (King et al. 1997). Besides the losses on the riparian land, crop yields on adjacent fields may be reduced from shading, increased competition from trees for nutrients and moisture, increased difficulty in cultivating fields, and increased wildlife damage. Riparian areas may also be invaded by noxious weeds. Currently, deer damages result in losses of 6%-12% of income to Maryland farmers (McNew and Curtis 1997).

A study was completed in 1998 to evaluate the costs to farmers of installing riparian forest buffers in Virginia (Faulkner 1998). This study examined agricultural landuse for 15 counties in the Chesapeake Bay watershed and 15 counties outside the Chesapeake Bay watershed. The study considered opportunity costs (loss of income from livestock or crop production), installation costs, and transaction costs (cost to the farmer in time required to enroll in the program, create a management plan, etc.) over a period of 15 years. Opportunity costs were based on: 1) projected returns for typical crops in each county (accounting for production costs, local property tax rates, crop and farm insurance, commodity prices, and federal payments); 2) an adjustment to account for the types and productivity of soils found in the riparian area in each county; and 3) the assumption that only 75 percent of projected net income would be achieved on cropland because the riparian area is periodically flooded, many sites are already in other vegetation, and some is eroded or otherwise unusable. Installation costs included: 1) costs of

materials and labor to install a 50 foot buffer of trees and grasses (assuming the landowner receives 75% cost-share from federal and state programs); and 2) annual operation and maintenance costs. Based on these considerations, the average cost to the landowner to install and maintain a riparian forest buffer in Virginia for a period of 15 years ranged from an average of $65 to $107 per acre per year for cropland in counties within the Chesapeake Bay watershed and from $53 to $90 per acre per year for cropland in counties outside of the Bay watershed. Costs of participation for pastureland were about the same. However, this does not include costs due to operational inefficiencies (for example, when buffers break up fields into smaller areas with irregular borders) or impacts on adjoining cropland, nor does it address concerns farmers have about lost grazing areas, lost access to water, or the hassle of enrolling and maintaining the buffer.

Table 7.1. Average Costs for Riparian Forest Buffer Planting and Maintenance in Virginia.

Materials and Labor	Estimated Average Cost
Hardwood seedlings	$80 per hundred
Labor to plant	$1.00 per tree
Shrubs	$20 per hundred
Shrubs for bank stabilization	$25 per hundred
Labor to plant	$0.20 each
Switchgrass (recommended rate 10 lbs. per acre)	$4 per pound
Planting costs (conventional or no-till)	$16 per acre
Fescue (recommended rate 60 lbs. per acre)	$1.50 per pound
Ladino clover (recommended rate 3 lbs. per acre)	$4 per pound
Planting costs (conventional or no-till)	$12 per acre
Site preparation	
Disking (2 passes)	$34 per acre
Bush hog	$8 per acre
Sod control (spot spray with herbicide)	$0.15 per tree
Weed control	
Tree shelters (3' shelters with stakes)	$2.80 each
Labor to install	$0.30 each
Mulch mats	$0.75 each
Herbicide treatment[1]	$54 per acre
Streambank Stabilization	
Riprap (including earth movement)	$91 per foot
Bioengineering (including earth movement to slope back bank, plant materials, and placement of rootwads, brush layers and live stakes)	$21.50 per linear foot
Livestock exclusion	
Electric fence	$0.85 per foot
Installation	$0.40 per foot
Charger, clamps, grounding rods	$399 per thousand feet
Alternate watering facility (gravity fed concrete trough)[2]	$800 each
Stream crossing for animals [2]	$1150 each
Maintenance	
Mow between trees	$8 per acre
Mow grass buffer	$8 per acre

From: USDA Natural Resource Conservation Service. 1997. 1997 CRP practice cost and flat rate

payment estimates for Virginia, March 1997. USDA Natural Resource Conservation Service. Richmond, VA.

[1] Figures for herbicide treatment from Palone, R.S. and A.H. Todd (eds.). 1997. Chesapeake Bay riparian handbook: A guide for establishing and maintaining riparian forest buffers. USDA Forest Service NA-TP-02-97.

[2] Figures for watering facility and stream crossing from Faulkner, D.L. 1998. The economics of Conservation Reserve Enhancement program. Virginia Department of Conservation & Recreation. Division of Soil & Water Conservation. Richmond, VA.

Cost share and technical assistance

Many governmental agencies and non-profit conservation organizations provide information, educational programs, and technical assistance to landowners who wish to restore riparian areas. Many also offer funding to help compensate for the costs of restoration.

❑ Federal Government

U.S. Department of Agriculture - Natural Resource Conservation Service offers technical assistance and cost-share and/or rental payments to retire environmentally sensitive lands such as wetlands and riparian areas.

- The **Conservation Reserve Program (CRP)** was introduced in the 1985 Food Security Act (Farm Bill) to reduce soil erosion and protect water quality by retiring highly erodible and other environmentally sensitive lands (such as riparian areas). This program offers a 50% cost-share to establish trees or other cover in riparian areas, as well as annual rental payments while the practice is being maintained. Eligible lands include agricultural lands that have been planted in crops two of the last five years or marginal pasture that is suitable for use as a riparian buffer planted to trees. Highly erodible cropland or cropland within the Chesapeake Bay Priority Area is also eligible. Riparian buffers must be at least 35 feet wide in order to eligible for cost-share and rental payments. Land must be owned or operated by the applicant for 12 months prior to the signup period and landowners must agree to maintain the practice for a 10- to 15-year contract period.
- The **Environmental Quality Incentives Program (EQIP)** was established in the 1996 Farm Bill to replace the Water Quality Improvement Program (WQIP) and the Agricultural Conservation Program (ACP). EQIP provides cost-share funds to address critical environmental needs and concerns of an area or watershed. Up to 75% cost-share funds for fencing of livestock from riparian areas is available. Practices must be part of a planned grazing system for livestock operations. Eligibility is limited to livestock and agricultural producers. Landowners must agree to maintain the practices for a 5- to 10- year contract period.
- The goal of the **Watershed Protection Projects** program is to reduce and provide protection from flooding through better land management. Up to 65% cost-share funds are available to install conservation practices on private lands. Practices which are eligible for funding vary from project to project. Currently, funding is available in 13 watersheds in Virginia.

- The **Wetland Reserve Program (WRP)** provides 75% cost-share for riparian wetland restoration to provide habitat for fish and wildlife, protect water quality, reduce flooding, protect biological diversity, and furnish scientific, recreational and aesthetic benefits. Landowners must agree to maintain the restored area for at least 10 years. WRP also offers funds to enroll the property in a permanent or short-term (30-year) conservation easement. Lands enrolled in permanent easements are eligible for 100% of the costs of restoration.
- The **Wildlife Habitat Incentive Program (WHIP)** is a voluntary program for landowners who want to establish and improve wildlife habitat on private agricultural lands. Cost share funds of up to 75% are available for establishing riparian buffers, creating habitat for waterfowl, installing field borders, and establishing and maintaining warm-season grasses. Riparian buffer must be at least 35 feet wide to qualify for funding and landowners must agree to a 5- to 10- year contract period which provides cost-share and technical assistance to carry out an approved wildlife habitat development plan.

U.S. Fish and Wildlife Service offers technical and financial assistance to restore wildlife habitat on private lands, particularly those that support rare or declining species, or communities and habitat for migratory birds.

- Through their **Partners for Fish and Wildlife** program they will provide assistance to restore wetlands, streams, grasslands, and forested areas to benefit wildlife. In Virginia the program currently targets livestock operations in the Upper Tennessee, Roanoke, and Potomac River basins in an effort to improve water quality and regenerate streamside vegetation. Approved practices in riparian areas include livestock fencing, alternative watering systems, streambank stabilization, and planting of native trees and shrubs. In-kind services and/or materials may be counted toward the landowner portion of the cost-share. Eligible lands include private lands, and lands owned by local and state governments of at least 5 acres in size. The preferred width for a riparian buffer is at least 35 feet on either side of the stream, depending on the site. The landowner must agree to maintain the area for fish and wildlife for at least 10 years.

The **Tennessee Valley Authority (TVA)** provides funding through the Clean Water Initiative for riparian and stream restoration projects in the Tennessee River drainage basin. Private landowners, community groups and local governments in the Clinch, Powell, and Holston River watersheds of southwestern Virginia are eligible for funding. Landowners should contact their local Soil & Water Conservation District office for information on the availability of funds.

❑ **Commonwealth of Virginia**

Virginia Department of Conservation and Recreation offers cost-share funds through the Virginia Agricultural Best Management Practices cost-share program to establish riparian buffers along streams and tidal shorelines. Landowners are also eligible for a Virginia state tax credit equal to 25% of the landowner's out-of-pocket expenses incurred in installing the practices (up to $17,500/yr). Eligible lands include agricultural lands owned by private individuals, foundations, non-profit organizations and other non-governmental entities. This programs is managed by local Soil and Water Conservation Districts and includes the following practices:

- The **Grazing Land Protection** practice provides cost-share funds of 75% for fencing and stream crossings to eliminate direct access of livestock to streams. The landowner must agree to maintain the practice for at least 10 years.
- The **Stream Protection** practices provide 75% cost-share funds for permanent fencing and up to 100% for planting streamside vegetation in riparian areas. A tax credit is also available for installing livestock crossings and for stream channel stabilization practices. The landowner must agree to maintain practices for at least 5 years.
- The **Grass Filter Strips** practice provides a one-time payment of $175 per acre to install and maintain grass filter strips along streams. A larger payment of $250-$300 is available under the "wildlife option" if warm-season grasses are planted. The landowner must agree to maintain the area for at least 5 years. The minimum width for the filter strip is 25 feet.
- The **Woodland Buffer Filter Area** practice provides a one time payment of $200 per acre to establish forested buffers along streams. Cost-share assistance for seedlings, labor, and site preparation is permissible from other sources. This practice is limited to crop and pasture land that has been in production two of the last five years. The width of the buffer is determined by land capability class, but must be at least 50 feet wide and the landowner must agree to maintain the practice for at least 10 years.
- **Vegetative Stabilization of Marsh Fringe Areas** provides funds to stabilize tidal shorelines. The practice provides cost-share of 50% to establish marsh grasses.
- The **Wetland Restoration** practice provides a tax credit to landowners who restore wetlands on their property. Landowners must agree to maintain the wetland for at least 10 years.

Virginia Department of Forestry offers technical and financial assistance for tree planting in riparian areas:

- The **Forestry Incentive Program (FIP)** is a federal program managed by the Department of Forestry to provide funds for tree planting, site preparation, and timber stand improvement practices on non-industrial private lands. To be eligible for FIP funds, landowners must have an approved forest management plan, enroll a minimum of 10 acres of land, and agree to maintain the practices for at least 10 years. Current cost-share rates are approximately 40% for pine plantings and 65% for hardwood management.
- The **Restoration of Timberlands (RT)** provides cost-share funds (up to 40%) for tree planting and timber stand improvement practices on private, non-profit, and community

forest lands. Only lands planted to pine are eligible. There is a 10-year contract period. The program is funded by the forest industry in Virginia, with matching state funds.

- The **Water Quality Improvement Fund** is a special fund created in the 1997 General Assembly to support voluntary programs of pollution prevention and control. The fund provides grants to local governments and individuals to upgrade sewage treatment plants and for management practices to control nonpoint source pollution. The fund will provide 50% of the cost of riparian restoration projects. There is no minimum acreage requirement for WQIF funds.

The **Virginia Department of Environmental Quality/Virginia Coastal Resources Management Program** provides grants to local governments, state agencies, and others for restoration, demonstration, and monitoring projects on public lands. Streambank restoration projects and establishing forested riparian buffers are eligible for funding.

Resource Conservation and Development Councils (RC&Ds) offer technical and financial assistance to landowners for riparian and streambank restoration projects. Practices which are funded vary between councils, however, they may include fencing, construction of alternative watering facilities for livestock, trees, and streambank stabilization. In some watersheds, limited funds are available for the purchase of conservation easements. Eligible lands include those owned by private landowners, municipalities, state governments, non-profit conservation agencies, and other ownerships. There is no minimum width requirement for buffer establishment.

Virginia Department of Game and Inland Fisheries offers assistance for landowners wishing to enhance the riparian area for fish and wildlife. They work closely with biologists from the U.S. Fish & Wildlife Service, Ducks Unlimited, and other agencies to develop management plans and to secure sources of funding for landowners. They will also accept donations of conservation easements for properties with high value to fish and wildlife.

❑ **Non-profit conservation organizations**

Ducks Unlimited and the Chesapeake Bay Foundation are non-profit conservation agencies which offer funding to restore wetland and riparian areas for water quality improvement and habitat restoration.

- Through their **Habitat Stewardship Program** they will provide up to 75% to 90% cost-share funds to plant riparian vegetation (native trees, shrubs, warm-season grasses, and/or other native vegetation), fence livestock from streams, and provide alternate watering systems and stream crossings. To be eligible, riparian buffers must protect streams from sedimentation and nutrient loading, provide habitat for wildlife, and improve water quality for aquatic organisms. No haying, grazing, or timber harvesting is allowed during the 10- year contract period.

The **Izaak Walton League of America** sponsors the "Save-Our-Streams" program which recruits and trains volunteers to monitor water quality in streams. They also offer educational materials and assistance to individuals, citizen groups, local governments and government agencies for streambank restoration projects.

American Forests provides grant funding through their **Global ReLeaf Forest Ecosystem Restoration Program** for riparian forest restoration. They will fund projects on both public and

private lands, however, private landowners must enroll their riparian lands in a conservation easement or other long-term agreement with a conservation agency (for example, their local Soil & Water Conservation District) to be eligible for funding. They will cover the normal costs associated with tree planting, for example, seedling purchase, site preparation, and tree shelters.

Trout Unlimited will provide funding for stream restoration along trout streams through their **Embrace-a-Stream** program. This program will support the cost of tree plantings, in-stream restoration, fencing, alternate watering facilities for livestock, and other costs associated with stream restoration. There is no minimum acreage or width requirement, nor a requirement for the landowner to enter into a long-term agreement with a conservation agency. However, priority is given to lands that are protected. Where landowners are receiving funding through other sources (for example, state or federal cost-share funds), Trout Unlimited will provide the landowner match for the project, thereby assuring that all costs of restoration are met. The Embrace-a-Stream program will also fund research and educational projects. Trout Unlimited works with federal agencies through the **Bring Back the Natives** restoration project where the goal is to promote the re-establishment of native trout or salmon fisheries on federal lands.

The **Canaan Valley Institute** offers technical assistance to local governments, landowner associations, and groups of private landowners to develop stream restoration plans on a watershed scale. They also have limited funding available for restoration projects. The Canaan Valley Institute serves landowners in the mid-Atlantic highlands (including areas west of the Blue Ridge in Virginia, West Virginia, Maryland, and Pennsylvania).

The **James River Association** offers technical assistance to landowners along the lower James River (approximately from Richmond downstream to the Charles City line). They work with private landowners, industry, and local governments who own properties on the James River to develop and implement shoreline protection strategies and riparian habitat restoration projects. They will assist landowners in locating sources of funding and volunteer assistance to complete restoration projects. The Association accepts and encourages the use of conservation easements to protect riparian lands along the James River.

Fairfax ReLeaf is an organization of volunteers who plant and preserve trees and restore habitat on public lands in Northern Virginia. They offer financial and technical assistance to help plan projects, coordinate volunteer groups and to locate planting stock.

Conservation Easements

Conservation easements are perpetual legal agreements between a private property owner and a qualified conservation agency (such as a land trust, conservation organization, or public agency). The easement voluntarily places restrictions on the type and amount of activity that may take place on that property. The conservation easement may either be donated by the landowner to the conservation agency, or the landowner may accept payment for the “rights” that are conveyed. Each easement is individually tailored to the unique value of the land and the wishes of the landowner. The easement becomes part of the property deed and remains in effect for the entire life of the agreement, binding future property owners to the same terms as the present owner. Easements may be perpetual or for a specific period of years. Conservation easements can offer the landowner income tax, estate tax, and property tax advantages, while at the same time allowing the landowner rights of ownership.

❑ **Federal Government**

The federal government accepts conservation easements through the U.S. Department of Agriculture and the U.S. Fish and Wildlife Service. The **Wetland Reserve Program (WRP)** offers cost-share funds to restore wetlands on private property and allows landowners to sell either permanent or short-term easements to the U.S. Department of Agriculture. A one-time payment of the appraised agricultural value of the land (not to exceed $1200) is made to the landowner for perpetual easements; 30-year easements are eligible for 75% of the easement value. The landowner maintains ownership of the land. Income from timber harvesting, leasing of hunting and fishing rights, or other compatible uses can be included in the Wetlands Reserve Program agreement. The Wetlands Reserve Program is administered by the USDA Natural Resources Conservation Service.

The U.S. Fish and Wildlife Service accepts conservation easements through the **Partners for Fish and Wildlife** program. Lands targeted for easements are lands with threatened and endangered species and lands adjacent to or near a National Wildlife Refuge.

❑ **Commonwealth of Virginia**

The Commonwealth of Virginia accepts easements through the **Division of Natural Heritage**, the **Department of Game and Inland Fisheries**, and the **Virginia Outdoors Foundation**. Lands targeted for easements by Natural Heritage include those that support rare species or significant natural communities; the Department of Game and Inland Fisheries accepts easements for wetlands and open space. The **Virginia Outdoors Foundation** was established by the Virginia General Assembly to conserve Virginia's scenic, natural, historic, and recreational areas for the public benefit. They purchase a variety of conservation easements, including easements for riparian corridors, flood plain protection areas, and other lands important to water quality protection. Easements are conveyed to the Virginia Outdoors Foundation and a local co-holder, such as a local government, Soil and Water Conservation District, or conservation organization.

❑ **Non-profit conservation organizations**

Many national conservation organizations also accept easements of wetlands and riparian areas. Those operating in Virginia include **The Nature Conservancy** and **Ducks Unlimited**.

In addition, there are many local and regional private organizations which accept conservation easements of riparian lands, such as the **Chesapeake Bay Foundation**, the **James River Association**, **Piedmont Environmental Council**, the **Valley Conservation Council**, the **Western Virginia Land Trust**, the **Fairfax Land Preservation Fund**, **Friends of Dragon Run**, and others. In some counties, local **Soil and Water Conservation Districts** may use part of their funding to purchase conservation easements in eroding areas or areas of important ecological value, including riparian areas.

Tax Incentives

Riparian landowners may be eligible for reductions in state and federal income taxes and local property taxes for restoration and conservation of streamside areas.

In Virginia, the **Use-Value Taxation Assessment** allows counties, at their own option, to voluntarily reduce property taxes for agricultural and forested lands and to remove property taxes entirely on wetlands and riparian lands that have been placed in a perpetual conservation easement. Not all counties currently allow the tax reduction. In order to qualify, riparian areas must be at least 35 feet in width, adjacent to a body of water, and managed to maintain the integrity of stream channels and reduce the effects of upland sources of pollution.

Reductions in federal income tax for the costs of tree planting and site preparation (up to $10,000 each year) are provided by the **Reforestation Tax Credit** and **7-year amortization**. However, only sites larger than one acre which are managed for the production of commercial timber are eligible. Buffers planted for water quality, aesthetic, or wildlife purposes are excluded. Reductions in federal and state income taxes are also provided when riparian lands are placed in a permanent conservation easement. The easement value is considered a 'charitable gift' for income tax purposes (this applies only if the landowner has not been compensated for the easement).

Who to contact

For further information on these and other programs, contact your local Virginia Cooperative Extension Service office or one of the other organizations listed below:

Addresses

American Forests
P.O. Box 2000
Washington, DC 20013
(202) 955-4500
Contact: Bill Tikkala

Chesapeake Bay Foundation
1001 E. Main St., Suite 815
Richmond, VA 23219
(804) 780-1392

Canaan Valley Institute
P.O. Box 673
Davis, WV 26265

(800) 922-3601

Ducks Unlimited
1001 E. Main St., Suite 710
Richmond, VA 23219
(804) 780-1392
Contact: David Sausville

Fairfax Land Preservation Trust
Packard Center
4022 Hummer Rd.
Annadale, VA 22001
(703)354-5093

Fairfax ReLeaf
12055 Government Center Parkway
Suite 703
Fairfax, VA 22035
(703) 324-1409

Friends of Dragon Run
P.O. Box 882
Gloucester, VA 23061

Izaac Walton League of America
707 Conservation Lane
Gaithersburg, MD 20878
(800) 284-4952

James River Association
P.O. Box 110
Richmond, VA 23218
(804)730-2898
contact: Dana Bradshaw

The Nature Conservancy
Virginia Chapter
1110 Rose Hill Dr., Suite 200
Charlottesville, VA 22903
(804) 295-6106

Piedmont Environmental Council
P.O. Box 460
Warrenton, VA 20188
(540) 347-2334

Resource Conservation and Development Councils
Black Diamond RC&D
383 Highland Dr. Suite 2
Lebanon VA 24266
(540) 889-4180

New River Highlands RC&D
110 W. Spiller St. Suite C
Wytheville, VA 24382
(540) 228-2879
Contact: Gary Boring

Trout Unlimited
1500 Wilson Blvd. Suite 310
Arlington, VA 22209
(703) 522-0200

U.S. Department of Agriculture
Natural Resource Conservation Service
1606 Santa Rosa Rd.
Richmond, Virginia 23229
(804) 287-1668
Contact: John Meyers

U.S. Fish and Wildlife Service
P.O. Box 99
Gloucester, VA 23061
(804) 693-6694 x124
Contact: Will Smith

Valley Conservation Council
P.O. Box 2335
Staunton, VA 24402
(540)866-3541

Virginia Division of Soil and Water Conservation
Department of Conservation and Recreation
203 Governor Street, Suite 206
Richmond, VA 23219
(804) 371-7330

Virginia Division of Soil and Water Conservation Districts
203 Governor St. Suite 206
Richmond, VA 23219
(804) 786-2064
Contact: Dana Bayliss

Virginia Department of Forestry
P.O. Box 3758
Charlottesville, VA 22903
(804)977-6555
Contact: Mike Foreman

Virginia Department of Game and Inland Fisheries
P.O. Box 11104
Richmond, VA 23230
(804) 367-1000

Virginia Division of Natural Heritage
Department of Conservation and Recreation
217 Governor St., 3rd Floor
Richmond, VA 23219
(804) 786-7951

Virginia Coastal Resources Management Program
Department of Environmental Quality
629 E. Main St.
Richmond, VA 23219
(804) 698-4323
Contact: Laura McKay

Virginia Outdoors Foundation
203 Governor St., Suite 316
Richmond, VA 23219
(804) 225-2147

Western Virginia Land Trust
P.O. Box 18102
Roanoke, VA 24014
(540) 985-0000
Contact: Rupert Cutler

Bibliography

Aadlund, L.P. 1996. Effects of forestry practices on stream fisheries. Pages 113-117. *In:* Laursen, S.B. (ed.) At the water's edge: the science of riparian forestry. Proceedings of a conference June 19-20, 1995. Duluth, MN. Univ. of MN Pub. BU-6637-S. St. Paul, MN.

Adams, L.W. and L.E. Dove. 1989. Wildlife reserves and corridors in the urban environment: a guide to ecological landscape planning and resource conservation. National Institute for Urban Wildlife, Columbia, MD. and U.S. Fish & Wildlife Service, Washington, DC.

Ahle, R.C. and G. Jobsis. 1994. Riparian wetlands: their value to fish and fisheries habitat in South Carolina. Pages 139-155. *In:* Riparian ecosystems in the humid U.S. Functions, values and management. Proceedings of a Conference March 15-18, 1993. Atlanta, GA. National Association of Conservation Districts.

Aitchison, S.W., S.W. Carothers, and R.R. Johnson. 1977. Some ecological considerations associated with river recreation management. Pages 222-225. *In:* Proceedings: River recreation management and research symposium. Jan. 24-27, 1977 Minneapolis, MN. USDA Forest Service GTR-NC-28. St. Paul, MN.

Alexander, S.V. 1994. Riparian restoration through integrated resource management. Pages 232-239. *In:* Riparian ecosystems in the humid U.S. Functions, values, and management. Proceedings of a conference March 15-18, 1993. Atlanta, GA. National Association of Conservation Districts.

Alig, R.J., K.J. Lee, and R.J. Moulton. 1990. Likelihood of timber management on nonindustrial private forests: evidence from research studies. USDA Forest Service GTR-SE-60.

Baker, D.B. 1985. Regional water quality impacts of intensive row-crop agriculture: a Lake Erie basin case study. J. Soil & Water Cons. 40:125-132.

Beare, M.H., R.R. Lowrance, and J.L. Meyer. 1994. Biotic regulation of nitrate depletion in a Coastal Plain riparian forest: experimental approach and preliminary results. Pages 388-397. *In:* Riparian ecosystems in the humid U.S. Functions, values and management. Proceedings of a Conference March 15-18, 1993. Atlanta, GA. National Association of Conservation Districts.

Beaulac, M.N. and K.H. Reckhow. 1982. An examination of land use - nutrient export relationships. Water Res. Bull. 18:1013-1024.

Bell, C.D., R.K. Roberts, B.C. English, and W.M. Park. 1994. A logit analysis of participation in Tennessee's forest stewardship program. J. Agr. and Applied Econ. 26:463-472.

Benke, A.C., R.L. Henry, D.M. Gillespie, and R.J. Hunter. 1985. Importance of snag habitat for animal production in southeastern streams. Fisheries 10(5):8-13.

Best, L.B., R.C. Whitmore, and G.M. Booth. 1990. Use of cornfields by birds during the breeding season: the importance of edge habitat. Am. Mid. Nat. 123:84-95.

Blakesley, J.A. and K.P. Reese. 1988. Avian use of campground and noncampground sites in riparian zones. J. Wildl. Manage. 52:399-402.

Blanchard, P.E., W.W. Donald, and E.E. Alberts. 1995. Herbicide concentrations in groundwater in a claypan soil watershed. Pages 21-24. *In:* Clean water, clean environment - 21st century. Vol. I: Pesticides. Proceedings of a conference March 5-8, 1995. Kansas City, MO. ASAE, St. Joseph, MI.

Bohlen, C.C. and D.M. King. 1996. Ecological principles of riparian buffer functions. Univ. MD. Center for Environmental and Estuarine Studies. Technical Contribution UMCEES-CBL-96-161.

Bratton, S.P., J.R. Hapeman, and A.R. Mast. 1994. The lower Susquehanna River gorge and floodplain (USA) as a riparian refugium for vernal, forest-floor herbs. Cons. Biol. 8:1069-1077.

Brinson, M.M, H.D. Bradshaw, and E.S. Kane. 1984. Nutrient assimilative capacity of an alluvial floodplain swamp. J. Appl. Ecol. 21:1041-1057.

Brown, G.W. and J.T. Krygier. 1967. Changing water temperatures in small mountain streams. J. Soil & Water Cons. 22:242-244.

Brown, G.W. and J.T. Krygier. 1970. Effects of clearcutting on stream temperature. Water Resour. Res. 6:1133-1139.

Brown, T.C. and T.C. Daniel. 1991. Landscape aesthetics of riparian environments: relationship of flow quantity to scenic quality along a wild and scenic river. Wat. Resour. Res. 27:1787-1795.

Capel, S. 1992. Warm season grasses for Virginia and North Carolina - benefits for livestock and wildlife. Virginia Department of Game and Inland Fisheries. 10 p.

Carson, R.T. and R.C. Mitchell. 1993. The value of clean water: the public's willingness to pay for boatable, fishable, and swimmable water quality. Water Resour. Res. 29:2445-2454.

Chen, Y.D., S.C. McCutcheon, and R.F. Carsel. 1994. Ecological perspectives on silvicultural nonpoint source pollution control. Pages 229-235 *In:* Watershed 93: A national conference on watershed management. Proceedings of a conference March 21-14, 1993, Alexandria, VA. EPA 840-R-94-002.

Chesters, G. and L.J. Schierow. 1985. A primer on nonpoint pollution. J. Soil & Water Cons. 40:9-13.

Chutter, F.M. 1969. The effects of silt and sand on the invertebrate fauna of streams and rivers. Hydrobiologia 34:57-76.

Clapp, C.E., R. Liu, R.H. Dowdy, U. Mingelgrin, and M.H.B. Hayes. 1995. Humic acid-herbicide complexes in soil and water biosystems. Pages 33-36. *In:* Clean water, clean environment - 21st century. Vol. I: Pesticides. Proceedings of a conference March 5-8, 1995. Kansas City, MO. ASAE, St. Joseph, MI.

Clark, E.H., II. 1985. The off-site costs of soil erosion. J. Soil & Water Cons. 40:19-22.

Clark, E.H., II, J.A. Haverkamp, and W. Chapman. 1985a. Eroding soils: the off-farm impacts. The Conservation Foundation, Washington, DC.

Clark, J. 1978. Freshwater wetlands: habitats for aquatic invertebrates, amphibians, reptiles, and fish. Pages 330-343. *In:* Greeson, P.E., J.R. Clark, and J.E. Clark (eds.). Wetland functions and values: the state of our understanding. Am. Wat. Res. Assoc. Minneapolis, MN.

Clark, R.N., D.R. Gibbons, and G.B. Pauley. 1985b. Influence of forest and rangeland management on anadromous fish habitat in Western North America: Influences of recreation. USDA Forest Service GTR-PNW-178.

Clonts, H.A. and J.W. Malone. 1990. Preservation attitudes and consumer surplus in free-flowing rivers. Pages 301-315. *In:* Vining, J. (ed.) Social Science and Natural Resource Recreation Management.

Compton, B.B., R.J. Mackie, and G.L. Dusek. 1988. Factors influencing distribution of white-tailed deer in riparian habitats. J. Wildl. Manage. 52:544-548.

Constance, D.H., J.S. Rikoon, and W.D. Heffernan. 1995. Seperation of ownership and environmental decision-making on rented farmland. Pages 65-68. *In:* Clean water- clean environment - 21st century. Vol. III: practices, systems, and adoption. Proceedings of a conference March 5-8, 1995, Kansas City, MO. ASAE, St. Joseph, MI.

Contant, C.K., M.D. Duffy, and M.A. Holub. 1993. Determining tradeoffs between water quality and profitability in agricultural production: implications for nonpoint source pollution policy. Wat. Sci. Tech. 28:27-34.

Cook, M.G. 1996. Good soil management helps protect groundwater. North Carolina Cooperative Extension Service. Publ. AG-439-09.

Cooper, A.B. 1990. Nitrate depletion in the riparian zone and stream channel of a small headwater catchment. Hydrobiologia 202:13-26.

Cooper, J.R. and J.W. Gilliam. 1987. Phosphorus redistribution from cultivated fields into riparian areas. Soil Sci. Soc. Am. J. 51:1600-1604.

Cooper, J.R., J.W. Gilliam, R.B. Daniels, and W.P. Robarge. 1987. Riparian areas as filters for agricultural sediment. Soil Sci. Soc. Am. J. 51:416-420.

Correll, D.L. 1997. Buffer zones and water quality protection: general principles. Pages 7-20. *In:* Haycock, N.E., T.P. Burt, K.W.T. Goulding, and G. Pinay (eds.). Buffer zones: Their processes and potential in water protection. Proceedings of the international conference on buffer zone. September 1996. Quest Environmental. Harpenden, England.

Croghan, M.B. 1994. Virginia's integrated agricultural nonpoint source pollution control strategies. Pages 17-21. *In:* Campbell, K.L., W.D. Graham, A.B. Bottcher (eds.). Environmentally sound agriculture: proceedings of the 2nd conference April 20-22, 1994. Orlando, FL. ASAE, St. Joseph, MI.

Croonquist, M.J. and R.P. Brooks. 1991. Use of avian and mammalian guilds as indicators of cumulative impacts in riparian-wetland areas. Env. Manage. 15:701-714.

Croonquist, M.J. and R.P. Brooks. 1993. Effects of habitat disturbance on bird communities in riparian corridors. J. Soil and Water Cons. 48:65-70.

Crutchfield, S.R., J.C. Cooper, and D.R. Hellerstein. 1997. Benefits of safer drinking water: the value of nitrate reduction. USDA Economic Research Service AER-752. Washington, DC.

Cummins, K.W. 1974. Structure and function of stream ecosystems. BioScience 24:631-641.

Cummins, K.W., Wilzbach, M.A., D.M. Gates, J.B. Perry, and W.B. Taliaferro. 1989. Shredders and riparian vegetation. Bioscience 39(1):24-30.

Daniels, R.B. and J.W. Gilliam. 1996. Sediment and chemical load reduction by grass and riparian filters. Soil Sci. Soc. of Am. J. 60:246-251.

Darveau, M. 1996. Experimentation of different approaches for protecting boreal forest wildlife habitats with riparian forest strips. Pages 107-112. *In:* Laursen, S.B. (ed.) At the water's edge: the science of riparian forestry. Proceedings of a conference June 19-20, 1995. Duluth, MN. Univ. of MN Pub. BU-6637-S. St. Paul, MN.

Darveau, M., P. Beauchesne, L. Belanger, J. Huot, and P. Larue. 1995. Riparian forest strips as habitat for breeding birds in boreal forest.

DeGraaf, R.M. and D.D. Rudis. 1990. Herpetofaunal species composition and relative abundance among three New England forest types. For. Ecol. and Manage. 32:155-165.

DeGraaf, R.M., M. Yamasaki, W.B. Leak, and J.W. Lanier. 1992. New England wildlife: Management of forested habitats. UDSA Forest Service GTR-NE-144. Radnor, PA.

Dickson, J.G. and M.L. Warren. 1994. Wildlife and fish communities of eastern riparian forests. Pages 1-31. *In:* Riparian ecosystems in the humid U.S. Functions, values and management. Proceedings of a Conference March 15-18, 1993. Atlanta, GA. National Association of Conservation Districts.

Dickson, J.G. and J.H. Williamson. 1988. Small mammals in streamside management zones in pine plantations. Pages 375-378. *In:* Management of amphibians, reptiles and small mammals in North America. Proceedings of the symposium July 19-21, 1998 Flagstaff, AZ. US Forest Service GTR-RM-166.

Dickson, J.G., J.H. Williamson, R.N. Conner, and B. Ortego. 1995. Streamside zones and breeding birds in eastern Texas. Wildl. Soc. Bull. 23:750-755.

Dillaha, T.A., and J.C. Hayes. 1991. A procedure for the design of vegetative filter strips. Final report to USDA Soil Conservation Service, September 30, 1991.

Dillaha, T.A., R.B. Reneau, S. Mostaghimi, and D. Lee. 1989. Vegetative filterstrips for agricultural nonpoint source pollution control. Trans. ASAE 32:513-519.

Dillaha, T.A., J.H. Sherrard, and D. Lee. 1986. Long-term effectiveness and maintenance of vegetative filter strips. Virginia Water Resources Research Center Bulletin VPI-VWRRC-Bull 153 4C. Blacksburg, VA.

Donald, W.W., R.N. Lerch, A.T. Hjelmfelt, and E.E. Alberts. 1995. Herbicides and degradation products contaminate Goodwater Creek, Missouri. Pages 61-64. *In:* Clean water, clean environment - 21st century. Vol. I: Pesticides. Proceedings of a conference March 5-8, 1995. Kansas City, MO. ASAE, St. Joseph, MI.

Dosskey, M.G., R.C. Schultz, and T.M. Isenhart. 1997. How to design a riparian buffer for agricultural land. National Agroforestry Center. Agroforestry Notes AF Note - 4. USDA Forest Service/ Natural Resources Conservation Service. Lincoln NE.

Doyle, A.T. 1990. Use of riparian and upland habitats by small mammals. J. Mammol. 71:14-23.

Dronen, S.L. 1988. Layout and design criteria for livestock windbreaks. Agr. Ecosystems Env. 22/23:231-240.

Duda, A.M. and R.J. Johnson. 1985. Cost effective targeting of agricultural nonpoint source pollution controls. J. Soil & Water Cons. 40:108-111.

Dupont, D.P. 1992. Economic assessment of the performance of alternative environmental policy instruments as they pertain to agriculture and water quality. *In:* Miller, M.H., J.E. FitzGibbon, G.C. Fox, R.W. Gillham, H.R. Whiteley (eds.). Agriculture and water quality. Proceedings of an interdisciplinary symposium. Centre for Soil and Water Conservation. University of Guelph. Guelph, Ontario. Canada.

Eisel, M.C. 1988. Deciduous woody plants for the florist trade. Pages 57-64. *In:* Commercial field production of cut and dried flowers. Proceedings of a symposium December 6-8, 1988. University of Minnesota Center for Alternative Crops and Products and The American Society of Horticultural Science.

Elias, T.S. 1980. The complete trees of North America. Outdoor Life/Nature Books. Van Nostrand Reinhold Co. NY.

Emerson, P.M. 1996. Cultural values in riparian areas. Pages 36-39 *In:* Laursen, S.B. (ed.) At the water's edge: the science of riparian forestry. Proceedings of a conference held June 19-20, 1995, Duluth MN. Univ. of Minn. Publication BU-6637-S.

Ervin, C.A. and D.E. Ervin. 1982. Factors affecting the use of soil conservation practices: hypotheses, evidence, and policy implications. Land Econ. 58:277-292.

Evanylo, G.K. 1994. Mineralization and availability of nitrogen in organic waste-amended Mid-Atlantic soils. Pages 77-104. *In:* Perspectives on Chesapeake Bay, 1994: Advances in estuarine sciences. Chesapeake Bay Program Scientific and Technical Advisory Committee. Chesapeake Research Consortium. CRC Publication 147. Edgewater, MD.

Faulkner, D.L. 1998. The economics of Conservation Reserve Enhancement Program (CREP) participation in Virginia. Virginia Department of Conservation & Recreation. Division of Soil & Water Conservation.

Fausey, N., R. Dowdy, T. Steinheimer, R. Spalding, P. Blanchard, B. Lowery, W. Albus, and S. Clay. 1995. Where's the atrazine? - a regional groundwater synopsis. Pages 69-72. *In:* Clean water, clean environment - 21st century. Vol. I: Pesticides. Proceedings of a conference March 5-8, 1995. Kansas City, MO. ASAE, St. Joseph, MI.

Ferguson, H.L., R.W. Ellis, and J.B. Whelan. 1975. Effects of stream channelization on avian diversity and density in Piedmont VA. Proc. Ann. Conf. Southeast. Assoc. Game and Fish Comm. 29:540-548.

Firehock, K. and J. Doherty. 1995. A citizen’s streambank restoration handbook. Izaak Walton League of America, Inc. 707 Conservation Lane. Gaithersburg, MD 20878.

Fischer, R.A., and N.R. Holler. 1991. Habitat use and relative abundance of gray squirrels in southern Alabama. J. Wildl. Manage. 55:52-58.

Flebbe, P.A. and C.A. Doloff. 1995. Trout use of woody debris and habitat in Appalachian wilderness streams of North Carolina. N. Am. J. Fish. Manage. 15:579-590.

Geier, A. and L.B. Best. 1980. Habitat selection by small mammals of riparian communities: evaluating effects of habitat alterations. J. Wildl. Manage. 44:16-24.

Gilliam, J.W. 1994. Riparian wetlands and water quality. J. Environ. Qual. 23:896-900.

Gilliam, J.W., D.L. Osmond, and R.O. Evans. 1997. Selected agricultural best management practices to control nitrogen in the Neuse River Basin. North Carolina Agricultural Research Service Technical Bulletin 311. Raleigh, NC.

Gitelson, R.J. and A. Graefe. 1990. Economic impacts associated with whitewater boating on the Upper Youghiogheny River. Pages 65-69. *In:* Proceedings of the 1990 Northeastern recreation research symposium Feb. 25-28, 1990. Saratoga Springs, NY. USDA Forest Service GTR-NE-145.

Gold, A.J. and P.M. Groffman. 1995. Groundwater nitrate removal in riparian buffer zones. Pages 63-65. *In:* Clean water, clean environment - 21st century. Volume II: Nutrients. Proceedings of a conference March 5-8, 1995. Kansas City, Missouri. ASAE, St. Joseph, MI.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. Bioscience 41:540-551.

Guldin, R.W. 1989. An analysis of the water situation in the United States: 1989-2040. USDA Forest Service GTR-RM-177.

Haefner, J.D. and J.B. Wallace. 1981. Shifts in aquatic insect populations in a first-order southern Appalachian stream following a decade of old field succession. Can. J. Fish. Aquat. Sci. 38:353-359.

Hagan, P.T. 1996. Evaluating determinants of participation in voluntary riparian buffer programs: a case study of Maryland's Buffer Incentive Program. University of Maryland Master's Thesis. Marine, Estuarine, and Environmental Sciences Program.

Hall, D.W. and D.W. Risser. 1993. Effects of agricultural nutrient management on nitrogen fate and transport in Lancaster County, Pennsylvania. Water Resour. Bull. 29:55-76.

Harrington, W., A.J. Krupnick, and H. M. Peskin. 1985. Policies for nonpoint source water pollution control. J. Soil & Water Cons. 40:27-32.

Harris, C.C., W.J. McLaughlin, and D.K. Rawhouser. 1990. Comprehensive evaluation of information/education programs to reduce recreational impacts on the Lower Salmon River. J. Env. Manage. 31:19-28.

Harris, L.D. 1988. The faunal significance of fragmentation of Southeastern bottomland forests. Pages 126-134. *In:* The forested wetlands of the Southern U.S. Proceedings of a symposium July 12-14, 1988. Orlando, FL. USDA Forest Service GTR-SE-50.

Hatfield, J.L., S.K. Mickelson, J.L. Baker, K. Arora, D.P. Tierney, and C.J. Peter. 1995. Buffer strips: landscape modifications to reduce off-site herbicide movement. Pages 85-88. *In:* Clean water, clean environment - 21st century. Vol. I: Pesticides. Proceedings of a conference March 5-8, 1995. Kansas City, MO. ASAE, St. Joseph, MI.

Hawks, L.J., F.W. Cubbage, H.L. Haney, R.M. Shaffer, and D.H. Newman. 1993. Forest water quality protection: a comparison of regulatory and voluntary programs. J. of For. 91:48-54.

Haycock, N.E. and G. Pinay. 1993. Groundwater nitrate dynamics in grass and poplar vegetated riparian buffers during the winter. J. Environ. Qual. 22:273-278.

Hedman, C.W. and D.H. Van Lear. 1995. Vegetative structure and composition of Southern Appalachian riparian forests. Bull. Torrey Bot. Club 122:134-144.

Higgins, D.A. 1996. Forest management in riparian areas. Pages 118-122. *In:* Laursen, S.B. (ed.). At the water's edge: the science of riparian forestry. Proceedings of a conference June 19-20, 1995. Duluth, MN. Univ. of MN Pub. BU-6637-S. St. Paul, MN.

Hoban, T.J. and W.B. Clifford. 1994. Public attitudes about agricultural water pollution. Pages 151-170. *In:* Swanson, L.E. and F.B. Clearfield (eds.). Agricultural policy and the environment - Iron fist or open hand? Soil and Water Conservation Society. Ankeny, IA.

Hodges, M.F. and D.G. Krementz. 1996. Neotropical migratory breeding bird communities in riparian forests of different widths along the Altamaha River, GA. Wilson Bull. 108:496-506.

Hoffman, J.T., D.L. Green, and D. Eager. 1998. Riparian restoration and streamside erosion control handbook. State of Tennessee Nonpoint Source Water Pollution Management Program. Tennessee Department of Agriculture. Nashville, TN.

Holbrook, H.T., M.R. Vaughan, and P.T. Bromley. 1987. Wild turkey habitat preferences and recruitment in intensively managed piedmont forests. J. Wildl. Manage. 51:182-187.

Holmes, T.P. 1988. The offsite impact of soil erosion on the water treatment industry. Land Econ. 64:356-367.

Hoover, S.L., D.A. King, and W.J. Matter. 1985. A wilderness riparian environment: visitor satisfaction, perceptions, reality, and management. Pages 223-226. *In:* Johnson, R.R., C.D. Ziebell, D.R. Patton, P.F. Folliott, and R.H. Hamre. (eds.). Riparian ecosystems and their management: reconciling conflicting uses. First North American riparian conference. April 16-18, 1985. Tuscon, AZ. USDA Forest Service GTR-RM-120.

Hupp, C.R. 1992. Riparian vegetation recovery patterns following stream channelization: a geomorphic perspective. Ecology 73:1209-1226.

Hupp, C.R., M.D. Woodside, and T.M. Yanosky. 1993. Sediment and trace element trapping in a forested wetland, Chickahominy River, Virginia. Wetlands 13(2):95-104.

Jenkins, D.F. 1991. Woody plants as cut flowers. Pages 68-74. *In:* From a grower's perspective: the business of growing specialty cut flowers. Proceedings of the 4th national conference on specialty cut flowers. November 1-4, 1991. Cleveland, OH. Association of Specialty Cut Flower Growers, Inc.

Johnson, J.L., D. Grotelueschen, and M. Knott. 1994a. Evaluation of bovine perinatal nitrate accumulation in western Nebraska. Vet. Hum. Toxicol. 36:467-471.

Johnson, R.J. and M.M. Beck. 1988. Influences of shelterbelts on wildlife management and biology. Ag. Ecosystems Env. 22/23:301-335.

Johnson, R.L., R.J. Alig, E. Moore, and R.J. Moulton. 1997. NIPF: Landowner's view of regulation. J. of For. 95(1):23-28.

Johnson, W. E., J.R. Plimmer, R.B. Kroll, and A.S. Pait. 1994b. The occurrence and distribution of pesticides in Chesapeake Bay. Pages 105-146. *In:* Perspectives on Chesapeake Bay, 1994: Advances in estuarine sciences. Chesapeake Bay Program Scientific and Technical Advisory Committee. Chesapeake Research Consortium. CRC Publication 147. Edgewater, MD.

Johnston, C.A., G.D. Bubenzer, G.B. Lee, F.W. Madison, and J.R. McHenry. 1984. Nutrient trapping by sediment deposition in a seasonally flooded lakeside wetland. J. Env. Qual. 13:283-289.

Jordan, J.L. and A.H. Elnagheeb 1992. The structure of citizen preferences for government soil erosion control programs. South. J. Ag. Econ. 24:73-82.

Jordan, J.L. and A.H. Elnagheeb. 1993. Willingness to pay for improvements in drinking water quality. Water Resour. Res. 29:237-245.

Jordan, T.E., D.L. Correll, and D.E. Weller. 1993. Nutrient interception by a riparian forest receiving inputs from adjacent croplands. J. Env. Qual. 22:467-473.

Karr, J.R., and I.J. Schlosser 1978. Water resources and the land-water interface. Science 201:229-234.

Kasi, V. and B. Botter. 1994. Streambank fencing for the remediation of agricultural nonpoint source pollution. Pages 301-305. *In:* Riparian ecosystems in the humid U.S.: functions, values, and management. Proceedings of a conference March 15-18, 1993. Atlanta GA. National Association of Conservation Districts.

Kauffman, J.B. and W.C. Krueger. 1984. Livestock impacts on riparian ecosystems and streamside management implications: a review. J. Range Manage. 37: 430-438.

Keller, C.M.E., C.S. Robbins, and J.S. Hatfield. 1993. Avian communities in riparian forests of different widths in Maryland and Delaware. Wetlands 13(2):137-144.

Kelly, J.W. 1991. Field production of cut flowers. HortScience 26:1136-1138

King, D.M., P.T. Hagan, C.C. Bohlen. 1997. Setting priorities for riparian buffers. Univ. of MD. Center for Environmental and Estuarine Studies. Technical Contribution UMCEES-CBL-96-160.

Kort, J. 1995. Economics of Agroforestry. Pages 227-230. *In:* W.J. Rietveld (ed.) Agroforestry and sustainable systems: symposium proceedings. USDA Forest Service GTR-RM-261.

Kuenzler, E.J. 1988. Value of forested wetlands as filters for sediments and nutrients. Pages 85-96. *In:* The forested wetlands of the Southern U.S. Proceedings of a symposium July 12-14, 1988. Orlando, FL. USDA Forest Service GTR-SE-50.

Kuska, J.J. 1977. Biological approach to river planning and management. Pages 296-304. *In:* Proceedings: River recreation management and research symposium. USDA Forest Service GTR-NC-28. St. Paul, MN.

Lant, C.L. 1991. Potential of the Conservation Reserve Program to control agricultural surface water pollution. Env. Manage. 15:507-518.

Larsen, R.E., J.R. Miner, J.C. Buckhouse, and J.A. Moore. 1994. Water quality benefits of having cattle manure deposited away from streams. Bioresource tech. 48:113-118.

LaRue, P., L. Belanger, and J. Huot. 1995. Riparian edge effects on boreal balsam fir bird communities. Can. J. For. Res. 25:555-566.

Lasley, P. and K.Kettner. 1990. Iowa farm and rural life poll 1990 summary. Iowa State University Extension. Ames Iowa. 16pp.

Leopold, L.B. 1969. Landscape esthetics: How to quantify the scenics of a river valley. Nat. Hist. 78(8):36-45.

Libby, L.W. 1985. Paying the nonpoint pollution control bill. J. Soil & Water Cons. 40:33-36.

Licht, L.A. 1992. *Salicaceae* family trees in sustainable agroecosystems. For. Chron.68:214-217.

Lichtenberg, E. and B.V. Lessley. 1992. Water quality, cost-sharing, and technical assistance: perceptions of Maryland farmers. J. Soil & Water Cons. 47:260-264.

Lipman, J. 1995. The status of riparian forest policy in the Chesapeake Bay watershed. Pages 46-50 *In:* Riparian forest buffers: restoring and managing a vital Chesapeake resource. Proceedings of a conference October 5-6, 1994. Ellicott City, MD. EPA-903-R-95-008.

Litton, R.B. 1977. River landscape quality and its assessment. Pages 46-54. *In:* Proceedings: River recreation management and research symposium. USDA Forest Service GTR-NC-28. St. Paul, MN.

Lowrance, R., L.S. Altier, J.D. Newbold, R.R. Schnabel, P.M. Groffman, J.M. Denver, D.L. Correll, J.W. Gilliam, J.L. Robinson, R.B. Brinsfield, K.W. Staver, W. Lucas, and A.H. Todd. 1997. Water quality functions of riparian forest buffers in Chesapeake Bay watersheds. Env. Manage. 21:687-712.

Lowrance, R., R. Leonard, and J. Sheridan. 1985. Managing riparian ecosystems to control nonpoint pollution. J Soil and Water Cons. 40:87-91.

Lowrance, R., J.K. Sharpe, and J.M. Sheridan. 1986. Long-term sediment deposition in the riparian zone of a coastal plain watershed. J Soil and Water Cons. 41:266-271.

Lowrance, R.R., R.L. Todd, and L.E. Asmussen. 1984a. Nutrient cycling in an agricultural watershed: I. phreatic movement. J. Environ. Qual. 13:22-27

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

Lynch, L. 1997. Closed geese season brings economic chill to eastern shore's winter. Univ. MD Coop. Ext. Serv. Econ. Viewpoints. 2(1):9-11.

Lynne, G.D., J.S. Shonkwiler, and L.R. Rola. 1988. Attitudes and farmer conservation behavior. Am. J. Ag. Econ. 70:12-19.

Machtans, C.S., M.A. Villard, and S.J. Hannon. 1996. Use of riparian buffer strips as movement corridors by forest birds. Cons. Biol. 10:1366-1377.

MacKay, D. 1992. A perspective on the fate of chemicals in soils. Pages 1-11. *In:* Miller, M.H., J.E. Fitzgibbon, G.C. Fox, R.W. Gillham, and H.R. Whiteley (eds.). Agriculture and water quality: proceedings of an interdiscipliinary symposium. April 23-24, 1991. Centre for Soil and Water Conservation, Guelph, Ontario.

Magette, W.L., R.B. Brinsfield, R.E. Palmer, and J.D. Wood. 1989. Nutrient and sediment removal by vegetated filter strips. Trans. ASAE 32:663-667.

Malik, A.S., B.A. Larson, and M. Ribaudo. 1994. Economic incentives for agricultural nonpoint source pollution control. Water Resour. Bull. 30:471-479.

Manci, K.M. 1989. Riparian ecosystem creation and restoration: A literature summary. U.S. Fish and Wildlife Service Biological Report 89(20). 59 p.

Marra, M. and K. Zering. 1996. Finding the "best of the best" in water quality BMPs: the economists' viewpoint. North Carolina State University Department of Agricultural & Resource Economics Applied Resource Economics and Policy Group. AREP96-10.

McConnell, L.L., E. Nelson, C.P. Rice, J.A. Harman, J.E. Baker, W.E. Johnson, and S.M. Chernyak. 1995. Pesticides in Chesapeake Bay, atmosphere, and surface waters. Pages 129-132. *In:* Clean water, clean environment - 21st century. Vol. I. Proceedings of a conference March 5-8, 1995. Kansas City, MO. ASAE, St. Joseph, MI.

McCormick, J.H., K.E.F. Hokanson, and B.R. Jones. 1972. Effects of temperature on growth and survival of young brook trout, *Salvelinus fontinalis*. J. Fish. Res. Bd. Canada 29:1107-1112.

McKevlin, M.R. 1992. Guide to regeneration of bottomland hardwoods. USDA Forest Service GTR-SE-76. Southeastern Forest Experiment Station. Ashville, NC.

McNew, K. and J. Curtis. 1997. Maryland farmers lose bucks on deer-damaged crops. University of Maryland Agricultural & Resource Economics. Econ. Viewpoints 2(2): 8-11.

Meyer, J.L., M.H. Beare, P. Saunders, and R.R. Lowrance. 1994. Effects of aldicarb on microbial processes in riparian soils. Pages 324-336. *In:* Riparian ecosystems in the humid U.S. Functions, values and management. Proceedings of a Conference March 15-18, 1993. Atlanta, GA. National Association of Conservation Districts.

Meyer, M.H. 1988. Everlasting ornamental grasses. Pages 69-73. *In:* Commercial field production of cut and dried flowers. Proceedings of a symposium December 6-8, 1988. University of Minnesota Center for Alternative Crops and Products and The American Society of Horticultural Science.

Miller, B.K., B.C. Moser, K.D. Johnson, and R.K. Swihart. 1994. Designs for windbreaks and vegetative filterstrips that increase wildlife habitat and provide income. Pages 567-574. *In:* Campbell, K.L., W.D. Graham, and A.B. Bottcher (eds.). Environmentally sound agriculture: Proceedings of the second conference April 20-22, 1994, Orlando, FL. American Society of Agricultural Engineers. St. Joseph, MI.

Minshall, G.W. 1968. Community dynamics of the benthic fauna in a woodland spring. Hydrobiologia 32:305-339.

Minshall, G.W. 1978. Autotrophy in stream ecosystems. Bioscience 28(12):767-771.

Mitsch, W.J. and J.G. Gosselink. 1993. Wetlands. Van Nostrand Reinhold. New York, NY.

Molnar, J.J. and P.A. Duffy. 1987. Public supports farmers on soil erosion issues. Highlights Agr. Res. 34(4):10. Ala. Agr. Exp. Stn. Auburn AL.

Moorman, T.B., D.B. Jaynes, K. Jayachandran, J.M. Novak, J. Miller, C.A. Cambardella, and J.L. Hatfield. 1995. Processes controlling atrazine leaching in the pothole topography of Central Iowa. Pages 133-136. *In:* Clean water, clean environment - 21st century. Vol. I: Pesticides. Proceedings of a conference March 5-8, 1995. Kansas City, MO. ASAE, St. Joseph, MI.

Moss, B. 1988. The chemical birth of fresh waters. Pages 51-55 *In:* Ecology of Fresh Waters: Man and Medium. (2nd edition). Blackwell Scientific Publications. Oxford.

Mozaffari, M. and J.T. Sims. 1994. Phosphorus availability and sorption in an Atlantic Coastal Plain watershed dominated by animal-based agriculture. Soil Sci. 157:97-107.

Murray, N.L. and D.F. Stauffer. 1995. Nongame bird use of habitat in central Appalachian riparian forests. J. Widl. Manage. 59:78-88.

Myers, L.H. 1989. Riparian area management - inventory and monitoring riparian areas. U.S. Bureau of Land Management. Technical Reference 1737-3. Denver, CO.

Napier, T.L., C.S. Thranen, and S.M. Camboni. 1988. Willingness of land operators to participate in government sponsored soil erosion control programs. J. Rural Stud. 4:339-347.

Neary, D.G., W.T. Swank, and H. Riekerk. 1988. An overview of nonpoint source pollution in the Southern United States. Pages 1-7. *In:* The forested wetlands of the Southern U.S. Proceedings of a symposium July 12-14, 1988. Orlando, FL. USDA Forest Service GTR-SE-50.

Nilsson, C., A. Ekblad, M. Dynesius, S. Backe, M. Gardfjell, B. Carlberg, S. Hellqvist, and R. Jansson. 1994. A comparison of species richness and traits of riparian plants between a main river channel and its tributaries. J. Ecol. 82:281-295.

Norris, P.E. and S.S. Batie. 1987. Virginia farmers' soil conservation decisions: an application of tobit analysis. So. J. Ag. Econ. 79-90.

Norris, P.E. and L.A. Shabman. 1988. Reducing nitrogen pollution from crop production systems: a watershed perspective. Pages 29-38 *In:* Novotny, V. (ed.). Proceedings of the symposium on nonpoint pollution: 1988 - policy, economy, management, and appropriate technology. American Water Resources Association, Bethesda, MD.

Nowak, P.J. 1987. The adoption of conservation technologies: economic and diffusion explanations. Rural Soc. 42:208-220.

Nowak, P.J. and P.F. Korsching. 1983. Social and institutional factors affecting the adoption and maintenance of agricultural BMPs. Pages 349-373. *In*: Schaller, F.W. and G.W. Bailey (eds.) Agricultural management and water quality. Iowa State University Press. Ames IA.

Nowak, P.J. and M. Schnepf. 1994. When Conservation Reserve Program contracts expire. Pages 103-109. *In:* Swanson, L.E. and F.B. Clearfield (eds.). Agricultural policy and the environment - Iron fist or open hand? Soil and Water Conservation Society. Ankeny, IA.

Nutter, W.L. and J.W. Gaskin. 1988. Role of streamside management zones in controlling discharges to wetlands. Pages 81-84. *In:* The forested Wetlands of the Southern U.S. Proceedings of the symposium July 12-14, 1988. Orlando, FL. USDA Forest Service GTR-SE-50.

O'Laughlin, J. and G.H. Belt. 1995. Functional approaches to riparian buffer strip design. J. For. 93(2):29-32.

Ohio Division of Forestry. (no date). TREES - the tree resource establishment and enhancement service. Ohio Division of Forestry Top of Ohio RC&D. Urbana Ohio.

Olmstead, C.J. and D.R. McCurdy. 1989. Factors affecting tree planting by landowners under the CRP, southern Illinois, 1986-1987. J. Soil & Water Cons. 44:498-500.

Oli, M.K., H.A. Jacobson, and B.D. Leopold. 1997. Denning ecology of black bears in the White River National Wildlife Refuge, Arkansas. J. Wildl. Manage. 61:700-706.

Omernik, J.M., A.R. Abernathy, and L.M. Male. 1981. Stream nutrient levels and proximity of agricultural and forest land to streams: some relationships. J. Soil & Water Cons. 36:227-231.

Osborne, L.L., and D.A. Kovacic. 1993. Riparian vegetated buffer strips in water quality restoration and stream management. Freshwater Biol. 29:243-258.

Overcash, M.R., F.J. Humenik, J.R. Miner. 1983. Livestock waste management: Volume I. CRC Press, Inc. Boca Raton, FL.

Pais, R.C., S.A. Bonney, and W.C. McComb. 1988. Herpetofaunal species richness and habitat associations in an eastern Kentucky forest. Proc. Ann. Conf. Southeast Assoc. Fish and Wildl. Agencies. 42:448-455.

Palmateer, G.A. 1992. Transport of biological pollutants from agricultural sources through aquatic sediment systems in Ontario. Pages 59-77. *In:* Miller, M.H., J.E. Fitzgibbon, G.C. Fox, R.W. Gillham, and H.R. Whiteley (eds.). Agriculture and water quality: proceedings of an interdiscipliinary symposium. April 23-24, 1991. Centre for Soil and Water Conservation, Guelph, Ontario.

Palone, R.S. and A.H. Todd (eds.) 1997. Chesapeake Bay riparian handbook: a guide for establishing and maintaining riparian forest buffers. USDA Forest Service Northeastern Area State and Private Forestry NA-TP-02-97. Radnor, PA

Park, W.M and E.B. Dyer. 1986. Off-site damages from soil erosion in West Tennessee. Pages 113-123. *In:* Waddell, T.E. (ed.). The off-site costs of soil erosion. Proceedings of a symposium held May 1985. Conservation Foundation, Washington, DC.

Parsons, J.E., J.W. Gilliam, R. Munoz-Carpena, R.B. Daniels, and T.A. Dillaha. 1994. Nutrient and sediment removal by grass and riparian buffers. Pages 147-154. *In:* Campbell, K.L., W.D. Graham, and A.B. Bottcher (eds.). Environmentally Sound Agriculture - Proceedings of the 2nd Conference. Orlando, FL Apr. 20-22, 1994. ASAE, St. Joseph, MI.

Pawelko, K.A., E.B. Drogin, A.R. Graefe, and D.P. Huden. 1995. Examining the nature of river recreation visitors and their recreational experiences on the Delaware River. Pages 43-49. *In:* Dawson, C.P. (ed.) Proceedings of the 1995 Northeastern recreation research symposium. USDA Forest Service GTR-NE-218.

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

Phillips, J.D. 1989. Nonpoint source pollution control effectiveness of riparian forests along a Coastal Plain river. J. Hydrol. 110:221-237.

Pigram, J. 1983. Outdoor recreation and resource management. St. Martin's Press, N.Y.

Pionke, H.B., W.J. Gburek, A.N. Sharpley, and R.R. Schnabel. 1995. Flow and nutrient export patterns for an agricultural hill-land watershed. Pages 167-170. *In:* Clean water, clean environment - 21st century. Volume II: Nutrients. Proceedings of a conference March 5-8, 1995. Kansas City, Missouri. ASAE, St. Joseph, MI.

Prato, T. and H. Shi. 1990. A comparison of erosion and water pollution control strategies for an agricultural watershed. Wat. Resour. Res. 26:199-205.

Pritchard, T.W., J.G. Lee, and B.A. Engel. 1993. Reducing agricultural sediment: an economic analysis of filter strips versus micro-targeting. Wat. Sci. Tech. 28: 561-568.

Quigley, T.M. 1981. Estimating contribution of overstory vegetation to stream surface shade. Wildl. Soc. Bull. 9(1):22-26.

Rhode, W.A., L.E. Asmussen, E.W. Hauser, R.D. Wauchope, and H.D. Allison. 1980. Trifluralin movement in runoff from a small agricultural watershed. J. Environ. Qual. 9:37-42.

Ribaudo, M.O. 1986. Regional estimates of off-site damages from soil erosion. Pages 29-46. *In:* Waddell, T.E. (ed.). The off-site costs of soil erosion. Proceedings of a symposium held May 1985. Conservation Foundation, Washington, DC.

Roseboom, D. and K. Russell. 1985. Riparian vegetation reduces streambank and row crop flood damages. Pages 241-244. *In:* Johnson, R.R., C.D. Ziebell, D.R. Patton, P.F. Folliott, and R.H. Hamre. (eds.). Riparian ecosystems and their management: reconciling conflicting uses. First North American riparian conference. April 16-18, 1985. Tuscon, AZ. USDA Forest Service GTR-RM-120.

Rosgen, D.L. 1994. A classification of natural rivers. Catena 22:169-199.

Rudolph, D.C. and J.G. Dickson. 1990. Streamside zone width and amphibian and reptile abundance. Southwestern Naturalist 35:472-476.

Schnabel, R.R., L.F. Cornish, and W.L. Stout. 1995. Denitrification rates at four riparian ecosystems in the Valley and Ridge physiographic province, Pennsylvania. Pages 231-234. *In:* Clean water - clean environment - 21st century. Volume III: Practices, systems, and adoption. Proceedings of a conference March 5-8, 1995 Kansas City, MO. ASAE, St. Joseph, MI.

Schnabel, R.R., W.J. Gburek and W.L. Stout. 1994. Evaluating riparian zone control on nitrogen entry into Northeast streams. Pages 432-445. *In:* Riparian ecosystems in the humid U.S. Functions, values and management. Proceedings of a conference March 15-18, 1993. Atlanta, GA. National Association of Conservation Districts.

Schultz, R.C., J.P. Colletti, W.W. Simpkins, C.W. Mize, and M.L. Thompson. 1994. Developing a multispecies riparian buffer strip agroforestry system. Pages 203-211. *In:* Riparian ecosystems in the humid U.S. Functions, values, and management. Proceedings of a conference March 15-18, 1993. Atlanta, GA. National Association of Conservation Districts.

Schultz, R.C., T.M. Isenhart, and J. P. Colletti 1995. Riparian buffer systems in crop and rangelands. Pages 13-26. *In:* Rietveld, W.J. (ed.) Agroforestry and sustainable systems: symposium proceedings. USDA Forest Service RM-GTR-261.

Schultz, S.D. and B.E. Lindsay. 1990. The willingness to pay for groundwater protection. Wat. Resour. Res. 26:1869-1875.

Seale, R.D., J.W. Hubbard, and E.H. Kaiser. 1985. Subsidy and tax effects of controlling stream sedimentation in South Carolina. J. Soil & Water Cons. 40:144-148.

Sharpley, A.N., T.C. Daniel, and D.R. Edwards. 1993. Phosphorus movement in the landscape. J. Prod. Agric. 6:492-500.

Snyder, N.J., S. Mostaghimi, D.F. Berry, R.B. Reneau, E.P. Smith. 1995. Evaluation of a riparian wetland as a naturally occurring decontamination zone. Pages 259-262. *In:* Clean water - clean

environment - 21st century. Volume III: Practices, systems, and adoption. Proceedings of a conference March 5-8, 1995 Kansas City, MO. ASAE, St. Joseph, MI.

Speiran, G.K., P.A. Hamilton, and M.D. Woodside. 1998. Natural processes for managing nitrate in ground water discharged to Chesapeake Bay and other surface waters: more than forest buffers. U.S. Geological Survey Fact Sheet FS-178-97. USGS Richmond, VA.

Stauffer, D.F., and L.B. Best. 1980. Habitat selection by birds of riparian communities: evaluating effects of habitat alterations. J. Wild. Manage. 44:1-14.

Staver, K.W., and R.B. Brinsfield. 1994. Groundwater/estuarine interactions in a Coastal Plain riparian agroecosystem. Pages 256-276. *In:* Riparian ecosystems in the humid U.S. Functions, values and management. Proceedings of a Conference March 15-18, 1993. Atlanta, GA. National Association of Conservation Districts.

Steiner, F. R. 1990. Soil conservation in the United States: policy and planning. Johns Hopkins University Press. Baltimore, MD. 249pp.

Sun, H., J.C. Bergstrom, and J.R. Dorfman. 1992. Estimating the benefits of groundwater contamination control. Southern J. of Ag. Econ. 19:63-71.

Sweeney, B.W. 1992. Streamside forests and the physical, chemical, and trophic characteristics of Piedmont streams in eastern North America. Water Sci. Tech. 26:2653-2673.

Sweeney, B.W. 1993. Effects of streamside vegetation on macroinvertebrate communities of White Clay Creek in eastern North America. Proc. Acad. Nat. Sci. of Philadelphia 144:291-340.

Swift, L.W. and J.B. Messer. 1971. Forest cuttings raise temperatures of small streams in the southern Appalachians. J. Soil & Water Cons. 26:111-116.

Tappe, P.A., R.E. Thill, M.A. Melchiors, and T.B. Wigley. 1994. Wildlife values of streamside management zones in the Ouachita Mountains, Arkansas. Pages 122-138. *In:* Riparian ecosystems in the humid U.S. Functions, values and management. Proceedings of a Conference March 15-18, 1993. Atlanta, GA. National Association of Conservation Districts.

Tjaden, R.L. and G.M. Weber. 1997. Trees for riparian forest buffers. Maryland Cooperative Extension Service Fact Sheet 726. College Park, MD.

Triquet, A.M., G.A. McPeek, and W.C. McComb. 1990. Songbird diversity in clearcuts with and without a riparian buffer strip. J. Soil and Water Cons. 45:500-503.

U.S. Department of Agriculture Agricultural Research Service. 1995. Farming systems: impact on water quality. Management systems evaluation areas (MSEA) progress report 1994. USDA-ARS-135.

U.S. Department of Agriculture Natural Resources Conservation Service. n.d. Grasses that can be used for planting in riparian forest buffers and herbaceous buffers. USDA Natural Resources Conservation Service. Annapolis, MD.

U.S. Department of Agriculture Natural Resources Conservation Service. 1992. National engineering handbook, Part 650 - engineering field handbook. Chapter 18- Soil bioengineering for upland slope protection and erosion reduction. USDA NRCS. Washington, DC.

U.S. Department of Agriculture Natural Resources Conservation Service. 1996a. National engineering handbook, Part 650 - engineering field handbook. Chapter 16- streambank and shoreline protection. USDA NRCS. Washington, DC.

U.S. Department of Agriculture Natural Resources Conservation Service. 1996b. Maryland conservation practice standard: riparian forest buffer. USDA NRCS-MD. Riparian Forest Buffer 391-1. Annapolis, MD

U.S. Department of Agriculture Natural Resources Conservation Service. 1996c. Virginia conservation practice standard: riparian forest buffer. USDA NRCS-VA. Riparian Forest Buffer 391-1. Richmond, VA.

U.S. Department of Agriculture Natural Resources Conservation Service. 1997. 1997 CRP practice cost and flat rate payment estimates for Virginia, March 1997. USDA NRCS-VA. Richmond, VA.

U.S. Environmental Protection Agency. 1995. National water quality inventory: 1994 report to Congress. U.S. EPA Office of Water. EPA841-R-95-005. Washington, DC.

U.S. Environmental Protection Agency. 1998. National Water Quality Inventory: 1996 Report to Congress. U.S. EPA Office of Water. EPA841-R-97-008.

U.S. Environmental Protection Agency Chesapeake Bay Program. 1995. Small group discussions. Pages 71-79 *In:* Riparian forest buffers: restoring and managing a vital Chesapeake resource. Proceedings of a conference October 5-6, 1994. Ellicott City, MD. EPA-903-R-95-008.

U.S. Environmental Protection Agency Chesapeake Bay Program, Forestry Work Group of the Nonpoint Source Subcommittee 1993. The role and function of forest buffers in the Chesapeake Bay basin for nonpoint source management. U.S. EPA CBP/TRS 91/93.

U.S. Fish & Wildlife Service and U.S. Bureau of the Census. 1996. National survey of fishing, hunting, and wildlife-associated recreation. U.S. Fish & Wildlife Service FHW/96 NAT.

USA Today. March 24, 1998. Across the USA: news from every state - Virginia. USA Today. Section A Page 10.

Veenhuizen, M.F. and G.C. Shurson. 1992. Effects of sulfate in drinking water for livestock. J. Am. Vet. Med. Assoc. 201:487-492.

Verry, E.S. 1996. Riparian structure and function: physical and chemical components. Pages 47-53. *In:* Laursen, S.B. (ed.). At the water's Edge: the Science of Riparian Forestry. Proceedings of a Conference June 19-20, 1995. Duluth, MN. University of Minnesota. Publ. BU-6637-S. St. Paul, MN.

Virginia Department of Agriculture and Consumer Services. 1998. Virginia Agricultural Stewardship Act Guidelines. Virginia Department of Agriculture and Consumer Services. Richmond, VA.

Virginia Department Conservation & Recreation. n.d. Native plants for conservation, restoration, and landscaping. Riparian forest buffers. Virginia Department Conservation & Recreation. Division of Natural Heritage. Richmond, VA.

Virginia Department of Forestry. 1997a. Logging and water quality - know the law. Virginia Department of Forestry. Publication 9-97-5M. Charlottesville VA.

Virginia Department of Forestry. 1997b. Forestry best management practices for water quality in Virginia technical guide. Virginia Department of Forestry. Charlottesville VA.

Virginia Department of Forestry. 1999. Herbicide use sheets - program year 1999. http://state.vipnet.org/dof/herbuse.htm.

Virginia Departments of Environmental Quality and Conservation & Recreation. 1998. Virginia Water Quality Assessment 1998. 305(b) Report to the EPA Administrator and Congress. Virginia Departments of Environmental Quality and Conservation & Recreation. Richmond, VA.

Virginia Marine Resources Commission Habitat Management Division. n.d. Local, state, federal joint permit application. Published jointly by the U.S. Army Corps of Engineers, Virginia Marine Resources Commission, Virginia Department of Environmental Quality and local wetlands boards. P.O. Box 756. Newport News, VA 23607.

Virginia Riparian Forest Buffer Panel. 1998. Riparian buffer implementation plan. Commonwealth of Virginia Riparian Forest Buffer Panel.

Walbridge, M.R. and J.P. Struthers. 1993. Phosphorus retention in non-tidal palustrine forested wetlands of the mid-Atlantic region. Wetlands 13 (2):84-94.

Walbridge, M.R. 1993. Functions and values of forested wetlands in the southern United States. J. Forestry 91(5):15-19.

Wall, G. and C. Wright. 1977. The environmental impact of outdoor recreation. University of Waterloo Dept. of Geography Publication 11. Waterloo, Ontario, Canada.

Wallace, J.B. and A.C. Benke. 1984. Quantification of wood habitat in subtropical coastal plain streams. Can. J. Fish. Aquat. Sci. 41:1643-1651.

Weiler, C.J. 1988. Wildflowers and weeds: a floral designer's view. Pages 153-158. *In:* Commercial field production of cut and dried flowers. Proceedings of a symposium December 6-8, 1988. University of Minnesota Center for Alternative Crops and Products and The American Society of Horticultural Science.

Welsch, D.J. 1991. Riparian forest buffers - function and design for protection and enhancement of water resources. USDA Forest Service Northeastern Area State & Private Forestry. NA-PR-07-91. Radnor, PA.

Wichelns, D. and J.D. Kline. 1993. The impact of parcel characteristics on the cost of development rights to farmland. Ag. Resour. Econ. Rev. Oct 93:150-158.

Wigley, T.B., and T.H. Roberts. 1997. Landscape level effects of forest management on faunal diversity in bottomland hardwoods. Forest Ecol. and Manage. 90:141-154.

Wilson, L.G. 1967. Sediment removal from flood water by grass filtration. Trans. Am. Soc. Agric. Eng. 10:35-37.

Wolf, W.D. and D.A. Fiske. 1995. Planting and managing switchgrass for forage, wildlife, and conservation. Virginia Polytechnic Institute and State University Cooperative Extension. Publication Number 418-013.

Young, R.A., T. Huntrods, and W. Anderson. 1980. Effectiveness of riparian buffer strips in controlling pollution from feedlot runoff. J. Environ. Qual. 9:483-487.

Appendix A
Common and Scientific Names

Trees and shrubs

Alder	*Alnus spp.*
American beech	*Fagus grandifolia*
American elm	*Ulmus americana*
American holly	*Ilex opaca*
Apple	*Malus spp.*
Arrowwood viburnum	*Viburnum dentatum*
Bald cypress	*Taxodium distichum*
Balsam fir	*Abies balsamea*
Bankers willow	*Salix x cotteri*
Birch	*Betula spp.*
Bitternut hickory	*Carya cordiformis*
Black cherry	*Prunus serotina*
Blackgum	*Nyssa sylvatica*
Black walnut	*Juglans nigra*
Black willow	*Salix nigra*
Boxelder	*Acer negundo*
Boxwood	*Buxus spp.*
Bradford pear	*Pyrus calleryana* 'Bradford'
Buffaloberry	*Shepherdia argentea*
Cherry	*Prunus spp.*
Chinese chestnut	*Castenea mollissima*
Chokecherry	*Prunus virginiana*
Corkscrew willow	*Salix matsudana* ‘Tortuosa’
Cottonwood	*Populus deltoides*
Crab apple	*Malus spp.*
Deciduous holly	*Ilex spp.*
Dogwood	*Cornus spp.*
Eastern cottonwood	*Populus deltoides*
Eastern hemlock	*Tsuga canadensis*
Eastern hophornbeam	*Ostrya virginiana*
Eastern red cedar	*Juniperus virginiana*
Elderberry	*Sambucus canadensis*
Elm	*Ulmus spp.*
Euonymus (winged)	*Euonymus altata*
Fantail willow	*Salix sachalinensis* ‘Sekko’
Flowering dogwood	*Cornus florida*
Flowering quince	*Chaenomeles speciosa*
Forsythia	*Forsythia spp.*
Fringetree	*Chioanthus virginicus*
Gray dogwood	*Cornus racemosa*
Green ash	*Fraxinus pennsylvanica*
Groundsel bush	*Baccharis halimifolia*

Hackberry	*Celtis occidentalis*
Hawthorne	*Crataegus spp.*
Hazelnut	*Corylus americana*
Hickory	*Carya spp.*
Highbush blueberry	*Vaccinium corymbosum*
Highbush cranberry	*Viburnum trilobum*
Holly	*Ilex spp.*
Hybrid poplar	*Populus spp.*
Hydrangea	*Hydrangea spp.*
Ironwood	*Carpinus caroliniana*
Japanese cherry	*Prunus yoshino, Prunus shrotea*
Lilac	*Syringa spp.*
Loblolly pine	*Pinus taeda*
Lombardy poplar	*Populus nigra* 'Italica'
Maple	*Acer spp.*
Magnolia	*Magnolia spp.*
Mock orange	*Philadelphus coronarius*
Mountain laurel	*Kalmia latifolia*
Nandina	*Nandina domestica*
Nanking cherry	*Prunus tomentosa*
Nannyberry viburnum	*Viburnum lentago*
Ninebark	*Physocarpus opulifolius*
Northern red oak	*Quercus rubra*
Norway maple	*Acer platanoides*
Oak	*Quercus spp.*
Pawpaw	*Asimina triloba*
Peach	*Prunus persica*
Pear	*Pyrus spp.*
Persimmon	*Diospyros virginiana*
Pin oak	*Quercus palustris*
Pine	*Pinus spp.*
Plum	*Prunus domestica*
Privet	*Ligustrum spp.*
Pussywillow	*Salix spp.*
Pyracantha	*Pyracantha spp.*
Redbud	*Cercis canadensis*
Red maple	*Acer rubrum*
Red mulberry	*Morus rubra*
Red osier dogwood	*Cornus stolonifera, Cornus sericia*
Red twig dogwood	*Cornus stolonifera, Cornus sericia, Cornus alba* 'sibirica'
Rhododendron	*Rhododendron spp.*
River (black) birch	*Betula nigra*
Sandbar willow	*Salix interior*
Saskatoon berry	*Amelanchier alnifolia*
Sea-buckthorn	*Hippophae rhamnoides*

Serviceberry	*Amelanchier arboreum*
Silky dogwood	*Cornus amomum*
Silver maple	*Acer saccharinum*
Southern red oak	*Quercus falcata*
Spice bush	*Lindera benzoin*
Spirea	*Spiraea spp.*
Spruce	*Picea spp.*
Streamco willow	*Salix purpurea*
Sumac	*Rhus spp.*
Sweetgum	*Liquidambar styraciflua*
Sycamore	*Platanus occidentalis*
Tree-of-heaven	*Ailanthus altissima*
Tulip (yellow) poplar	*Liriodendron tulipifera*
Viburnum	*Viburnum spp.*
Weigela	*Weigela florida*
White ash	*Fraxinus americana*
White oak	*Quercus alba*
Willow	*Salix spp.*
Willow oak	*Quercus phellos*
Winterberry	*Ilex verticillata*
Witch hazel	*Hamamelis virginiana*
Yellow-twig dogwood	*Cornus sericea* 'Flaviramea'

Grasses, Herbs, and Vines

Annual rye	*Secale cereale*
Baby's breath	*Gypsophila spp.*
Big bluestem	*Andropogon gerardii*
Birdsfoot trefoil	*Lotus corniculatus*
Bittersweet	*Celastrus spp.*
Blackberry	*Rubus spp.*
Bromegrass	*Bromus spp.*
Broomsedge	*Carex scoparia*
Buttonbush	*Cephalanthus occidentalis*
Cattail	*Typha spp.*
Corn	*Zea mays*
Deertongue	*Panicum clandestinum*
Eastern gamma grass	*Tripsacum dactyloides*
Fountain grass	*Pennisetum alopecuroides*
Galax	*Galax spp.*
Goldenrod	*Solidago spp.*
Grama grass	*Bouteloua spp.*
Grape	*Vitus spp.*
Greenbriar	*Smilax rotundifolia*
Honeysuckle	*Lonicera japonicus*
Indiangrass	*Sorghastrum nutans*
Japanese bamboo	*Phyllostachys species*

Kudzu	*Pueraria montana var. lobata*
KY-31 tall fescue	*Festuca arundinacea*
Lespedeza	*Lespedeza spp.*
Little bluestem	*Andropogon scoparius*
Lovegrass	*Eragrostis spp.*
Mile-a-minute	*Polygonum perfoliatum*
Milkweed	*Asclepias spp.*
Multiflora rose	*Rosa multiflora*
Nutsedge	*Cyperus spp.*
Oats	*Avena sativa*
Orchard grass	*Dactylis glomerata*
Oriental bittersweet	*Celastrus orbiculatus*
Perennial ryegrass	*Lolium perenne*
Phragmites	*Phragmites communis*
Plume grass	*Erianthus ravennae*
Poison ivy	*Toxicodendron radicans*
Porcelain berry	*Ampelopsis brevipendunculata*
Queen Anne's lace	*Daucus carota*
Reed canarygrass	*Phalaris arundinacea*
Reed grass	*Calamagrostis spp.*
Smartweed	*Polygonum spp.*
Sorghum	*Sorghum spp.*
Soybean	*Glycine max*
Sudangrass	*Sorghum sudanense*
Switchgrass	*Panicum virgatum*
Teasel	*Dipsacus sylvestris*
Trumpet creeper vine	*Campsis radicans*
Wild yarrow	*Achillea millefolium*
Wiregrass	*Eleusine indica*
Wormwood	*Artemisia caudata*

Fish

Brook trout	*Salvelinus frontinalis*
Brown trout	*Salmo trutta*
Carp	*Cyprinus carpio*
Rainbow trout	*Oncoryhynchus mykiss*

Amphibians

American toad	*Bufo americanus*
Dusky salamander	*Desmognathus fuscus*
Green frog	*Rana clamitans melanota*
Mudpuppy	*Necturus maculosus*
Jefferson salamander	*Ambystoma jeffersonianum*
Spring salamander	*Gyrinophilus porphyritcus*
Two-lined salamander	*Eurycea bislineata*

Reptiles

Eastern spiny softshell	*Trionyx spiniferus*
Eastern box turtle	*Terrapene carolina*
Painted turtle	*Chrysemys picta*
Ribbon snake	*Thamnophis sauritus*
Map turtle	*Graptemys geographica*
Worm snake	*Carphophis amoenus*

Birds

Acadian flycatcher	*Empidonax virescens*
Alder flycatcher	*Empidonax alnorum*
American goldfinch	*Carduelis tristis*
Bald eagle	*Haliaeetus leucocephalus*
Barred owl	*Strix varia*
Belted kingfisher	*Cergle alcyon*
Blue grosbeak	*Guiraca caerulea*
Brown-headed cowbird	*Molothrus ater*
Carolina wren	*Thryothorus ludovicianus*
Cerulean warbler	*Dendroica cerulea*
Chicken	*Gallus gallus*
Common yellowthroat	*Geothlypis trichas*
Cowbird	*Molothrus ater*
Eastern kingbird	*Tyrannus tyrannus*
Eastern phoebe	*Sayornis phoebe*
Eastern wood-pewee	*Contopus virens*
Eastern screech owl	*Otus asio*
Gray catbird	*Dumetella carolinesis*
Indigo bunting	*Passerina cyanea*
Louisana waterthrush	*Seiurus motacilla*
Northern waterthrush	*Seiurus noveboracensis*
Northern oriole	*Icterus galbula*
Orchard oriole	*Icterus spurius*
Prairie warbler	*Dendroica discolor*
Prothonotary warbler	*Protonotaria citrea*
Red-bellied woodpecker	*Melanerpes carolinus*
Red-eyed vireo	*Vireo olivaceus*
Red-shouldered hawk	*Buteo lineatus*
Rough-winged swallow	*Stelgidopterx serripennis*
Song sparrow	*Melospiza melodia*
Tufted titmouse	*Parus bicolor*
Veery	*Catharus fuscenscens*
Wood duck	*Aix sponsa*
Yellow warbler	*Dendroica petechia*
Yellow-billed cuckoo	*Coccyzus americanus*
Yellow-breasted chat	*Icteria virens*

Mammals

Beaver	*Castor canadensis*
Big brown bat	*Eptesicus fuscus*
Black bear	*Ursus americanus*
Cougar	*Felis concolor*
Eastern chipmunk	*Tamias striatus*
Eastern pipistrelle	*Pipistrellus subflavus*
Ermine	*Mustela erminea*
Gray squirrel	*Sciurus carolinensis*
Keen's myotis	*Myotis keenii*
Little brown myotis	*Myotis lucifugus*
Long-tailed weasel	*Mustela frenata*
Mink	*Mustela vison*
Muskrat	*Ondatra zibethica*
Northern flying squirrel	*Glaucomys sabrinus*
Northern short-tailed shrew	*Blarina brevicaude*
Racoon	*Procyon lotor*
River otter	*Lutra canadensis*
Silver-haired bat	*Lasionycteris noctivagans*
Virginia opossum	*Didelphis virginiana*
Water shrew	*Sorex palustris*
White-tailed deer	*Odocoileus virginianus*

Vitae

Julia Caldwell Klapproth

Julia Caldwell Klapproth graduated from the University of Florida School of Forest Resources and Conservation in June 1981 with a B.S. in Forest Resource Conservation. She was a member of the Forestry Club, Society of American Foresters, Xi Sigma Psi Honor Society and a volunteer at the Morningside Nature Center. After graduation, she was employed by the School of Forest Resources and Conservation, first as a technician in the Integrated Forest Pest Management Cooperative, then as a biologist in the forest physiology program. She moved to Delaware with her husband in April 1985, where she worked as a research associate in the University of Delaware College of Agriculture plant breeding program. Later, she accepted a position with the Delaware Forest Service as a forester.

In August 1995, she began her current position with the University of Maryland Cooperative Extension Service as a natural resources faculty assistant. At the same time, she decided to continue her education at Virginia Polytechnic Institute and State University, and will graduate with a Master of Forestry in May 1999. She is a member of the Society of American Foresters, the Association of Natural Resource Extension Professionals, Phi Kappa Phi Honor Society and Gamma Sigma Delta Agriculture Honor Society.

She lives with her husband, Michael, in Galena, Maryland.