MARYLAND COOPERATIVE EXTENSION
Fact Sheet
Fact Sheet 774

When a Landowner Adopts a Riparian Buffer—Benefits and Costs

Society's Economic Benefits

The environmental benefits of riparian buffers, such as improvements in water quality, fish and wildlife habitat, and recreation, have been documented. To assess the economic benefits or values of riparian buffers, however, society must decide how willing it is to pay for the environmental improvements.

Determining the exact value of these improvements is difficult. The environmental benefits of each buffer zone depend on whether grass or trees are planted, how wide the buffer is, the land use of adjacent property, and the conditions that exist both up- and downstream from the buffer. In addition, some benefits are immediately evident, others take time. For example, it may take years or even decades for aquatic habitats and stream formation to improve and for the public to be aware of the benefits these changes bring. This complicates how environmental effects and thus economic benefits are calculated.

If improved water quality enhances goods and services that are bought or sold in the marketplace, economists can assign a value to this improvement. For example, if trout return to a stream and the landowner is then able to sell fishing rights, the income from the sale represents a direct economic benefit, which can be calculated. If adopting a buffer results in topsoil retention and higher crop yields for a farm, the added production and income is an economic benefit.

Economists can also assess the value of the increase in recreational opportunities in streams, tributaries, and the Chesapeake Bay. They use valuation methods based on the amount of money people are willing to spend to take advantage of the improved recreation. In addition, economists can calculate the health benefits improved water quality brings, in terms of lives saved, health costs reduced, or sick days avoided. It can be harder to assign a value to other benefits of improved water quality that are not bought or sold.

We do not yet have exact figures for how much society will benefit economically from the creation of riparian buffers. Other studies of improved water quality, however, can give us an idea of what the potential benefits are. According to USDA economists, the 40 to 45 million acres of cropland retired under the Conservation Reserve Program (CRP), at an annual cost of $1 billion, have generated $3.5 to $4.5 billion, annually, in water quality benefits. Reduced erosion; increased recreational fishing; and improvements in ease of navigation, water storage and treatment, and flood control are among the benefits. Ribaudo et al. hypothesize that the dollar value of benefits would be higher if more environmentally sensitive land had been targeted.

The Chesapeake Bay's Riparian Forest Buffer Panel Technical Team reports that established riparian forest buffers can remove 21 pounds of nitrogen per acre at $.30 per pound and about 4 pounds of phosphorus per acre at $1.65 per pound, annually. The Interstate Commission for the Potomac River Basin (ICPRB) estimates that urban retrofitting of best management practices (BMPs) to remove 20 percent of the current nutrient runoff will cost approximately $200 per acre, or $643,172,600 for the Bay basin, a much larger price tag. The ICPRB also estimates the costs of reducing runoff from highly erodible agricultural land to be $130 per acre. According to the buffer panel, establishing forest buffers in Maryland could cost $617,000 per year in order to achieve the 40-percent reduction of nutrients by the year 2000; comparable structural engineered approaches cost $3.7 million per year. In this case structural engineering approaches are those that require major con-

struction and engineering design such as stormwater retention ponds.

Even without the exact societal benefits or willingness to pay for these riparian buffer–generated improvements, policy makers have concluded that on a societal scale the overall benefits are greater than the cost. However, from an individual landowner's perspective, benefits may not always clearly outweigh costs.

Landowner Benefits

Establishing a streamside buffer will result in decreased soil erosion from the adjacent field and will assist in maintaining stable streambanks. In addition, landowners can benefit from the aesthetic value of the trees or grass and may see increases in property values. Other benefits can include payments from government programs, such as the cost-share and annual incentive and rental payments. In some cases, buffers can provide income from tree, grass, and orchard crop harvesting; hunting and fishing; hunting and fishing leases; and medicinal herbs. Under certain government programs, however, participating landowners cannot derive any income from the buffer during their years of participation.

Many growers who hunt derive added benefit from attracting wildlife, in addition to any possible leasing opportunities. (Leases for deer and upland game hunting cost between $5 and $20 per acre.) The economic returns depend on the type of vegetation planted as well as on whether or not a particular program permits harvest opportunities.

Under one program, USDA-CREP (U.S. Department of Agriculture—Conservation Reserve Enhancement Program), landowners who decide to plant riparian buffers are eligible for an annual rental payment for the length of the selected contract, which is between 10 and 15 years. The payment is based on the county's rental rate levels where the land is located and the types of soil found in the riparian area. In addition, the landowner receives an annual incentive payment equal to 70 percent of the rental rate, for planting trees, and 50 percent of the rental rate, for planting grasses next to waterways such as streams, wetlands, and drainage ditches.

Besides the rental and incentive payments, a landowner can receive up to 100 percent in cost-share payments to establish forested buffers and up to 95 percent to establish grass buffers, through a cooperative agreement of USDA, the U.S. Fish and Wildlife Service, the Maryland Department of Agriculture, the Chesapeake Bay Foundation, and Ducks Unlimited. In addition to these payments, landowners also have the option of putting a permanent easement on the land and receiving a lump-sum payment based on number of acres and the county where the land is located. In this case, the riparian area would have to remain in a vegetated buffer forever with the landowner having limited rights for harvesting the timber or grass.

Planting and Maintenance Costs

Forest Buffer

Direct planting costs depend on the size and type of buffer. A forest buffer costs between $218–$729 per acre to plant and maintain. Establishment costs can be broken down into site preparation, the plants, planting, replanting, and maintenance. Planting costs depend on geographic location, number of acres planted, number of trees planted per acre, species of trees, and whether or not the trees are from bare root or container stock. Trees can be planted either by machine or by hand. Machine-planted trees often have a higher survival rate. Machine planting can be less expensive and the property owner avoids having to hire laborers, who may or may not be available.

Planting costs shown in Table 1, "Tree Buffer Costs," are based on a range of $0.11 to $0.40 per tree for hand planting and $0.14 to $0.30 per tree for machine planting. The cost of the plant material—the seedlings—are based on the Maryland Department of Natural

Table 1. Tree Buffer Costs
(436–550 trees)

	Per acre
Plant by machine	$75–130
Plant by hand	$60–174
Plant material	$60–275
Site preparation	
(herbicides for grass control)	
Band	$30–50
Broadcast	$80–120
Replanting	$56–100
Maintenance	
Herbicides	$30–60
Mowing	$12–60
Total	**$218–729**

Resources Tree Nursery Rates of $0.11 to $0.50 per seedling. Depending on the adjacent land-use, the optimal site preparation may include broadcast application of an herbicide or mowing and a band application of pre- and post-emergent herbicides. Herbicide costs are based on a range of chemicals and assume that application followed label recommendations. The costs of replanting will depend on the survival rate of the trees. We assume a survival rate of 80 percent. Thus, 20 percent of the trees (110 trees) need to be replanted by hand at a rate of $0.40 per tree. The seedling cost of the replanted trees ranges between $12 and $55 per acre.

In many areas of Maryland, tree shelters are also being recommended to ensure the survival of the buffer's high-value trees. Because of vole damage, many foresters are recommending tree shelters for all trees planted on pastureland. Tree shelter costs are based on the length of the shelters: 4-foot shelters cost $1.89 each and 5-foot shelters cost $2.29 each. In addition, stakes cost between $0.31 and $0.40 each. Labor costs to install shelters range from $0.50 to $0.75 per shelter. Although CREP does not offer cost sharing for tree shelters, it is available through another USDA program. The Farm Service Agency office can assist landowners in submitting a separate application to receive this money.

Grass Buffer

Grass buffers tend to cost less than tree buffers to plant and maintain. See Table 2, "Grass Buffer Costs." For warm and cool season grasses, costs for site preparation, seeds, planting, fertilizer, and maintenance need to be considered. Seed costs vary depending on the seed mixture used. We found that the cost of seeds varies annually because of fluctuating availability. Planting costs depend on the number of acres planted and the distance the planting drill must travel. Some of the low costs here reflect that some landowners will engage in the buffer planting themselves. The higher numbers reflect the cost of hiring a contractor to provide the machinery and do the planting.

Costs will be higher for establishing buffers in an area where animals have been pastured. If animals have had previous access to a stream, a fence, a crossing, and/or an alternative watering source are needed. See Table 3, "Costs of Keeping Animals Away from a Stream." Electric fences cost from $2.15 to $2.60 per foot to erect. The cost of an alternative watering source depends on the type of generator necessary for pumping the water and the distance the water has to travel between the water source and the watering trough. Similarly, a gravity system usually costs between $2,000 and $4,000, but some landowners have spent $7,000, to pay for

Table 2. Grass Buffer Costs

	Per acre
Planting	$10–50
Seeds	$100–225
Site preparation	$18–40
Fertilizer/lime	$30–50
Maintenance	
Mowing or herbicide	$10–60
Total	**$168–400**

increased costs of pumping water a long distance or up a steep slope. Although a typical solar unit costs between $4,000 and $6,000, some growers buy units that cost as much as $10,000. Stone and concrete stream crossings, the most common type, typically cost from $2,000 to $4,000. Some growers, however, have chosen to use culverts and/or bridges to provide a crossing for their animals. Under the USDA-CREP program, marginal pastureland is eligible for tree buffer establishment only, not grass.

Transaction Costs

Beyond these direct costs of establishment and maintenance is the investment of time, which is rarely factored into a project cost estimate. Participants find that the paperwork for signing up for and participating in the cost-share and/or incentive programs is time consuming. Program coordinators and field staff estimate that a typical CREP program request in Maryland takes 3 hours of a landowner's time, even with field staff help. According to participants' reports, completing the paperwork can take anywhere from 2 to 8 hours. In addition, landowners who participate in the site visit, the buffer design, and planting could invest another 15 hours in the process, depending on the number of acres involved. This cost can be significant, depending on the value a landowner places on his or her time.

Table 3. Costs of Keeping Animals Away from a stream

Fencing (High tensile—3 strand)		$2.15–2.60 (per ft)
Alternative watering source		
	Solar	$4,000–10,000
	Gravity	$2,000–7,000
Stream crossing		
	Stone	$2,000–6,000
	Culverts/bridges	$4,000–10,000

Program requirements may also be inflexible. A participant usually has to take part in more than one program or to piggyback programs to cover all costs. A number of different agencies run these programs, with limited coordination, and each agency has different rules. Often, cost-share payments are not made at the same time monetary expenditures occur; landowners may have to wait for up to a year for reimbursement. As a result, paperwork and other perceived difficulties may keep a landowner from becoming involved in the programs.

Opportunity Costs

An individual incurs opportunity costs for all the opportunities (options B through Z, for instance) lost because option A was chosen. The loss of earnings from crops that could have been grown in place of the buffer is an opportunity cost. Landowners can calculate opportunity costs by considering other possible uses for the land where the buffer is being

planted. Opportunity costs include the net changes in current and future income that will result from establishing the buffer. Factors such as the productivity of the land nearest the stream and the type of crop grown will affect these costs. In some areas, the streamside will be the grower's most productive land, in others, the least productive.

Option Value

Opportunity costs also include the option value of the land. The option value, similar to options in the stock or futures market, is the possible price the landowner would receive for the land in the future if all his or her options were available. Most landowners will take into account the possible change, which could be a reduction, in the potential sales price of converting the land to residential development because of the buffer's presence. The change may not be negative, however; sales prices can increase or decrease with a forested parcel. For example, the Chesapeake Bay Program reports in its "Economics of Riparian Forest Buffers" that according to a Bank of America Mortgage survey, real estate agents find that homes with treed lots are 20 percent more saleable. According to the Chesapeake Bay Program, Maryland developers receive prices 10 to 15 percent above the average for lots next to forests and buffers.

Landowner Concerns

Landowners have expressed a number of concerns regarding the adoption of buffers. Some owners worry that once the buffer is in place they will not be able to remove it. The irreversibility could derive from future regulations or existing legislation that will apply to the land once a buffer is planted. For example, if an endangered species establishes itself in the buffer, would a landowner ever be able to cut down the buffer, even though the endangered species would not exist there had the buffer not been established? Thus, the buffer could limit the landowner's flexibility or options.

As another example, if the land containing the buffer reverts to a wetland, would the land then be subject to all wetland legislation? Most growers have to be assured that they will be able to drain and farm this area again or would need a risk premium or "option value" to cover the new restriction. In the case of CREP participants, landowners have a 5-year

window following the termination of the contract to reclaim the cropland before the wetland legislation goes into effect.

Although some landowners favor adopting a buffer that creates habitat and attracts wildlife, others worry that buffers might attract members of endangered species or too many deer. A possible increase in the deer population could lead to an increase in crop destruction or an increase in expenditures to prevent deer from entering the fields. University of Maryland economists found that, 92 percent of Maryland farmers experienced a deer-related yield loss in 1996. Between 6 and 12 percent of farmers' income has been lost, depending on crop and location. Wildlife biologists have not yet determined if the adoption of a buffer will affect the number of deer present on a farm.

Some growers think trees will shade their fields, decreasing yields. Careful attention to the design of the buffer is important to ensure trees are not located where they would shade fields. A landowner can also choose to plant both trees and grass to ensure adequate distance between trees and field. Other growers think buffers will draw moisture from crops or nutrients in the field, decreasing production. Farmers are also concerned about how much of their time will be necessary to maintain a buffer and about crop destruction that might result from falling limbs of trees or from noxious weeds growing in the buffers. Some farmers fear that a buffer will alter the configuration of the field, making machinery or equipment maneuvering more difficult.

In the case of waterfront property, landowners express concern that establishing a forest buffer might result in a lost or hindered scenic view. Views have aesthetic value to the landowner and to any others who live on the property. The sales price for land with a view can be higher than similar land nearby. However, a buffer design incorporating a view corridor could potentially enhance the aesthetics by framing the view, resulting in a higher or at least undiminished sales price.

Available Programs

Programs exist that offer money to landowners who establish buffers on their property. These programs decrease the costs associated with a buffer, through cost-share programs and technical assistance, and increase the benefits through incentive payments. These are described in Fact Sheet 769, "Riparian Buffer Financial Assistance Opportunities."

Calculating Net Benefits of Buffer Adoption

We have computed the net benefits for two types of farmers in Table 4, "Partial Budget Worksheet #1," and Table 5, "Partial Budget Worksheet #2." These numbers are estimates that farmers might use. Although payments and costs cover a 15-year period, the values are not discounted to 1999 dollars. Fact Sheet 547, "Using the Partial Budget To Analyze Farm Change," explains partial budgets more fully.

The first case is a farmer in Queen Anne's County who traditionally grows nonirrigated corn on a 200-acre farm. This farmer has a first order or intermittent stream on the property and wants to consider whether to adopt a riparian buffer. The farmer's yield is 120 bushels per acre with a per acre cost (excluding land rent) of $210. At the 5-year average price of $2.60 a bushel, the profit computes to $102 per acre. Of course, as with any agricultural commodity, yield and market price can vary with climatic conditions and changes in demand. Therefore, the $102 profit per acre is not guaranteed. If yields or prices fell, the farmer could earn less. If yields rose or prices increased, the farmer could earn more.

If the farmer joins CREP and puts in a tree buffer, the program calculates a rental rate based on the types of soil in the buffer area. In this case, he can earn $81 per acre in rental fees plus an incentive bonus of $56.70 (70 percent of the rental rate) for a total payment of $137.70 per acre. This is a guaranteed payment each year for the length of the contract, which can vary from 10 to 15 years. If he plants grass, the incentive bonus is $40.50 per

Table 4. Partial Budget Worksheet #1 for Queen Anne County Corn Farmer

Proposed change:

Establishing a riparian buffer on 10 acres of land
Enrolling in the Conservation Reserve Enhanced Program

Positive Effects	Value	Negative Effects	Value
Increases in income		**Reductions in income**	
CREP payments		*Crop revenue*	
Rental payment: $81 per acres	$12,150	120 bushels per acre at $2.60 per bushel	$46,800
Incentive payment: $56.70 per acre for 10 acres for 15 years	$8,505	on 10 acres for 15 years	
Cost-share payments			
100 percent of $575 per acre for 10 acres	$5,750		
Maintenance payments			
$5 per acre for 10 acres for 15 years	$750		
Total increases in income	**$27,155**	**Total reductions in income**	**$46,800**
Reductions in costs		**Increases in costs**	
Production expenses		*Tree establishment*	
$210 for 10 acres for 15 years	$31,500	$575 per acre for 10 acres	$5,750
		Time for program sign-up	
		15 hours at $10 per hour	$150
Reduced soil erosion		*Other costs*	
Tax implications		Changed configuration of field	
		Long-term consequences	
Total reductions in costs	**$31,500**	**Total increases in costs**	**$5,900**
Total income increases and cost reductions	**$58,655**	**Total income reductions and cost increases**	**$52,700**
Change in net income:			
(Total income increases and cost reductions) minus (Total income reductions and cost increases)			**$5,955**

Source: Adapted from "Using the Partial Budget To Analyze Farm Change" 1990.

Table 5. Partial Budget Worksheet #2 for Frederick County Farmer

Proposed change:

Establishing a riparian buffer on 5 acres of land
Enrolling in the Conservation Reserve Enhanced Program

Positive Effects	Value	Negative Effects	Value
Increases in income		**Reductions in income**	
CREP payments		*Dairy revenue*	
Rental payment: $74 per acre for 5 acres for 15 years	$5,550	No change anticipated	$0
Incentive payment: $51.80 per acre for 5 acres for 15 years	$3,885		
Cost-share payments			
100 percent of $575 per acre for 5 acres	$2,875		
100 percent of fence establishment costs	$3,750		
100 percent of bridge establishment costs	$5,000		
100 percent of watering source costs	$3,000		
Maintenance payments			
$5 per acre for 5 acres for 15 years	$375		
Total increases in income	**$24,435**	**Total reductions in income**	**$0**
Reductions in costs		**Increases in costs**	
Production expenses		*Tree establishment*	
No change anticipated	$0	$575 per acre for 5 acres	$2,875
		Fence establishment	
Less probability of mastitis reoccurrence		High tensile (3 strands) for 1,500 feet at $2.50 per foot	$3,750
Reduced soil erosion		*Watering source*	
Tax implications		Solar-generated water delivery	$5,000
		Stream crossing establishment	
		Stone passage	$3,000
		Time for program sign-up	
		15 hours at $10 per hour	$150
		Other costs	
		Long-term consequences	
Total reductions in costs	**$0**	**Total increases in costs**	**$14,775**
Total income increases and cost reductions	**$24,435**	**Total income reductions and cost increases**	**$14,775**

Change in net income:

(Total income increases and cost reductions) minus (Total income reductions and cost increases) **$9,660**

acre (50 percent of the rental rate) for a total payment of $121.50 per acre. The program adds on another $5 per year per acre for maintenance costs.

The cost to install a hardwood buffer is estimated to be $575 per acre. Combining CREP, MACS (Maryland Agricultural Cost-Share Program) and funds from the Chesapeake Bay Foundation and Ducks Unlimited, the cost share for trees equals 100 percent. In most cases, the farmer would have to expend the money and be reimbursed later. In addition to paying the establishment costs, the farmer must spend time signing up for the program and possibly participating in the site visit, taking part in the buffer design, and ordering plant material. Estimating these steps taking 15 hours and valuing the owner's labor at $10 per hour equals an additional cost of $150. Of course, some growers may value their time at a higher rate and others may not find the time outlay burdensome.

After examining the partial budget worksheet #1, we find that the farmer's benefits—an increase in income and a reduction of costs—exceed his costs, which are a reduction of revenue and an increase in costs. Therefore, if this farmer did not estimate any additional costs, he might consider investigating the CREP program and establishing a buffer.

In case number 2, a Frederick County farmer pastures her cows on 75 acres. The cows water in the stream running through the property. This has caused some streambank destruction, and several dairy cows have come down with mastitis from walking in the stream's bacteria-laden water.

After reading some information on CREP, the farmer is considering installing a forest buffer, the only type permitted on marginal pasture. Besides the cost of installing a tree buffer at $575 per acre, the farmer must erect a fence to keep the cows out of the buffer and the stream. Since pasture lies on both sides of the stream, she must also build a stream crossing. In addition, she must provide a watering source for her animals. Depending on the evaluation of the streambank destruction, the owner may also have to employ some engineering or bioengineering tools and methods to keep the bank from degrading and to ensure its integrity. (More information about bioengineering or streambank restoration can be found in Fact Sheet 729, "Riparian Buffer Management: Soil Bioengineering or Streambank Restoration for Riparian Forest Buffers.")

She does not anticipate any reduction in income resulting from the buffer, nor does she expect any reduction in expenses related to the farm. She will have to invest in mechanisms to keep the cows out of the stream. There will be some increase in income, however, from the rental, incentive, and cost-share payments. The farmer uses Partial Budget Worksheet #2 to get a rough idea of what the net benefits are of installing a riparian forest buffer. Based on the estimated payments and added costs, she finds that the overall impact is positive and therefore worth a visit to the local Farm Service Agency office to discuss actual numbers.

Conclusions

Buffers provide another mechanism for reducing the flow of nutrients into the Chesapeake Bay, and thus contribute to increased water quality. However, while society obviously benefits from these buffers, a landowner's decision whether or not to adopt a buffer will have to be based on his or her individual circumstances. We have provided information about the costs of establishing different types of buffers and their possible benefits. We present two case studies of farmers who may be eligible for the CREP program: in the first study, the farmer grows a field of row crops, and in the second, the farmer pastures cows. We present a format landowners can use to determine what the cost-benefit tradeoffs are for their individual situations.

We would like to thank Anne Hairston-Strang of Maryland Department of Natural Resources, Patty Engler of USDA Natural Resource Conservation Service, and Claudia Jones of the Chesapeake Bay Critical Area Commission for their review of and comments about the document.

References

Chesapeake Bay Program, Annapolis, Md. May 1998. "Economics of Riparian Forest Buffers."

Lessley, Billy V., Dale M. Johnson, and James C. Hanson. 1990. "Using the Partial Budget To Analyze Farm Change." University of Maryland Cooperative Extension Fact Sheet 547.

McNew, Kevin, and John Curtis. Fall 1997. "Maryland Farmers Lose Bucks on Deer-Damaged Crops," *Economic Viewpoints* 2(2). Department of Agricultural and Resource Economics, University of Maryland Cooperative Extension.

Ribaudo, Mark O., C. Tim Osborn, and Kazim Konyar. 1994. "Land Retirement as a Tool for Reducing Agricultural Nonpoint Source Pollution." *Land Economics* 70(1): 77-87.

Riparian Forest Buffer Panel Technical Team. October 1996. "Riparian Forest Buffer Panel Report: Technical Support Document." Chesapeake Bay Program.

Tjaden, Robert L., and Glenda M. Weber. 1998. "Riparian Buffer Management: Soil Bioengineering or Streambank Restoration for Riparian Forest Buffers." University of Maryland Cooperative Extension Fact Sheet 729.

by
Lori Lynch
Assistant Professor
Agricultural and Resource Economics
University of Maryland, College Park
and
Robert Tjaden
Regional Extension Specialist
Wye Research and Education Center

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, University of Maryland, College Park, and local governments. Thomas A. Fretz, Director of Maryland Cooperative Extension, University of Maryland.

P2000