BUFFER MAINTENANCE AND MONITORING

Planning for the maintenance and monitoring of a newly established buffer site is crucial before planting even begins. The most critical period during streamside forest buffer establishment is the time spent in maintenance of newly planted trees, until their growth gives adequate shade to control weed competition, typically three to five years.

Ongoing maintenance practices are necessary to ensure establishment of a thriving buffer, particularly where smaller seedling plant material has been used. Even where large plants are involved, deer browse, invasion by exotic plant species and competition by herbaceous forbs and grasses will be a continuing problem. Maintenance and monitoring plans should be written for the specific site. Caretakers need to be advised of the duties involved in performing regularly scheduled buffer maintenance. These preventative measures are necessary to ensure the long-term effectiveness of the buffer and can include:

- watering
- mulching
- weed control
- monitoring for problems
- proper planting methods and placement of plants
- replacement of dead plant materials

Crown closure will occur approximately 10 years after a riparian buffer planting using 200 trees per acre.

Until canopy closure, a newly planted buffer should be maintained to control competition from weeds.

Weed competition has been found to be a significant factor in limiting buffer growth and survival.

Watering

Deep regular watering throughout the first growing season is optimal for buffer establishment. If watering is difficult due to accessibility or lack of labor, plants will need to rely on rain events. Planting in the fall may produce the best results as the likelihood of sufficient rain during the initial phase of establishment is increased. When possible, plant the buffer following a period of rain when the soil is already moist. Local fire companies may be willing to help with the initial watering of the buffer using a pumper truck. Planting day is a good time to recruit volunteers for a regular, seasonal watering schedule.

Regularly scheduled watering and removal of weeds or invasive plants around the base of plants are the most important first steps in maintaining a newly planted riparian buffer.

Mulching

Organic mulch will help retain soil moisture, retard evaporation, moderate soil temperature and provide some weed suppression around the plants. Mulch the soil surface around the plants with two to four inches of a coarse, slow to decompose medium, such as shredded bark, compost, leaf mulch or wood chips. Uncomposted mulches, such as grass clippings and sawdust, decompose rapidly and require more frequent applications. Leave air space between the tree trunk and any mulch.

Mulches placed directly against the tree trunk create a moist area that can provide a favorable environment for boring insects or fungus growth.

Mulch is considered by many to be a cosmetic top dressing. However, the proper type of mulch can have many benefits. Research suggests that height, growth and trunk diameter increase significantly if the ground near the tree base is kept free of grass. Besides the clear advantage of preventing competition between turf and young trees, expect fewer tree injuries caused by mowing equipment. For added protection against the invasion of weeds, lay heavy cardboard beneath the mulch. The cardboard will eventually decompose.

Mulch Selection - Shredded hardwood mulch has good moisture retention, provides weed control benefits and is relatively unaffected by wind and rain. Shredded mulch is marketed in coarse, medium and fine grinds. The more coarse the grind, the greater the moisture retention and weed control benefits. Coarse ground mulch is less susceptible to dispersion by wind and rain. Make sure that it has been properly composted before use to minimize the ensuing leachate. Composted mulch is typically darker and does not exhibit the heating and strong odor of newly mulched wood.

Improperly composted wood chips can be harmful to plants because the decomposing micro-organisms are not yet neutralized. When the chips are stored in large piles, sufficient amounts of alcohol and/or acetic acid can accumulate and kill plants when the chips are later used as mulch. Another concern of using freshly chipped waste is that the composition is unknown. If the material being chipped was dead, diseased, insect infested or not properly sterilized, these problems can be spread by using it as mulch. Uncomposted yard waste, such as grass clippings, twigs, branches, and leaves can be harmful to plants when used as mulch due to competition with the plant for soil nitrogen to continue decomposition.

The mulches used most frequently on reforestation sites are a combination of wood chips, leaves and twigs because they are readily available and require a nominal delivery fee. If possible, stockpile this type of mulch for six months to a year before use or reserve monies in the buffer budget for obtaining composted mulch.

Controlling Weed Competition

Until canopy closure, a newly planted buffer should be maintained to control competition from weeds. Weed competition has been found to be a significant factor in limiting buffer growth and survival. A buffer

Mulch Checklist:

- If using an organic mulch, check its source, to make sure the mulch is not contaminated with weed seeds or invasive tubers.
- A 2-4 inch layer of mulch is needed to prevent weed growth, to conserve moisture and to moderate soil temperature.
- All trees and shrubs should be mulched at planting time to help them become established.
- Coarse mulching materal is best; finer materials compact too easily.
- Mature weeds draw much needed moisture away from newly planted trees and shrubs; remove weeds sprouting through the mulch promptly.

maintenance plan should include weed control as well as monitoring for invasive plants, which thrive in newly disturbed soils.

Mowing or String Trimming – Mowing or trimming is a suggested method for controlling weed competition in a newly established buffer. This activity should occur twice during the growing season: once before weeds grow higher than 18 inches and again just before seed production, typically in late summer. Mower height should be between 8-12 inches to minimize cutting of slow-growing native plants. Mowing or trimming will also help in the control of vole populations by decreasing cover for the animals.

Weed Mats – Weed mats are black geo-textile fabric, typically sold in 3 feet by 3 feet sheets with a split in the middle to allow each mat to be placed over a seedling. Weed mat fabric is available in rolls to cover entire rows. Mats are used to suppress weed growth around newly planted vegetation by providing shade and preventing seed deposition.

A properly installed weed mat can be effective for several years. It is installed after the tree is planted and should be installed over mowed or otherwise cut or removed vegetation. The mat is secured with one stake at each corner, tamped into the soil at an angle to prevent heaving. The estimated cost in 2003 of an installed weed mat was between $1.25-$1.40. The mats should be removed once the trees have developed a canopy that will naturally shade out competitive weed growth.

Herbicide – An appropriate herbicide may be sprayed between rows of plants in a buffer in order to control weed competition in a large area. Always consider the proximity to water and choose an herbicide appropriate to a natural area. Herbicide use is regulated in Pennsylvania by the Department of Agriculture. Pennsylvania's regulations require that volunteers work under the supervision of a certified applicator. To get additional information on the certification regulations visit the PA code web site at www.Pacode.com and search Title 7.

Animal Damage

Deer

Overabundance of deer has become a problem in much of Pennsylvania due to the elimination of large predators and the availability of abundant habitat and food sources in agricultural fields and suburban landscapes, particularly where sprawling development creates more forest edge habit. The normal diet of white tailed dear consists of leaves, twigs, forbs, acorns, lichens and fruit consumed at an average of 5-15 pounds per day per deer. In areas in which deer densities are high, deer will browse all vegetation within reach, severely damaging or killing

Mortality Factors for Riparian Buffers:

- A survival rate of 60-67% for planted trees on a typical site is considered a fairly good indicator of success.
- Tree shelters improve survival.
- Weeds and vines are the most significant problems affecting the survial and growth of planted trees.
- Deer, damage from mowing, insects, poor planting and shading from adjacent trees are lesser factors.
- Weed control in riparian planting sites must be weighed with the potential for increasing deer browse.
- Effects of drought are difficult to determine. Decisions on site selection, time of planting, species and type of stock should be made to ensure that planted trees will succeed despite dry weather.

Riparian Forest Buffer Survival and Success in Maryland, April 2001.

many plants in a newly planted buffer.

There are several ways to evaluate the potential threat of deer damage during the planning stage of the buffer project. One sign of a high deer density is an overgrazed understory. In areas of high deer population densities, a browse line 5-6 feet above the ground will be apparent. Look for rubbing and scraping marks on trees in the area. If the buffer area is currently in agricultural use, the farmer should be able to indicate the intensity of the deer problem locally.

Take steps to protect newly planted buffer plants in areas of higher deer populations and monitor for deer damage. The following approaches can be used to minimize damage to young plants.

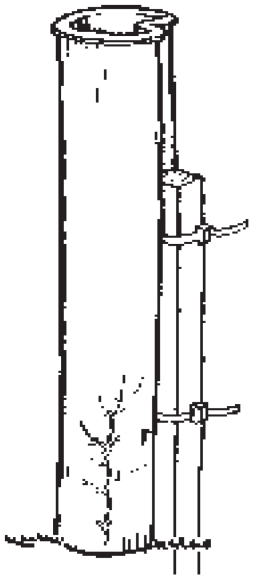
Plant Selection – Some tree varieties are rarely damaged by deer except in areas of high deer densities. They include: Downy Serviceberry, Shadbush, Allegheny Serviceberry, Paper Birch, Beech, and Ash. Less frequently damaged small trees and shrubs include: Pawpaw, Red Osier Dogwood and Common Elderberry.

Deer Repellants – Deer repellants work on the principle of repelling deer with a bad smell, a frightening scent or a bad taste. Results vary widely. Homemade remedies including soap, human hair cuttings, mothballs, ammonia and dried blood meal operate on the same principle as commercial repellents. Most repellants must be reapplied after rain or periodically, in order to guarantee continued coverage. Repellants are most effective when the deer herd is not very large and work better during summer when a wider variety of alternative food is available. When population pressures are high, deer will overcome smell or taste obstacles and browse treated plants.

Tree Shelters – In areas where deer browse is a substantial problem, shelters have been used with considerable success. Tree shelters are plastic tubes that fit over newly planted trees. They are available in heights from 2-6 feet and are secured with a wooden stake. A shelter can protect a tree from gnawing by voles or rabbits if it is installed with the base buried at least three inches in the ground. Improperly installed shelters that are vulnerable to vole intrusion can actually create an inviting place for voles by protecting the rodents from predators. In locations with high vole populations, rodenticide may be placed in the tree tube to prevent vole damage. Netting should be placed over the top of the tree tube, to prevent woodland debris from smothering the plant.

Tree shelters also have been shown to create a favorable microclimate for seedlings. Inside a properly installed tree shelter, moisture is con-

Tree Shelters are not a substitute for weeding. Check regularly to make sure shelters do not become choked with weeds. Use of a weed mat to keep vegetation 3 feet away from newly planted trees is recommended.



Check tree shelters at regular maintenance intervals to:

- repair broken stakes
- tighten stake lines
- straighten a leaning tube
- clean debris from the tube
- remove netting as tree grows

served from transpiring leaves and carbon dioxide levels are increased providing favorable growth conditions. Tree shelters make mowing and trimming easier by protecting trees from accidental strikes. Most tree shelters do not decompose over time and should be removed when the trunk diameter grows beyond 2 inches. When the bark begins to grow against the shelter, the tree can develop cankers that threaten the health of the tree. It is suggested that the shelters be slit rather than completely removed so that they continue to protect the trunk from deer rubbing.

Stream Buffer Fencing – Deer can jump a fence up to 10 feet high. They prefer to go under barriers, so the bottom wire of a fence should be placed no more than 10-12 inches off the ground. Fences should be monitored regularly and repairs should be done immediately, before deer discover the new food source within the buffer.

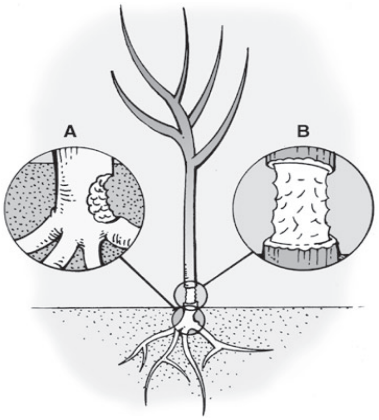
One of the least expensive types of fencing is 8 foot plastic fencing. It is both effective and easily repaired. Electric fences can have as few as two wires, placed at 10-12 inches and 30-36 inches high. To be effective the electric fence should be baited initially and baited again every month or so. The bait consists of metal tabs smeared with a food such as peanut butter. Deer will learn to fear the fence by contact with it through their sensitive mouth area and will habitually stay away from the area it encloses.

Farm animals such as mature cattle, horses and swine cause the greatest damage to stream banks. Fencing prevents livestock from entering and polluting the stream with waste products, trampling banks causing erosion and grazing streamside buffer zones. Livestock fencing systems commonly used along waterways for permanent installations are page wire fencing and 4 strand barbed wire fencing for large livestock. Barbed wire fence is less expensive to install than page fencing systems but requires far more maintenance.

High-tensile smooth wire fencing when electrified for livestock is usually installed as permanent fencing. When not electrified, this system uses 6-8 strands; electrified systems use 2 strands. High-tensile wire fencing offers increased strength, reduced maintenance cost and is easier to handle than barbed wire fencing.

Voles

Pennsylvania has two species of vole that are known to damage trees: the meadow vole and the pine vole. Voles are small, mouse-like rodents which feed on herbaceous plants in spring, fall and summer. During



Vole damage on young tree

Meadow voles (*Microtus pennsylvanicus*) and pine voles (*Microtus pinetorum*) formerly more common in commerical orchards, have become a significant problem in newly planted riparian areas.

Damage from voles includes girdling, destruction of the root system by chewing, and disappearance of herbaceous plants.

Deep layers of mulch, mulch placed directly next to tree trunks and mulch with a fine particle size attracts voles and should not be used.

winter months, when their preferred food is unavailable, voles feed on the roots and bark of tree or shrub seedlings, leading to the eventual death of the plants. The meadow vole is the most common vole in Pennsylvania and is found throughout the state. It favors meadow areas that have a dense ground cover of grasses that will protect it from being seen by predators as it makes its way along above-ground runs. The pine vole is found primarily in the southeastern part of the state. It creates underground runs in old farm fields, orchards and thickets that have sandy, loose soil. Vole populations can vary from year to year depending on food, climate, disease and the presence of predators.

A newly established buffer site should be monitored for voles before winter, when extensive plant damage can occur. To monitor for voles during the summer months:

- Look for telltale sign of voles such as surface runways of meadow voles. These will have fresh grass clippings and piles of green or tan rice shaped droppings. Also evident are the barrow entrances of pine voles, which tend to have a conical pile of dirt beside them composed of soil discarded by the vole while digging.
- Set bait stations that can provide an indicator of the vole population. Place apple slices in suspected runways or under a roofing shingle or piece of tarpaper. Check apple daily for elongated tooth marks, partly eaten slices or missing slices.

Protecting Trees from Voles – Voles have many natural predators including hawks, owls, foxes, cats and snakes, so they seek out areas that provide ample cover from these dangers. Mowing grass and other cover or spacing plants with plenty of open space between them can reduce vole populations by exposing them to predators.

If installed to a soil depth of 3 inches, tree shelters or quarter-inch mesh tree guards can protect trunks from meadow vole gnawing. One study of tree shelters showed that shelters which allow more light to penetrate the interior seemed to deter vole damage. Anticipate typical yearly snow depth, then install tree guards at least 8 inches higher than the snow cover, to protect the trunk throughout winter.

Trapping of voles during the fall can help bring down population numbers before winter when they can threaten small trees. It is recommended that traps be placed beside active vole trails.

Beaver

Beaver are found throughout Pennsylvania. Though typically preferring remote areas, they are now found in more developed areas. In many

Beaver are strict vegetarians who prefer the bark, cambium, twigs, leaves and roots of deciduous trees that grow along streams. They favor aspen, alders, boxelder, fir, pine, cedar, willows, maple, poplar and beech. But beavers will also eat soft aquatic vegetation including duckweed, pond lily, bullrushes, bracken fern and green grasses.

While the positive impacts of beaver are more numerous than their negative ones, the impact of local beaver on new riparian buffers can turn a planted area into a lake or a field of gnawed sticks.

Trees can be protected from girdling or cutting by wire mesh extending 2-3 feet about ground or by painting sanded paint or aluminum roof coating on lower trunks.

cases, the presence of beaver can be spotted by the existence of a dam and lodge. Along streams or rivers too wide or fast to dam, beavers will burrow deep into the bank or build a lodge on the bank. Adult beavers have been found to cut down up to 300 trees per year, most having diameters of less than 3 inches. This can pose a serious threat to newly planted trees.

Protection of Trees from Beaver - Monitor for signs of beaver activity before installation of a buffer. Signs include gnawed trees and lodge sites. If beaver appear to be active near the project site, tree seedlings can be protected with wire fencing with a nine-inch or smaller mesh, installed around the tree to a height of 3 feet. This fencing should be anchored at the bottom to keep the beaver from working its way under the fence.

Another method to prevent beaver gnawing is to paint the lower bark of the tree seedlings with a mixture of latex paint and mason sand. The ratio is approximately 5 ounces of sand to one quart of paint. The mixture results in an unappetizing cover for the beaver to gnaw through.

Invasive Plants – The Super Weeds

Invasive plants are weeds with characteristics that make them extremely threatening to the survival of a new buffer. They pose a threat because of their ability to spread aggressively, reproduce prolifically and are very difficult to control once established.

Invasive plants can overrun native vegetation and prevent the long term sustainability of native riparian vegetation. Non-native species can degrade the habitat for wildlife and diminish the pollution prevention capacity of a vegetated buffer significantly.

Restoration sites that did not contain invasive plants at the time of restoration may develop an unanticipated infestation, due to the soil disturbance associated with planting. Monitor restoration sites regularly for signs of invasive plants. The most common invasive plant found in an informal survey of 99 riparian buffer restoration sites in Pennsylvania was multiflora rose (Rosa multiflora) followed by Canada thistle (Cirsium arvense), purple loosestrife (Lythrum salicaria), Japanese honeysuckle (Lonicera japonica), and Tree-of-heaven (Ailanthus altissima).

Invasive Plant Identification

Become familiar with the appearance of invasive plants common to your region. When a plant seems to be spreading aggressively by growing back quickly and tenaciously after weeding, it should be

What is a Noxious Weed?

Noxious weeds are not necessarily invasive plants, they are ones which have proved to be a significant threat to agriculture, human health or the environment, thereby earning the designation of noxious weed from the Pennsylvania Department of Agriculture.

PA Noxious Weed:
Canada Thistle

Pennsylvania's list of noxious plants includes:

- ***Canada thistle***
- ***Bull thistle***
- ***Musk thistle***
- ***Multiflora rose***
- ***Mile-a-minute***
- ***Kudzu***
- ***Purple loosestrife***
- ***Giant hogweed***
- ***Jimsonweed***
- ***Goatsrue***
- ***Shattercane***
- ***Johnsongrass***

identified and appropriate control methods researched. Many invasive plants look similar to one or more native plants. Research should include an understanding of how the invasive plant differs from similar natives. Check at least two sources to confirm identification before taking action. If those sources cannot help make a positive identification, call the county Conservation District office or Cooperative Extension office to arrange for identification of the sample.

Invasive Plant Control Methods

Invasive plant control in a riparian or a wetland setting should be approached with caution for several reasons:

- Proximity to water makes herbicide contamination of surface and ground water much harder to avoid or impossible to control.
- Riparian and wetland areas are critical wildlife habitat areas. Invasive plant control can disturb or destroy habitat for a large number of valuable species. Mechanical removal of invasive plants can lead to erosion, resulting in siltation of the waterway.

PA Noxious Weed:
Bull Thistle

Choice of control method is based on a number of considerations including the size of the infestation, the amount of vegetation that should be retained and resources available to the group. Control methods fall into three broad categories:

- Mechanical
- Mechanical with application of systemic herbicide
- Herbicide

Plan to monitor and retreat for regrowth of the invasive plant, in spring and fall, for several years after initial control efforts.

The most current set of suggestions for invasive plant control can be found on the web. Two sites for control discussions are: http://tncweeds.ucdavis.edu and http://www.IPCNYS.org. The IPCNYS site includes a weeds directory with input from multiple land managers detailing their experience in controlling particular plants.

Mechanical Methods of Invasive Plant Control – Mechanical methods stop the invasive plant from growing and spreading without the use of chemical herbicides. Methods used depend on the plant, the location and the resources available. Among them are:

- Hand pulling
- Cutting of seed heads/repeated cutting to diminish vigor
- Pulling with tools, such as weed wrench
- Mowing to diminish plant vigor and prevent seed formation

Weed Wrench

A new tool for controlling woody invasive plants is the *Weed Wrench* which can easily uproot Norway maple, buckthorn, multiflora rose, honeysuckle and Russian olive up to 2.5 inches in diameter.

It can permanently eliminate unwanted shrubs and sapling trees by "wrenching" the plant and its roots out of the ground with minimal soil disturbance.

For woody shrubs and plants that are impossible to uproot, the wrench, which can be operated by one adult, can be a very effective tool in invasive plant control.

- Covering with plastic
- Brush hogging or bulldozing

Invasive plants are extremely persistent, requiring regular monitoring and continued removal efforts. Many cannot be eradicated by manual means alone.

Herbicides – In some instances herbicides are appropriate to use - with caution. Herbicides are one type of pesticide. All pesticides are regulated in several ways:

- Use of any pesticide on property not owned by the applicator can only be done by a Certified Pesticide Applicator or someone working under the direction of a Certified Pesticide Applicator,
- Purchase of or use of restricted use pesticides can only be done by a Certified Pesticide Applicator,
- Pesticide recommendations can only be made by a Certified Pesticide Applicator.

Check for the exact rules governing your situation with the Pennsylvania Department of Agriculture, Bureau of Plant Industry at 717-772-5231. It is extremely important that the rules and best management practices of pesticide application be followed when this approach is used.

Herbicide can be applied either on the leaves (foliar), on the lower bark (basal bark) or on the seed (pre-emergent), depending on the type. Foliar applications can take many forms. To carefully control the application of the herbicide so that it does not fall on desirable plants or water, it can be wiped on using gloves or sponges dampened by the herbicide. Herbicide can also be delivered directly into the vascular tissue of a tree, the fluid that transports nutrients within the plant, by making cuts into the bark and spraying the herbicide into the cut or by directly injecting the herbicide. A spray bottle or backpack sprayer can be used with a lesser degree of accuracy for small scale foliar applications in less sensitive areas. To cover a large or difficult to reach area, a large boom sprayer can be used.

Basal bark application of herbicide is applied with a brush or sprayed directly onto the bark.

Pre-emergent herbicides are used to prevent seeds from sprouting. This type of herbicide is used primarily around newly planted sites to prevent germination of the seed of undesirable plants. Many invasive plant species produce copious numbers of seeds that will germinate over the course of several years if not controlled.

The Bureau of Plant Industry, a division of the PA Department of Agriculture, regulates pesticides under the state's Title 7 laws.

The Pennsylvania Pesticide Control Act covers all aspects of the regulation of pesticides in the Commonwealth including:

- Use, distribution, storage and registration
- Requirements for the use of restricted use pesticides
- Certification of pesticide applicators
- Licensing of pesticide dealers, pesticide application businesses and pest management consultants
- Registration of pesticide application technicians
- Notification procedures for pesticide applications

For specific information on when a Certified Pesticide Applicator is required, go to: www.agriculture.state.pa.us/plantindustry

Conservation groups have addressed some of the risk factors associated with using herbicides within natural areas in innovative ways. Techniques of direct placement of herbicide, mentioned above, minimize drift to water or desired plants and have been found to be highly effective, though labor intensive. Wiper applicators in various forms are used for direct placement, such as herbicide dampened gloves (worn over a nitrile glove) used to wipe herbicide over the leaves of the target plant, tongs with herbicide-dampened sponges or sponge applicator bottles.

Glyphosate (as in Roundup), and to a lesser extent triclopyr (sold as Garlon), are selected for direct applications in natural areas. Both are systemic herbicides; they travel throughout the plant and kill the roots. Glyphosate has formulations for use in or near water, has limited persistence in the environment and does not harm animals.

An excellent, non-biased source for information on herbicides is the National Pesticide Information Hotline: 1-800-858-PEST.

Several alternative herbicides have been found to be effective on some plants and in certain settings, such as 10%-15% acid vinegar. This higher percentage acid vinegar is hard to find locally, but can be found in gardening catalogues. A spray of high acid vinegar has been found to be very effective on some herbaceous annuals. Corn gluten meal has also been used as a pre-emergent herbicide to inhibit root formation in a wide variety of grasses and broadleaf weeds during germination. Neither of these products has been tested by regulating authorities for effectiveness or environmental safety.

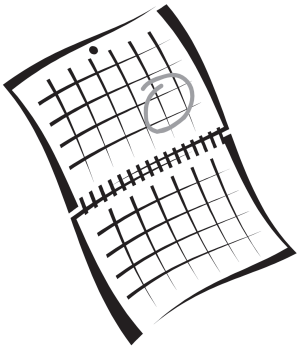
Hack and Squirt Herbicide Application

Hack and squirt refers to making 2-4 inch wide hacks into the tree's bark with an ax or a machete at intervals of 2 inches around the trunk.

Glyphosate is squirted into the hacked area. This method helps prevent the tree from resprouting, as happens when a tree is girdled, by removing a ring of bark around the trunk.

Monitoring the Buffer

Buffer strips must be monitored and managed to maintain their maximum water quality and wildlife habitat benefits. Monitoring should be done to discover emerging threats to the planting and to determine the effectiveness of the restoration project. During the first few years after installation, the new buffer should be monitored four times annually. Recommended times for monitoring are February, May, August and November. The buffer should also always be inspected within a few days after severe storms for evidence of sediment deposit, erosion or gully formation. Repairs should be made as soon as possible.



New buffers should be monitored four times annually for the first three years after installation.

Recommended months for monitoring are:

- *February*
- *May*
- *August*
- *November*

Monitoring for Survival – If the buffer area is small enough to make it feasible to count survival over the entire project site, that approach will provide the richest data. But since manpower may be limited and a total count not feasible, development of a systematic sampling system may be the most practical method of monitoring the site.

A representative sample can be determined by delineating sample plots and making counts within the sample sites. A description of how to designate sample plots appears at the end of this chapter. The data derived from this type of monitoring should look at both survival of the planted material and natural regeneration to determine if project goals have been met and if in-fill plantings should be done to maintain plant density. Information on species survival or on environmental factors impacting the planting can be of use in planning new management strategies and future projects. The monitoring can inform buffer owners about which species to replant and whether tree shelters or new weed control practices are necessary.

Survival rates can be calculated as the number of live plants divided by number of installed plants multiplied by 100:

# of live plants/# of plants installed x 100 = percent survival

This is the survival rate for the riparian buffer. Compare this survival rate to the project goal or acceptable performance standard. For some government programs a 70% survival rate is deemed to be a successful establishment.

Monitoring for Problems or Changes – A number of problems can occur after planting that can be corrected if discovered early. The project site should be monitored to determine if any of the following problems have occurred:

- Wildlife damage
- Livestock damage
- Damage from insects
- Disease
- Invasion by invasive plants
- Erosion
- Vandalism
- Damage to fencing or tree shelters
- Flooding
- Drought mortality

If identified early, many of these problems can be resolved or controlled before significant damage is done to the buffer. An online resource for the diagnosis of insect or disease problems is available from the Maryland Cooperative Extension Home and Garden Information Center. This resource offers photographic keys to diagnose and solve plant problems. www.agnr.umd.edu/users/hgic/diagn/home.html.

Monitoring for Water Quality – Water quality monitoring data can be of value if a project goal is to ultimately protect or improve water quality. Continued testing of chemical parameters and macroinvertebrates will provide an understanding of the impact of the project. To learn more about water quality monitoring, contact Pennsylvania Department of Environmental Protection Citizens' Volunteer Monitoring Program at 717-772-5807 or on the web at http://www.dep.state.pa.us Keyword: volunteer monitoring.

Monitoring Tools

No matter what technique is used you will need several items to help systematically monitor the buffer site. These include:

- Field notebook for recording observations such as damage, wildlife sightings or soil conditions
- Final planting plan for the site, to locate trees and determine a walking route or sampling plan for the site
- Handheld counter to aid counting of living plants
- Field guide to track survival by species or identify invasives
- Camera for photographing the buffer from permanent photo stations; i.e. fixed points within the buffer site such as a marked post or a designated spot near a mature tree
- Site Monitoring Summary Form to organize collected data

Why monitor?

- Assess ecosystem health
- Detect early signs of change
- Identify problems
- Document successes
- Determine achievement of planting goals

What is a macrovertebrate?

Macroinvertebrates are small bottom-dwelling aquatic animals without backbones, which can be seen with the naked eye.

They include insects, shrimp, crayfish, clams, larvae, snails and worms. The abundance and type of macroinvertebrates in a stream provide indicators of water quality.

Pennsylvania Citizens' Volunteer Monitoring Program

Designing Your Monitoring Program: A Technical Handbook for Community-Based Monitoring in Pennsylvania
http://www.dep.pa.us

Monitoring Survival Using Systematic Line Plot Cruise

The Maryland Department of Natural Resources Forest Service developed the sampling method described below to monitor a broad range of riparian forest buffers. This method is designed to collect information about natural regeneration as well as survival of planted trees. The sampling method can be used for plantings with a variety of buffer management practices including mowed sites, overgrown sites and sites with or without tree shelters.

This monitoring procedure has been designed to have a sampling intensity ranging from approximately 2.5% to 10% of the buffer area, depending on the size of the buffer. Testing has shown that this level of sampling will provide an accurate picture of overall plant survival for the whole site.

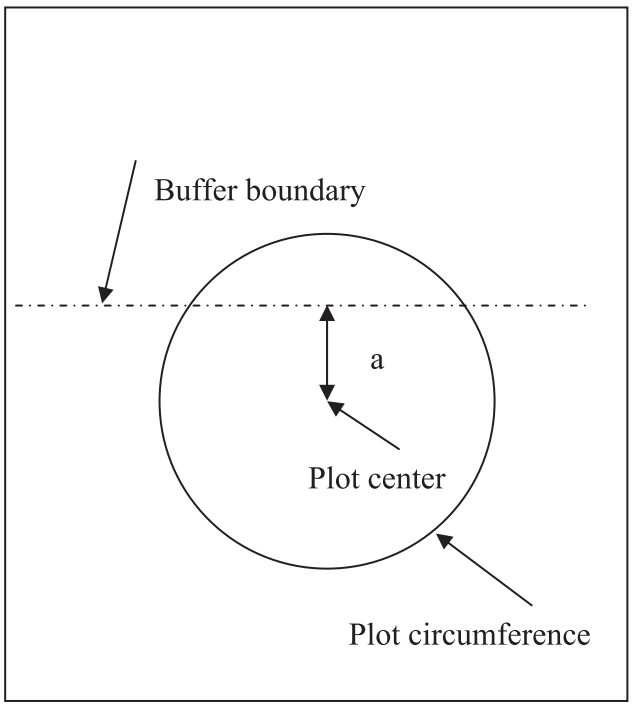
Calculation of Monitoring Results From Partial Plots – It is quite possible that one or more plots will straddle the boundary of the buffer. When this occurs, data from the "partial" plot is collected and added to the data from the other plots. Refer to Figure 1 and Table 1 below to determine the area of a partial plot. Once you have determined the area of the partial plot, this number must be added to the area of the other plots when calculating the total area sampled. **Only the area of the partial plot located within the buffer boundary should be added to the total area sampled.**

This partial plot area is obtained by measuring the distance from plot center to the buffer boundary (distance "a") and finding the corresponding plot area in the following table. Round "a" to the nearest foot.

Table 1 Plot table

Value of "a" (feet)	Area of Plot (acres)
1	.0055
2	0.0061
3	0.0066
4	0.0071
5	0.0076
6	0.0081
7	0.0085
8	0.0089
9	0.0093
10	0.0096
11	0.0099
11.78	0.01

Figure 1 Descriptive drawing of a partial plot



On Site Data Collection

1. Use buffer map used for planting plan and/or aerial photograph showing site to record position of sampling sites.

2. Determine the boundary of your buffer area using features such as fences, field edges, woodland edges or streams within 12 feet of the planted trees. If there is no defining boundary within 12 feet, mark the buffer boundary as a line outside the line of planted trees by a distance of ½ the average distance between trees in the buffer area. If trees are planted approximately 10 feet apart, the boundary will be five feet beyond the outside row.

3. Unless the current acreage and location of the buffer are known with certainty, map the perimeter of the buffer either by pacing off the area or using a measuring tape. Record on the site map the location of the buffer relative to the stream and other key landscape features.

4. Calculate the area of the buffer and record the acreage.

   To determine the area in square feet, multiply the average length of the buffer by the average width: Area (ft^2) = Average Length (ft) x Average Width (ft)

   To determine the acreage, divide the area by 43,560: Acreage (ac) = Area (ft^2)/(43,560 ft^2/ac)

5. Using a compass, determine the azimuth or direction, of a baseline that is approximately in line with the long axis of the riparian buffer. If the upland side of the buffer is relatively straight, this is usually a good baseline. Plot lines will fall perpendicular to the baseline, from waters edge along a 90 degree line the width of the buffer.

6. Determine the appropriate sampling intensity based on the area of the buffer to be measured as described in table two.

Table 2

Buffer Area	Distance between Plotlines	Distance between Plots	Approximate Area Samples
< 1 acre[1]	132 feet	33 feet	10%
1-10 acres	264 feet	33 feet	5%
> 10 acres[2]	264 feet	66 feet	2.5%

7. Choose one end of your baseline as a starting point, if possible at boundary. From that point, measure or pace off a distance of 132 feet (66 feet for buffer areas <1 acre) along the baseline.

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[1] For areas of less than one acre, always take at least four plots, on at least two plotlines. Adjust distance between plot lines as needed.

[2] For areas greater than ten acres but less than 66 feet wide, use plotlines 528 feet apart and plots 33 feet apart along each line.

8. Turn 90 degrees toward the stream; this will point you in the direction of your plot line. From this point measure a distance of 16.5 feet (33 feet for buffer areas >10 acres) in along the plotline toward the stream. Establish this point as the plot center of the first plot using a wire flag, stake or pole.

9. Define a plot with a radius of 11.78 feet from the center point. The plot area is equal to 1/100th of an acre.

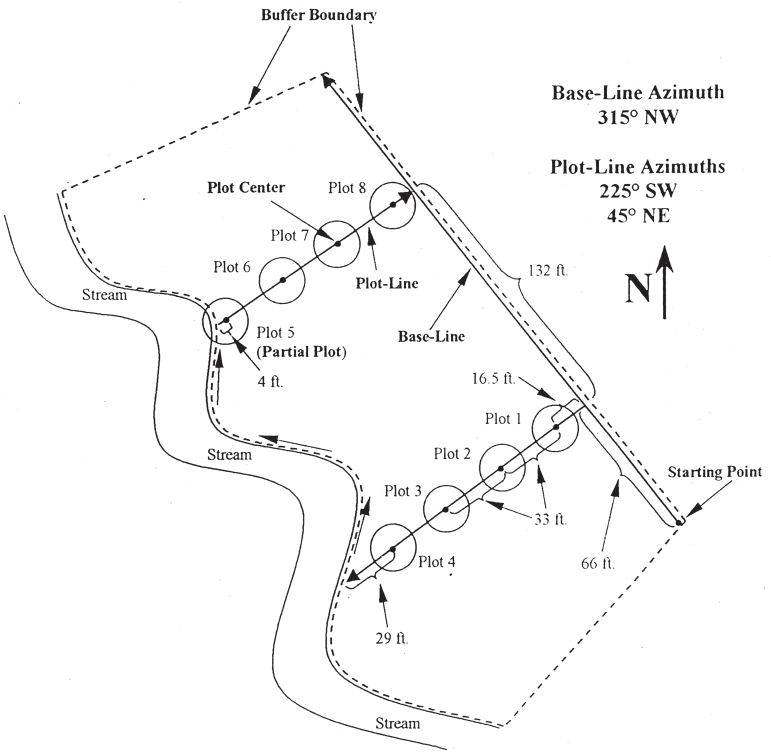
10. Record all data using the Data Collection Form at the end of the chapter.

11. Continue on in this manner until you reach the boundary of the buffer area. If your plot center falls within the buffer area but at a distance less than 11.78 feet from the boundary, your plot will straddle the buffer boundary, forming a partial plot. Refer to the section "Calculation of Moni toring Results from Partial Plots".

12. To begin a new plotline, pace off 264 feet (132 feet for buffers < 1 acre) parallel to the base line at waters edge and away from your original starting point.

13. Repeat steps 8-10 along the new plotline.

Figure 2. Riparian buffer site with example of monitoring layout. Note that the area of this site is less than 1 acre so the distance between the starting point and the first plot-line is 66 feet and the distance between plot-lines is 132 feet.



Buffer Avg. Length ~ 265 feet
Buffer Avg. Width ~ 125 feet
Buffer Area ~ 33,125 feet^2

Buffer Acreage ~ 0.76 acres
Total Area Sampled ~ 0.077 acres
Percent Sampled ~ 10.1%

Additional Resources

Allegheny Land Trust. “Land Conservation Handbook.” Pittsburgh, PA. 1995

Alliance for the Chesapeake Bay. “Streamside Buffer Monitoring Protocol: For Maryland’s Tributary Strategies Teams.” Baltimore, MD. 1999.

Brandywine Conservancy, Environmental Management Center. “Transfer of Development Rights: A Flexible Option for Redirecting Growth in Pennsylvania.” Chadds Ford, PA. 2003.

Center for Watershed Protection. “Better Site Design: A Handbook for Changing Development Rules in Your Community.” Ellicott City, MD. 1998.

Goldstein, Debra Wolf, Esq. “Using Conservation Easements to Preserve Open Space.” Doylestown, PA.

Montgomery County Planning Commission. “Guidebook for Riparian Corridor Preservation” Norristown, PA. June 1997.

Illustration Credits

Vole damage graphic. Used with permission of University of Missouri Extension. Copyright 2004.

Table 1, Figures1-2. Alliance for the Chesapeake Bay, “Streamside Buffer Monitoring Protocol: For Maryland’s Tributary Strategies Teams.” Baltimore, MD. 1999

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ALLIANCE for the CHESAPEAKE BAY

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Streamside Forest Buffer Monitoring
SITE MONITORING SUMMARY FORM

Site Name _____ **Date Collected** _____ **Collected by** _____

Total Buffer Area (acres) _____ **Area Sampled** _____ **Number of Plots** _____

Original Planting Density (Trees or Shrubs per Acre)

Original Planting Density _____

B&B/Containerized Saplings _____ **Sheltered Seedlings** _____

Seedlings w/o Shelters _____ **Other** _____

Trees and Shrubs Counted During Monitoring

		Number of Each Plant Type					Condition*	
Tree or Shrub Species	Number Counted	Planted Seedling	Sheltered Seedling	B&B/ Container	Natural Regen.	Other	1	2
TOTALS:								

* 1= Healthy and free to grow, not significantly impaired or damaged. Likely to survive and grow.
* 2 = Damaged or impaired by some problem

Number of Species Counted: _____

Plant Condition Summary: Percent Healthy _____% **Percent Damaged** _____%

Vegetative Competition:

None		Light	Medium	Heavy
Over Entire Site				
Tally for each plot				

Comments: _____