3.4 Riparian Vegetation Ecology and Management

Role of vegetation in maintaining a healthy stream

Although people value trees and other plants along a stream for their contribution to the beauty of the streamside landscape, the vegetation in a watershed, especially in the *riparian* area, plays a critical role in providing for a healthy stream system. The riparian, or streamside, plant community maintains the riverine landscape and moderates conditions within the aquatic ecosystem.

As rainfall runs off the landscape, riparian vegetation:

- Slows the rate of runoff;
- Captures excess nutrients carried from the land;
- Protects stream banks and floodplains from the erosive force of water;
- Regulates water temperature changes.

It also:

- Provides food and cover to terrestrial and aquatic fauna;
- Conserves soil moisture, ground water and atmospheric humidity.

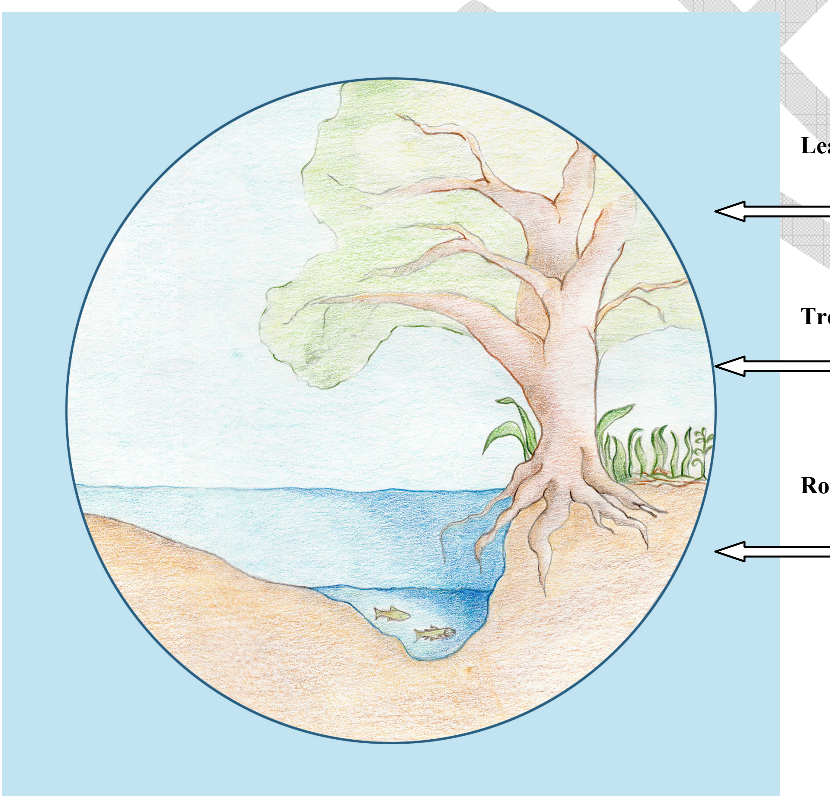

Figure 3.4.1 Illustrates ecological functions of various plant parts. (Patty Hanson, LaDue Design)

Erosion and pollution prevention capabilities

Riparian vegetation serves as a buffer for the stream against activities on upland areas. Most human activities whether agriculture, development, or even recreation, can result in a disturbance or discharge which can negatively impact the unprotected stream. Riparian vegetation captures, stores and filters pollutants in overland flow from upland sources, such as salt from roadways and excess fertilizers from lawns and cropland. The width, density, and structure of the riparian vegetation community are important characteristics of the buffer that also impact the level of its functionality.

On bare soils, high stream flows can result in bank erosion and overbank flow can cause soil erosion and scour on the floodplain. The roots of vegetation along the bank hold the soil and shield against erosive flows. On the floodplain, vegetation slows flood flows, reducing the energy of water. This reduction in energy will decrease the ability of water to cause erosion and scour. Furthermore, as vegetation slows the water, the soil suspended in the water is deposited on the floodplain (rather than carried to the stream).

Photo 3.4.1. Riparian understory along Rondout Creek.

Hydrologic influences

Vegetation intercepts rainfall and slows runoff. This delay increases the amount of precipitation that infiltrates the soil, recharges groundwater supplies and reduces overland runoff. This reduction and delay in runoff decreases the occurrence of destructive flash floods, lowers the height of flood waters, and extends the duration of the runoff event. These benefits are evident in forested watersheds such as the lower Rondout when compared to watersheds of similar size which have high levels of urban development (Fig.2). The reduction in flood stage and duration also results in fewer disturbances to stream banks and floodplains.

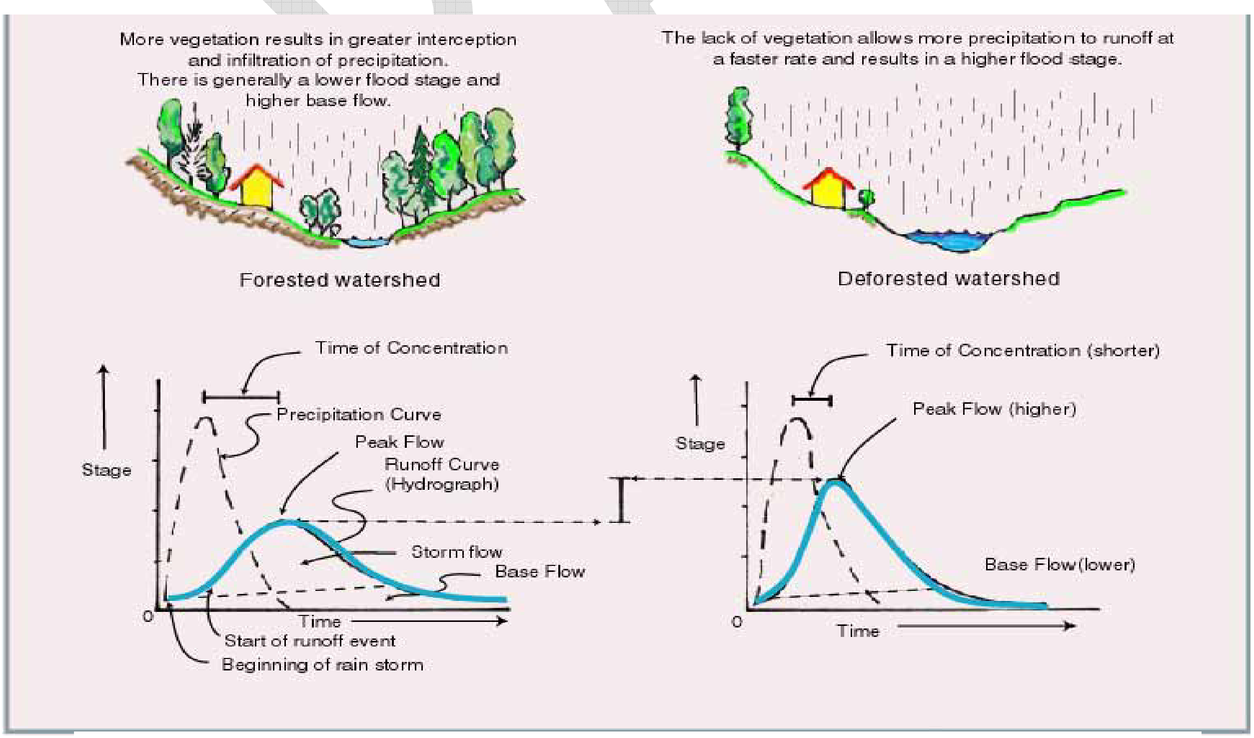

Figure 3.4.2 Comparison of Runoff on a Forested Watershed Versus a Deforested Watershed. Illustration by P. Eskeli 2002, from Watershed Hydrology, P.E. Black,1991, Prentice Hall, page 202, 214.

Ecological importance of vegetation in the riparian zone

Streamside vegetation also functions to provide climate, habitat, and nutrients necessary for aquatic and terrestrial wildlife. Trees shading a stream help maintain cool water temperatures needed by native fish populations. Low-hanging branches and roots on undercut banks create cover for fish from predators such as birds and raccoons. Natural additions of organic leaf and woody material provide a food resource needed by terrestrial insects and aquatic macorinvertebrates (stoneflies, mayflies, etc.) – the primary source of food for fish. Large woody material also provides valuable in-stream habitat for both fish and aquatic wildlife. Terrestrial wildlife depends upon vegetation for cover as they move from the upland community to the water's edge. A diverse plant community, one similar to the native vegetation of the lower Rondout, provides a wide range of conditions and materials needed to support a diverse community of wildlife. If vegetation is continuous within the riparian zone along the length of a stream, a corridor is available for wildlife migration. Connectivity between the riparian and upland plant communities enhances the ability of upland and riparian plant and animal communities to thrive despite natural or human induced stress on either community. These intact corridors will become even more critical if temperatures begin to increase with climate change as wildlife potentially shifts from southern to northern ranges and lower to higher elevations.

Characteristics of a healthy riparian plant community

A healthy riparian community should be diverse. It should have a wide variety of plants, including trees, shrubs, grasses, and herbs (Fig. 3). The age of plant species should be varied with sufficient regeneration of new plants to ensure the future of the community. An important difference between an upland plant community and a riparian community is that the riparian community must be adapted to frequent disturbance from flooding. Consequently, many riparian plants including willow, alder, and poplar, can re-grow from stump sprouts or can reestablish their root system if up-ended. Furthermore, the seeds from these species are adapted to thrive in depositional areas, such as gravel bars and lower flood benches.

Diverse Plant Types
(trees, shrubs, grasses, herbs)

+

Diverse Plant Ages
(young and old)

+

Disturbance-adapted,
Moisture-loving Plants
(accustomed to flooding & ice flows)

=

Healthy Riparian Buffers

Figure 3.4.2 A healthy riparian community is densely vegetated, has a diverse age structure andis composed of plants that can resist disturbance.

Riparian Vegetation in the lower Non-Tidal Rondout Watershed

Forest history and composition in the lower Rondout Watershed

Catskill Mountain and Hudson Valley forests have evolved since the ice age reflecting the changes in climate, competition and human land use. The first of these changes was the result of the climatic warming that occurred after the ice age which enabled warm climate adapted plant communities to replace the cooler climate communities. Following the retreat of the glaciers, the forest of the Rondout watershed gradually re-established and evolved from the boreal spruce/fir dominated forests, (examples of which can presently be found in Canada) to the maple-beech-birch northern hardwood forests (typical of the Adirondacks and northern New England) with the final transition of the lower elevations of the watershed to a southern hardwood forest dominated by oaks, hickory and ash (typical of the northern Appalachians). Dr. Michael Kudish provides an excellent documentation of evolution and site requirements of the region's forests in his book, The Catskill Forest: A History (Kudish, 2000).

Photos 3.4.2 & 3.4.3 Primarily forested upper Rondout watershed and lower Rondout Creek as it flows out of the NYC DEP Reservoir.

More recently, human activities have affected the forest either through manipulation of forests through development or for maintenance of desirable species (high-grade wood) for wood products. Native Americans used prescribed burning as a means of allowing nut bearing oaks and hickories to establish dominance in the forests. European settlers in the 18th and 19th centuries contributed to a rising industrial economy by clearing vast areas of land for agriculture, harvest of construction materials, and hemlock bark harvesting for the extraction of tannin. The land cover in the lower Rondout began to revert to forest with the local collapse of these economies in the 20th century and the acquisition of land by the State for the Catskill Forest Preserve, known as Sundown Wild Forest (Kudish, 2000).

Previous land uses have had a significant role in determining the type of vegetation found along the stream. The most intensive development activities were confined to the valley floor along the stream. Pastures and fields were created from cleared, forested floodplains. Abandoned, old fields have experienced a consistent pattern of recovery, with primary-colonizer species dominating the initial regrowth including sumac, dogwoods, aspens, hawthorns, and white pine. These species are succeeded by other light loving hardwood tree species such as ash, basswood and elm or in lower parts of the watershed, hickories, butternut, and oak. Hemlocks are largely confined to steeper stream banks and slopes where cultivation or harvesting of hemlocks for bark was impossible. More recent housing construction has re-intensified activity along the stream and been accompanied by the introduction of non-native vegetation typical of household lawns and gardens. While today the lower Rondout watershed is largely forested, agriculture and development activities are still concentrated along the valley floor, leaving the riparian area predominantly herbaceous.

The valley floor, which predominately follows the Route 209 corridor, is consistently dotted with municipalities and agriculture. This mosaic of impervious cover and farm fields within the valley floor has left riparian buffers somewhat fragmented unlike the upper reaches of the lower Roundout, which flow out of more heavily forested areas like the Catskills to the north & west and the Shawangunks to the south & east.

Closer examining the lower Rondout's Catskill watersheds through land cover data, the Beerkill, Sandburg Creek, Vernooy Kill and Rochester Creek all appear to have fairly healthy riparian buffers until they approach the Route 209 corridor. This also holds true when looking at the streams coming out of the Shawangunks like the Stony Kill, Saunders Kill, Peters Kill and Coxing Kill. These streams garner even greater protection than the Catskill tributaries due to the multitude of land preservation organizations located in the Shawangunks including Sam's Point Preserve, Minnewaska State Park, Mohonk Preserve and The Mohonk Mountain House.

Photo 3.4.4 Healthy riparian buffer of lower Rondout Creek as it flows adjacent to Route 213 through the Town of Rosendale.

Two points of concern regarding riparian buffers are again confined to the Route209 corridor; first being the channelized portion of the Beerkill as it flows through Ellenville, and secondly the Rondout itself as it begins to be flanked by agriculture. As an Army Corps of Engineers flood control project, the Beerkill was essentially channelized and had its bed hardened as it passes through Ellenville. Although this has reduced flooding in Ellenville, it has no doubt increased downstream flows, sedimentation, increased water temperature and reduced both terrestrial and wildlife populations.

Secondly, as the lower Rondout begins its meandering journey through the agricultural valley floor, it becomes more entrenched and with little vegetative buffer between the Rondout and its adjacent agriculture fields. Vegetation is typically limited to the steep stream banks with little (ie. a single line of trees) if no buffer on the floodplain. Some of these banks are more than 20 ft. in vertical height and vegetation serves as the only real stabilizing protection for the Rondout. One of the reasons the lower Rondout has become more entrenched is the berm building that has taken place with increased sediment loads from agriculture and development runoff.

Photo 3.4.5 Lower Rondout Creek meandering through the farms of Accord.

In many instances, farmers have added fill and debris to berms to increase their height, further cutting off the Rondout from its floodplain. The streambanks of the lower Rondout, especially on outside bends, are subject to greater stresses and with minimal vegetative stabilization above them, are subject to potential loss of vegetation and loss of property. Ideally buffers could be restored in the floodplain sections adjacent to these banks to help improve their stability and reduce sediment input into the stream, while at the same time improving water quality and wildlife & fish habitat.

The Riparian Forest

Photo 3.4.6 A wetland indicator, skunk cabbage, thrives in the riparian areas along the lower Rondout Creek amongst a variety of other understory vegetation.

Typically, riparian forest communities consist of species that thrive in wet locations and have the ability to resist or recover from flood disturbances. Extensive riparian communities typically exist in floodplain or wetland areas where a gentle slope exists. Many of the species present in these plant communities are exclusive to riparian areas. In areas where a steep valley slope exists, the riparian community may occupy only a narrow corridor along the stream and then quickly transition to an upland forest community. Soils, ground water and solar aspect may create conditions that allow the riparian forest species to occupy steeper slopes along the stream, as in the case where hemlock in habits the steep, northfacing slopes along the watercourse.

Natural disturbance and its effects on the riparian vegetation

Due to the proximity of riparian areas to water, they are subject to disturbances associated with extreme forces of nature and human development. Natural disturbances include floods, ice floes, and to a lesser extent, high winds, pest and disease epidemics, drought, and fire. Large deer herds can also significantly alter the composition and structure of vegetation through browsing, leaving stands of mature trees with no understory.

The flood of 1996 on the lower Rondout created and reopened numerous high flow channels, reworked point bars, scoured floodplains and eroded formerly vegetated stream banks. Immediately following the flood, the channel and floodplains were scattered with woody debris and downed live trees. In the years since this event, much of the vegetation has recovered. Trees and shrubs, flattened by the force of floodwaters, have re-established their form. Gravel bars and sites disturbed in previous flood events became the seedbed for herbs and grasses. This type of natural regeneration is possible where the stream is stable and major flood events occur with sufficient interval to allow establishment. The effect of flood disturbance on vegetation along stable stream reaches is short term and the recovery/disturbance regime can be cyclical. If the disturbance of floods and ice are too frequent, large trees will not have the opportunity to establish. Typically, the limit that trees can encroach upon the channel is defined by the area disturbed by the runoff event that achieves bankfull flow (expected to occur on average every 1.3 years).

Local geology and stream geomorphology may complicate the recovery process. A number of sites were found along Rondout Creek where vegetation has not been able to reestablish itself on bank failures created during recent flood events. On these sites it will be necessary to understand the cause of the failure before deciding whether or not to attempt planting vegetation to aid in site recovery. In these instances, the hydraulics of flowing water, the morphological evaluation of the stream channel, the geology of the stream bank, and the requirements and capabilities of vegetation must be considered before attempting restoration. Since the geologic setting on these sites is partially responsible for the disturbance, the period required for natural recovery of the site would be expected to be significantly longer unless facilitated by large-scale restoration efforts.

Damage caused by ice break up in the spring can result in increased mortality for young trees and shrubs located along the stream banks. These ice flows can also cause channel blockages, resulting in erosion and scour associated with high flow channels and overbank flows. Typically this type of disturbance has a short recovery period.

Threats to Riparian Forests

1) Pests and Disease

Photo 3.4.6 Hemlock woolly adelgid on the underside of a Hemlock branch

Pests and diseases that attack vegetation can also affect changes in the ecology of the riparian area and could be considered a disturbance. The hemlock woolly adelgid (*Adelges tsugae*) is an insect, which feeds on the sap of hemlocks (*Tsuga spp*.) at the base of the needles causing them to desiccate and the tree to take on a grayish color (Fig. 4). Stress caused by this feeding can kill the tree in as little as 4 years or take up to 10 years where conditions enable the tree to tolerate the attack (McClure, 2001). This native insect of Japan was first found in the U.S. in Virginia in 1951 and has spread northward into the Hudson Valley and Catskills (Adams, 2002).

With respect to stream management, the loss of hemlocks along the banks of the Rondout Creek and its many tributaries poses a threat to bank stability and the aquatic habitat of the stream. Wildlife, such as deer and birds, find the dense hemlock cover to be an excellent shelter from weather extremes while cool water species such as trout benefit greatly from the shading these hemlock stands create along streams. Finally, dark green hemlock groves along the stream are quiet, peaceful places that are greatly valued by the people who live along the Rondout Creek. Nearby the Olive Natural Heritage Society, Inc. is monitoring the advance of the hemlock woolly adelgid in the Catskills and is working in cooperation with NYS DEC on testing releases of *Pseudosymnus tsugae.*

Without a major intervention (as yet unplanned), it is likely that the process of gradual infestation and demise of local hemlock stands by woolly adelgid will follow the patterns observed in areas already affected to the south. Reports from Southern Connecticut describe the re-colonization of hemlock sites by black birch, red maple and oak (Orwig,2001). This transition from a dark, cool, sheltered coniferous stand to open hardwood cover is likely to raise soil temperatures and reduce soil moisture for sites where hemlocks currently dominate vegetative cover. Likewise, in the streams, water temperatures are likely to increase and the presence of thermal refuge for cool water loving fish such as trout are likely to diminish.

Other forest pests are on the brink of infesting the Rondout Valley that pose even greater risks than the woolly adelgid. Emerald Ash Borer (*Agrilus planipennis*; EAB) and Asian Long-horned Beetle (*Anonplophora glabripennis*; ALB) are two particular insects that have ravaged forests elsewhere in the United States. EAB has recently been indentified at a campground in Saugerties, which is in the neighboring Esopus Creek watershed. Likewise ALB threatens to invade from the south (New York City) or east (Worchester, MA). The high level of tourism and second home ownership in and throughout the Rondout Valley makes this area particularly vulnerable to the transport of these species. Together, these two pests could seriously impact the forests that comprise the livelihood of so many creatures and humans. Statewide concerns about EAB and ALB have led to a recent ban on the movement of firewood within a 50 mile radius of where it was cut.

2) Human disturbance and its effects on the riparian vegetation

Although natural events disrupt development and succession of riparian vegetation growth, human activities frequently transform the environment and, as a result, can have long lasting impacts on the capability of vegetation to survive and function. Presently, the most significant sources of human disturbance on riparian vegetation in the upper Rondout include the construction and maintenance of roadway infrastructure, the maintenance of utility lines, and the development of homes and gardens near the stream and its floodplain.

The alignment Route 209 and Route 213 closely follows the stream alignment of the lower Rondout Creek. Use and maintenance of these roads has a significant impact on the riparian vegetation. The narrow buffer of land between the creek and the road receives runoff containing salt, gravel, and chemicals from the road that stunt vegetation growth and increase mortality. Road maintenance activities also regularly disturb the soil along the shoulder and on the road cut banks. This disturbance fosters the establishment of undesirable, invasive plants which establish more quickly than native vegetation in these areas. The linear gap in the canopy created by the roadway separates the riparian vegetation from the upland plant communities. This opening also allows light into the vegetative understory which may preclude the establishment of native, shade-loving plants such as black cherry and hemlock.

Utility lines parallel the roadway and cross the stream at various points requiring the utility company to cut swaths through the riparian vegetation at each crossing, further fragmenting essential beltways for animal movement from streamside to upland areas. Although the road right-of-way and utility line sometimes overlap, at several locations along the stream, the right-of-way crosses through the riparian area separate from the road. This further reduces the vigor of riparian vegetation and prevents the vegetation from achieving the later stages of natural succession, typified by climax species such as sugar maple, beech and hemlock.

Residential land use and development of new homes can have a great impact on the watershed and the ecology of the riparian area. Houses require access roads and utility lines that frequently have to cross the stream. Homeowners who love the stream and want to be close to it may clear trees and shrubs to provide access and views of the stream. Following this clearing, the stream bank begins to erode, the channel over-widens and shallows. The wide, shallow condition results in greater bedload deposition and increases stress on the unprotected bank. Eventually stream alignment may change and begin to cause erosion on the property of downstream landowners. Hudson valley stream banks require a mix of vegetation such as grasses and herbs that have a shallower rooting depth, shrubs with a medium root depth, and trees with deep roots. Grasses

Photo 3.4.7 Lower Rondout Creek entering Kingston flanked by roads and development on both sides of the stream.

alone are insufficient to maintain bank stability in steeply sloping streams such as the Rondout Creek.

Invasive Plants and Riparian Vegetation

Sometimes the attempt to beautify a home with new and different plants introduces a plant that spreads out of control and “invades” the native plant community. Invasive plants present a threat when they alter the ecology of the native plant community. This impact may extend to an alteration of the landscape should the invasive plant destabilize the geomorphology of the watershed (Melanson, 2002).

The spread of Japanese Knotweed (*Fallopia japonica*), an exotic, invasive plant gaining a foothold in many streams in the Hudson Valley, is an example of a plant causing such a disruption. As its common name implies, Japanese knotweed’s origins are in Asia. It shades out existing vegetation and forms dense stands along the bank (Fig. 5 a-c). Although the impact of a Japanese knotweed invasion on the ecology of the riparian area is not fully understood, the traits of Japanese knotweed pose several concerns. Some of these concerns include:

- Knotweed appears to be less effective at stabilizing streambanks than deeper-rooted shrubs and trees, possibly resulting in more rapid bank erosion.
- The shade of its broad leaves and the cover by its dead litter limit the growth of native plants that provide food and shelter for associated native animals.
- Knotweed branches do not lean out over stream channels, providing little cooling from shade.
- Dead knotweed leaves (*detritus*) may alter food webs and impact the food supply for terrestrial and aquatic life.
- Large stands of knotweed impede access to waterways for fishing and streamside hiking.
- The presence of knotweed could reduce property value.
- Knotweed may alter the chemical make-up of the soil, altering soil microfauna and soil properties.

Figure 3.4.3 (a), (b), and (c) Stages of Japanese knotweed’s growth throughout the growing season.

Recommendations for healthy Riparian Buffers

Hemlock Woolly Adelgid

- Potential link between the presence of Hemlock woolly adelgid on a site and the degree to which people use or access the site
- Chemical pest control options would most likely provide little more than temporary, localized control due to the widespread nature of the infestation
- the use of pesticides to the control the infestation is not recommended in the riparian area due to impacts on water quality and aquatic life
- Planting adelgid resistant conifers such as white pine is recommended to maintain coniferous cover on former hemlock dominated sites (Ward, 2001).

Extensive information about the Hemlock Woolly adelgid is available at the US Forest Service's Northeastern Area "forest health protection" webpage: www.na.fs.fed.us.

Asian Long horned Beetle and Emerald Ash Borer

For more information about the Asian Long-horned Beetle and the Emerald Ash Borer:

APHIS fact sheets for general information about invasive forest pests:
www.aphis.usda.gov/publications/plant_health/content/printable_version/fs_invspec_forest_health.pdf

For ALB:
www.aphis.usda.gov/publications/plant_health/content/printable_version/faq_alb_mass_regarea.pdf

For EAB:
www.aphis.usda.gov/publications/plant_health/content/printable_version/EAB-GreenMenace-reprint-June09.pdf

Human Disturbance

- Routes to the stream from individual residences should be carefully selected. Access points should be located where the force of the water on the bank under high flow is lower and disturbance to riparian vegetation can be minimized.
- Foot traffic and disturbance in the flood prone are should be restricted
- Dense natural buffers should be promoted and encouraged.

Additional information on streamside gardening and riparian buffers can be found at: www.catskillstreams.org/stewardship_streamside_rb.html.

Japanese knotweed

- The broad use of herbicides is not recommended in riparian areas due to threats to water quality and aquatic life
- Mechanical control, by cutting or pulling requires regular attention to remove any regrowth; rhizomes can extend up to 12 ft. deep and 25 ft. wide.
- Any fill material introduced into a riparian area should be free of Japanese knotweed fragments.
- Any Japanese knotweed roots pulled or dug up should be disposed of in a manner that will prevent it from spreading or re-establishing itself.
- Bare streambanks should be planted with native vegetation so that Japanese knotweed does not become established.

An excellent source for native plants and expert advice can be found at Catskill Native Nursery on Samsonville in the Town of Rochester. For more information: www.catskillnativenursery.com. [1]

[1] Submitted by Jennifer Grieser, Catskill Stream Buffer Initiative Coordinator, NYC Department of Environmental Protection

For more information about invasive species in general: www.dec.ny.gov/animals/265.html

Implementation Strategies for Riparian Buffers

1. Use GIS technology to map land use in riparian areas
2. Identify and prioritize potential riparian planting sites using a combination of mapping techniques and field surveys.
3. Develop a network of volunteers that can be trained to assist in assessing sites, planting trees along riparian buffers, eradicating invasive species, and monitoring for forest pests such as the Asian longhorned beetle. Establish a subcommittee that focuses on coordinating plantings for target areas, and eradicating invasive species.
4. Develop education programs focused on farmers as well as smaller landowners that raise awareness about best management practices in the riparian areas.
5. Coordinate a Visual Stream Assessment. The Lower Hudson Coalition of Conservation Districts offers a Streamwalk program www.lhccd.org/streamwalk2004.html that a stream assessment can be modeled after. This will assist in determining location of invasive species as well as potential planting sites in the riparian corridor.