2.7 Riparian Vegetation Issues in Stream Management

General Concepts of Riparian Vegetation Ecology and Management

The Role of Vegetation in Maintaining a Healthy Stream

Although people value trees and 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 serves to maintain the riverine landscape and moderate 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.

Vegetation's 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 and stores pollutants in overland flow from upland sources such as salts from roadways and excess fertilizer from lawns and cropland. The width, density, and structure of the riparian vegetation community are important characteristics of the buffer that can be used to define 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.

Vegetation's Hydrologic Influences

Vegetation intercepts rainfall and slows runoff. This delay increases the amount of precipitation that infiltrates the soil and reduces overland runoff. A 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 generally most readily observed in forested watersheds such as the East Kill, as opposed to similar watersheds where urban development is the chief land use (Figure 2.7.1). The reduction in flood stage and duration typically means fewer disturbances to stream banks and floodplains.

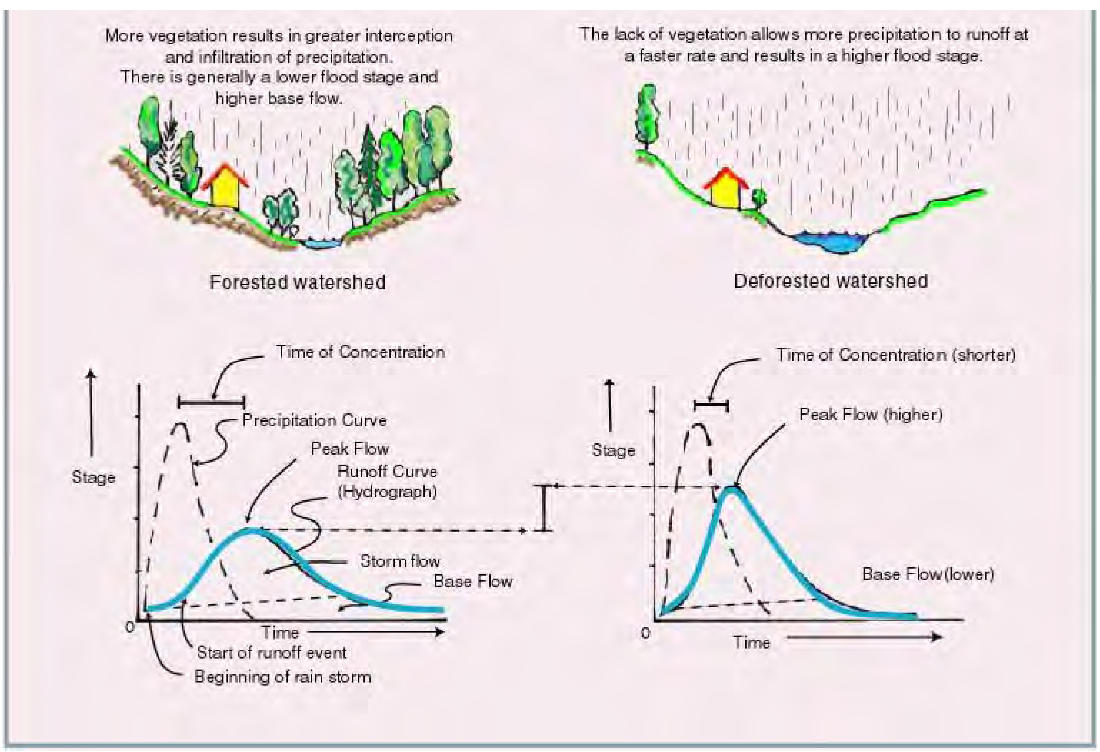

Figure 2.7.1. Comparison of Runoff on a Forested Watershed Versus a Deforested Watershed. Illustration by P. Eskeli 2002, from Watershed Hydrology, P.E. Black, 1991, Prentice Hall, page 202, 214.

Ecological Importance of Vegetation in the Riparian Zone

Vegetation along a stream also functions to provide the 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 tree 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 macroinvertebrates (stoneflies, mayflies, etc.), the primary source of food for fish. 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 East Kill, provides a wide range of conditions and materials needed to support a diverse community of wildlife. If the 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.

Characteristics of a Healthy Riparian Plant Community

A healthy riparian plant community should be diverse. It should have a wide variety of plants including trees, shrubs, grasses or herbs (Figure 2.7.2). The age of the plants should be varied and there should be sufficient regeneration of new plants to ensure the future of the community. A diverse community provides a multitude of resources and the ability to resist or recover from disturbance. 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, such as willow, alder, or poplar can regrow from stump sprouts or can reestablish their root system if up-ended. Furthermore, the seed of these trees may have a greater ability to germinate and establish 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 floes)

=

Healthy Riparian Buffers

Figure 2.7.2. A healthy riparian community is densely vegetated, has a diverse age structure and is composed of plants that can resist disturbance.

Riparian Vegetation of the East Kill

Forest History and Composition of the East Kill

Catskill mountain 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 forests of the East Kill basin 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 (Kurdish, 2000).

More recently, human activities have affected the forest either through the manipulation of regeneration for the maintenance of desirable species, the exploitation of the forest for wood and wood products or through development. Native American land management practices included the use of prescribed burning as a means of enabling the nut bearing oaks and hickories to remain dominant in the forest. European settlers contributing to the rising industrial economy in the 18th and 19th century greatly altered the landscape and forest cover through land clearing for agriculture, forest harvesting for construction materials, and hemlock bark harvesting for the extraction of tannin. The land cover in the East Kill began to revert to forest with the local collapse of these economies in the 20th century and the acquisition of much of the land by the state for the Catskill Forest Preserve (Kudish, 2000). Please refer to individual Management Unit descriptions for more detailed information about past activities that affected the streamside and floodplain vegetation.

Previous land uses have had a significant role in determining the types of vegetation found along the stream. Due to the steepness of the sides of the valley, the most intensive development activities were confined to the valley floor along the stream. Pastures and fields were created from cleared, forested floodplains. After abandonment, these old fields have experienced a consistent pattern of recovery, with 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 the 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. Today, the East Kill watershed and riparian areas are largely forested, although the continuity of the forest is frequently interrupted by infrastructure, utility lines, residential land use and abandoned agricultural lands.

The Riparian Forest

Typically, a riparian forest community is composed of those plant species that thrive in a wet or moist location and have the ability to resist or recover from disturbance. Generally, the riparian forest community is more extensive where a floodplain or wetland exists and the side slopes to the valley are more gently sloping. The plant associations found in forested floodplain communities may be exclusive to riparian areas. Where the valley side slopes are steeper, the riparian community may occupy only a narrow corridor along the stream and then quickly transition to an upland forest community. From a vegetation assessment in a nearby watershed, it was found that northern hardwood communities on steep slopes adjacent to the stream contained a mix of ash, poplar, elm, beech, yellow birch and some maple, whereas in upland northern hardwood communities, the yellow birch and maple became the dominant species. 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 inhabits the steep, northfacing slopes along the watercourse.

Natural Disturbance and its Effects on the Riparian Vegetation

Riparian vegetation is disturbed by the forces of nature and development activities of those who live near the stream. Sources of natural disturbance include damage due to floods, ice floes, and to a lesser extent, high winds, pest and disease epidemics, drought and fire. Deer herds can also alter the composition and structure of the vegetation due to their specific browse preferences.

The 1996 flood created and reopened numerous high flow channels, reworked point bars, scoured floodplains and eroded formerly vegetated stream banks in the East Kill. 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). While shrubs like willow and alder or herbaceous plants like sedges, which reestablish themselves quickly after disturbance, can grow in the bankfull channel, it is unadvisable to plant trees in this channel area.

Local geology and stream *geomorphology* may complicate the recovery process. A number of sites were found in the East Kill where vegetation has not been able to reestablish itself on the high, steep bank failures created during recent flood events. On these sites it will be necessary to understand the cause of the failure before deciding on whether to attempt planting vegetation to aid in site recovery. In these instances, the hydraulics of the flowing water, the morphological evolution of the stream channel, the geology of the stream bank, and the requirements and capabilities of the 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 restoration efforts.

The ice break up in the spring, like floods, can damage the established vegetation along the stream banks and increase mortality of the young tree and shrub regeneration. Furthermore, ice floes can cause channel blockages which result in erosion and scour associated with high flow channels and overbank flow. Typically this type of disturbance also has a short recovery period.

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 greyish color. 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 Catskills (Adams, 2002).

Hemlock woolly adelgid on the underside of a branch.

In the eastern United States, the adelgid attacks eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*Tsuga carolinianna* Engelman) and can affect entire stands of hemlock. Once a tree is infested, population trends for the insect are typified by a fluctuating density of the insect with some hemlock regrowth occurring in periods when population densities are lower. This regrowth is stunted and later attacked as the adelgid population increases. With each successive attack tree reserves become depleted and eventually regrowth does not occur. The native predators of hemlock woolly adelgid have not offered a sufficient biological control, but recent efforts to combat the insect include experimentation with an Asian lady beetle (*Pseudoscymnus tsugae* Sasaji) which is known to feed on the adelgid. Initial experimental results have been positive, but large-scale control has yet to be attempted. The US Forest Service provides extensive information about this pest at its Morgantown office "forest health protection" webpage: www.fs.fed.us/na/morgantown/.

With respect to stream management, the loss of hemlocks along the banks of the East Kill 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. Finally, dark green hemlock groves along the stream are quiet, peaceful places that are greatly valued by the people who live along the East Kill. 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*. Initial results of the monitoring suggested a possible link between the presence of hemlock woolly adelgid on a site and the degree to which people use or access the site. Due to the widespread nature of the infestation, the use of chemical pest control options such as dormant oil would most likely provide little more than temporary, localized, control. The use of pesticides to control adelgid is not recommended in the riparian area due to potential impacts on water quality and aquatic life.

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. Alternatives for maintaining coniferous cover on hemlock sites include the planting of adelgid resistant conifers such as white pine as the hemlock dies out in the stand (Ward, 2001).

Human Disturbance and its Effects on the Riparian Vegetation

Although natural events disrupt growth and succession of riparian vegetation, human activities frequently transform the environment and, as a result, can have a long lasting impact on the capability of vegetation to survive and function. Presently, the most significant sources of human disturbance on riparian vegetation along the East Kill includes 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.

Roadway and Utility Line Influences on Riparian Vegetation

Due to the narrow valley and steepness of the valley walls, the alignments of County Routes 23C and 17 closely follow portions of the East Kill's stream alignment. Use and maintenance of the road right-of-way impacts the vigor of riparian vegetation. The narrow buffer of land between the creek and the road receives the runoff of salt, gravel, and chemicals from the road that stunt vegetation growth or increase its 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. 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 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.

Utility crossing.

Residential Development Influence

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. Catskill 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 alone are insufficient to maintain bank stability in steeply sloping streams such as the East Kill.

Streamside development and limited riparian vegetation leads to compromised streambanks. This bank has been reinforced with riprap.

Many people live close to the stream and maintain access to the water without destabilizing the bank. By carefully selecting a route from the house to the water's edge and locating access points where the force of the water on the bank under high flow is lower, landowners can minimize disturbance to riparian vegetation and stream banks. Restricting access to foot traffic, minimizing disturbance in the flood prone area, and promoting a dense natural buffer provide property protection and a serene place that people and wildlife can enjoy. Additional information on concepts of streamside gardening and riparian buffers can be found at the following web site produced by the Connecticut River Joint Commission, Inc: http://www.crjc.org/riparianbuffers.htm and Catskillstreams.org. A list of native trees and shrubs "Native Trees for Riparian Buffers in the Upper Connecticut River Valley of New Hampshire and Vermont" developed by this group is provided in Appendix A. A list of native vegetation for the Catskill Mountain Region has been compiled using several sources, see Appendix A for this list or contact GCSWCD for more information.

Japanese Knotweed 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 (Malanson, 2002). The spread of Japanese knotweed (*Polygonum cuspidatum*), an exotic, invasive plant gaining a foothold in the East Kill, is an example of a plant capable of causing such a disruption. As its common name implies, Japanese knotweed's origins are in Asia, and it was brought to this county as an ornamental garden plant.

Japanese knotweed is quite recognizable throughout the year. The series of photographs in Figure 2.7.3 illustrate different stages of Japanese knotweed's growth throughout each season. This herbaceous, or non-woody, perennial goes through these cycles every year. In the spring (generally late April, early May), new red, asparagus-like shoots sprout from last year's crown or from underground roots (*rhizomes*). By July, individual stems may reach 11 feet tall. Many thick, hollow stems are based at a crown.

Figure 2.7.3. Stages of Japanese knotweed's growth throughout the growing season.

The upper areas of the stems form a few branches that reach out like an umbrella from the crown. Each main stem and branch holds several large, nearly-triangular leaves. In August knotweed dons abundant clusters of small, white flowers that attract several pollinators, such as bees, wasps and Japanese beetles.

Knotweed seeds.

The numerous flowers turn into buckwheat-like seeds by late September, early October. Although some seeds may create small seedlings (Forman & Kesseli 2003), knotweed spreads more by their *rhizomes*.

Cold weather halts the growth of knotweed; once frost covers the land, knotweed drops its leaves and turns an auburn hue. These dead stems often remain standing for one or two years and then cover the ground, decaying slowly.

Knotweed following a frost.

Knotweed's leaf pattern.

Dense stand of knotweed.

The above ground portion dies back each fall and re-grows to a height of 6-9 feet tall each spring. The canopy of the dense stands of bamboo-like stalks, covered by large heart shaped leaves, blocks out almost all light from reaching the soil, thereby shading out other plants and leaving the soil bare.

Japanese knotweed spreads primarily by vegetative means. Often, earthmoving contractors, highway department crews or gardeners transfer small portions of the roots in fill or soil that gets dumped on or near a streambank. These roots then grow into a new plant that soon becomes a colony. Japanese knotweed is able to spread rapidly on disturbed sites and prefers the moist, open conditions of the stream edge and bank for colonization. Once knotweed has established itself in the riparian area, it is able to spread downstream after disturbances caused by beaver activity or by high flows scouring the streambank. Such disturbances often cause stems and rhizomes to break off and float downstream where fragments may establish themselves on streambanks that were previously unaffected by knotweed. Exposed streamside areas such as sediment deposits or disturbed banks with eroded soils lacking vegetation are particularly vulnerable to invasion by knotweed.

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.

Japanese knotweed is very difficult to control. The broad use of herbicides, while potentially effective following a protocol of repeated treatments by a professional certified applicator, does present risks due to the threat the chemicals pose to water quality and the fragile aquatic ecosystem. Mechanical control, by

Japanese knotweed colony along the East Kill.

cutting or pulling, is labor intensive and requires regular attention to remove any re-growth. Biological controls are untested. The first step for residents and those who manage land and infrastructure in the East Kill is to familiarize themselves with the appearance and habits of knotweed. Next, it is important for landowners and land managers to monitor its spread. Landowners should avoid practices that would destabilize the stream banks or weaken the natural riparian vegetation that can prevent its spread. Any fill material introduced to the riparian area should be tested for the presence of Japanese knotweed. Any Japanese knotweed roots pulled or dug up from your property should be disposed of in a manner that will prevent it from spreading or re-establishing itself.

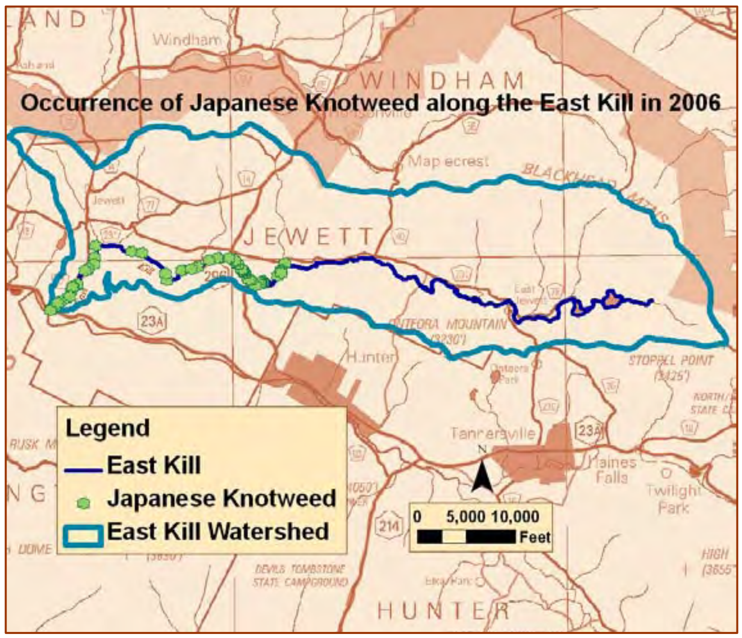

Figure 2.7.4. Japanese knotweed along the East Kill

During the 2006 stream feature inventory and assessment, the project team mapped the distribution of Japanese knotweed along the East Kill. During these mapping efforts, the size of a colony was estimated; however the map does not show the area covered by each colony, only the presence of a colony (Figure 2.7.4). As is evident from the map, in 2006, Japanese knotweed was absent from more than half of the stream corridor; the first occurrence of knotweed was found in management unit #7, more than 8.5 miles downstream from the headwaters of the East Kill. Knotweed had colonized many sites along the East Kill downstream of its first occurrence, with 53 occurrences of knotweed affecting approximately 1,556 feet of stream banks (Figure 2.7.4). Without control efforts it is likely to continue to spread and fill in along the banks within a matter of a few years. Since much of the stream corridor has not been colonized by knotweed, it is critical to contain its spread and prevent invasion along unaffected stream banks. For more information about the specific quality and composition of a particular riparian area, please refer to individual Management Unit descriptions.

For several years, NYCDEP, GCSWCD and Hudsonia have been collaborating on research efforts to gain a greater understanding of Japanese knotweed. In 2003, Hudsonia submitted a final draft of their report *Japanese Knotweed and Water Quality on the Batavia Kill in Greene County, New York: Background Information and Literature Review*. This report provided a review of available information on Japanese knotweed including, the biology, ecology, history of its invasive spread, and methods of management (Talmage and Kiviat, 2003). Currently, the NYCDEP, GCSWCD and Hudsonia are working together on a project, along the Batavia Kill, to determine an effective treatment method for Japanese knotweed. Three experimental treatment methods are being tested for their effectiveness at managing stands of knotweed; these methods include, 1)frequent mowing, 2) limited excavation with planting of native species and a weed barrier around the trees, and 3) herbicide injection. This research is part of an effort to develop management recommendations for its future control. For more information on Japanese knotweed and for a link to Hudsonia's report, visit the GCSWCD website http://www.gcswcd.com/stream/knotweed/ and/or Catskillstreams.org.

Japanese knotweed has established colonies along the East Kill and some of its' associated tributaries. Management of knotweed is a difficult task and careful consideration must be taken before determining how to manage individual knotweed stands or colonies on streamside properties. Besides understanding key characteristics about knotweed (e.g. how it spreads, what environments it prefers), it is also essential to recognize a few key concepts that actually apply to most invasive species. First and foremost, prevention is the best policy. Preventing the spread of knotweed is the most cost effective and time efficient approach to take, and may be achieved by: telling others about knotweed and warning them of its associated problems; keeping streambanks stable by allowing native trees and shrubs to grow and mature; and checking transported soil for any knotweed fragments.

It is critical to recognize that knotweed grows under diverse conditions and in varying locations, so there are different ways to approach its control. Before simply mowing down all the knotweed or spraying herbicides everywhere, one should first ask:

- How large is the stand of knotweed?
- Is it located near a waterway?
- What native plants exist nearby?

With answers to the questions above a customized approach may be taken, saving time and money by applying the most appropriate techniques.

Finally, someone wanting to control knotweed should understand that:

- **A disposal plan for all knotweed material is a must**; otherwise a new colony will just sprout somewhere else. This might include burning the material, burying it more than 6 ft. deep or letting it completely dry out.
- **Most treatments require multiple applications**. A one-time cutting or mowing of knotweed will not do anything besides stunt it temporarily and cause the rhizomes to extend underground faster towards more nutrients, possibly causing a higher rate of spread.
- **Revegetation with native species after treatment is necessary.** Leaving bare ground only promotes the reinvasion of knotweed. Rapid-growing, native trees and shrubs must be planted soon after removing knotweed in order to affect the most beneficial change.

Below are various treatment prescriptions depending on size of the knotweed stand, its proximity to a waterway and amount of surrounding vegetation. Please note that where bare ground exists after removing knotweed stems and roots, it is essential to revegetate the area with competitive (fast-growing) native trees and shrubs. This is especially critical if surrounding vegetation is limited or nonexistent. Otherwise reestablishment of knotweed is likely and control efforts are futile.

For *small* stands (less than $3ft^2$):

  - Cover with dark plastic.
  - Frequent cutting, grubbing or pulling with safe disposal of knotweed stems.
  - Herbicide injection of stems. PLEASE READ HERBICIDE CAUTION BELOW.

For *medium* stands ($3ft^2$ to $25ft^2$):

  - Frequent mowing (do not allow cut material to leave site).

For *large* stands ($25ft^2$+):
In some cases, the extent of a knotweed colony is so extensive that more harm (e.g. damage to soils) would be done in trying to eliminate the entire stand. For this reason control of expansion is the appropriate action.

- Frequent mowing around edges of stand (do not allow cut material to leave site).
- Herbicide injection of stems in edges of stand. PLEASE READ HERBICIDE CAUTION BELOW.

Herbicide Caution: Glyphosate (e.g. Rodeo, Roundup, Aquamaster) is the recommended active agent. When used with care and according to product labels, this herbicide does NOT negatively affect *un*touched plants and animals. Using an injection method is the highest recommendation, because knotweed material is not cut therefore requiring no disposal. Also this method eliminates drift and targets only injected stems. Only certain herbicides, such as Rodeo and Aquamaster, should be used near a waterway. Please take care to wear appropriate protective equipment. Check with Cornell Cooperative Extension of Greene County at 518-622-9820 for information about the proper, safe and legal use of herbicides.

Assessment of the Current Condition of Riparian Vegetation

As part of the stream management planning process, physiognomic classes (e.g., deciduous open tree canopy, shrub land, herbaceous) were mapped and the riparian vegetation assessed for the East Kill watershed (methodology available in Appendix B). The purpose of this exercise was to provide the planning team with baseline information about communities present in the watershed, a description of the condition of vegetation in the riparian area, and to aid in the development of recommendations related to the management of riparian vegetation along the stream.

Mapping of Physiognomic Classes

Mapping of physiognomic classes was loosely based on the Vegetation Classification Standard produced by The Federal Geographic Data Committee. The mapping was based upon 2001 digital-ortho photos and confined to the riparian and near adjoining upland areas within 300 ft. of the mainstem of the East Kill. This classification was selected because it allows identification of locations, such as herbaceous or cobble deposits, where the

Riparian vegetation (closed mixed), protects stream banks and water quality, and provides habitat and food sources for fish and wildlife.

combination of channel morphology and riparian vegetation would indicate the greatest cost-benefit from riparian buffer plantings and bio-engineered bank stabilizations.

The mapping exercise included the approximate delineation of the classes through the photointerpretation of 2001 infra-red digital orthophotography acquired by New York State. A physiognomic class GIS data layer was created using heads-up digitizing techniques with ESRI's Arcview software. The photo interpretation was field checked with class boundaries, and classifications were amended based upon field observations. The vegetation map resulting from this process is folded and included in the back of this management plan.

Summary of Findings

According to this ripairan vegetation assessment, evergreen closed tree canopy (approximately 289 acres) and herbaceous (approximately 231 acres) were the largest physiognomic classes within the 300ft. buffer, while mixed closed tree canopy and deciduous closed tree canopy occupied approximately 206 acres and 167 acres respectively. This predominance of closed forest cover helps to provide a high degree of stability to the watershed. Forest cover slows storm runoff, and the stream banks in much of the watershed have some woody vegetation to protect against bank erosion. Protection of the forest communities near the stream will help ensure long-term stream stability, but the effectiveness of stream protection provided by vegetative communities, differs based on their width, plant density, vegetation type and the stream's geomorphic characteristics.

Although forested land covered a large portion of the watershed's riparian area, the extent of herbaceous cover is a concern. While herbaceous cover is better than no cover at all, plants with a variety of rooting depths (herbs, shrubs and trees) provide more extensive stream bank protection. Approximately 262 acres, or 21% of land area was considered to have inadequate vegetative cover; this included areas of herbaceous vegetation, bare soil and revetment. A streamside planting program is recommended to address these areas of inadequate vegetation.

Table 2.7.1 provides the results of the GIS vegetation assessment of the East Kill, including the area and percentage of each land cover type. Classes listed in italics contribute to the total area of inadequate vegetation.

Table 2.7.1. Summary of Physiognomic Vegetation Classification		
Vegetation Classification	**Area (acres)**	**Percent**
Bare Soil	28.10	2.22%
Deciduous Closed Tree Canopy	166.55	13.19%
Deciduous Open Tree Canopy	85.78	6.79%
Evergreen Closed Tree Canopy	288.96	22.88%
Evergreen Open Tree Canopy	19.90	1.58%
Herbaceous Vegetation	231.48	18.33%
Impervious Surface	28.63	2.27%
Mixed Closed Tree Canopy	205.57	16.28%
Mixed Open Tree Canopy	24.76	1.96%
Revetment	2.52	0.20%
Shrubland	93.22	7.38%
Unpaved Road	5.89	0.47%
Water	81.51	6.45%
Total Area	1262.87	
Inadequate Vegetation	262.09	20.75%

Riparian ecosystems are an important component of watershed protection and resource conservation. Therefore, it is important to maintain and improve the riparian vegetation along the East Kill and its' tributaries.

East Kill Streamside Planting

A streamside planting program is recommended for the East Kill. The findings from the mapping of physiognomic classes can be used to identify candidate stream reaches for inclusion in future streamside planting programs. There are three main steps to establish this type of program.

1. *Identify priority sites* using information gathered during riparian vegetation characterization analyses to identify potential planting sites where improvement of the riparian vegetation is likely to be both effective and successful.
2. *Develop treatment designs* for participating prioritized sites using primarily native plants that address landowner aesthetics, ecological enhancement and water quality improvement or protection.
3. *Install the designs* and document the planting process and results for program replication and general education/outreach.

To effectively carry out riparian planting projects, it is necessary to develop objective physical criteria for identifying and prioritizing eroding banks that may be stabilized with riparian vegetation plantings. It is also important to coordinate with streamside landowners by canvassing riparian landowners whose properties meet these objective criteria for their interest in participating in a project, and establishing a partnership with interested landowners. Technical assistance may then be provided to landowners to reestablish the riparian buffer on their property with native vegetation. GCSWCD and NYCDEP will be piloting such a project in 2007.

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