~ 5. Riparian Vegetation ~

Riparian vegetation plays a crucial role in stream health, and thus is important to sound stream stewardship and management. This section discusses riparian vegetation in terms of general ecology, forest history of the East Branch Delaware River basin, natural and human disturbances, and the effects of invasive plants on riparian vegetation. A separate subsection focuses particularly Japanese knotweed (*Fallopia japonica*), an ecologically harmful invasive plant that has gained a significant foothold in the watershed.

General Concepts of Riparian Vegetation Ecology

Riparian vegetation provides numerous benefits to water quality, aquatic and terrestrial plants and animals, and local landowners. Vegetated *riparian zones, also frequently referred to as riparian buffers,* facilitate stream bank stability by providing root structure to protect against bank erosion and flood damage. Riparian vegetation buffers the stream against non point source pollution, such as nutrient and sediment runoff, and the adverse impacts of human activities. Streamside forests and shrublands also provide food and shelter for aquatic and upland wildlife, and moderate fluctuations in stream temperature. Streamside vegetation also improves the aesthetic quality of the riparian landscape.

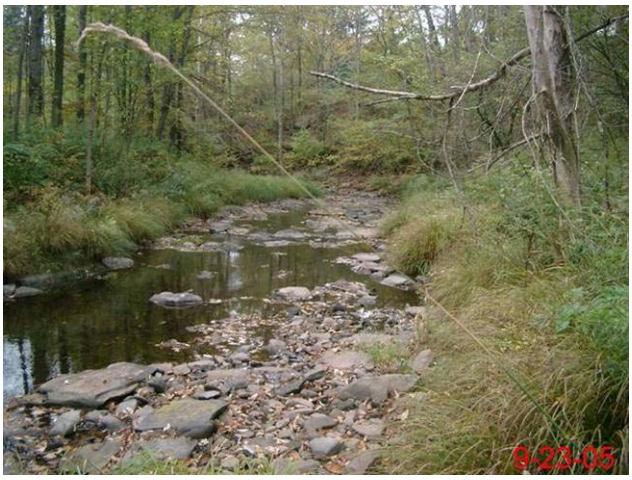


Figure 5.1 A Healthy Riparian Community

The extent of benefits of a riparian buffer is proportional to the width of the riparian zone and its species diversity. For example, a narrow 25 foot buffer zone may offer only bank stabilization as a benefit while a buffer over 200 feet wide includes a diverse range of water quality and ecological benefits. A buffer containing a diverse community of plant species and forms (trees, shrubs, grasses and forbs) offers the best protection **(Figure 5.1)**. A buffer composed of a diverse mix of native species of different ages - including adequate regeneration - will function better than a community dominated by only one or two species. Diverse native plant communities are better suited to the local growing conditions, provide great occupation of the rooting zone and have the ability to resist or recover from disturbance, such as flooding, disease or pest outbreaks.

The riparian forest community can be more extensive where a floodplain exists and valley walls are gently sloping. Where valley side slopes are steeper, the riparian community may occupy only a narrow corridor along a stream and quickly transition to an upland forest community. Soils, ground water and solar aspect may create conditions allowing the riparian forest species to occupy steeper slopes along a stream, as in the case

where Eastern hemlock (*Tsuga canadensis*) which commonly inhabits steep, north facing slopes along a watercourse.

Changes in the composition, vigor and density of riparian vegetation produce corresponding changes in rooting depth and density, shading, water temperature, physical protection from bank erosion processes, terrestrial insect habitat and contribution of detritus to the channel. The decline or destruction of the riparian vegetation generally results in the destabilization of the stream system. The loss of vegetation opens the system up to the potential for radical channel adjustments which cause bank erosion, sedimentation, and the degradation of aquatic habitat. Eventually the stream alignment may change and problem may migrate up or down stream to other landowners (Rosgen, 1996).

Previous stream management planning efforts in neighboring watersheds have undertaken a riparian land cover mapping exercise designed to provide more accurate information on the extent of each land cover within the stream corridor. This exercise was delayed for this basin and will be initiated as a follow-up activity for the watershed. The results of this effort will be instrumental in prioritizing riparian buffer protection efforts. Information is available within this plan on the average width of the riparian buffer for each management unit discussed in the Stream Assessment Section.

Natural Disturbance and its Effects on Riparian Vegetation

Natural disturbances can greatly affect the vigor of riparian vegetation. These disturbances include floods, ice or debris 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 vegetation due to their specific browse preferences.

The effect of flooding on healthy streamside vegetation is generally short term and the recovery/ disturbance regime can be cyclical. Following a large flood, the channel and adjacent floodplains can be littered with everything from woody debris to downed live trees. In following years, much of the vegetation recovers. Trees and shrubs flattened by floodwaters re-establish their form. In stable streams, gravel bars and sites disturbed in previous flood events become seedbeds for natural regeneration of grasses and forbs. However, if significant flood or ice floe events occur too frequently to allow adequate vegetation re-establishment, large trees do not have the opportunity to establish.

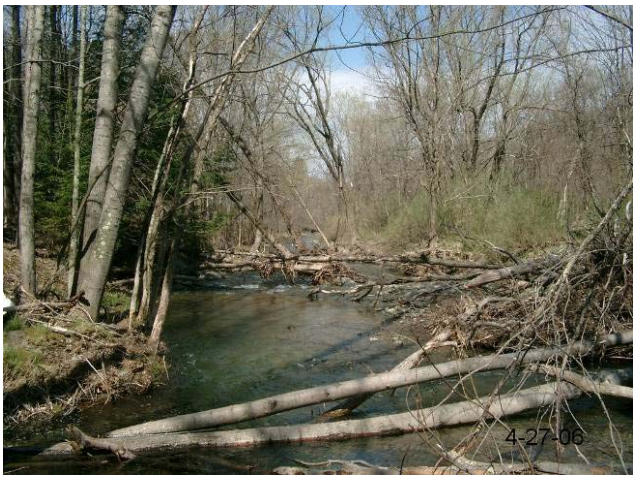


Figure 5.2 Channel-wide Debris Jam

Springtime ice break-up, like floods, can damage established vegetation along streambanks and increase mortality of young tree and shrub regeneration. Ice floes can also cause channel blockages **(Figure 5.2)**, which result in erosion and scour associated with high flow channels and over-bank flow. This type of disturbance generally has a short recovery period.

When stream managers seek to expedite or augment the recovery process, the following local geology and stream morphology factors are important to consider before attempting restoration: hydraulics of flowing water, morphological evolution of the stream channel, geology of the streambank, and the requirements and growth capabilities of vegetation.

Pests and diseases that attack vegetation also impact the riparian area. In portions of the eastern United States, the hemlock wooly adelgid (*Adelges tsugae*) attacks eastern hemlock and can ravage a stand. Currently, the adelgid is known to exist in 20 counties in New York State[19], including a population in the Town of Middletown[20]. According to the NYSDEC Region 4 Forester, the adelgid has migrated from Ulster County. Natural resource managers are aware of its potential to expand its impacted range.

Forest Land Cover

Catskill region forests have evolved since the last ice age, reflecting changes in climate, competition and human land use. As ice melted, plants adapted to warmer temperatures and migrated north, replacing species with a colder climate preference. The forests of the East Branch Delaware basin gradually re-established and evolved from boreal spruce-fir dominated forests (examples of which can presently be found in Canada) to maple-beech-birch forests (typical northern hardwood forests of the Adirondacks and northern New England) with a final transition in some areas to oak-hickory-ash dominated southern hardwood forests typical of the northern Appalachians (Kudish, 2000). The forests of the western Catskills and East Branch of the Delaware River basin are the eastern most extension of the Allegany Highlands forests, a broadleaf, temperate, mixed forest ecozone. The pre-settlement forests in this ecozone consisted largely of American beech (*Fagus grandifolia*) and Eastern hemlock (*Tsuga canadensis*). Sugar maple (*Acer saccharum*) later replaced hemlock as a major component of the forest on drier sites as fire controlled hemlock. Red maple (*Acer rubrum*), white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), yellow birch (*Betula alleghaniensis*) and black birch (*Betula lenta*) were and continue to be associates of the beech-maple and beech-hemlock forests. Eastern white pine (*Pinus strobus*) established nearly pure stands after fire or wind impacted the previous stands. One of the earliest recorded natural disturbances was the March 20th blowdown in 1797. Regional high winds felled trees around Delaware and surrounding counties (Kudish, 2000). There have also been several significant floods that have altered the landscape over the years. Hemlock has remained an important species in riparian forests along the north facing slopes of the East Branch Delaware River. Because of its dense overstory and allelopathic characteristics, hemlock may have been

[19] NYS DEC website - http://www.dec.ny.gov/animals/7250.html (verified September 27, 2007).
[20] Email from NYS DEC Regional Forester, Stamford, New York, dated May 7, 2007.

able to preserve its dominance by regulating the diversity and abundance of ground cover vegetation in riparian zones (Williams and Moriarity, 1999).

The activities of people have affected forests through manipulation of regeneration for desirable species maintenance, exploitation for wood and wood products and through clearing for development. Native American land management practices included the use of prescribed burning as a means of enabling nut bearing oaks to remain dominant in the forest. In response to a rising industrial economy, European settlers altered the landscape and forest cover through land clearing for agriculture, harvesting for construction materials, and hemlock bark harvesting for tannin extraction. These activities may have allowed the migration of some southern hardwood species (e.g. American sycamore (*Platanus occidentalis*) and shagbark hickory (*Carya ovata*)). Land cover in the basin began to revert back to forest with the local collapse of these economies in the 20th century (Kudish, 2000).

Continued evolution of the forest cover should be anticipated with changes in climate. Although the expected increase in rainfall predicted Catskills by global change scientists (see Volume 1 – Climate on page 4) will continue to support a moist-temperate forest cover, the potential for more frequent summer droughts and warmer average temperatures may lead to an accelerated loss of sugar maples and coincided with an increased presence of southern species such as oak and hickory. Additionally, the continued invasion of exotic species in the woodland may be exacerbated with further climate change.

Invasive Plants and Riparian Vegetation

Sometimes attempts to beautify a property with new and different plants will introduce a plant that aggressively spreads out of control. These "invasive" plants present a threat when they alter the ecology of the native plant community. Their impact may even alter the landscape should the invasive plant destabilize the geomorphology of the watershed (Malanson, 1993). Japanese knotweed, an invasive plant gaining a foothold in the East Branch basin, is an example of a plant capable of causing such a disruption. Although others exist, additional invasive plants of note along the East Branch corridor include common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*) and garlic mustard (*Alliaria petiolata*)[21].

All three of these plants are not native to the United States and are termed "exotic species". Because exotic species are often transported without the associated plants and animals that normally keep them in check, they can become *invasive* species. Invasive species earn this categorization by out-competing local, native species and may alter the ecosystem and its functions. Invasive plants can often survive under less than perfect conditions – from high and low soil pH levels, full sun to much shade, or wet to dry soils. The following text briefly describes common reed and purple loosestrife, followed by an in-depth description of Japanese knotweed, its traits as an invasive species, what people can do about it and resources for additional information.

[21] The Nature Conservancy, 2006

It should be noted that only a cursory plant inventory was taken by staff working on this plan and that the northern bounds of The Nature Conservancy study was New York State Route 28 and the Pepacton Reservoir. It is reasonable to assume that these species also inhabit parts of the East Branch watershed north of this demarcation but further study will be required to validate this.

Common Reed

Common reed is a large grass native to wetland sites throughout temperate and tropical regions of the world. It is generally regarded as the sole species of the genus *Phragmites*, though some botanists divide the genus into three or four species.

Figure 5.3 *Phragmites australis*

It commonly forms extensive stands, up to a square kilometre or more (known as reedbeds); where conditions are suitable, it can spread at up to 5 m or more per year by horizontal 'runner' stems, which put down roots at regular intervals. The erect stems grow to 2–6 m tall, with the taller plants growing in areas with hot summers and fertile growing conditions. The leaves are broad for a grass, 20–50 cm long and 2–3 cm broad. The flowers are produced in a dense, dark purple panicle 20–50 cm long.

Common Reed is a very important plant for wildlife and conservation, particularly in Europe and Asia, where several species of birds are strongly tied to large *Phragmites* stands[22]. Common reed can occur in undisturbed habitats, but is most common in roadside ditches, disturbed wetlands and disturbed soil. It can reproduce vegetatively and from seed. Once a new population takes hold, it spreads vegetatively, forming dense monolithic stands, changing vegetation structure, composition, and altering wildlife habitat (paraphrased)[23].

Purple Loosestrife

Purple loosestrife is native to Eurasia and was introduced to the northeastern United States and Canada in the 1800's for ornamental and medicinal uses. It is still widely sold as an ornamental. Purple loosestrife adapts readily to natural and disturbed areas and is capable of invading wetlands, river and stream banks, pond edges, reservoirs and ditches. Under favorable conditions, loosestrife is able to rapidly establish and replace native

Figure 5.4 Purple Loosestrife

[22] http://en.wikipedia.org/wiki/Common_reed, (verified May 16, 2007)
[23] The Nature Conservancy, 2006

vegetation with a dense, homogenous stand that reduces local biodiversity, endangers rare species, and provides little value to wildlife.

Small infestations of purple loosestrife plants may be pulled by hand, preferably before seed set. For older plants, spot treatment with a glyphosate herbicide may be effective. Biological control using USDA approved beetle species is probably the most effective method for long-term control of large infestations[24].

Garlic Mustard

Figure 5.5 Garlic Mustard

Garlic mustard is an herbaceous biennial native to Europe, Asia and other parts of the world but invasive in North America. A single plant can produce hundreds of seeds, which scatter as much as several meters from the parent plant. Depending upon conditions, garlic mustard flowers either self-fertilize or are cross-pollinated by a variety of insects [25].

It can tolerate a wide range of moisture and light levels, invading a forest understories and out-competing native vegetation. The rapid spread of garlic mustard is primarily associated with small scale disturbances that expose mineral soil. Its importance to stream corridor management is that it has been found in high densities on floodplains where flood disturbance is frequent, out-competing some native plants[26].

Other Invasive Species

Other invasive species noted in The Nature Conservancy study that have potential to occur in Catskill Mountains forest ecosystems include: Norway maple (*Acer platanoides*), Japanese barberry (*Berberis thunbergii*), Asiatic bittersweet (*Celastrus orbiculatus*), autumn olive (*Elaeagnus umbellata*), bush honeysuckle (*Lonicera* spp.), buckthorn (*Rhamnus spp.*), multiflora rose (*Rosa multiflora*), and black swallow-wort (*Vincetoxicum nigrum*)[27]. Their impact on stream corridor management has not been evaluated.

[24] National Park Service, 2004
[25] http://en.wikipedia.org/wiki/Garlic_Mustard (verified September 27, 2007)
[26] The Nature Conservancy, 2006
[27] Ibid, page iv.

Japanese Knotweed

A plant whose presence within the Catskill region has become much more prevalent in the last few years, Japanese knotweed (*Fallopia japonica*) is an invasive plant that is often referred to by Catskill residents as bamboo or Japanese bamboo. Although bamboo and Japanese knotweed are two different plants, they do have a couple of similarities. Both have tall, hollow stems, but more importantly, neither belong in the United States. As implied by its name, Japanese knotweed originates from Asia. This categorizes knotweed as an *exotic* plant, one that evolved in another area of the world with different plants and animals.

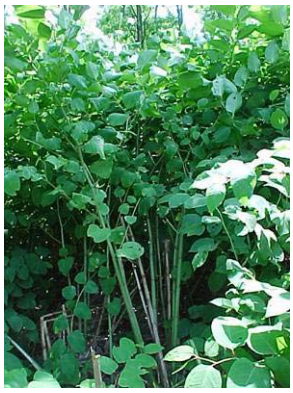
Figure 5.6 Japanese Knotweed in the Town of Halcott, June 2006

Characteristics of Japanese knotweed

Fortunately, Japanese knotweed is quite recognizable throughout the year. The photographs to the left 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 as tall as 11 feet. Many thick, hollow stems are based at a crown. The upper areas of the stems form a few branches that reach out like an umbrella from the crown. Each mainstem and branch holds several large, nearly-triangular leaves that shade out most of summer's sunlight.



In August knotweed dons abundant clusters of small, white flowers that attract several pollinators, such as bees, wasps and Japanese beetles.

The numerous flowers turn into buckwheat-like seeds by late September, early October. Although some seeds may create small seedlings, 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.

Problems associated with Japanese knotweed

As previously mentioned, knotweed is an exotic, invasive species. Some texts explain that knotweed was brought to Great Britain as early as 1825 where it won accolades as an ornamental plant. By the late 1800s immigrants to the United States brought their prized garden plant. Knotweed has escaped personal gardens and spread into lawns, farm fields (**Figure 5.7**), along roadsides and railroads, along streambanks and onto floodplains. It is found in five Canadian provinces and all but ten states in the US.

Figure 5.7 Knotweed Growing Amongst Corn

Knotweed spreads vegetatively from portions of the roots or shoots. This vegetative propagation characteristic explains how it has expanded into such a wide variety of environments. The rhizomes begin new colonies of knotweed by spreading up to 20 feet from an existing plant. For this reason people may transport knotweed unknowingly by digging up rhizome-contaminated soils and dumping them elsewhere. Even a very small piece of this rhizome can sprout a new plant.

When kept moist, other plant parts, such as the stem, can also sprout new plants. Stems and rhizomes float downstream after breaking off from floods (knotweed is actually a very brittle plant and breaks easily) or from beaver damage. These fragments then come into contact with disturbed or eroded soils lacking vegetation and begin more new colonies. This is why streams host such dense stands of knotweed.

Knotweed can also be unwittingly introduced to new areas by highway departments and contractors through soil transported from gravel and sand pits contaminated with knotweed. *Stream assessment* teams have noted several instances where knotweed stands have developed in the new soil where a *culvert* or bridge has been renovated. Once established near the waterway, the knotweed is able to spread downstream after disturbance associated with a storm event.

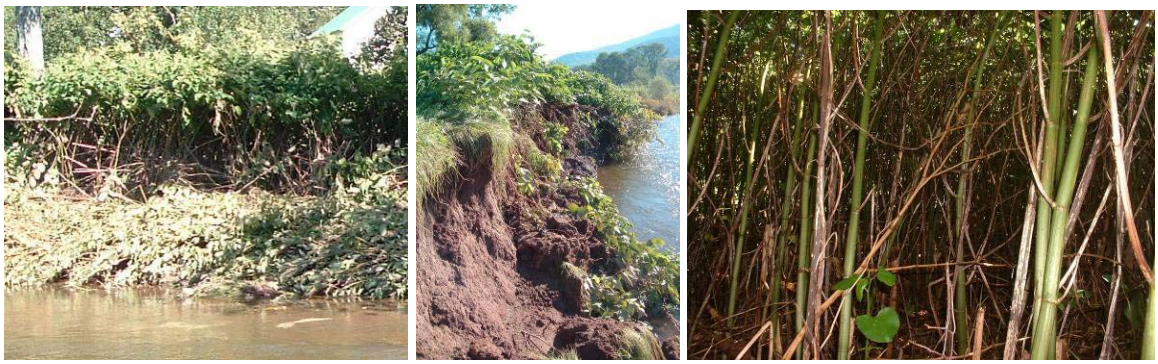


Figure 5.8 From left to right:
Knotweed flattened by a high flow event
A stream bank *slump* where only grass and knotweed bordered the streambank
The shade created by the dense canopy of broad knotweed leaves.

Why is this rapid invasion such a concern? Knotweed's traits pose a broad array of 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 (**Figure 5.8**).
- 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 (**Figure 5.8**).
- 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.

In spring 2005, a group of concerned people recognized that Japanese knotweed was starting to invade the headwaters of the Bush Kill sub-basin. Working together with Delaware County Soil and Water Conservation District SCMPr staff, the group found a demonstration project site on West Settlement Creek tributary at the intersection of Greene County Route 3 and Greene County Route 1. There are few knotweed patches along Vly Creek and this site was a good candidate for a project. The group has dubbed the project site "Knot-A-Lot". The research obtained from the demonstration project will be used for education and outreach to the local area in the hope to inspire community awareness and involvement for future projects.

What to know before treating knotweed

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

No knotweed is the best knotweed.

Preventing its spread is the best, most cost effective, and time efficient approach to take.

Prevention may be in the form of:

1). Telling others about knotweed and warning them of its associated problems
2). Keeping stream banks stable by allowing native trees and shrubs to grow
3). Testing transported soil and sources for any knotweed colonies and plant fragments

Unfortunately, the East Branch Delaware River has a knotweed problem and some level of treatment is necessary. 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 above questions, 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 except stunt it temporarily and cause the rhizomes to extend underground faster towards more nutrients, possibly causing a higher rate of spread. Be prepared to make follow-up visits to past treatment sites to ensure complete control of knotweed.
- Re-vegetation 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.

What to do about knotweed

Getting involved is as simple as 1, 2, 3:

1. Check your property. Locate any knotweed or areas of bare soil to know where you may need to remove knotweed or add more native trees or shrubs.
2. Become informed & spread the word. Since knotweed can travel anywhere, via stream or dump truck, let your neighbors know about it. *Spread the word, not the weed.*
3. Ask for help. Contact the Delaware County Soil & Water Conservation District for assistance with assessment or control.

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 re-vegetate 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 may be 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 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 CAUTION BELOW**.

Herbicide Caution: Glyphosate (e.g. Rodeo, Roundup, and 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 highly recommended, 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, can be safely used near a waterway.

Please take care to wear appropriate protective equipment. Check with Cornell Cooperative Extension of Delaware County at (607) 865-6531 for information about the proper, safe and legal use of herbicides.

Delaware River, Delaware & Sullivan Counties
The Delaware River Invasive Plant Partnership (DRIPP) was formed to increase public awareness and understanding of invasive plants and their impacts, facilitate the exchange of information regarding invasive plant management, and help coordinate public and private efforts to control these weeds in the Delaware River watershed. Recently the director of DRIPP, in partnership with the National Park Service, established a Knotweed Initiative working group that meets periodically to coordinate efforts to address knotweed management.

Catskill Region, Delaware, Greene, Sullivan & Ulster Counties
Through matching funds from the WAC Forestry Program, The Nature Conservancy's Catskill Mountain Chapter began a study in summer 2004 of the distribution of nine exotic, invasive species, including Japanese knotweed, in seven forest matrix blocks in the Catskills – Beaverkill, Cannonsville, Panther Mountain, Sugarloaf, Catskill Escarpment, Westkill and Bear Pen Vly.

Catskill Regional Invasive Species Partnership
The Catskill Regional Invasive Species Partnership (CRISP), formed following the rise in interest from numerous groups and agencies within the region about the issues related to invasive species. CRISP is a voluntary, cooperative partnership that promotes prevention, early detection and rapid response, and in limited areas/cases, broader control of invasive species to protect natural resources. In addition to conducting public outreach and management activities, CRISP seeks to support research about ecological impact and effective controls of invasive species. The Catskills Streams (see table below) website contains a link to contact information and a membership form for the group.

Resources for more information

While scientists and resource managers throughout the U.S. and the United Kingdom are conducting useful research and experiments on knotweed, various agencies within the Catskill region are making their own efforts to address this problem plant. Learning from the experience of others has greatly informed the above text and will continue to inform future practices. **Table 5.1** below shows summaries of these local efforts, including contact information.

Table 5.1 Regional Agencies and Organizations for Additional Information (Verified September 27, 2007)

Regional Agencies & Organizations		
Catskill Regional Invasive Species Partnership CRISP		http://www.catskillstreams.org/stewardship_streamside_is.html
NYCDEP Stream Management Program	845-340-7515	http://www.ci.nyc.ny.us/html/dep/watershed/html/streams.html
Greene County Soil & Water Conservation District	518-622-3620	www.gcswcd.com
Hudsonia, Ltd.	845-758-7053	www.hudsonia.org
Delaware River Invasive Plant Partnership (DRIPP)	570-643-7922 x12	http://www.paflora.org/DRIPP%20Brochure%202004.pdf
Adirondack Park Invasive Plant Partnership (APIPP)	518-576-2082 x 131	http://www.adkinvasives.com/terrestrial/Program/Program.html
The Nature Conservancy-Catskill Mountain Program	845-586-1002	
National Park Service-Upper Delaware Scenic & Recreational River	570-729-7842	
Other Japanese Knotweed resources		
The Nature Conservancy-UC Davis		http://tncweeds.ucdavis.edu/esadocs/polycusp.html
The Nature Conservancy-Oregon	503-230-1221	http://tncweeds.ucdavis.edu/success/or002.html
The Knotweed Page		http://www.knottybits.com/Knotweed/
Japanese Knotweed Control Forum of Cornwall		http://www.ex.ac.uk/knotweed
The Invasive Plant Council of New York State	518-271-0346	http://www.ipcnys.org/default.aspx