Ohio River Pools 1, 2, and 3
Botany Report

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3 Rivers 2nd Nature
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Abstract

In 2003, the Ohio River was the focus of the data collection effort. The length of the river studies were divided into one-tenth of a mile segments. Sampling locations were located through a hand-held GPS unit. As in 2001, we focused on determining the presence and relative abundance of the woody vegetation because they are diagnostic of plant community types. When present, emergent woody and herbaceous aquatic vegetation was also recorded. Our primary survey method of the riverbank woody vegetation involved scanning the riverbank from the 3R2N vessel. We surveyed all woody vegetation from the shoreline to approximately twenty feet back from the river edge.

As in the last three year's studies, additional data on non-woody species was collected for a small number of species or plant functional groups. Three of these plants were mapped and geo-referenced: Justicia americana, the water willow, a useful indicator species; Iris psuedacorus, the yellow iris, a plant of special concern; and Lythrum salicaria or purple loosestrife, an invasive species. This baseline data can be used to monitor spread or decline of these species in the future.

Justicia americana (water willow) is a native aquatic species found along edges of lakes, ponds, and streams. It usually indicates a healthy and intact riparian zone and is the dominant member of the Waterwillow - Smartweed Community. Iris pseudacorus (yellow iris) is an introduced species also found along edges of lakes, ponds, and streams. I. pseudacorus was often found growing near acid mine drainage in the Monogahela pools studied in 2001. Lythrum salicaria (purple loose-strife) is a highly invasive species that was introduced to the United States from Europe. Here it is co-occuring with the native floodplain species Lobelia cardinalis(cardinal flower). It is found in scattered areas along our Pittsburgh Rivers and can be closely monitored for spread using this geo-referenced system.

Conclusions

- Four native woody plant communities and one native herbaceous plant community typical of large rivers in North America are found along the Monongahela River, Allegheny Rivers, and Ohio River.
- Although the same communities can be found along the Monongahela and Allegheny Rivers, the two rivers differ in which native communities are most common.
- Including Japanese knotweed, introduced species comprise 17-18% of woody plants along all three rivers. However, a lower proportion of those are both introduced and invasive.
- The frequency of invasive species decreases with distance from Point State Park on both the Allegheny and Monongahela Rivers, suggesting that human disturbance may be facilitating invasion or maintenance of invasive species once introduced.

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I. Introduction

"Seventy-seven percent of the total water discharge of the 139 largest river systems in North America north of Mexico, in Europe, and in the republics of the former Soviet Union is strongly or moderately affected by fragmentation of the river channels by dams and by water regulation resulting from reservoir operation, interbasin diversion, and irrigation. The remaining free-flowing large river systems are relatively small and nearly all situated in the far north, as are the 59 medium-sized river systems of Norway, Sweden, Finland, and Denmark. These conditions indicate that many types of river ecosystems have been lost and that the populations of many riverine species have become highly fragmented. To improve the conservation of biodiversity and the sustainable use of biological resources, immediate action is called for to create an international preservation network of free-flowing river systems and to rehabilitate exploited rivers in areas that lack unaffected watercourses." (Dynesius and Nilsson. 1994. Science 266: 753-762)

Statement of Purpose

Anthropogenic activities that alter the integrity of habitats, such as fragmentation or disturbance, pose challenges to the persistence of native species and favor invasive species. Invasive species are recognized as one of the greatest threats to global biodiversity (Williamson, 1996, Vitousek et al, 1997) and can incure severe and large economic costs (OTA, 1993, Pimentel et al, 2000, Leung et al, 2002). Long-standing disturbance of the river and riverbank creates conditions that both diminish the local native biodiversity in the plant community and can foster the invasion of non-native plant species (e.g. Gilvear et al., 2000). Both of these factors can diminish ecosystem health. Maintenance of biodiversity is important because high levels of biodiversity have been shown to enhance the reliability of ecosystems in terms of primary productivity (Naeem and Li, 1997). Biodiversity within the plant community also distributes functional diversity across multiple physical scales of the ecosystems, which allows for subsequent renewal and recovery after disturbance (Peterson et al, 1998), especially when habitats are fragmented. In addition, disturbances that cause declines in biodiversity have been shown to increase the invasibility of the community to non-native species (Tilman, 1999; Shea and Chesson 2002). Therefore, understanding the structure and composition of plant communities along rivers in the context of the management (disturbance) milieu is a key first step in maintaining and/or improving river function and health. The Botany Team's goal in the 3R2N project is to create a large-scale, spatially-referenced database of woody vegetation and selected herbaceous plants. This database will be used to determine the occurrence, integrity and spatial extent of native plant communities, and the frequency of invasive species within these plant communities, all in the context of human management of the Three Rivers. It is our goal that this knowledge will be used to inform land use planning decisions to ensure a sustainable river ecosystem that balances both the multi-uses of human and protects wildlife.

The Completed Goals for 2003

The first goal of the 2003 field season was to create a geo-referenced database of the riparian vegetation of the Ohio River. We sampled pool 2 and pool 3 downstream from the Allegheny County line. Due to inconsistencies of data-collection methodologies used in pool 1 in 2000, we also resurveyed pool 1, so that all datasets are now comparable. This was the fourth and final year of the vegetation survey, and this year's data completes the vegetation survey of the banks of the Monongahela, Allegheny and Ohio Rivers in Allegheny County. We merge all databases so that comparisons among plant communities and integrity of the banks of the Three Rivers can be made. Finally we aimed to synthesize the vegetative database with the geologic conditions database to create a more encompassing view of all bank conditions. We were able to identify the areas with the most natural bank conditions and riparian plant communities, as well as areas with slightly disturbed conditions that would be good candidates for restoration. Our data, in combination with the geological and hydrological databases as well as data on existing data on land use in the county will enable users of these databases to identify areas suitable for development or recreation, as well as those most in need of restoration and/or conservation.

II. Results and Discussion

The Ohio River Survey

As in previous years, we have identified all woody species and selected herbaceous species and estimated the abundance of each species at each 0.1mile survey segment along the both sides of 15.5 miles of the Ohio River (as well as the river islands within that stretch). All woody species occurring along the Ohio River banks are listed in Table 1. Percent abundances of each

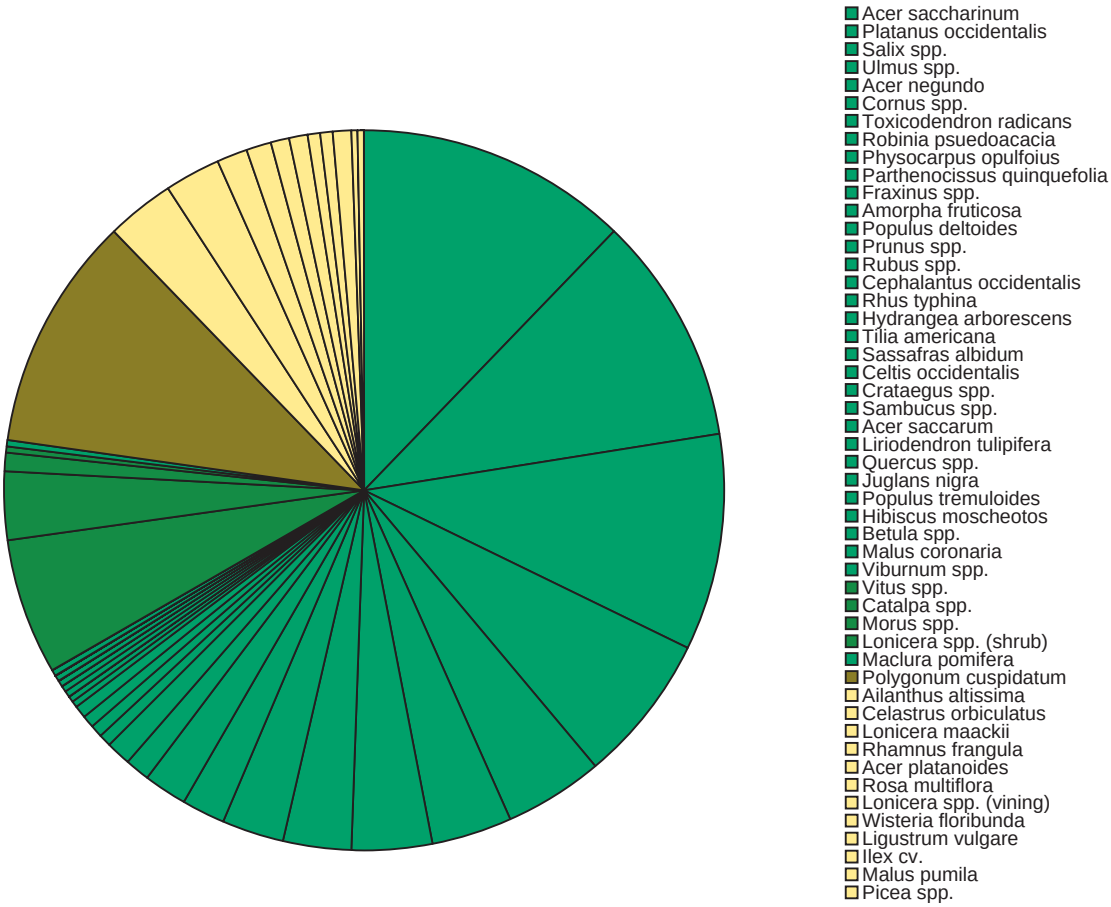

Figure 1.

Relative Abundance of Woody Species Along the Ohio River 2003.

Native species are most abundant.

species are presented in Figure 1. As in previous years, we present data on highly invasive, large herbaceous species found along the River as well (Appendix A). Data from each segment are geo-referenced using GIS technology, so that the database can be used to identify areas for potential restoration and to make other land management decisions. Although the species found along the Ohio River are commonly found along all three Rivers, the distribution of those species differs markedly among Rivers (Figure 2). In particular, the Ohio River has a higher frequency of invasive exotic species on it banks (see section below).

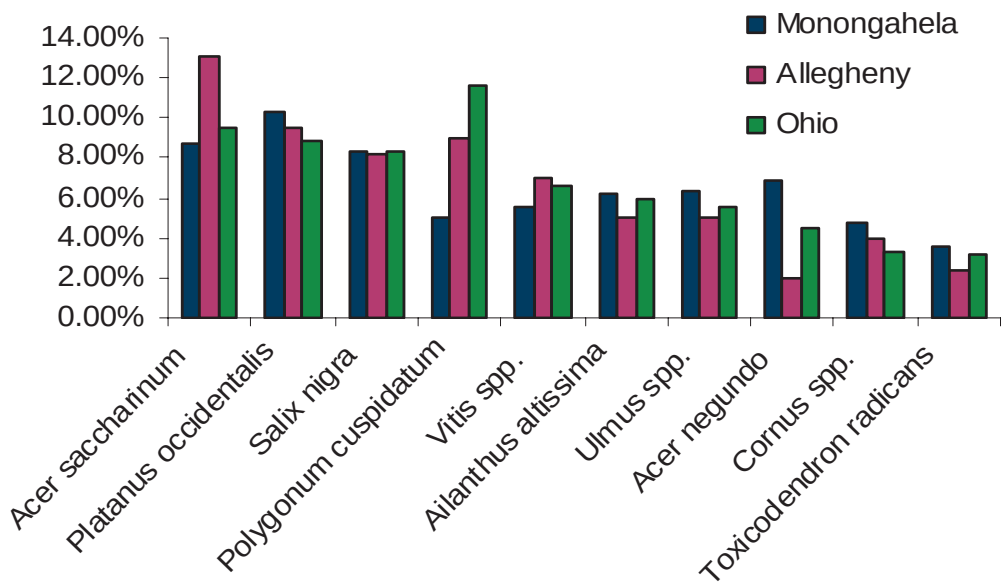

Figure 2.

Distribution of Commonly Found Species Along the Ohio River 2003

Synthesis: The Three Rivers Watershed is comprised of a River Bed – Bank – Floodplain Plant Community Complex

Fike (1999) describes the species that occur in typical native plant community complexes in Pennsylvania. (Note: Plant communities are cross-listed by the Nature Conservancy's International Vegetation Classification and the Society of American Foresters' Cover Types.) The River Bed – Bank – Floodplain Complex (RBBFC) is a mosaic of forest, shrub woodland, grassland, partially vegetated gravel and sandbar communities found in association with major rivers. These often transition into or coincide, with no distinct boundaries, due to the temporal variation of bank conditions (e.g. high water levels during flooding and low levels during drought) and the grading of riverbanks.

We found five of the eight riverine communities described by Fike in the riparian zone of our three rivers: Sycamore – Box-elder Floodplain Forest, Silver Maple Floodplain Forest, Black Willow Scrub/Shrub Wetland, Alder – Ninebark Wetland, and Water Willow – Smartweed River Bed Community. The compositions of these plant communities are described in Appendix A. The distributions of all community types are mapped in Figures 3-7.

Sycamore – Box-elder and Silver Maple Floodplain forests are both hardwood floodplain forests, which are rare, due to the human use, especially by industry, of floodplain areas. The Pennsylvania DCNR categorizes all hardwood floodplain forests in Pennsylvania as imperiled. The Three Rivers Watershed supports large areas of intact forests of these types (see Figures 3 and 4), which should be recognized as imperiled ecosystems that are in need of conservation efforts. We highly recommend intervention in these forest types where exotic plant invasion or human disturbance threatens these communities.

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All of these communities except for the Water Willow – Smartweed River Bed Community are found along the Ohio Riverbanks. Sycamore – Box-elder Floodplain Forests are more prevalent in Pool 1 while Silver Maple Floodplains dominate the downstream portion of the Ohio River. Black Willow Scrub/Shrub Wetlands are found scattered along all portions of the Ohio River. Alder – Ninebark Wetland is rare along the Ohio River, and was found in only three small areas in Pool 1 of the Ohio River. The absence of Water Willow – Smartweed River Bed Community is probably due to the Ohio River's fast moving waters. The Ohio River lacks the silt deposits that are required for the establishment of the Water Willow community. Figure 9 depicts the distribution of all community types along the Ohio River.

Invasive Plant Species in the Three Rivers Watershed

One of the leading threats to our native plant communities is invasive species (Ludsin and Wolfe 2001). "An "invasive species" is defined as a species that is 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. (Executive Order 13112). Invasive species can be plants, animals, and other organisms (e.g., microbes). Human actions are the primary means of invasive species introductions." (http://www.invasivespecies.gov) Typically, they are more able to invade a disturbed area than a stable environment. The high level of natural disturbance due to flooding along riverbanks has been proposed to make them more susceptible to invasion of non-native species. However, a recent study that compared North American and Scandinavian rivers of the same latitude had similar plant diversity along their banks (Dynesius 2004). However, the studied rivers in North America had 9% invasive plant species among the bank vegetation, while no invasive plant species were found along the Scandinavian rivers studied. The authors attribute this difference to the fact that the European exotics found along the North American rivers were due to human transport of these species. By contrast, Pittsburgh's longstanding industrial use of its riverbanks and the disturbances associated with that use makes the Three Rivers riparian zones extremely vulnerable to invasive species.

Our data from 2003 indicate that introduced species comprise 23.0 % of woody vegetation* of the Ohio River banks in Allegheny County. Of these introduced species, the invasives are the Norway maple (*Acer platanoides*), tree of heaven (*Ailanthus altissima*), barberry (*Berberis thunbergii*), oriental bittersweet (*Celastrus orbiculatus*), glossy buckthorn (*Rhamnus frangula*), and multiflora rose (*Rosa Multiflora*). These invasive species comprise 19.7% of the Ohio River's total vegetative cover (Table 2).

Overall the Ohio River has the highest abundance of exotic species of all three Rivers—significantly more exotics than the Allegheny (19.4%), and the Monongahela (17.9%) . This exact reason for this difference is unknown, but is likely that the high level of human activity and industrial development along the section of the Ohio River in Allegheny County contributes to this situation.

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Knowledge of the distribution and the rate of spread of invasive species are crucial to the success of management strategies. We have mapped the occurrence of woody invasive species that are the most problematic in the three rivers, tree of heaven (*Ailanthus altissima*) and oriental bittersweet (*Celastrus orbiculatus*), as well as two herbaceous species that are particularly destructive waterway invaders, Japanese knotweed (*Polygonatum cuspidatum*) and purple loosestrife (*Lythrum salicari*) [Figures 9-12, respectively]. These maps can be used to monitor spread of these highly invasive species in the riparian zones of our three Rivers.
Japanese knotweed is the most abundant invader of the Rivers' plant communities. The few areas that have not been invaded should be carefully monitored to prevent it establishment at those sites. It is much easier to eradicate a newly developing stand than a stand that has become established (see 2002 report for details). Purple loosestrife does not appear to be supplanting native species in the Pittsburgh region at this time. However, because it is so problematic in other areas (Blossey 2001), it should also be carefully monitored.

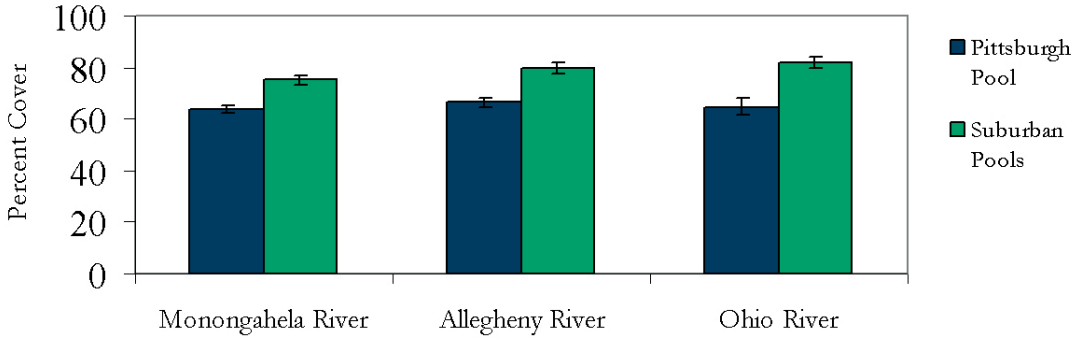
Vegetative Cover in Urban Pittsburgh

Our study shows a surprising high proportion of the Rivers' bank have vegetative cover within the city limits of Pittsburgh. As expected, there is less cover in the city limits than outside the city, but all three Rivers have more than 60% vegetative cover of their banks within the city of Pittsburgh limits (Figure 13). This high level of vegetation in an urban area is valuable, given the typical low proportion of green space in most urban areas (Hyun-Kil Jo 2001). Recent studies have generated interest and increasing awareness of the importance of urban green space. In addition to aesthetic value, it provides habitat for a wide range of wildlife (Jim 2003), removes pollutants from groundwater, especially storm water runoff, and removes fossil fuel combustion emissions from the air (McPherson 1998, Hyun-Kil 2001).

Although less vegetative cover overall was found in the Pittsburgh Pool (Pool 1), on average 62% of riparian land in the Pittsburgh Pool is covered with vegetation (Figure 13). Pools 2 and 3 are more highly vegetated, with an average of 79% vegetative cover. However, the makeup of the Pools' cover differs—on average, 76 % of the vegetation in the Pittsburgh Pool is woody and 83% of the vegetation in Pools 2 and 3 is woody. With the lower amount of woody cover in the Pittsburgh Pool, we recommend that this be conserved and areas without cover be replanted where possible, to stabilize the banks and act as filters for storm water runoff and to increase the aesthetic quality of the Rivers.

Figure 13.

Vegetative Cover In the Pittsburgh Pool versus the Suburban Pools



Recommendations for Preservation and Restoration:

The Three Rivers' banks support many obligate wetland species, as well as facultative wetland species. In Allegheny County's Three Rivers, three obligate wetland plant species occur, including black willow (*Salix nigra*), water willlow (*Justicia Americana*), and buttonbush (*Cephalanthus occidentalis*). Figure 14 identifies areas where these three obligate wetland species co-occur. The presence of obligate wetland species indicates that true wetland conditions still exist along the Rivers. Wetlands in the United States are protected by both the North American Wetlands Conservation Act (http://laws.fws.gov/lawsdigest/nawcact.html) and Section 404 of the Clean Water Act (http://www.epa.gov/owow/wetlands/vital/protection.html). The Clean Water Act defines wetland as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." (http://www.epa.gov/owow/wetlands/what/definitions.html).

We have queried the vegetation database and the geologic condition database to identify areas with both obligate wetland species elements and slope and soil conditions conducive to floodplain formation. These areas are indicated on the map on Figure 15. These uncommon areas likely qualify as wetlands and so may be protected by wetland preservation law.

We have also identified all areas along the survey area with hardwood floodplain forest communities (Figures 16.1, 16.2, 16.3). As discussed above, these forest types are globally threatened and should be preserved if at all possible. In order to preserve them, the forests must be protected from human development, and invasion by introduced species. We have separately mapped hardwood floodplain forest community areas that contain either high or low abundance of invasive species. Restoration efforts should be made in areas with high abundances of invasives. Japanese knotweed is likely the greatest threat in these areas due to its high local abundance and the thick understory growth. See Appendix B for recommended methods for removal and eradication of this species. We again queried the geologic condition database to find areas where hardwood floodplain elements in our database coincided with appropriate floodplain soil and slope conditions to locate the floodplain forest sites (see Figure 17). All efforts should be made to protect these rare floodplain forest remnant areas.

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III. Conclusions

- Five native Riverbed – Bank – Floodplain Plant Communities are found along the banks of Pittsburgh's Three Rivers: Sycamore – Box-elder Floodplain Forest, Silver Maple Floodplain Forest, Black Willow Scrub/Shrub Wetland, Alder – Ninebark Wetland, and Water Willow–Smartweed River Bed Community.

- The Ohio River supports four of five of the RBBFC types: it lacks the Water Willow – Smartweed Community type.

- The Three Rivers riparian zones support two hardwood floodplain forest types, the Sycamore–Box-elder Floodplain Forest and Silver Maple Floodplain Forest. Hardwood floodplain forests are globally rare and classified as threatened in Pennsylvania by the PA DCNR; therefore, these community types should be carefully protected.

- Native riparian plants of the Three Rivers watershed are threatened by the spread of aggressive, invasive species, specifically Japanese knotweed, tree of heaven, and oriental bittersweet.

- Of the three rivers, the Ohio River has a significantly greater proportion of introduced and invasive species relative to the other Rivers. The high abundance of introduced species is in the Ohio River is probably due to the extensive human disturbance of this River associated with industry.

- Pool 1, the Pittsburgh Pool, has significantly less vegetation than Pools 2 and 3, but still has on average 62% vegetative cover. This urban greenspace has important value to the city both economically and aesthetically.

- There is a lower abundance of woody plant species in Pool 1 than in outer pools. Because woody species are better at removing toxins and providing shade for aquatic species, the city would benefit from the recovery of woody species along the riverbanks.

- The Three Rivers supports areas with plant species and soil conditions indicative of wetland areas. These areas may be protected under the Clean Water Act.

- Hardwood floodplain communities are globally threatened. Hardwood floodplain communities have been identified using the combined elements of the vegetation and geological databases. Serious efforts should be made to secure and protect these rare communities.

IV. Field Methods for 2003

In 2003, pools one, two, and three of the Ohio River were the focus of the data collection effort. As in previous years, the length of the river studied was divided into one-tenth of a mile segments. Locations of sampling designated by GPS coordinates were located through a hand-held GPS unit. The Ohio River, as with the Allegheny and Monongahela rivers, rarely changed significantly between 0.1mile distances in pools 2 and 3, and we again sampled every other 0.1mile segment. Because of the spatial correlation in vegetation in adjacent segments, it is clear that sampling every other 0.1 mile segment provides sufficient detail to characterize the riverbank vegetation. Thus, we are able to accurately characterize the entire length of stream bank of pools two and three using this sampling scheme.

As in previous years of the study, we focused on determining the presence and relative abundances of the woody vegetation because they are diagnostic of plant community types (described below). When present, emergent woody and herbaceous aquatic vegetation was also recorded. Our primary method of surveying woody vegetation was to scan the riverbank from the 3R2N vessel. We surveyed all woody vegetation from the shoreline to approximately 20 ft from the river edge. This area encompasses the riparian zone. Because of the accessibility of the riverbank, we were usually able to collect data from within 30 feet of the shoreline in the boat and most identifications were easily made using binoculars. If closer examination was required to make an unambiguous identification, we went on shore, made observations from land, and either identified the plant(s) on-site or took a sample of the plant for later identification in our lab.

All raw data was recorded on data sheets (currently housed in binders in Kalisz's lab). The data was later entered into both an excel spreadsheet for data analysis and into MS Access to create a geo-referenced database using GIS.

Data Collection and Definition of Variables:

At each segment, each woody species was identified and each species identified was given an abundance rating from 1 to 4, denoting the percent of the total sample area covered by that species where the total sample area = [(0.1 mile X 20 ft.); not a percent of the vegetated area alone]. The scale for **percent cover** used is:

1 = ‹5% of the area
2 = 5-15%
3 = 16-40%
4 = ›40%

Estimates of total percent cover and percent composition of woody plants was taken at <u>every</u> 0.1 mile segment, including the segments not surveyed in detail. Taking this data at every segment would have revealed any large break in continuity that surveying every other segment

might have missed. Percent composition of exotic woody plants was estimated at every other segment.

A rating of **continuity** was also given to every 0.1 mile segment, again in order to reveal any large break in continuity that might have been missed by surveying every other segment. Each segment was given a rating from 1 to 7, with 1 being not continuous and 7 being completely continuous. (See R. Goto for photo examples of these ratings.)

Management type was recorded at the same locations in which we collected detailed vegetation data. The management type of every area was noted as one of four types: industrial, managed, semi-managed, not managed. Definitions of the four management types are:

1. **Industrial areas** are the areas where plant growth was inhibited by industry. These are the areas most impacted by humans.
2. **Managed areas** are areas where plant growth is directly controlled by humans (as in recreation areas or private homes).
3. **Semi-managed** areas are areas showing some human impact or control. Examples of these areas are areas around railroad beds and power-lines through relatively natural areas.
4. **Unmanaged areas** are those that showed no current, readily perceptible impact or control by humans, although those effects may have occurred in the past .

For the segments surveyed in detail, we also recorded **average canopy height, maximum canopy height,** and **minimum canopy height,** as these variables are typically correlated with the presence of and size/age of the trees and can indicate areas of significant shading of the river.

The **abundance of standing dead trees** was also noted at every other segment. Dead trees can be ecologically important to a forest community as habitats for cavity nesting birds and mammals. Each segment was given a rating from zero to four based on the number of standing dead trees. This is the scale used:

0 = 0
1 = 1-5
2 = 6-10
3 = 11-15
4 = 16+

As in 2000 and 2001 studies, additional data on non-woody species was collected for a small number of species or plant functional groups. Three of these plants were mapped and geo-referenced; Justicia americana the water willow a useful indicator species, Iris psuedacorus a the yellow iris a plant of special concern and Lythrum salicaria or purple loosestrife an invasive species. Their place in the database is warranted, as these baseline data can be used to monitor spread or decline of these species in the future.

- *Justicia americana* (water willow) is a native aquatic species found along edges of lakes, ponds, and streams. It usually indicates a healthy and intact riparian zone and is the dominant member of the Waterwillow-smartweed community.

- *Iris pseudacorus* (yellow iris) is an introduced species also found along edges of lakes, ponds, and streams. I. pseudacorus was often found growing near acid mine drainage in the Monogahela pools studied in 2001, but was rarely found on the Allegheny River, where there is little acid mine drainage.
- *Lythrum salicaria* (purple loose-strife) is a highly invasive species that was introduced to the United States from Europe. Here it is coincident with the native floodplain species Lobelia cardinalis (cardinal flower). It is found in scattered areas along our Pittsburgh Rivers and can be closely monitored for spread using this geo-referenced system.

The other non-woody plants noted were emergent aquatic grasses, sedges, and rushes, which form a plant functional group. Due to the distance constraints, grasses and sedges were not distinguishable and recorded in one category (grasses/sedges). Rushes were placed in a separate category. The presence of emergent grasses and sedges typically indicates the presence of sand bars and/or shallow water.

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Figure 3. Distribution of Sycamore – Box-elder Floodplain Community along the Allegheny, Monongahela, and Ohio Rivers

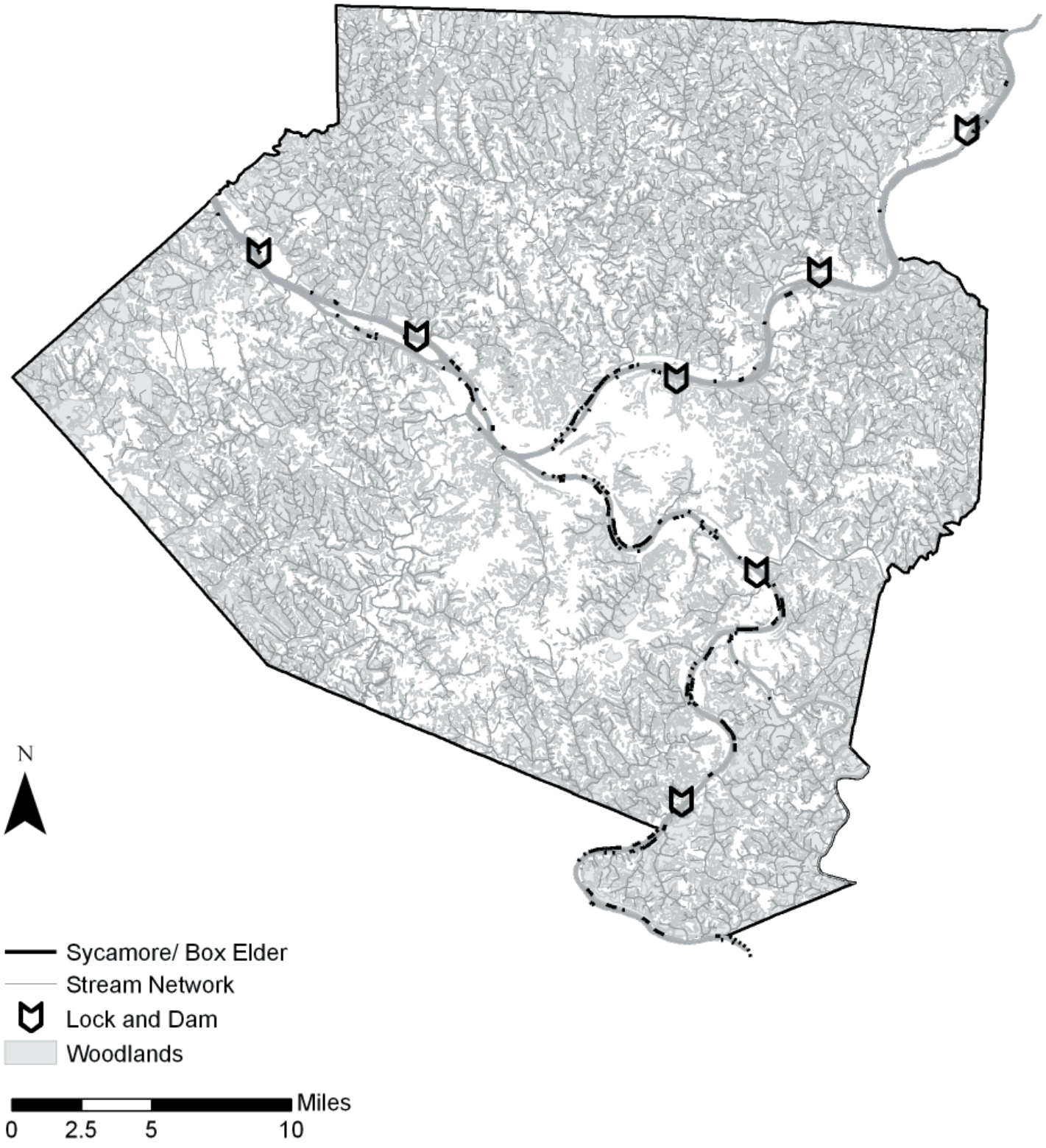


Figure 4. Distribution of Silver Maple Floodplain Community Along the Allegheny, Monongahela, and Ohio Rivers

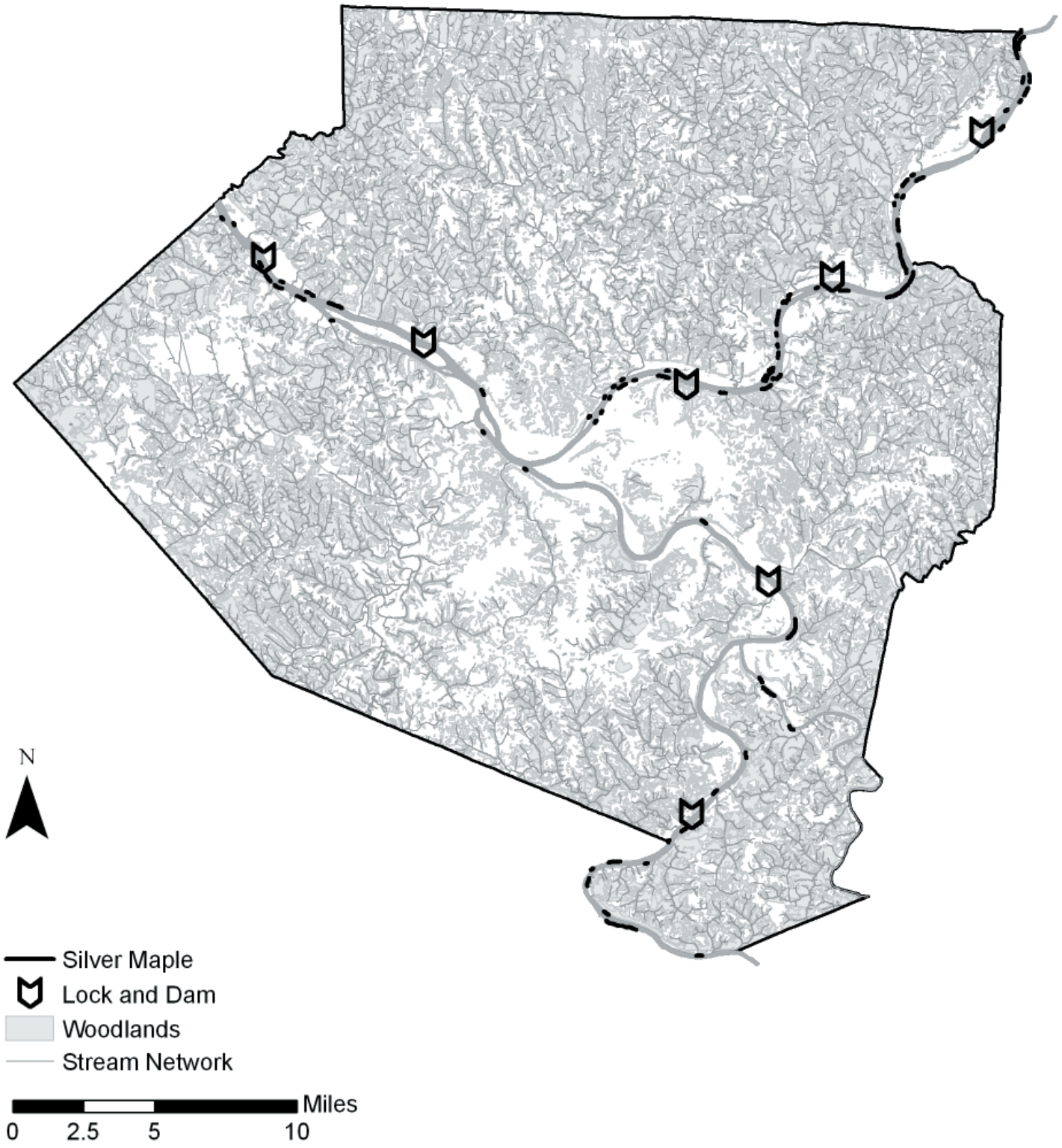


Figure 5. Distribution of Black Willow along the Allegheny, Monongahela, and Ohio Rivers

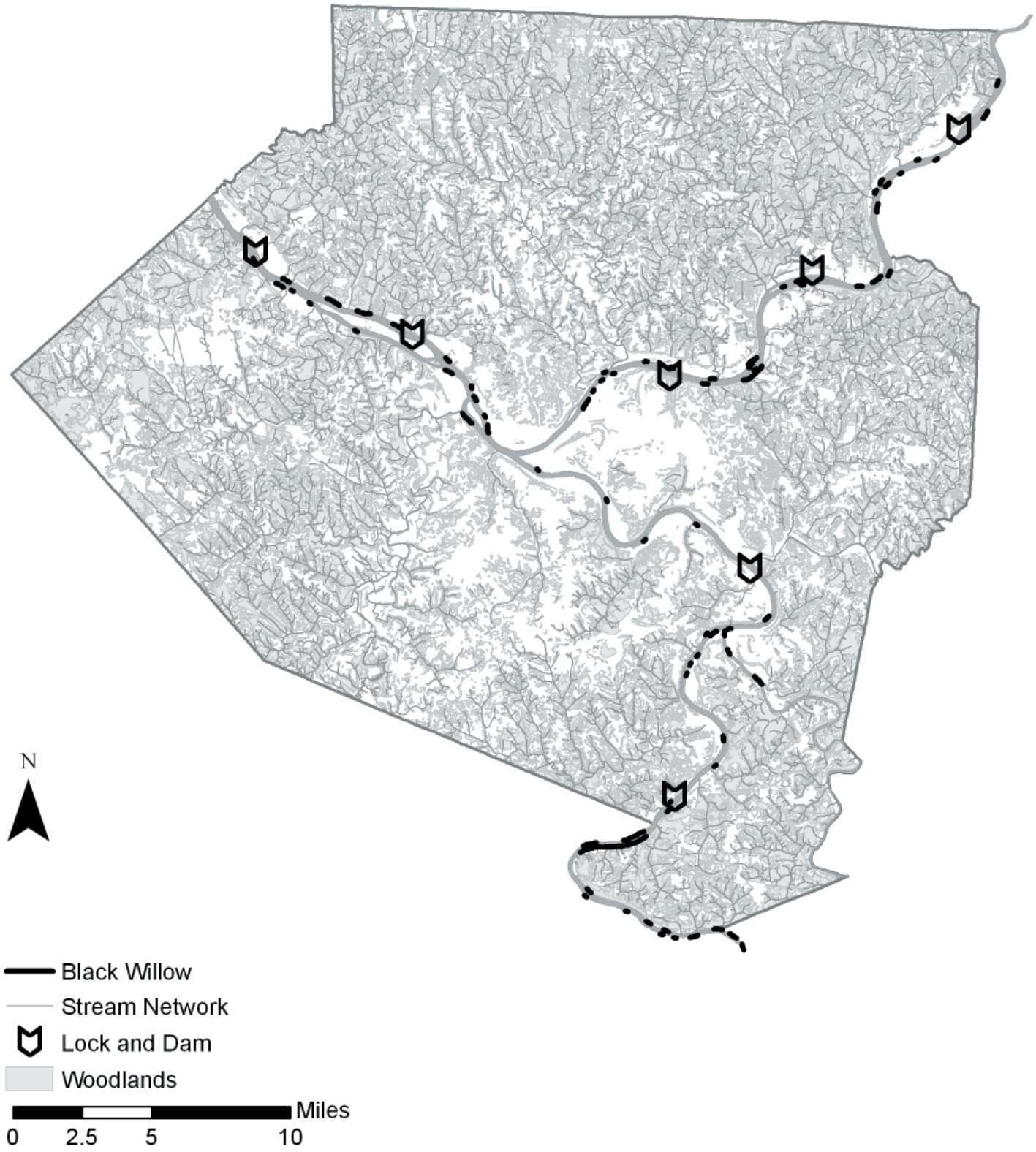


Figure 6. Distribution of Alder – Ninebark Wetland Along the Allegheny, Monongahela, and Ohio Rivers

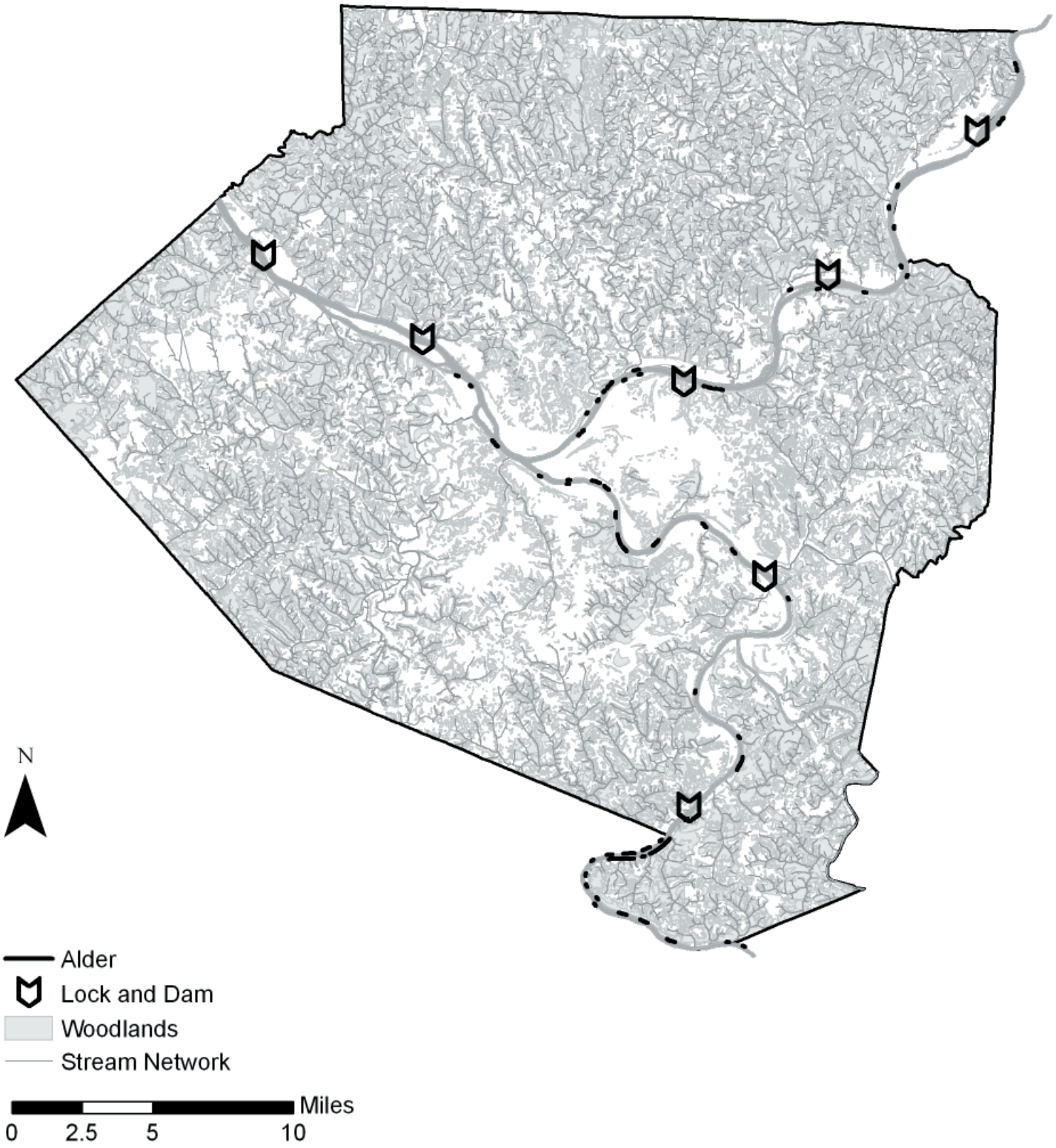


Figure 7. Distribution of Water Willow – Smartweed River Bed Community Along the Allegheny, Monongahela, and Ohio Rivers

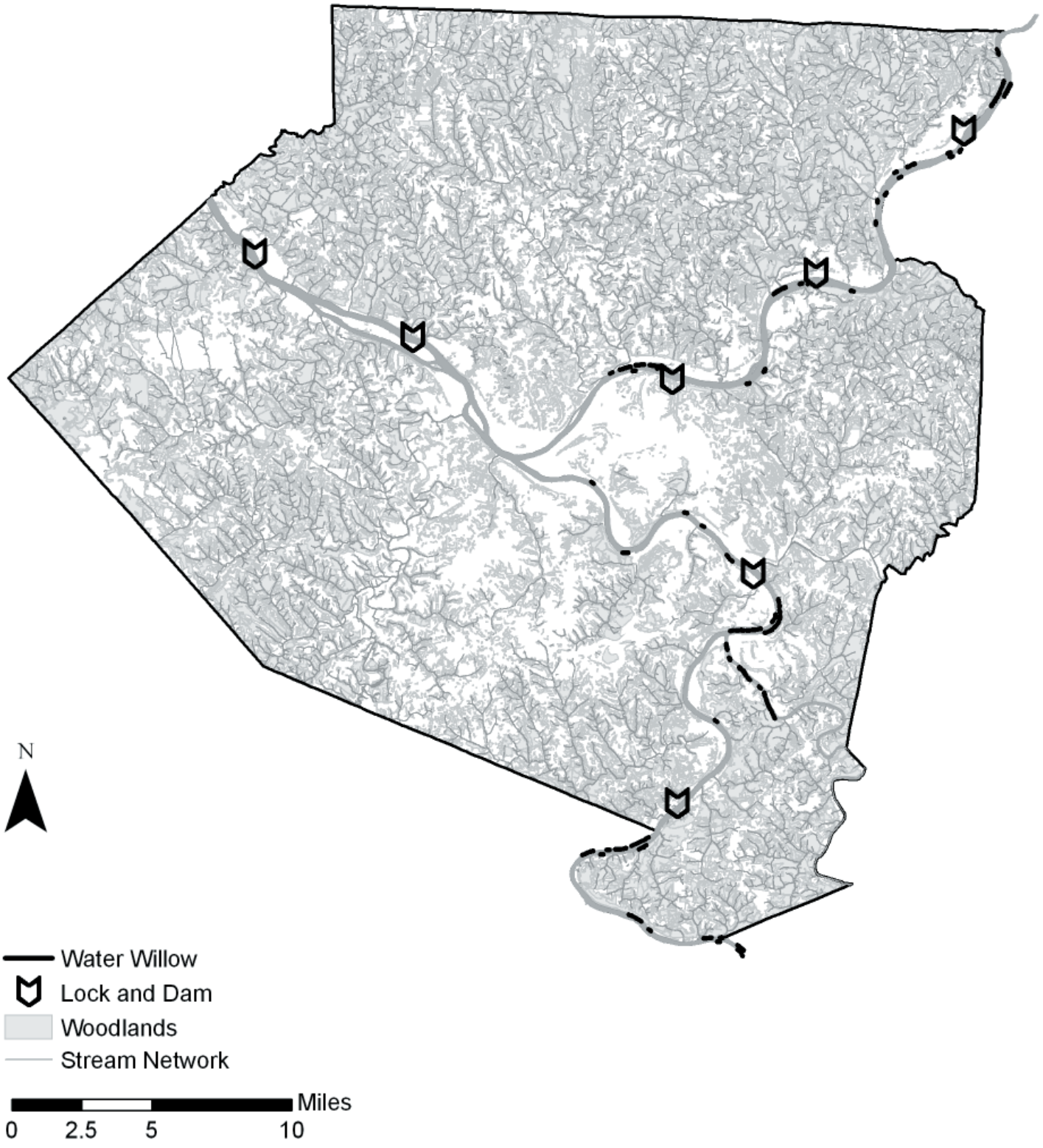


Figure 8. Distribution of Native Plant Communities Along the Allegheny, Monongahela, and Ohio Rivers

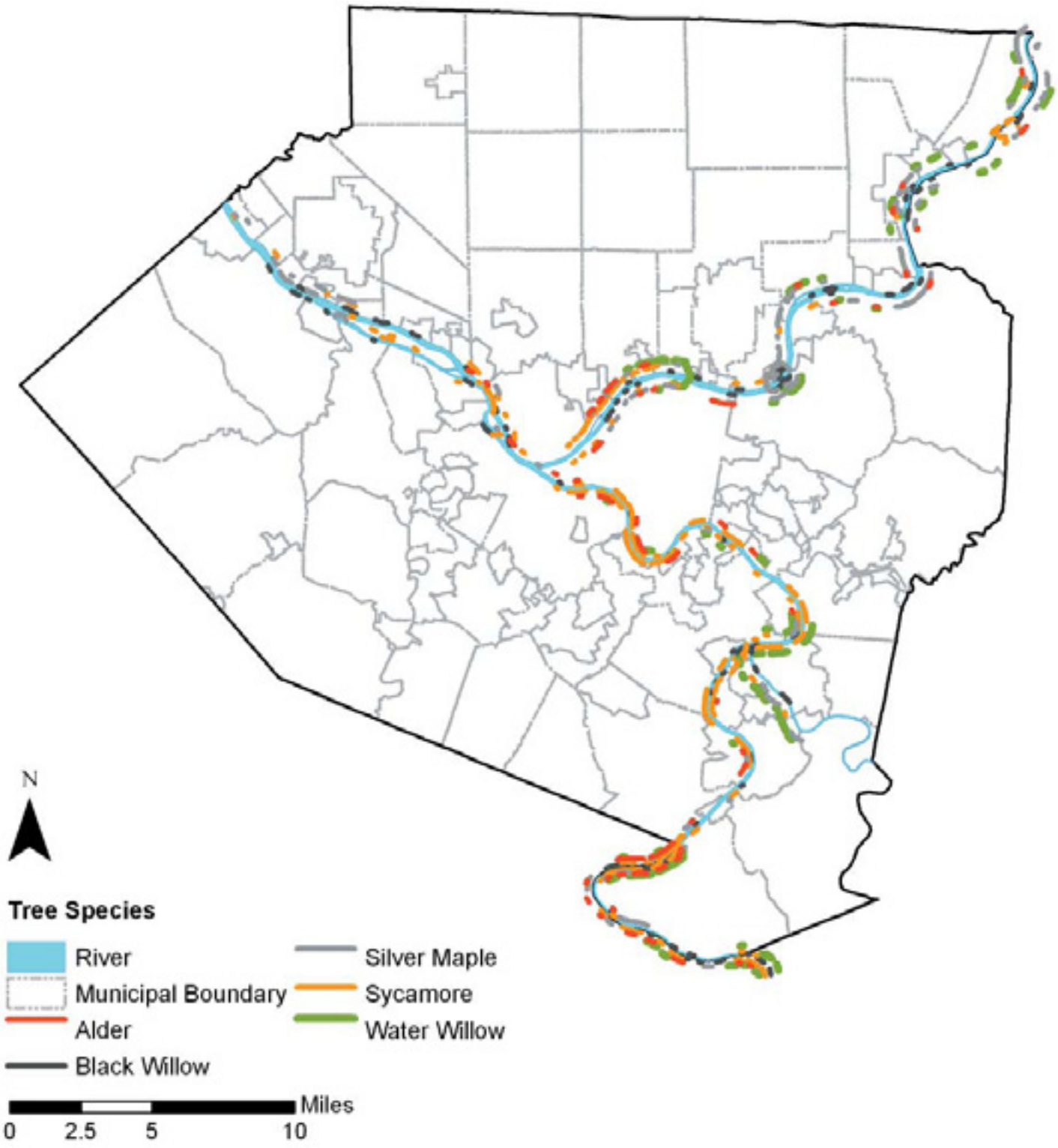


Figure 9. Distribution of tree of heaven (Ailanthus altissima) Along the Allegheny, Monongahela, and Ohio Rivers

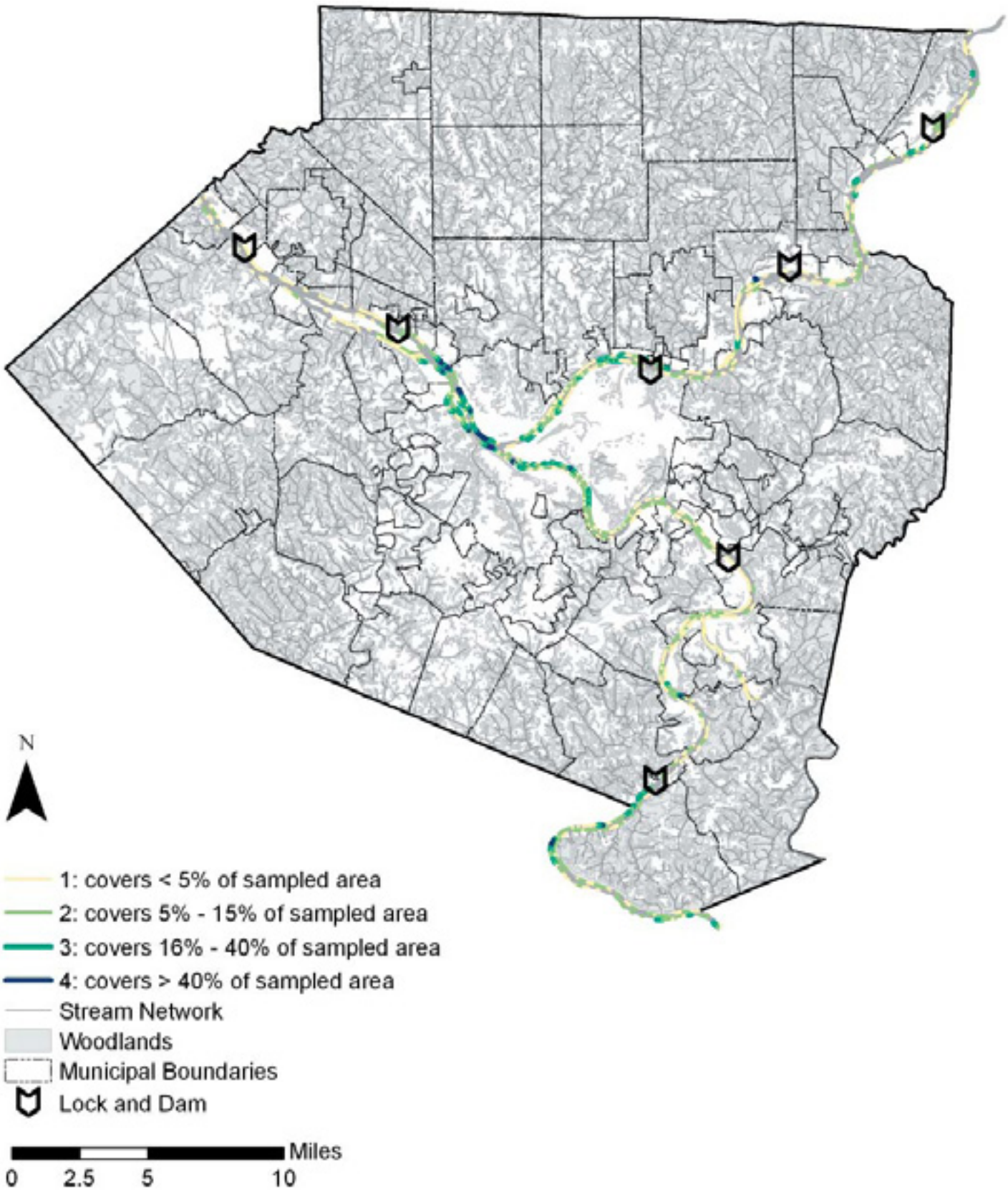


Figure 10. Distribution of oriental bittersweet (Celastrus orbiculatus) Along the Allegheny, Monongahela, and Ohio Rivers

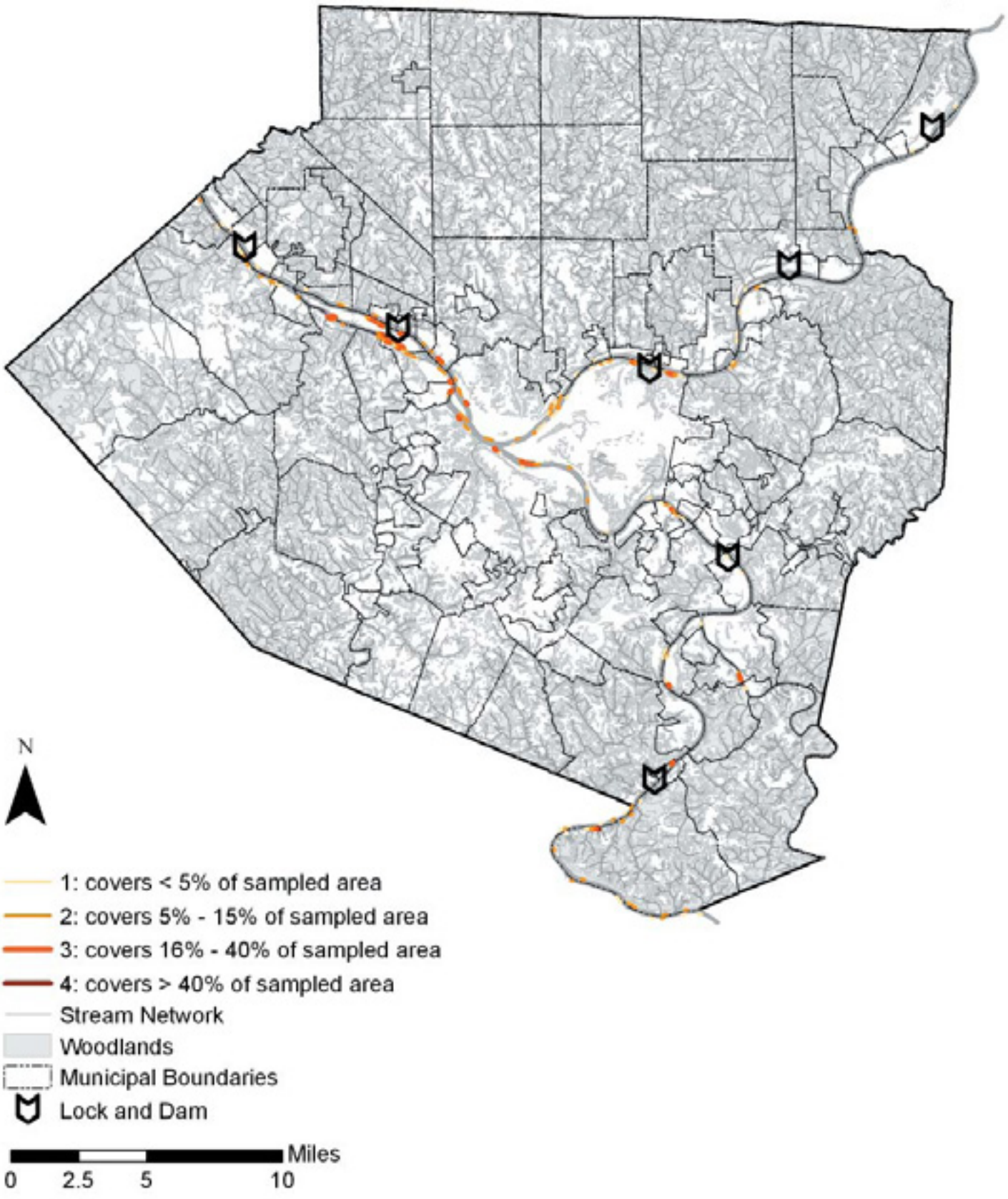


Figure 11. Distribution of japanese knotweed (Polygonum cuspidatum) Along the Allegheny, Monongahela, and Ohio Rivers

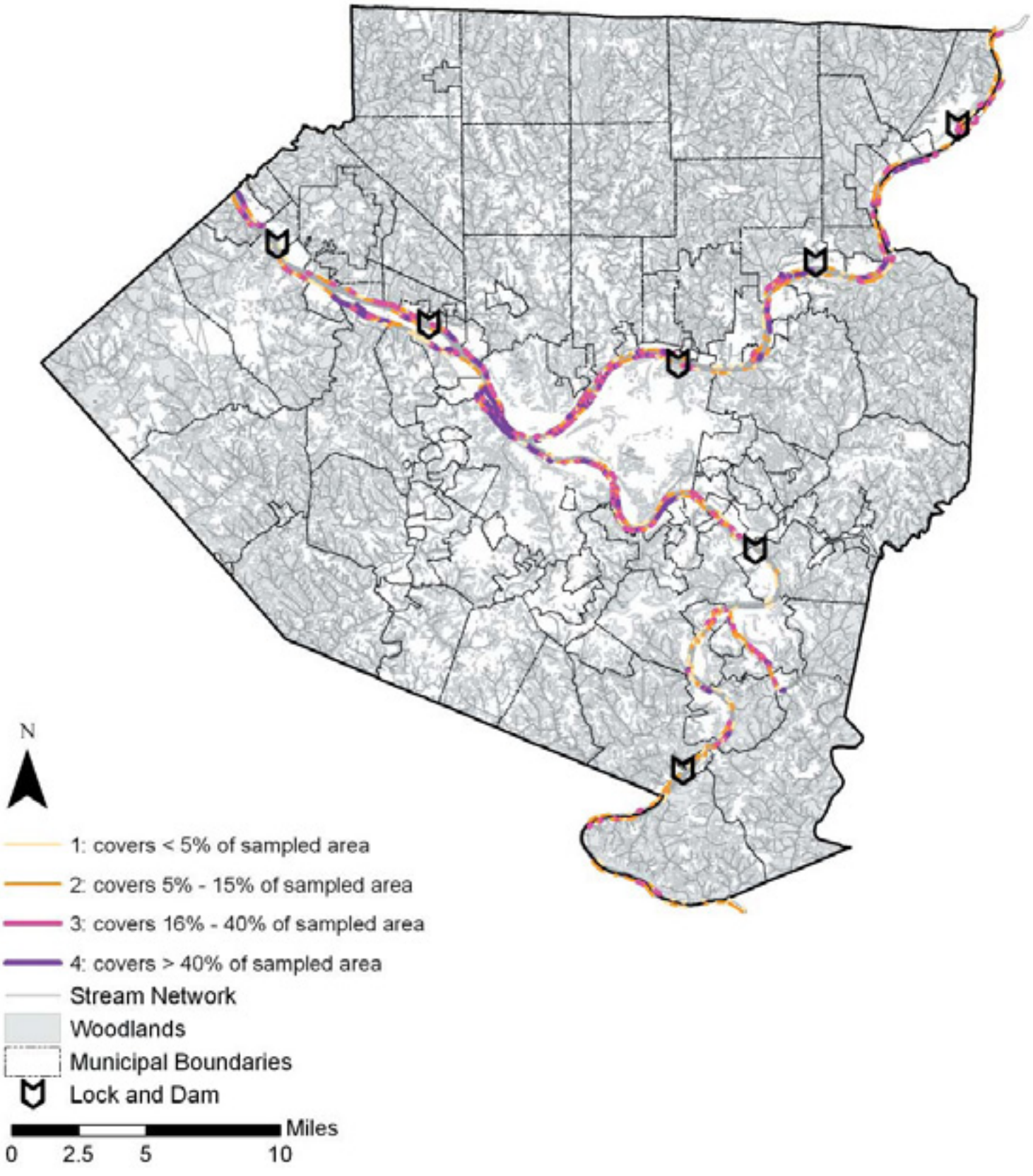


Figure 12. Distribution of purple loose-strife (Lythrum salicaria) Along the Allegheny, Monongahela, and Ohio Rivers

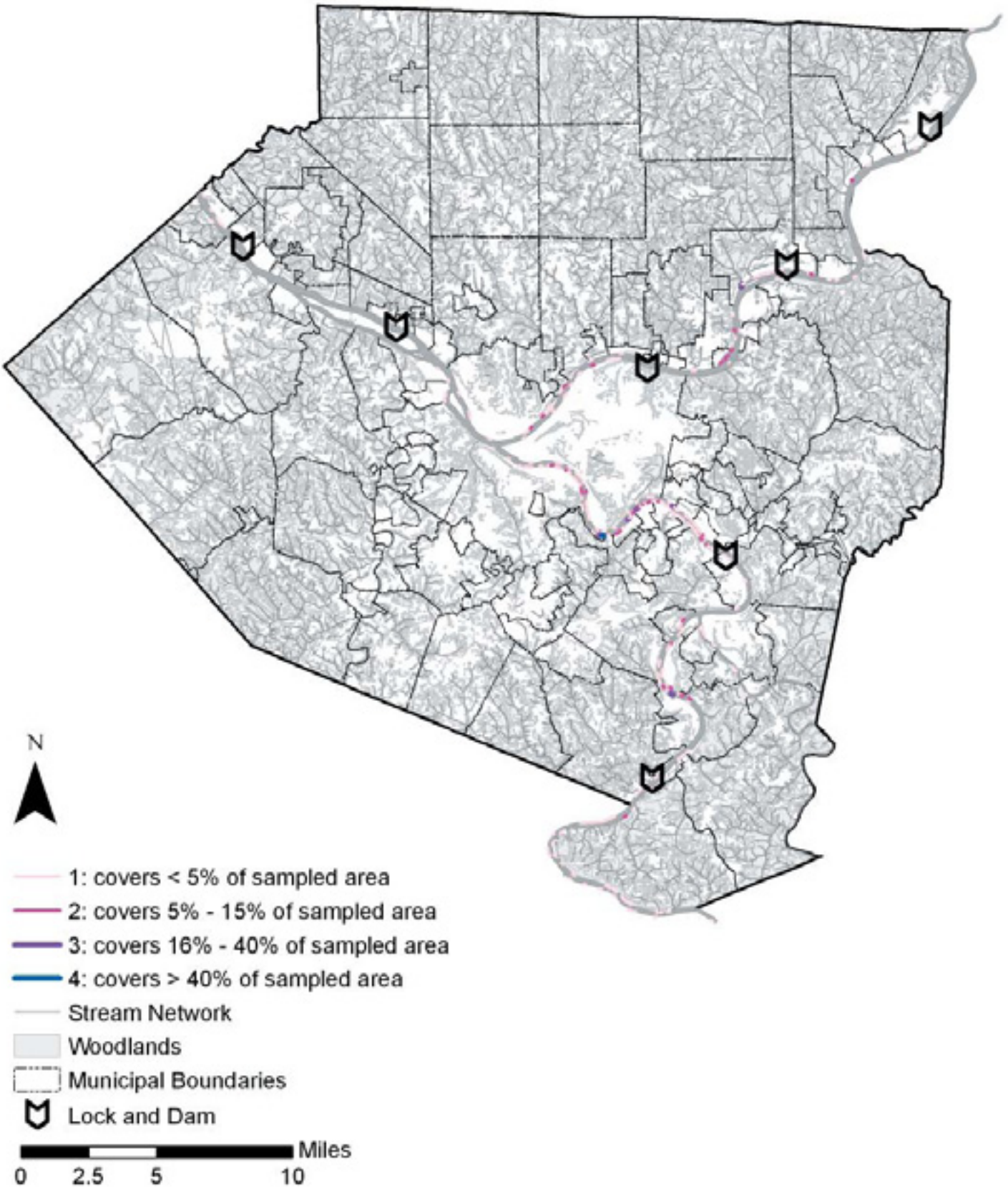


Figure 14. Co-occurrence of Obligate Wetland Species including Black Willow (Salix nigra), Water Willow (Justicia americana), and Buttonbush (Cephalanthus occidentalis)

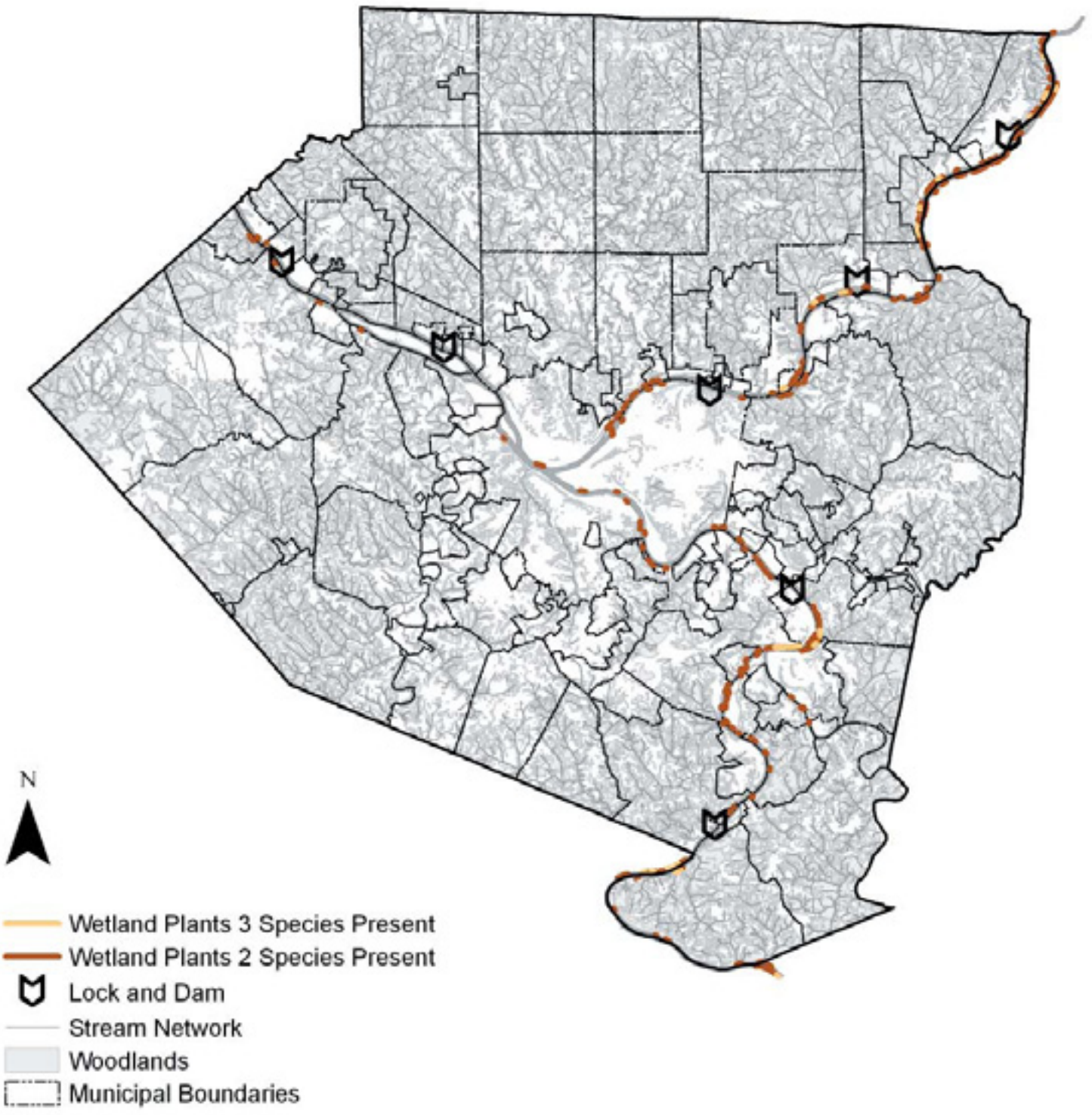


Figure 15. Distribution of Co-occurrence of Obligate Wetland Species and Wetland Soil

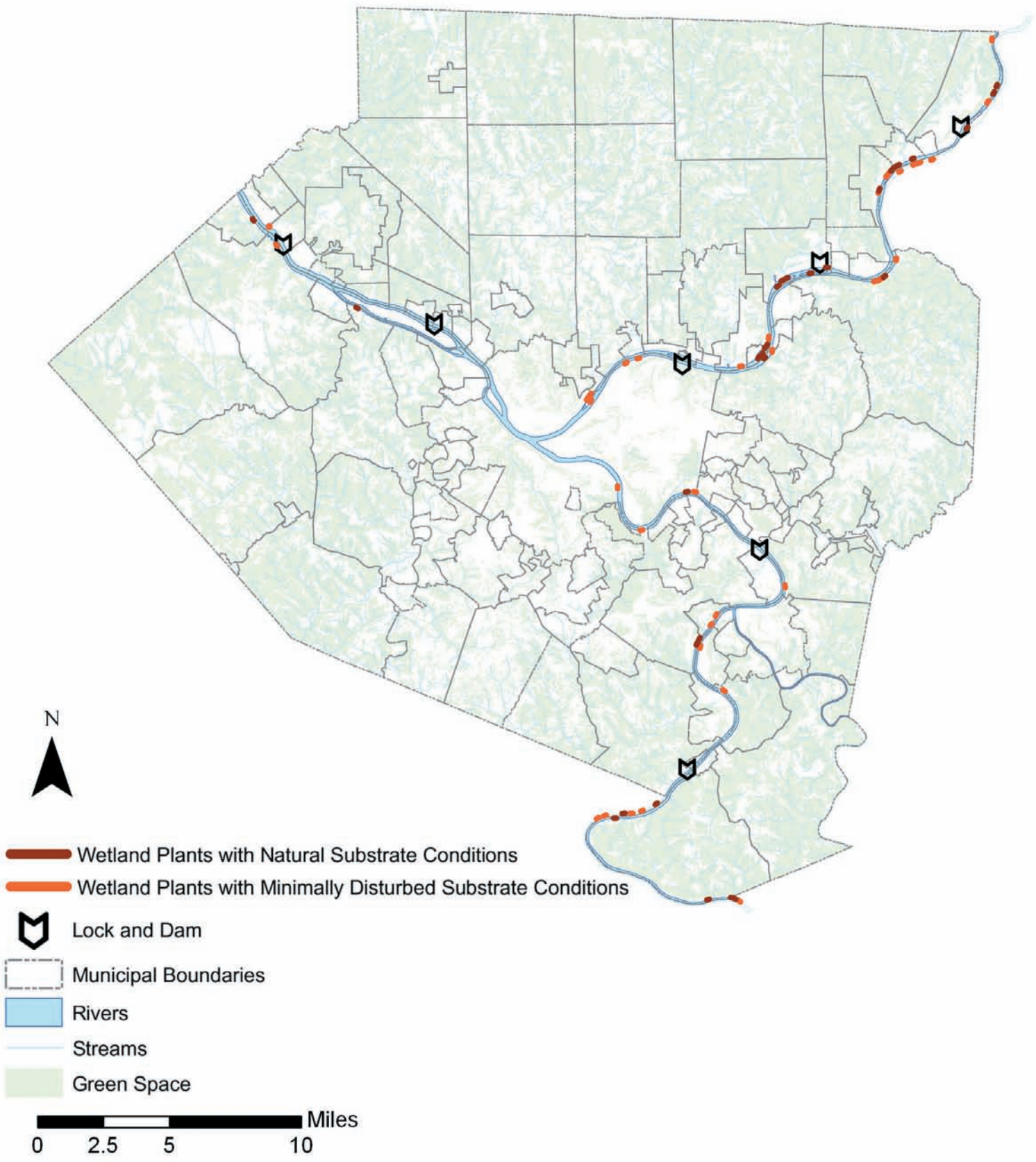


Figure 16.1 Distribution of Hardwood Floodplain Communities with High and Low threat of invasion by invasive plants

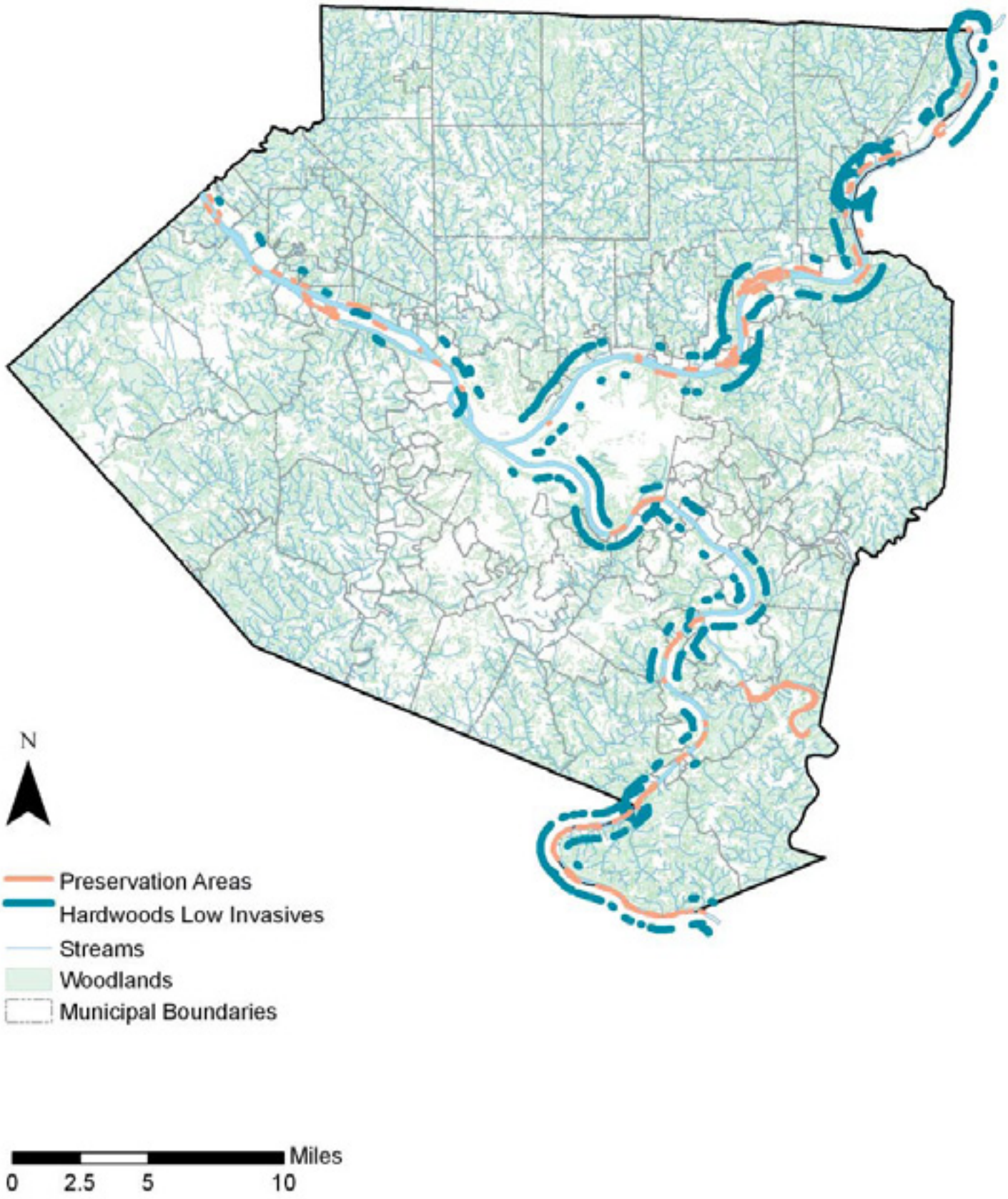


Figure 16.2 Distribution of Hardwood Floodplain Communities with High and Low threat of invasion by invasive plants

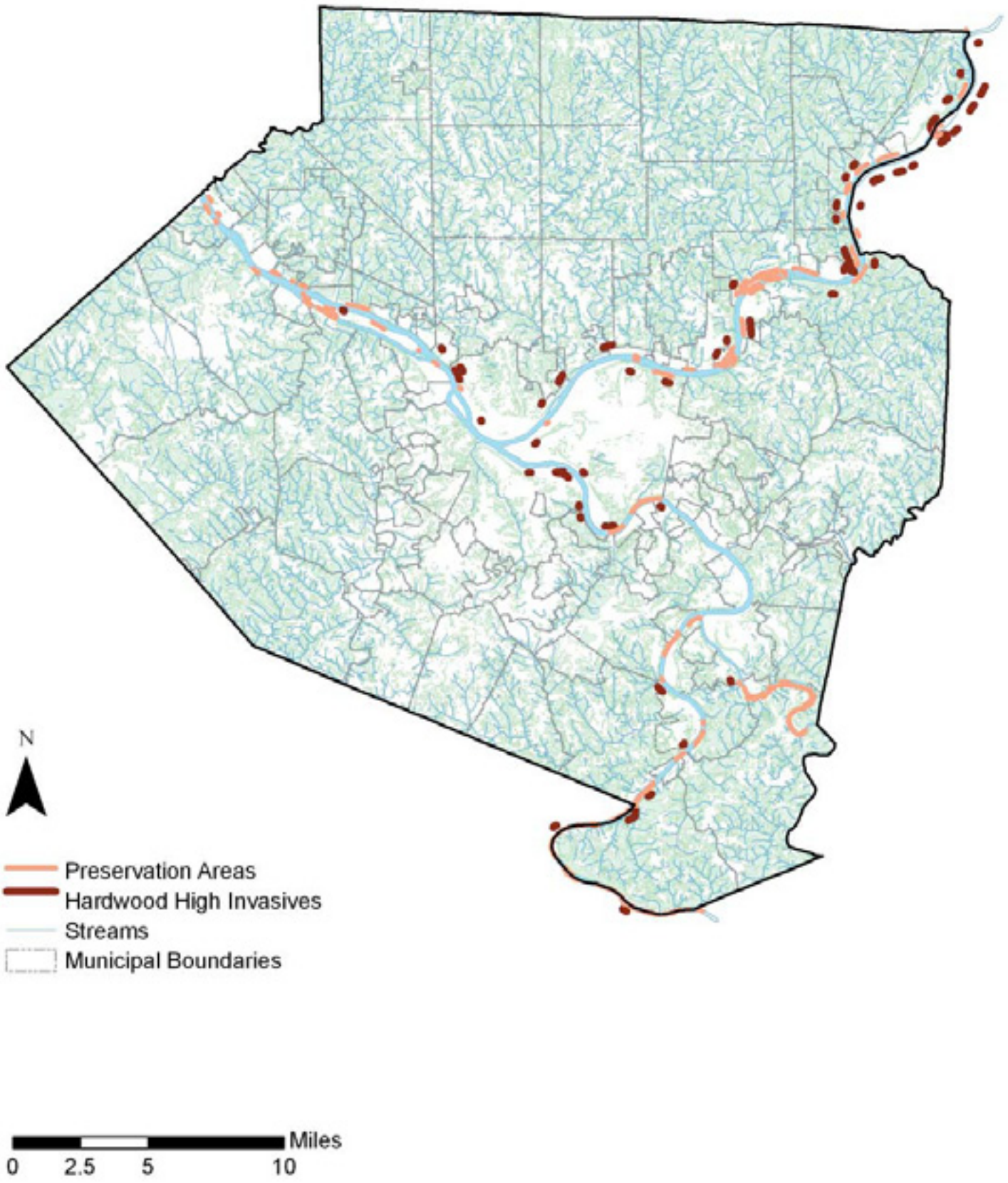


Figure 16.3 Distribution of Hardwood Floodplain Communities with High and Low threat of invasion by invasive plants

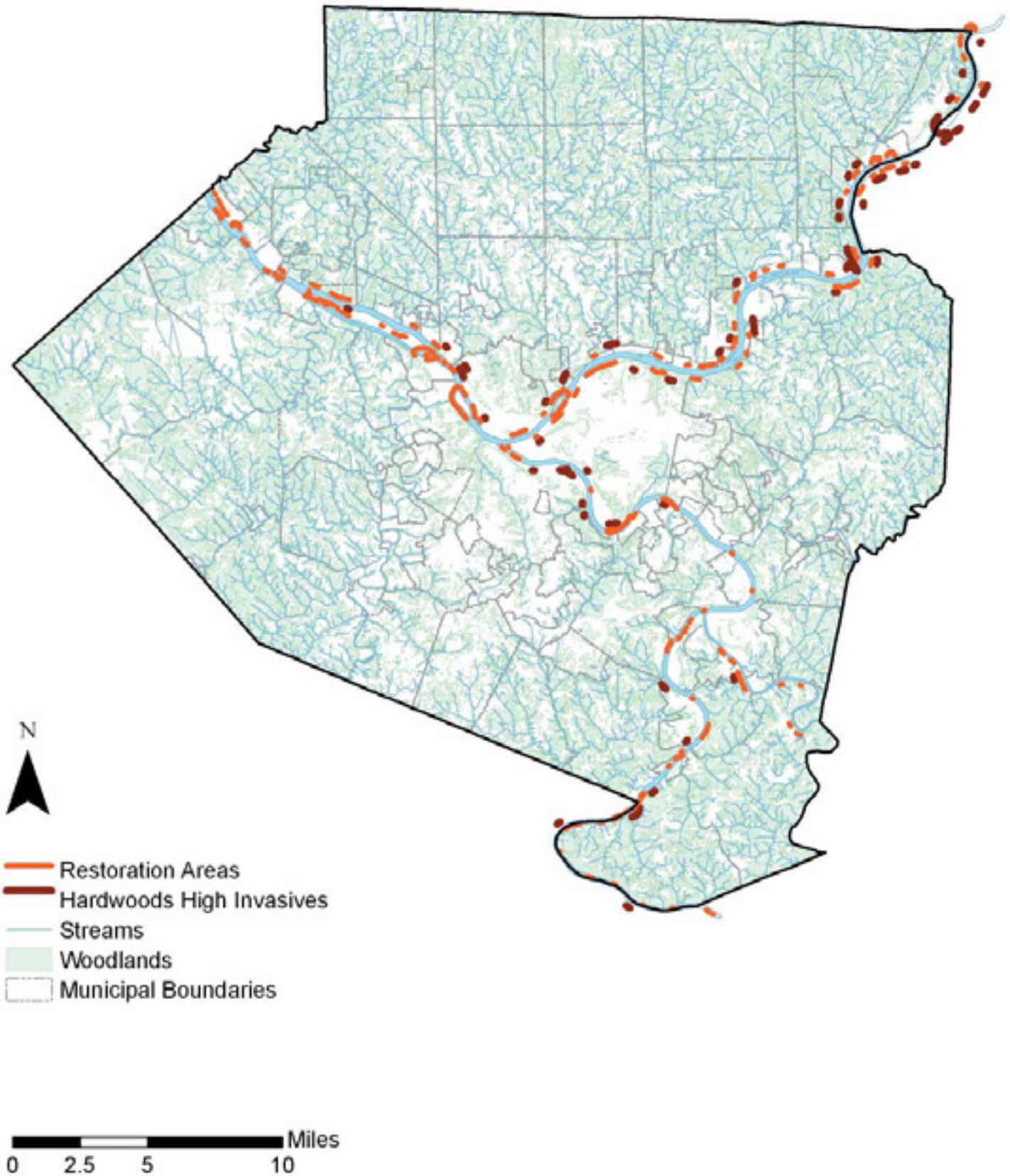
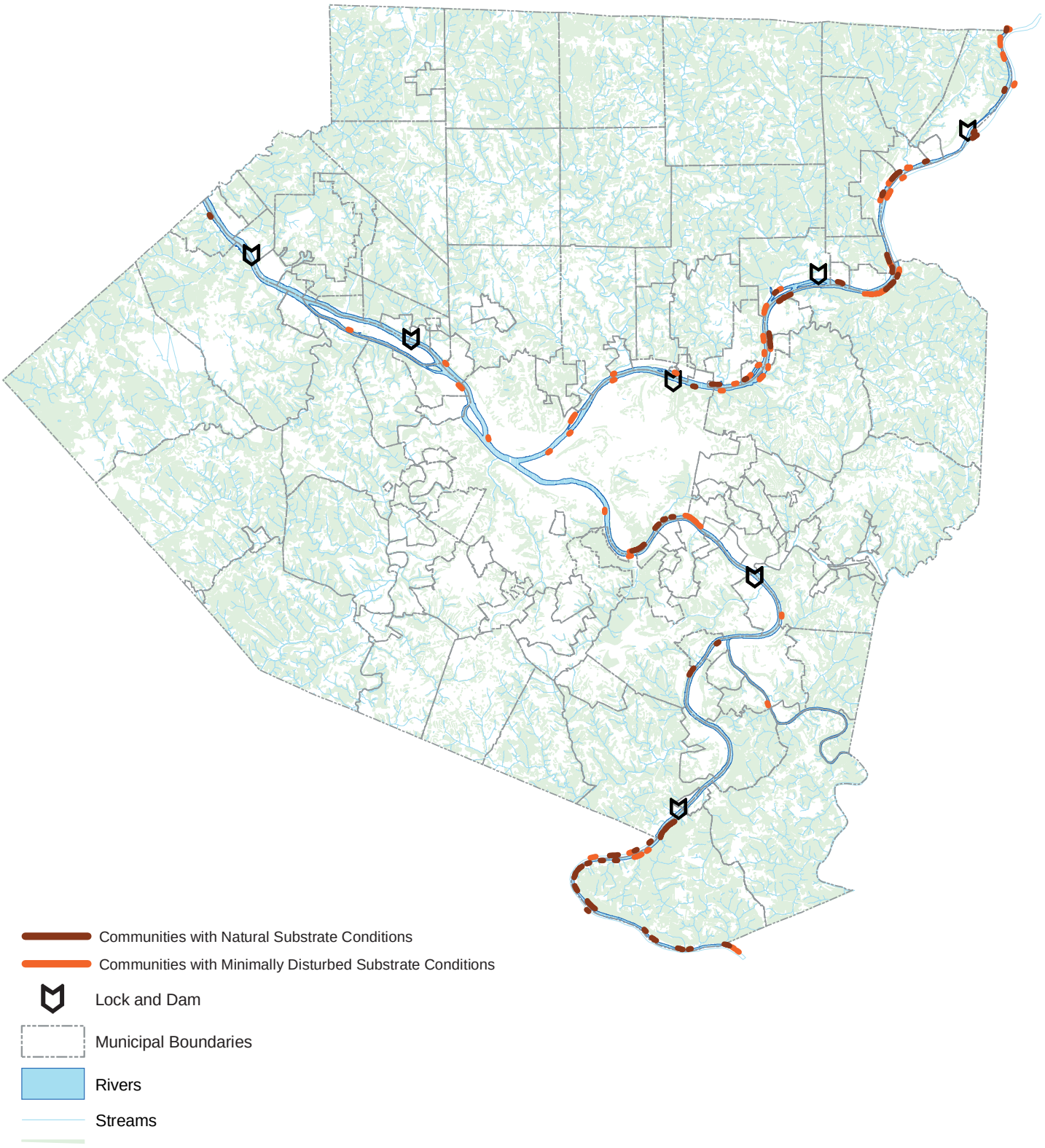


Figure 17. Distribution of Hardwood Floodplain Communities with Good Soil Conditions



Tables

Table 1. List of species identified in woody vegetation survey of the Ohio River.

Native Species			
Scientific name	**Family**	**Common name**	**Native/Introduced**
Acer negundo	Aceraceae	Box-elder	Native
Acer saccharinum	Aceraceae	Silver maple	Native
Acer saccharum	Aceraceae	Sugar maple	Native
Aesculus spp.	Sapindaceae	Buckeye	Native
Alnus spp.	Betulaceae	Alder	Native
Amorpha fruitcosa	Fabaceae	False indigo	Native
Aralia spinosa	Apiaceae	Devil's walking stick	Native
Betula spp.	Betulaceae	Birch	Native
Carya spp.	Juglandaceae	Hickory	Native
Catalpa spp.	Bignoniaceae	Catalpa	Introduced from southern USA
Celtis occidentalis	Ulmaceae	Hackberry	Native
Cephalanthus occidentalis	Rubiaceae	Buttonbush	Native
Cercis canadensis	Fabaceae	Redbud	Native
Cornus spp.	Cornaceae	Dogwood	Native
Crataegus spp.	Rosaceae	Hawthorn	Native
Fraxinus spp.	Oleaceae	Ash	Native
Gleditsia triacanthos	Fabaceae	Honey locust	Native
Hamamelis virginiana	Hamaelidaceae	Witch-hazel	Native
Hibiscus moscheutus	Malvaceae	Swamp rose mallow	Native
Humulus spp.	Moraceae	Hops	Native/Introduced from Asia
Hydrangea arborescens	Hydrangeaceae	Hydrangea	Native
Ilex cv.	Aquilfoliaceae	Holly cultivar	Native
Juglans spp.	Juglandaceae	Black Walnut	Native
Juniperus cv.	Cupressaceae	Juniper	Native
Lindera benzoin	Lauraceae	Spicebush	Native
Liquidambar styraciflua	Hamaelidaceae	Sweet-gum	Native
Liriodendron tulipifera	Magnoliaceae	Tulip tree	Native
Scientific name	Family	Common name	Native/Introduced
Malus coronaria	Rosaceae	Crabapple	Native
Menispermum canadense	Menispermaceae	Moonseed	Native
Morus rubra	Moraceae	Red Mulberry	Native
Nyssa sylvatica	Nyssaceae	Tupelo, Black gum	Native
Ostrya virginiana	Betulaceae	Hophornbeam	Native
Parthenocissus quinquefolia	Vitaceae	Virginia creeper	Native
Physocarpus opulifolius	Rosaceae	Ninebark	Native
Platanus occidentalis	Platanaceae	Sycamore	Native
Populus tremuloides	Salicaceae	Quaking aspen	Native
Populus deltoids	Salicaceae	Cottonwood	Native
Prunus spp.	Rosaceae	Wild Cherry	Native
Ptelea trifoliata	Rutaceae	Hop-tree	Native
Quercus spp.	Fagaceae	Oak	Native
Rhus typhina	Anacardiaceae	Staghorn Sumac	Native
Ribes spp.	Saxifragaceae	Currant	Native/Introduced
Robinia pseudoacacia	Fabaceae	Black Locust	Native
Rosa cv.	Rosaceae	Rose cultivar	Introduced
Rubus spp.	Rosaceae	Blackberry, raspberry	Native
Rubus oderatus	Rosaceae	Purple-flowering raspberry	Native

Salix spp.	Salicaceae	Willow	Native
Sambucus candensis	Caprifoliaceae	Elderberry	Native
Sambucus pubens	Caprifoliaceae	Red-berried Elder	Native
Sassafras albidum	Lauraceae	Sassafras	Native
Spiraea spp.	Rosaceae	Meadowsweet	Native
Staphylia trifolia	Staphyleaceae	Bladdernut	Native
Symphoricarpus albus	Caprifoliaceae	Snowberry	Native
Tilia americana	Tiliaceae	Basswood	Native
Tsuga canadensis	Pinaceae	Hemlock	Native
Toxicodendron radicans	Anacardiaceae	Poison ivy	Native
Ulmus spp.	Ulmaceae	Elm	Native
Viburnum sp.	Adoxaceae	Arrow-wood	Native
Vitis sp.	Vitaceae	Grapevine	Native

Introduced Species			
Scientific name	**Family**	**Common name**	**Native/Introduced**
Acer cv.	Aceraceae	Maple cultivar	Introduced
Ampelopsis brevipedunculata	Vitaceae	Porcelain-berry	Introduced from Asia
Berberis cv.	Berberidaceae	Barberry cultivar	Introduced from Asia
Betula cv.	Betulaceae	Birch cultivar	Introduced from Europe
Buddleia spp.	Loganiaceae	Butterfly bush	Introduced from Asia
Forsythia cv.	Oleaceae	Forsythia	Introduced from Europe
Hibiscus syriacus	Malvaceae	Rose-of-Sharon	Introduced from Asia
Ligustrum vulgare	Oleaceae	Privet	Introduced from Europe
Maclura pomifera	Moraceae	Osage orange	Introduced from southern USA
Malus pumila	Rosaceae	Apple	Introduced from Asia
Morus alba	Moraceae	White Mulberry	Introduced from Asia
Picea cv.	Pinaceae	spruce cultivar	Introduced
Pinus cv.	Pinaceae	pine cultivar	Introduced
Prunus cv.	Rosaceae	Cherry cultivar	Introduced
Salix babylonica	Salicaceae	Weeping willow	Introduced from Asia
Sorbus aucuparia	Rosaceae	Mountain Ash	Introduced from Europe
Wisteria floribunda	Fabaceae	Wisteria	Introduced from Europe

Introduced and Invasive Species			
Scientific name	**Family**	**Common name**	**Native/Introduced**
Acer platanoides	Aceraceae	Norway maple	Introduced from Europe/Invasive
Ailanthus altissima	Simaroubaceae	Tree of heaven	Introduced from Asia/Invasive
Berberis thunbergii	Berberidaceae	Barberry	Introduced from Asia/Invasive
Celastrus orbiculatus	Celastraceae	Oriental bittersweet	Introduced from Asia/Invasive
Lonicera maackii	Caprifoliaceae	Amur honeysuckle	Introduced /Invasive
Lonicera spp. (shrub)	Caprifoliaceae	Honeysuckle	Introduced /Invasive
Lonicera spp. (vining)	Caprifoliaceae	Honeysuckle	Introduced /Invasive
Rhamnus frangula	Rhamnaceae	Buckthorn Alder	Introduced from EurAsia/Invasive
Rosa multiflora	Rosaceae	Multiflora rose	Introduced from Asia/Invasive

Table 2. Percent Abundance of Invasive Species found along Ohio River

Species	Common Name	% abundance
Acer platanoides	Norway Maple	1.0%
Ailanthus altissisma	Tree of Heaven	3.3%
Berberris thunbergii	Barberry	0.1%
Celastrus orbiculatus	Oriental Bittersweet	2.6%
Polygonum cuspidatum	Japanese Knotweed	10.6%
Rhamnus frangula	Buckthorn Alder	1.0%
Rosa multiflora	Multiflora Rose	1.0%

APPENDIX A

River Bed – Bank – Floodplain Comminities of the Three Rivers Riverbanks

APPENDIX B

Recomendations for Eradication of Japanese Knotweed

Appendix A

River Bed – Bank – Floodplain Comminities of the Three Rivers Riverbanks
(communities delineated by Fike in Terrestrial and Palustrine Plant Communities of Pennsylvania*)

1. Sycamore – (River Birch) – Box-Elder Floodplain Forest
   This community type was the most common native plant community encountered on the Monongehela and was found throughout much of the surveyed area. These forests are typical of the floodplains of larger rivers in PA that receive periodic or seasonal flooding. They are characterized by dominance of *Platanus occidentalis* (sycamore) and Acer negundo (box elder) and in the eastern half of the state, *Betula nigra* (river birch). Typically river birch is not found in this forest type in the Ohio River drainage and was not seen in our survey.

2. Silver Maple Floodplain Forest
   These forests occur on well-developed floodplains along large rivers. They are characterized by the predominance of *Acer saccharinum* (silver maple) but also include *Acer rubrum* (red maple), *Salix nigra* (black willow), *Acer negundo* (box elder), *Ulmus Americana* (American elm), and *Ulmus rubra* (red elm). This forest type was not common, but was found in some small stretches. The scarcity of this habitat is likely due to the fact that humans have historically focused their riverfront development in flat areas where significant floodplain has formed.

3. Black Willow Scrub/Shrub Wetland
   This community is typically found along riverbanks and stream habitats and is characterized by the predominance of *Salix nigra* (black willow) in association with several dogwood species, *Cornus spp.* as well as *Alnus rugosa* (speckled alder). In this survey we found the invasive species *Polygonum cuspidatum* (Japanese knotweed) growing here. This habitat is found in small stretches in our survey.

4. Alder – ninebark wetland
   These wetlands are characterized as "shrub swamps" dominated by species of alder (*Alder spp.*) and/or *Physocarpus opulifolius* (ninebark). In our surveys, the plant association reached the riverbank edges, usually occurring in steeper, rockier areas. This community was found in small stretches.

5. Water-willow (*Justicia Americana*) – smartweed riverbed community
   This community is found on major rivers in areas where there is inundation of alluvium near the shore or sediment develops among rocks in the river. Plants in this community withstand flooding of their roots for most of the year. Water-willow is dominant but coincident with several species of smartweed (*Polygonum*) and several species of rushes (*e.g. Eleocharis*).

* Fike, J. 1999. Terrestrial and Palustrine Plant Communities of Pennsylvania. Pennsylvania Natural Diversity Inventory, Harrisburg, PA.

Appendix B

Recomendations for Eradication of Japanese Knotweed

Complete extirpation of *P. cuspidatum* has proven extremely difficult, but the species can be controlled with continuous effort (The Nature Conservancy 1992). Digging up the rhizomes is not recommended because dispersal of rhizome fragments usually occurs. The most recommended methods of control are cutting back of the above ground stems and herbicide application. Cutting must be done four times in a season to reduce rhizome biomass (Seiger 1997). Because even stem tissue can regenerate plants (DeWaal 2001), the cut material must be disposed of carefully. Herbicide application has also been recommended. Glyphosate [N-(phophonomethyl)glycine] is recommended by The Nature Conservancy (1992) and is approved for use near water. Both of these methods require several years of application and may be more effective if used in conjunction (The Nature Conservancy 1992). Because this species is not very shade-tolerant (Beerling 1994), planting native trees after removal by cutting or spraying may prevent future regrowth