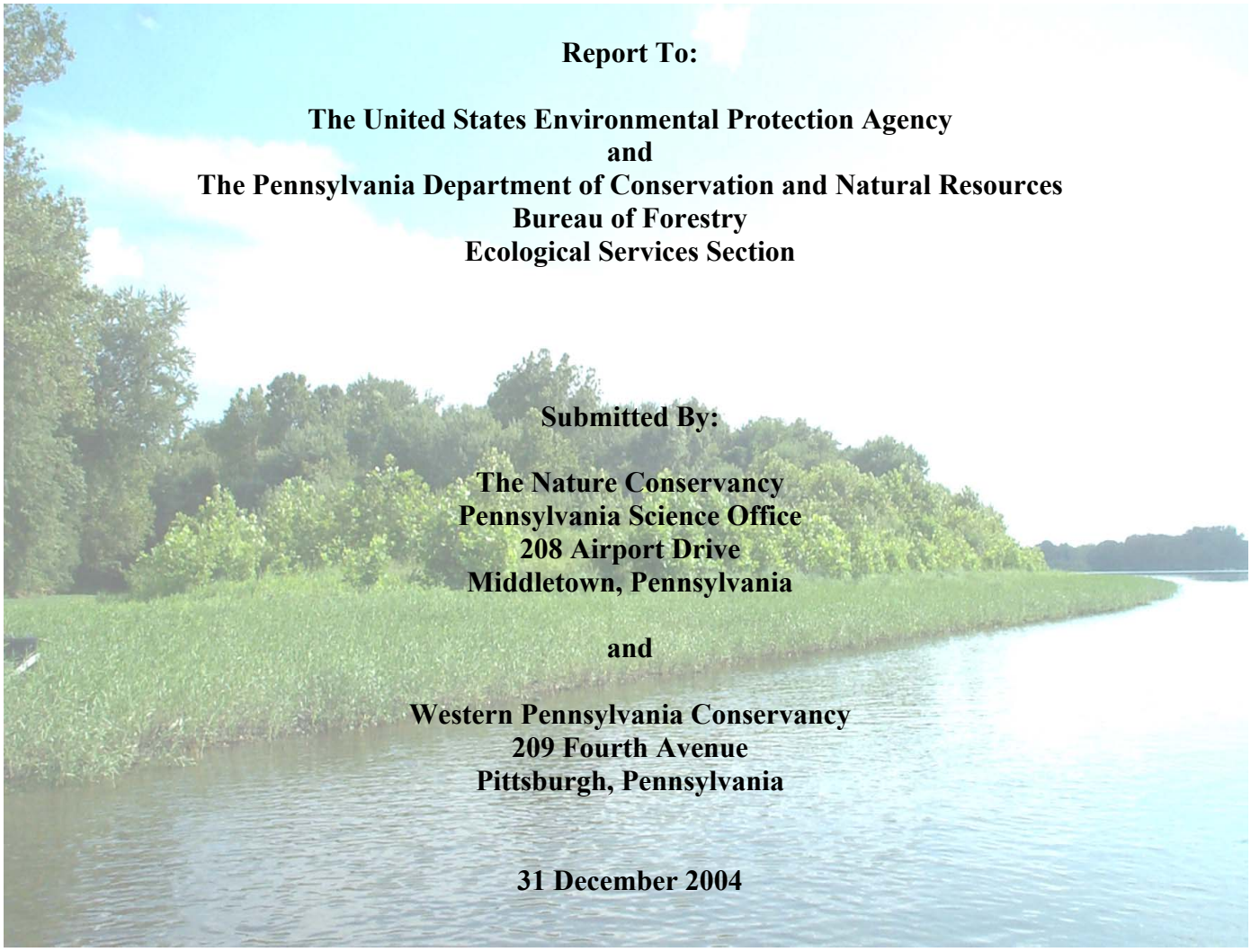
Classification, Assessment and Protection of Non-Forested Floodplain Wetlands of the Susquehanna Drainage



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and
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Bureau of Forestry
Ecological Services Section

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Stephanie Perles
Greg Podniesinski
Jeffrey Wagner

Pennsylvania Natural Heritage Program Ecologists Greg Podniesinski and Jeff Wagner (left) and Jeff Wagner and Stephanie Perles (right) sampling herbaceous plots during the course of the study.

EXECUTIVE SUMMARY

This study identifies and describes in detail 13 non-forested floodplain communities typically found in riparian complexes in the Susquehanna River watershed. The environmental setting, characteristic vegetation, distribution, and conservation rank of each community are discussed. In general, these floodplain communities are influenced by several interrelated factors: 1) frequency and duration of flooding; 2) the amount of energy received from the drainage as either water or ice flow; 3) the relative location of the site within the watershed; 4) substrate stability, and 5) available propagules. The newly identified floodplain communities are also compared to the existing Pennsylvania state classification, other state classifications and the National Vegetation Classification. A summary of the descriptions for the thirteen non-forested floodplain communities described in this report is provided in the table on the following page.

Floodplain communities, both individually and in riparian complexes, provide important habitat for a wide variety of insects, including beetles and moths. The insect species typical of floodplain communities and associated insect species of special concern are discussed. In particular, the survey was incredibly productive and interesting in studying the Carabidae family, capturing 38% of the known fauna, plus an additional 13 species not as yet officially recorded from the state.

In order to support insect and plant biodiversity in the Susquehanna River, we must maintain diverse assemblages of floodplain communities that are species rich and whose components are structurally diverse. Three strategies that will contribute to the maintenance of diverse riparian areas are: 1) maintain or approximate natural flow regimes, 2) reduce the spread and prevalence of invasive species, and 3) protect high quality examples of riparian communities**.**

Table 2. Vascular plants of the Susquehanna River non-forested floodplain wetlands (cont.)

Community Type	Composition	Riparian Position & Substrate	Position in Watershed	State Rank
Sycamore – Mixed Hardwood Riverine Shrubland	Community of dense, tall shrubs. Sycamore covers at least 30% of total shrub cover. Shrub willows, silver maple, eastern cottonwood, and river birch individually or together strong associates.	Bars adjacent to or contiguous with the shoreline on cobble and sand.	Small to moderate size streams	S4
River Birch (Sycamore) – Mixed Hardwood Riverine Shrubland	Community of dense, tall shrubs. River birch cover at least 30% of total shrub cover. Sycamore often co-dominant with silver maple, black willow and black ash individually or together as strong associates.	Islands, bars and low terraces on sand and/or silt with mixed cobbles.	Moderate size rivers and streams	S4
Mixed Hardwood Riverine Shrubland	Community of dense, tall shrubs. No single species clearly dominant. Sycamore, silver maple, black willow, and river birch present in combinations of two or more.	Islands, low terraces and bars adjacent to shallow backwater channels on sand, silt and cobble.	Moderate to small size rivers and streams.	S4
Black Willow – Mixed Hardwood Riverine Shrubland	A dense, tall shrub layer of black willow that covers greater than 30% of the area characterizes this community. Other common tall shrubs include: shining willow, river birch and silver maple.	Downstream ends and heads of islands on deeper soils of silt and loam.	Large rivers	S4
Silver Maple (River Birch) – Mixed Hardwood Riverine Shrubland	A dense, tall shrub layer of silver maple that covers greater than 30% of the area characterizes this community. Sycamore, black willow, river birch, and green ash may also be present.	Low terraces and upstream ends of islands on silt and sand.	Moderate and large streams and rivers.	S4
Speckled Alder Riverine Shrubland	Community of moderately dense to dense tall shrubs dominated by speckled alder. Black willow, eastern ninebark, and silky dogwood are other common shrubs.	Flats within active channels on cobble substrate.	Small to moderate size streams.	S3S4
Sycamore (Willow) – Mixed Hardwood Riverine Dwarf Shrubland	Communities of moderately dense to dense short shrubs under 2 meters in height, dominated or co-dominated by willows as well as dwarfed sycamore.	Low terraces, bars and islands on sand, gravel and cobble.	Small to moderate size streams.	S4
Willow – Indian Grass Riverine Shrubland	Community characterized by a thick layer of herbaceous and graminoid vegetation containing Indian grass and numerous other species including a 25 – 50 % cover of short shrubs, especially black and sandbar willow.	Island heads, low flats and bars on sand and cobbles.	Smaller streams in upper potions of watershed.	S3
Reed Canary Grass Riverine Grassland	Community characterized by dense herbaceous and graminoid vegetation dominated by reed canary grass. Numerous other species present with some short shrubs.	Bars attached to banks on cobble.	Small streams and upper portions of watershed.	S5
Sedge – Spotted Joe Pye Weed Riverine Herbaceous Vegetation	Community characterized by dense herbaceous and graminoid vegetation dominated by twisted sedge and spotted joe pye weed. Numerous other species present with some short shrubs.	Island heads, bars and backwater channels, low terraces and river banks on cobbles with silt, sand.	Smaller streams in upper potions of watershed.	S3
Riverine Scour Community	Community characterized by sparse to dense herbaceous and graminoid vegetation that includes a great number and variety of species. Community composition shaped by frequent scour from ice and water and variable seed sources.	Island heads, bars, spits, low terraces and river banks on various substrate, especially cobble and sand.	Throughout on all order streams.	S4
Water Willow Emergent Bed	Community of emergent vegetation dominated, often exclusively, by water willow.	Island heads, edges of bars, terraces and spits on variable substrate.	Throughout on all order streams.	S5
Lizard's Tail Emergent Bed	Communities of emergent vegetation dominated, often exclusively, by lizard's tail.	Island heads, edges of bars, terraces or channels, often on sand or silt with cobbles.	Moderate size streams and rivers.	S4

INTRODUCTION

This study is the second watershed-wide effort focused on documenting and classifying floodplain wetlands in the Pennsylvania portion of the Susquehanna River Basin. The first study (WPC/TNC 2002) considered forested floodplain wetlands within the basin while this study considers non-forested floodplain wetlands, many adjacent to and thereby successionally affiliated with the forested portions of numerous floodplains.

Riverine communities represent some of the most dynamic natural communities studied. The structure and species composition of riparian vegetation constitute fundamental elements of the diversity of riparian ecosystems (Toner and Keddy 1997). Where forested floodplain wetlands have been studied and are documented to provide a unique habitat for numerous species of breeding and migratory birds, invertebrates, amphibians, reptiles and mammals (Doherty and Grubb 2002, Jones et al 1999, Zalewski et al 2001), non-forested riparian wetland areas have received less attention, possibly because of their transient nature and seasonally difficult access.

Floodplain communities ultimately respond to the cycles of flow and flooding within their drainages whether produced by natural and anthropogenic influences. Direct manipulation and, in some cases, elimination of floodplains for agriculture, residential, industrial and commercial development, and drainage impoundments have substantially altered or eliminated entire floodplain complexes. These disturbances lead to profound changes in the structure and species composition of riparian vegetation, altering the fundamental elements of diversity in the riparian ecosystems (Toner and Keddy 1997). In addition, fragmented floodplain areas are less effective ecological buffers between upland and riverine ecosystems. This affects landscape-level processes such as nutrient transport, biomass export, sediment sequestration and export, and energy flow (Kreutzweiser and Capell 2001, Smart et al 2001, Diamond and Serveiss 2001, Sponseller et al 2001).

Perhaps the most pervasive and persistent changes in the structure and dynamics of floodplain communities are caused by alterations in flow associated with dredging, dams, reservoirs, levees and dikes. Dredging and damming can reduce peak flows by deepening channels and holding water back during normally high flow periods. The reduction of peak flows and augmentation of low flows promotes succession from herbaceous wetlands to wooded wetland types (Toner and Keddy 1997). Reservoir impoundments increase the duration and depth of flooding in riparian areas upstream of the impoundment and reduce flood frequency and duration downstream, leading to rapid and permanent changes in plant community type and composition (Deiller et al 2001, Shafroth et al 2002). Levees, dikes, and other flood control structures can amplify flood flows, by increasing the volume of water being funneled downstream during storm events. Such large-level flow alterations also have profound effects on nutrient input, levels of sedimentation, and the spread of exotic species. Ultimately, flow regulation can alter the disturbance and stress regimes that structure riparian ecosystems (Shafroth et al 2002).

Together, flow alteration, direct disturbance, nutrient input, increased levels of sedimentation, and exotic species lead to profound changes in the composition of natural communities and the loss of linkages and contiguity of floodplains within basins. For those organisms that complete their entire

life-cycle within a small area such as an island or cobble shore, loss of connecting habitat can isolate and possibly reduce vitality of populations.

River floodplain landscapes are diverse and dynamic, yet little is known about long-term changes in land-cover patterns in these systems (Freeman et al 2002). Anthropogenic disturbances to floodplain plant communities contribute to the loss of habitat and the reduction of contiguity between habitats. For those organisms that complete their entire life-cycle within a small riparian area such as an island or cobble shore, the loss of adjacent habitat can potentially reduce the viability of populations.

The continued threats to the remaining floodplain communities in the Susquehanna River Watershed and the importance of these plant communities to the ecological health of the river emphasize the need to identify and document the remaining high quality examples of floodplain communities. Through this study, we will identify the non-forested vegetation communities affiliated with floodplain wetlands and document the diversity and abundance of insect and small mammal assemblages that utilize these communities. This information will be used to update the natural community classification for Pennsylvania – Terrestrial and Palustrine Plant Communities of Pennsylvania (Fike 1999). This study complements previous work by the Pennsylvania Natural Heritage Program investigating forested floodplain wetlands (WPC/TNC 2002) as well as floodplain community classification projects in other states in the northeastern United States. The results of this project will provide much needed information to help guide efforts to conserve biodiversity, high quality examples of floodplain communities, and functional natural landscapes in Pennsylvania.

PURPOSE

Assessing and monitoring the ecological integrity of wetlands and promoting wetland conservation were identified as priorities in the 2003 EPA guidelines on wetland grants to local governments (US EPA 2002). It is impossible to assess or monitor the ecological integrity of a group of wetlands and related communities without fundamental baseline data to define and characterize specific community types. In particular, baseline data on species composition and structure is conspicuously lacking for non-forested floodplain wetlands in Pennsylvania.

The Terrestrial and Palustrine Plant Communities of Pennsylvania (Fike 1999) describes two floodplain shrubland communities and three floodplain herbaceous communities. However, little quantitative data exist to elucidate and refine these community types. The variation, geographic extent, quality, rarity and value of these plant community types and their associated organisms have yet to be determined.

It is this type of baseline information that this project collected. These data will be entered into the Pennsylvania Natural Diversity Inventory database maintained by the Pennsylvania Natural Heritage Program (PNHP) and will be available for use by a variety of stakeholders to identify,

investigate and protect the floodplain wetlands remaining in the Susquehanna River Basin. The development community, state agencies, conservation groups and environmental consultants will be able to use these data to consider possible conflicts or assess various impacts during project planning stages. Also, this information will be combined with that generated from projected future studies of floodplains in the remaining major watersheds in Pennsylvania to fully represent and classify the range of floodplain community types within the state. This study is the second watershed-wide effort focused on documenting and classifying floodplain wetlands in the Pennsylvania portion of the Susquehanna River Basin. The first study (WPC/TNC 2002) investigated forested floodplain wetlands within the basin and identified five forested floodplain community types.

The Western Pennsylvania Conservancy (WPC) and The Nature Conservancy (TNC) were primarily responsible for the data collection, analysis and production of this report. The Department of Conservation of Natural Resources (DCNR) provided administration, consultation and assistance during the reconnaissance phase of the project. In addition to the work performed by the PNHP partner organizations (WPC, TNC, and DCNR), the Carnegie Museum of Natural History (CMNH) participated integrally in the study, sharing data collection responsibilities and providing insect specimen identification and curation.

METHODS

Site Selection

In the early stages of this study, we performed aerial surveys over the majority of the Susquehanna River watershed, including the main stem from the Maryland border to Sunbury, PA, the West Branch, the North Branch and the Juniata. We also flew over and observed other major tributaries including: Sinnemahoning Creek, Pine Creek, Kettle Creek, Towanda Creek, Mehoopany Creek, Tunkhannock Creek, Shermans Creek, Mahoning Creek, Conodoguinet Creek, Octoraro Creek, Codorus Creek, Swatara Creek, Conewago Creek and others. Aerial surveys identified potential non-forested floodplain wetlands and stream reaches that contained a diversity of minimally anthropogenically altered shrub- and herbaceous-dominated floodplains.

Criteria for site selection included: 1) sizable non-forested floodplain wetland community or complex of communities; 2) areas subjected to frequent flooding as indicated by scour lines, flooding debris, or sediment deposits; and 3) dominance of native plant species. The vegetation sampling sites were stratified across the four TNC ecoregions, as well as the major drainages and tributaries in the Susquehanna River watershed (Figures 1 and 2, Table 1). Detailed location information and general descriptions of the sites sampled as part of this study can be found in Appendix I.

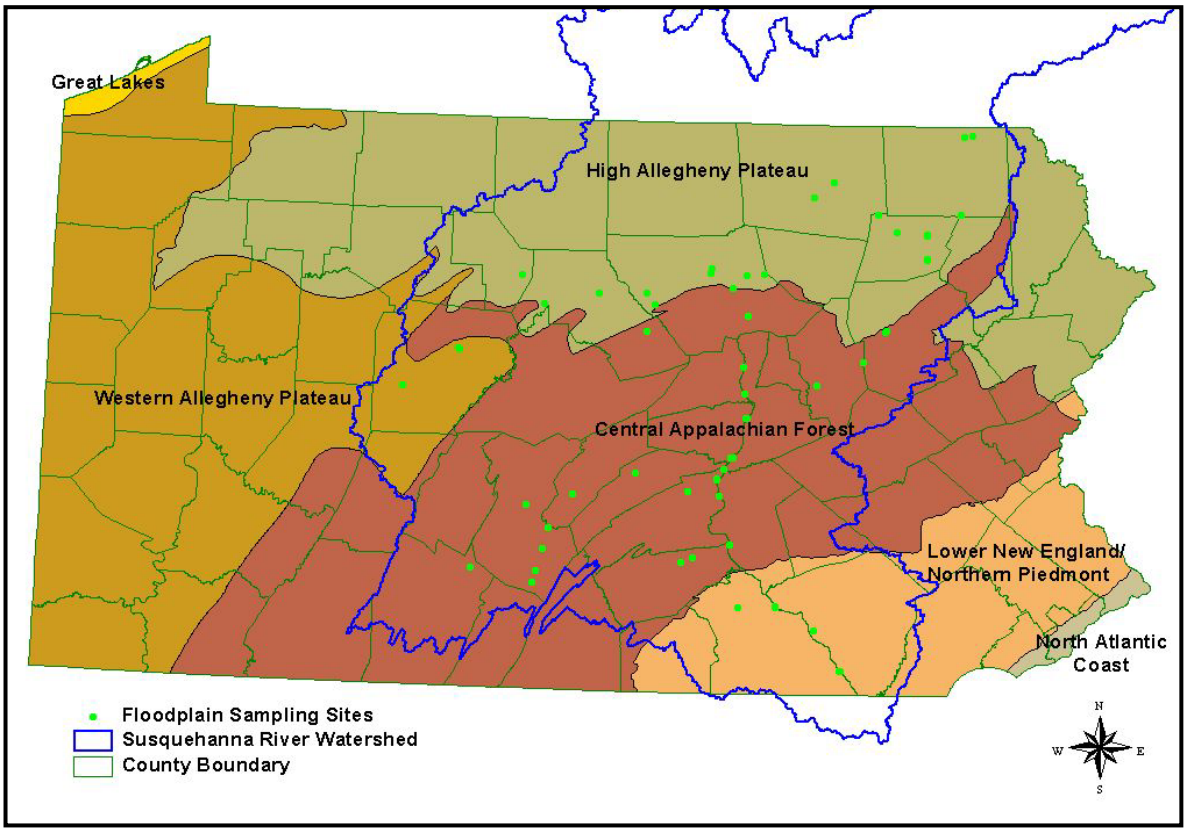

Figure 1. Ecoregional map of Pennsylvania showing locations of 50 floodplain wetland sampling sites in the Susquehanna River watershed.

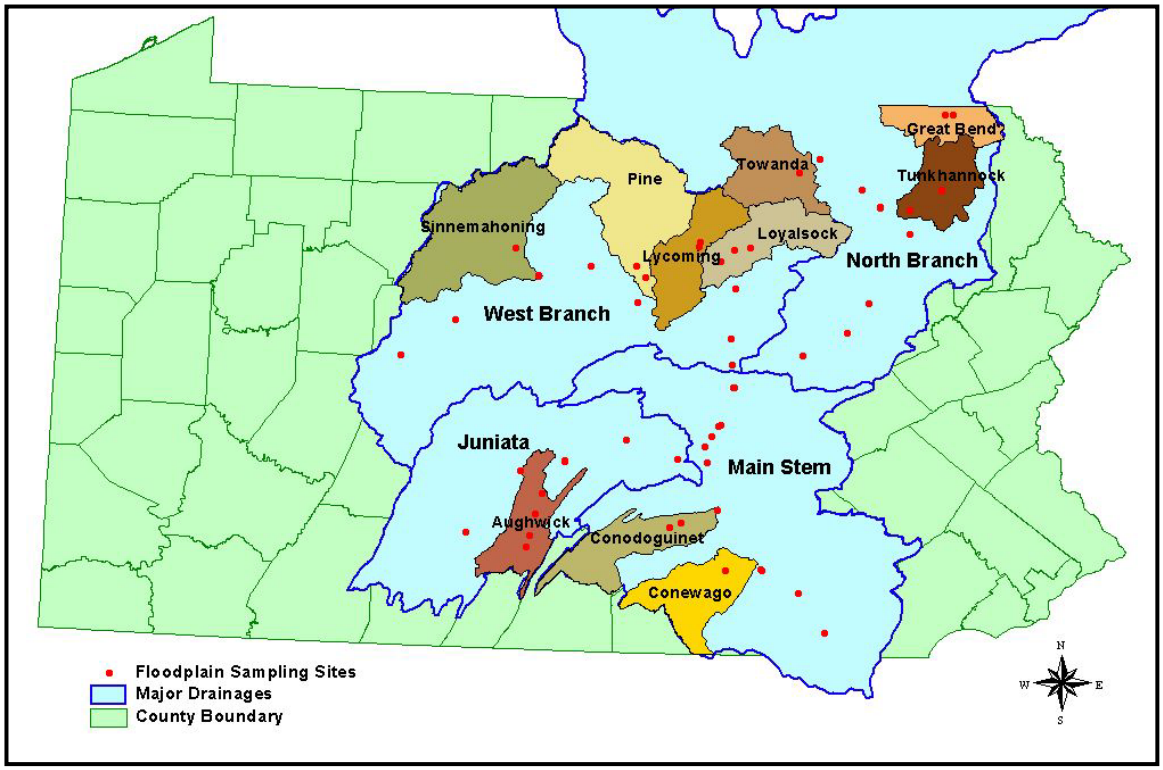

Figure 2. Major drainages and selected tributaries within the Susquehanna watershed, showing the locations of 50 floodplain wetland sampling sites.

Table 1. The distribution of vegetation plots sampled across TNC Ecoregions and river sections within the Susquehanna River watershed

ECOREGION	RIVER SECTION	# PLOTS	TOTAL
Lower New England/ Northern Piedmont			**9**
	Main Stem of the Susquehanna River	8	
	Conewago Creek	1	
Central Appalachian Forest			**55**
	Main Stem of the Susquehanna River	20	
	Condoquinet Creek	3	
	Juniata River	11	
	North Branch of the Susquehanna River	6	
	West Branch of the Susquehanna River	9	
	Augwick Creek	6	
High Allegheny Plateau			**46**
	Great Bend section of the North Branch	5	
	North Branch Susquehanna River	10	
	Tunhannock Creek	4	
	Towanda Creek	3	
	Sinnemahoning Creek	6	
	West Branch of the Susquehanna River	4	
	Loyalsock Creek	6	
	Lycoming Creek	4	
	Pine Creek	4	
Western Allegheny Plateau			**5**
	West Branch of the Susquehanna River	5	
Grand Total			**115**

During the 2003 field season, we visited many of the areas that we selected from aerial reconnaissance as well as some floodplains with which we had direct experience from our previous work on forested floodplains (WPC/TNC 2002). We collected data from 102 plots, representing 43 sites. During the 2004 field season, we sampled an additional 13 vegetation plots representing 7 sites, focusing on major drainages that were not sampled in the first season.

From the vegetation sampling sites, we selected six sites distributed across the four ecoregions for insect and small mammal surveys. Detailed descriptions and topographic maps of the six sites are located in Appendix I, however brief descriptions are provided below. The plot numbers for the vegetaion plots sampled at each site are also listed.

Green's Island (EPA 2.112) is located in Lake Clarke in the lower reaches of main stem of the Susquehanna River. Near the town of Central Manor in Lancaster County, this site

falls within the Lower New England / Lower Piedmont Ecoregion (see Appendix I, p.116).

Milton State Park (EPA 2.21, 2,22) is a fairly large island in the main stem of the Susquehanna River. It is located near the town of Milton, on the borders of Union and Northumberland Counties in the Central Appalachian Forest ecoregion (see Appendix I, p.75).

Byer's Island (EPA 2.4, 2.5) is a moderately sized island located in the main stem of the Susquehanna River. The island is located near the town of Sunbury on the border of Snyder and Northumberland Counties in the Central Appalchain Forest ecoregion (see Appendix I, p.69).

Loyalsock Creek site (EPA 2.29, 2.30, 2.31) is a small island in the Loyalsock Creek, near Barbours, Sullivan County in the High Allegheny Plateau ecoregion (see Appendix I, p.79).

Fulmer's Secret (EPA 2.61) is a fairly large island in the North Branch of the Susquehanna River. Near the town of Towanda, Bradford County, the island falls within the High Allegheny Plateau ecoregion (see Appendix I, p.92).

Shawville site (EPA 2.40, 2.41) is located in the West Branch of the Susquehanna River, near the town of Shawville, Clearfield County in the Western Allegheny Plateau ecoregion (see Appendix I, p 84).

Vegetation Sampling

All vegetation data were collected following accepted Natural Heritage sampling protocols developed for the quantitative characterization of plant communities (Strakosch-Walz 2000). For shrub-dominated community types, releve sampling plots of 10m x 10m (100 m^2) were used, and for open herbaceous community types, 5m x 5m (25m^2) plots were used. Plots were established non-randomly to be representative of the community (Mueller-Dombois and Ellenberg 1974). When site conditions did not allow for square plot configurations, rectangular plots were used of dimensions that provided the standard area specified for shrub and herbaceous community types. Each plot was sampled one time during the growing season between June and September. The bulk of the vegetation data were collected during intensive sampling windows of several consecutive weeks.

Estimated cover values based on the Braun-Blanquet method were recorded by strata for each vascular plant species present. The following strata were used: "subcanopy" for trees > 5m in height, "tall shrub" for woody plants 2 – 5m in height, "short shrub" for woody plants <2m in height, "herbaceous" for herbaceous vegetation, and "vines" for plants exhibitng vine growth forms. Bryophytes were seldom encountered and not sampled during this study. Any plants that could not be positively identified in the field were collected for later identification. Collected specimens were deposited in the herbarium of the Carnegie Museum of Natural History in Pittsburgh. Substrate

type, soil drainage, topographic position, and hydrologic regime were also evaluated on site as part of the standard data collection procedure. Using a hand level and a survey staff incremented in hundredths of a foot, the height of the plot above the water level was recorded. The date and time of this measurement were also recorded in order to link water levels at the study site to corresponding water levels reported at local stream gauges. This information allowed the estimation of the flood frequency and duration for each site. All plots were georeferenced with a Garmin 3+ connected to a MBX-3 differential beacon or a Trimble Pocket Pathfinder with a Beacon on a Belt.

Vegetation Data Analysis

The vegetation plot data were analyzed using several multivariate statistical techniques available in PC-ORD software (ver 3.0, MjM Software Design). Different techniques were employed to provide multiple lines of evidence from which to interpret the results. For a detailed discussion of the statistical techniques used in this study, please refer to McCune and Grace (2002).

To classify the plot data into vegetation communities, a hierarchical agglomerative cluster analysis was performed on the species' percent cover data using Ward's linkage method and Euclidean distance measure. Cluster analysis creates groups by sequentially merging sample units into larger groups. A two-way indicator species analysis (TWINSPAN) was also performed with the species' percent cover data. TWINSPAN successively divides the plots into groups that are similar in species composition (Hill and Gauch 1979). A non-metric multidimensional ordination analysis (NMS) was also performed using both the species' percent cover data and the environmental variables from the plots. NMS is an ordination technique well suited to non-normal data sets (Kruskal and Wish 1978). In this analysis, Sorensen distance measure, a random starting configuration, and a stability criterion of 0.005 were employed. Forty runs were performed with the real data, with a maximum of 400 iterations. A multi-response permutation procedure (MRPP) was also performed on the plots' environmental variables to determine if the differences between the vegetation communities classified by the cluster analysis and NMS were statistically significant. In the MRPP, Euclidean distance measure was used to analyse the groups defined by cluster analysis, while Sorensen distance measure was used to analyse the groups created from the NMS.

Mammal Sampling

The presence and diversity of small mammals (mice, voles, and shrews) was assessed at five sites in the Susquehanna watershed: Green's Island, Loyalsock Creek, Byer's Island, Milton State Park, and Fulmer's Secret. At each site, a single line of 25 trap stations was established through the available floodplain wetland communities. Stations were spaced at 20m intervals, and each station consisted of one pitfall trap with three Museum Special snaptraps. At three sites, cobble substrate and ground water saturation prevented the use of pitfall traps. In these stations, four Museum Special snaptraps were employed. All lines were run for three nights, weather and water levels permitting. The maximum and minimum air temperature and the amount of precipitation were recorded each day. The dominant vegetation was also described at each station. The traps were checked once daily with the sex, age, and species of each specimen recorded. All specimens were identified and processed in the field. Once prepared, specimens

will be installed into the mammal collection at the Pennsylvania State Museum under Accession Number 2003.30.

The presence and diversity of bats was also assessed at three of the five sites (Byer's Island, Milton State Park and Loyalsock Creek). Between two and four sets of ground-level mist nets, 4-6 m wide x 6 m high, were employed at each site. Nets were opened at dusk and closed at midnight. The air temperature, humidity and moon phase were recorded at the beginning of each trap session. The dominant vegetation was also described at each net. The sex, age, and species of each captured bat were recorded along with allometric measurements. All bats were released after trap sessions were completed. A SKYE bat detector was also used to informally assess bat activity during the trap sessions.

Insect Sampling

The diversity and abundance of insects utilizing non-forested floodplain communities were assessed at six sites in the Susquehanna watershed: Green's Island, Loyalsock Creek, Byer's Island, Milton State Park, Fulmer's Secret, and Shawville. Each site was sampled during twelve visits between April and October 2004 at approximately two-week intervals, conditions permitting.

Collection methods consisted of pitfall trapping, blacklight trapping and hand-collecting. Traps were oriented along the gradient of physiognomic vegetation zones from just above the water level to the highest elevation on the site that still fell within a non-forested wetland community type. Distance from trap to the water's edge, air temperature, and general information about the wind, precipitation, and cloud cover were recorded for each trap when they were set and retrieved. General information on the height and percent cover of each vegetation stratum was also recorded for each trap. In the event of inundation, traps were reestablished as close as possible to previous locations.

Pitfall trap collection

At low water level, pitfalls arrays of 10-12 traps were established across each site with an average of three to four traps set per physiognomic vegetation zone. A larger number of traps per zone were set if fewer zones were available due to water levels or individual site characteristics. Within each physiognomic zone, traps were placed in a variety of microhabitats. Pitfall traps contained propylene glycol for field preservation. During each visit, the entire contents of each trap was collected, strained, placed in large whirl-pak bags, and preserved in 80% ethanol. Specimens from pitfall traps located in the same physiognomic zone were pooled for each visit.

Blacklight trap collection

During each visit, two blacklight traps were established with one trap placed in the lower topographic reach of the site, and the other in the upper topographic reach of the site. The sites were trapped during the darker phases of the moon to ensure that the light trap was most effective in attracting insects. No trapping was conducted within one week of the full moon. The traps were operated over one night and the contents were collected the following morning.

Specimens were transferred to heavy, one-gallon plastic bags and placed in a cooler on ice. Upon return from the field, specimens were frozen and stored.

Hand-Collection

To augment the pitfall and blacklight trapping, we employed hand-collecting during each visit. This technique consisted of sweep-netting across the site and within all vegetation types for a 15-minute period followed by hand-picking of beetles in a variety of microhabitats for 15 minutes. Collecting methods for beetles included splashing water onto the exposed substrate immediately adjacent to the water edge, carrying water and pouring it over the substrate away from the water's edge, turning over rocks, pulling apart driftwood piles, pulling apart wet vegetation around pools and on bank undercuts, and treading on vegetation/algal mats in shallow water. An aspirator was used to assist with beetle collection. If time permited, an aerial net was used to collect flying insects (odonata, lepidoptera, etc.). Most insects collected by hand were placed in whirl-pak bags with 80% ethanol. Odonata and lepidoptera were placed dry in glycine envelopes and placed in a cooler. Dry specimens were placed in ziplock bags (unzipped) and frozen upon return from the field.

All samples were sent to Carnegie Museum of Natural History where determinations to species were performed, whenever possible. Species counts were recorded for selected groups, primarily within the orders Lepidoptera, Diptera and Coleoptera. Carnegie Museum assumes responsibility for the curation of the specimens.

Insect Data Analysis

Entomologists at the Carnegie Museum of Natural History summarized the insect data by sampling site, phenology, and ascension number. Although these summaries are not included in this report due to their volume, they are available upon request.

In order to determine if the insects were correlated to sampling sites or to the floodplain vegetation communities defined in this study, several analyses were performed. First, the data were divided by trap method, so that data collected from pitfall traps, blacklight traps, and hand collections were analyzed separately. For pitfall traps and blacklight traps, the variable analyzed was the number of specimens collected of each species per trap, in order to standardize sampling effort across sites and physiognomic zones. Several non-metric multidimensional ordination analyses (NMS) were performed to compare the differences in the insect assemblages by physiognomic vegetation zone and sampling site. In these analyses, Sorensen distance measure, a random starting configuration, and a stability criterion of 0.005 were employed. Forty runs were performed with the real data, with a maximum of 400 iterations.

RESULTS

Floristics

Over 262 species of vascular plants representing 180 genera and 73 families were recorded within releve plots over the course of this study (Table 2). Nomenclature follows Rhoads and Block (2000). Six families – Asteraceae, Cyperaceae, Lamiaceae, Poaceae, Polygonaceae and Rosaceae – accounted for about 37% of the genera and 45% of the species identified within the sampling plots. The herbaceous and graminoid species that occurred in the largest number of plots (as indicated) included: *Lythrum salicaria* (56), *Boehmeria cylindrica* (41), *Justicia americana* (39), *Phalaris arundinacea* (38) and *Apocynum cannabinum* (34). The most frequently occurring short shrub species were: *Salix nigra* (38), *Platanus occidentalis* (38), *Betula nigra* (33), and *Acer saccharinum* (32). The tall shrub species that occurred in the largest number of plots (as indicated) included: *Platanus occidentalis* (35), *Betula nigra* (28) and *Salix nigra* (18).

Table 2. Vascular plants identified in non-forested floodplain wetland communities in the Susquehanna River watershed.

Family	Scientific Name
Acanthaceae	Justicia americana
Aceraceae	Acer negundo
	Acer rubrum
	Acer saccharinum
Alismataceae	Sagittaria latifolia
Anacardiaceae	Rhus typhina
	Toxicodendron radicans
	Toxicodendron vernix
Apiaceae	Angelica atropurpurea
	Cryptotaenia canadensis
	Daucus carota
	Hydrocotyle americana
	Pastinaca sativa
	Sium suave
Apocynaceae	Apocynum androsaemifolium
	Apocynum cannabinum
Araceae	Arisaema triphyllum
Asclepiadaceae	Asclepias incarnata
	Asclepias syriaca
Asteraceae	Achillea millefolium
	Ambrosia trifida
	Artemisia vulgaris
	Aster ericoides
	Aster lateriflorus
	Aster prenanthoides
	Aster umbellatus
	Bidens connata
	Bidens coronata
	Bidens frondosa
	Centaurea maculosa
	Coreopsis major
	Erechtites hieracifolia
	Eupatorium album
	Eupatorium fistulosum
Asteraceae (cont.)	Eupatorium maculatum
	Eupatorium perfoliatum
	Eupatorium rugosum
	Eupatorium serotinum
	Euthamia graminifolia
	Galinsoga ciliata
	Helenium autumnale
	Heliopsis helianthoides
	Hieracium canadense
	Matricaria matricarioides
	Rudbeckia laciniata
	Senecio aureus
	Solidago gigantea
	Solidago juncea
	Solidago rugosa
	Tanacetum vulgare
	Tussilago farfara
	Verbesina alternifolia
	Vernonia noveboracensis
	Xanthium chinense
Balsaminaceae	Impatiens capensis
Berberidaceae	Berberis thunbergii
Betulaceae	Alnus incana ssp. rugosa
	Alnus serrulata
	Betula nigra
Bignoniaceae	Catalpa speciosa
Boraginaceae	Myosotis scorpioides
Brassicaceae	Alliaria petiolata
	Erucastrum gallicum
	Erysimum cheiranthoides
	Nasturtium officinale
	Rorippa sylvestris
Campanulaceae	Campanula americana
	Campanula aparinoides
	Lobelia cardinalis

Table 2. Vascular plants of the Susquehanna River non-forested floodplain wetlands (cont.)

Family	Scientific Name
Campanulaceae (cont.)	Lobelia inflata
Cannabaceae	Humulus lupulus
Caprifoliaceae	Lonicera tatarica
	Sambucus canadensis
Caryophyllaceae	Cerastium tomentosum
	Saponaria officinalis
	Stellaria pubera
Celastraceae	Celastrus orbiculatus
Chenopodiaceae	Chenopodium spp.
Clusiaceae	Hypericum ellipticum
	Hypericum mutilum
	Hypericum perforatum
	Hypericum punctatum
	Hypericum pyramidatum
	Triadenum virginicum
Convolvulaceae	Convolvulus spp.
	Convolvulus sepium
Cornaceae	Cornus amomum
	Cornus sericea
Cuscutaceae	Cuscuta spp.
	Cuscuta gronovii
Cyperaceae	Carex intumescens
	Carex lacustris
	Carex torta
	Cyperus bipartitus
	Cyperus strigosus
	Eleocharis acicularis
	Eleocharis tenuis
	Rhynchospora sp.
	Schoenoplectus pungens
	Scirpus cyperinus
Dipsacaceae	Dipsacus sylvestris
Dryopteridaceae	Dryopteris intermedia
	Onoclea sensibilis
Elaeagnaceae	Elaeagnus umbellata
Equisetaceae	Equisetum arvense
Euphorbiaceae	Acalypha rhomboidea
	Chamaesyce maculata
	Euphorbia corollata
Fabaceae	Amphicarpaea bracteata
	Apios americana
	Coronilla varia
	Gleditsia triacanthos
	Lotus corniculatus
	Robinia pseudoacacia
	Senna hebecarpa
Gentianaceae	Gentiana sp.
Hydrocharitaceae	Elodea sp.
Iridaceae	Iris pseudacorus
Juncaceae	Juncus canadensis
	Juncus effusus
Lamiaceae	Glechoma hederacea
	Leonurus cardiaca
	Lycopus americanus
	Lycopus uniflorus
	Mentha arvensis
	Nepeta cataria
	Prunella vulgaris
	Pycnanthemum virginianum
	Scutellaria lateriflora
	Teucrium canadense
Lauraceae	Lindera benzoin
Lemnaceae	Lemna minor

Table 2. Vascular plants of the Susquehanna River non-forested floodplain wetlands (cont.)

Family	Scientific Name
Linaceae	Linum virginianum
Lythraceae	Ammannia coccinea
	Lythrum salicaria
	Rotala ramosior
Magnoliaceae	Liriodendron tulipifera
Malvaceae	Abutilon theophrasti
	Hibiscus laevis
Melastomataceae	Rhexia virginica
Menyanthaceae	Nymphoides peltata
Molluginaceae	Mollugo verticillata
Oleaceae	Fraxinus nigra
	Fraxinus pennsylvanica
Onagraceae	Circaea quadrisulcata var. canadensis
	Epilobium glandulosum
	Ludwigia alternifolia
	Ludwigia palustris
	Oenothera biennis
	Oenothera fruticosa
Oxalidaceae	Oxalis stricta
Phytolaccaceae	Phytolacca americana
Plantaginaceae	Plantago major
Platanaceae	Platanus occidentalis
Poaceae	Agrostis sp.
	Andropogon gerardii
	Bromus sp.
	Dactylis glomerata
	Digitaria sanguinalis
	Echinochloa muricata
	Elymus virginicus
	Festuca sp.
	Leersia oryzoides
Poaceae (cont.)	Leersia virginica
	Microstegium vimineum
	Muhlenbergia sylvatica
	Panicum capillare
	Panicum clandestinum
	Panicum rigidulum
	Paspalum sp.
	Phalaris arundinacea
	Poa annua
	Setaria geniculata
	Setaria italica
	Sorghastrum nutans
	Spartina pectinata
Polygonaceae	Polygonum amphibium
	Polygonum arifolium
	Polygonum cespitosum
	Polygonum cuspidatum
	Polygonum hydropiper
	Polygonum lapathifolium
	Polygonum pensylvanicum
	Polygonum perfoliatum
	Polygonum persicaria
	Polygonum sagittatum
	Polygonum scandens
	Polygonum virginianum
	Rumex crispus
	Rumex obtusifolius
	Rumex orbiculatus
	Rumex salicifolius
Pontederiaceae	Heteranthera dubia
Primulaceae	Lysimachia ciliata
	Lysimachia nummularia
	Lysimachia terrestris
	Lysimachia vulgaris
Ranunculaceae	Caltha palustris
	Clematis virginiana
	Ranunculus hispidus
	Thalictrum sp.
Rhamnaceae	Rhamnus cathartica

Table 2. Vascular plants of the Susquehanna River non-forested floodplain wetlands (cont.)

Family	Scientific Name
Rosaceae	Agrimonia gryposepala
	Duchesnea indica
	Geum canadense
	Geum laciniatum
	Physocarpus opulifolius
	Potentilla canadensis
	Potentilla simplex
	Rosa multiflora
	Rubus allegheniensis
	Rubus idaeus
	Rubus odoratus
	Rubus phoenicolasius
	Spiraea alba
	Spiraea tomentosa
Rubiaceae	Cephalanthus occidentalis
	Galium aparine
	Galium asprellum
	Galium mollugo
	Galium obtusum
	Galium palustre
	Galium tinctorium
Salicaceae	Populus deltoides
	Salix discolor
	Salix eriocephala
	Salix exigua
	Salix fragilis
	Salix lucida
	Salix nigra
	Salix sericea
Saururaceae	Saururus cernuus
Scrophulariaceae	Digitalis sp.
	Linaria vulgaris
Scrophulariaceae (cont.)	Lindernia dubia
	Mimulus ringens
	Scrophularia lanceolata
Simaroubaceae	Ailanthus altissima
Smilacaceae	Smilax herbacea
Solanaceae	Datura stramonium
	Physalis subglabrata
	Solanum carolinense
	Solanum dulcamara
Thelypteridaceae	Thelypteris palustris
Typhaceae	Typha latifolia
Ulmaceae	Ulmus americana
Urticaceae	Boehmeria cylindrica
	Laportea canadensis
	Pilea pumila
	Urtica dioica
Verbenaceae	Verbena hastata
	Verbena urticifolia
Violaceae	Viola sp.
	Viola lanceolata
Vitaceae	Parthenocissus quinquefolia
	Vitis sp.
	Vitis riparia

Vegetation Community Classification

To classify the plot data into vegetation communities, several multivariate statistical techniques were employed. The cluster analysis yielded a dendrogram with 8.75% chaining and identified 10 different community groups (Figure 3). Nine of these groups were easily interpreted and identified, however, the largest group was heterogeneous and included a variety of vegetation types. The nine groups were identified as: Sycamore – Mixed Hardwood Riverine Shrubland, Silver Maple (River Birch) – Mixed Hardwood Riverine Shrubland, Black Willow – Mixed Hardwood Riverine Shrubland, River Birch (Sycamore) – Mixed Hardwood Riverine Shrubland, Sedge – Spotted Joe Pye Weed Riverine Herbaceous Vegetation, Reed Canary Grass Riverine Grassland, Purple Loosestrife Riverine Scour Vegetation, Water Willow Emergent Bed and Lizard's Tail Emergent Bed. A MRPP indicated that the groups created by the cluster analysis were significantly different from one another ($T = -5.10$, $A = 0.09$, $p = 0.0002$). The TWINSPAN of species data identified nine different groups; however, these groups could not be interpreted as ecologically meaningful communities.

The largest group identified by the cluster analysis contained 52 plots dominated by tall shrubs, dwarf shrubs, herbs, and graminoids. Further cluster analyses performed on this group yielded dendrograms with percents chaining that exceeded 30%, invalidating the results. An NMS of data from these plots also yielded no significant ordination. Given that these analyses were not elucidating, we consulted the existing Pennsylvania community classification for guidance in grouping by vegetation types.

The Pennsylvania classification separates communities by their physiognomy (e.g. forest, woodland, shrubland, herbaceous). Using these categories, we separated the plots into three physiognomic categories: tall shrublands, dwarf shrublands and herbaceous-graminoid communities. Each category was then analyzed separately in an attempt to classify the remaining 52 undifferentiated plots.

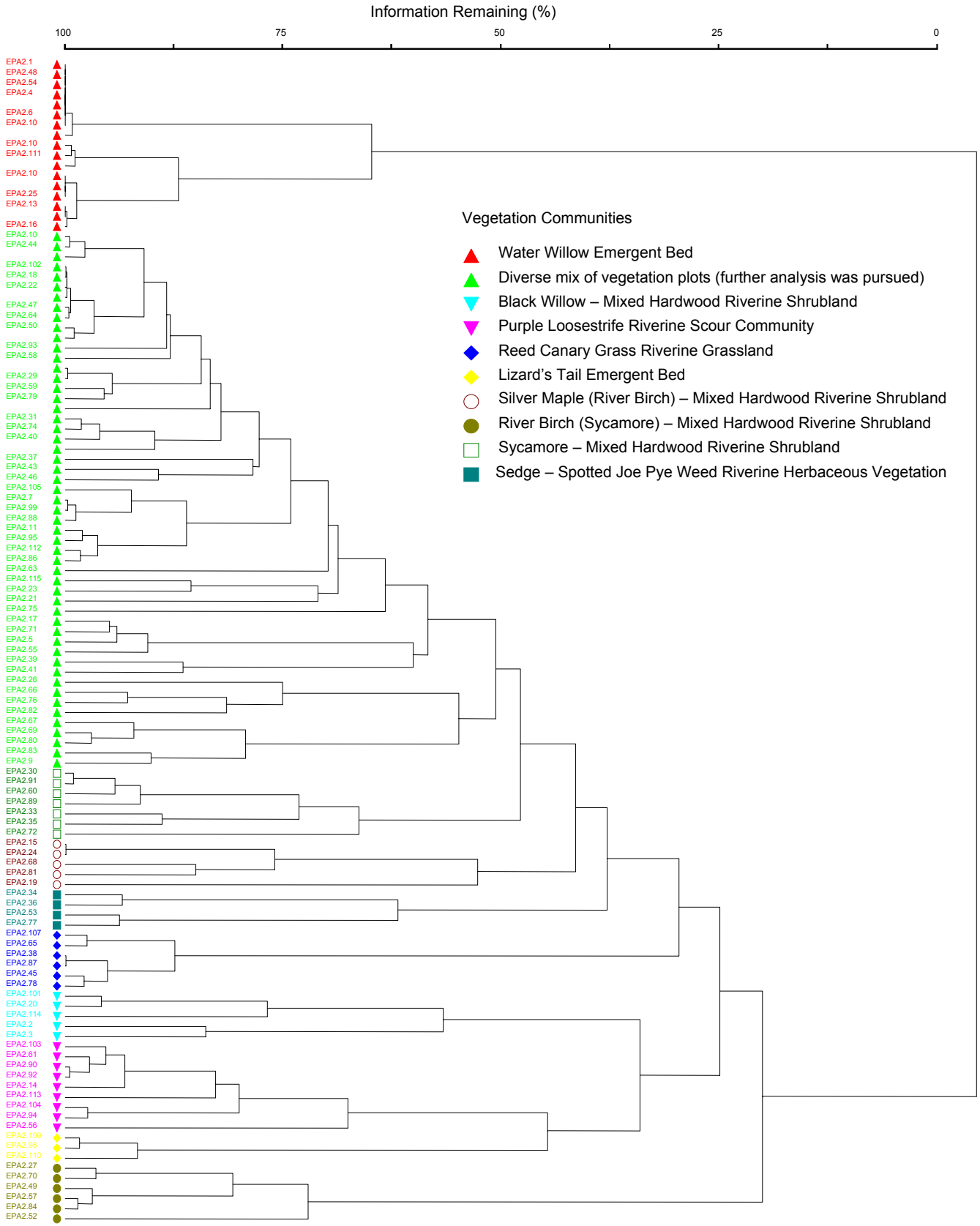

Figure 3. Cluster analysis dendrogram showing the grouping of vegetation plot data into nine vegetation communities and one undifferentiated group.

In the tall shrub category, all plots were covered by shrubs 2 to5 m in height over at least 25% of their area. Thirty-eight plots fell into this category. An NMS performed on data from these 38 plots yielded a three dimensional ordination in which all axes were significant (p=0.0196). The cumulative r^2 for all three axes equaled 0.781 (axis 1, r^2=0.177; axis 2, r^2=0.241; axis 3, r^2=0.363). The resulting ordination diagram (Figure 4) indicated 6 communities: Sycamore – Mixed Hardwood Riverine Shrubland, Silver Maple (River Birch) – Mixed Hardwood Riverine Shrubland, Black Willow – Mixed Hardwood Riverine Shrubland, River Birch (Sycamore) – Mixed Hardwood Riverine Shrubland, Mixed Hardwood Riverine Shrubland, and Speckled Alder Floodplain Shrubland. Of these, the first four were also identified by the cluster analysis. Figure 4 shows all three axes illustrating that the Silver Maple (River Birch) – Mixed Hardwood Riverine Shrubland is differentiated from the Mixed Hardwood Riverine Shrubland along axis 1, while the River Birch (Sycamore) – Mixed Hardwood Riverine Shrubland differentiates from the Mixed Hardwood Riverine Shrubland along axis 2.

The dwarf shrub category encompassed 12 plots, all which contained shrubs less than 2 m in height that covered at least 25% of the area. An NMS was also performed on the short shrub plot data. The resulting ordination had three significant axes (p<0.392; Figure 5) and suggested three groups: Sycamore (Willow) – Mixed Hardwood Riverine Dwarf Shrubland, Willow – Indian Grass Riverine Shrubland and Silky Dogwood Palustrine Shrubland. The cumulative r^2 for all three axes equaled 0.816 (axis 1, r^2=0.149; axis 2, r^2=0.254; axis 3, r^2=0.413).

The herbaceous – graminoid category contained 65 plots, each dominated by herbaceous or graminoid species with less than 25% cover by any shrub species. The initial cluster analysis identified the following groups: Sedge – Spotted Joe Pye Weed Riverine Herbaceous Vegetation (5 plots), Reed Canary Grass Riverine Grassland (4 plots), Purple Loosestrife Riverine Scour Vegetation (6 plots), Water Willow Emergent Bed (19 plots), Lizard's Tail Emergent Bed (5 plots), and one undifferentiated group of 26 plots. Further analysis confirmed these grouping, however, no analyses provided additional information on the undifferentiated group of 26 plots. These plots were then analyzed separately. A cluster analysis of these data resulted in a dendrogram with extremely high chaining (66%). A TWINSPAN of these 27 plots yielded 4 groups, none of which could be interpreted as ecologically significant. An NMS was also performed on data from these plots. Similar to the TWINSPAN results, the groups created on the NMS ordination diagram could not be interpreted as ecologically meaningful communities. The removal of low frequency species is a common data adjustment that often clarifies evenly scattered NMS results. However, even after the removal of all species that only occurred in a single plot (frequency = 1), the subsequent NMS ordination diagram was evenly distributed. These four inconclusive analyses suggested that these 26 plots belonged to one broadly defined group: Riverine Scour Vegetation.

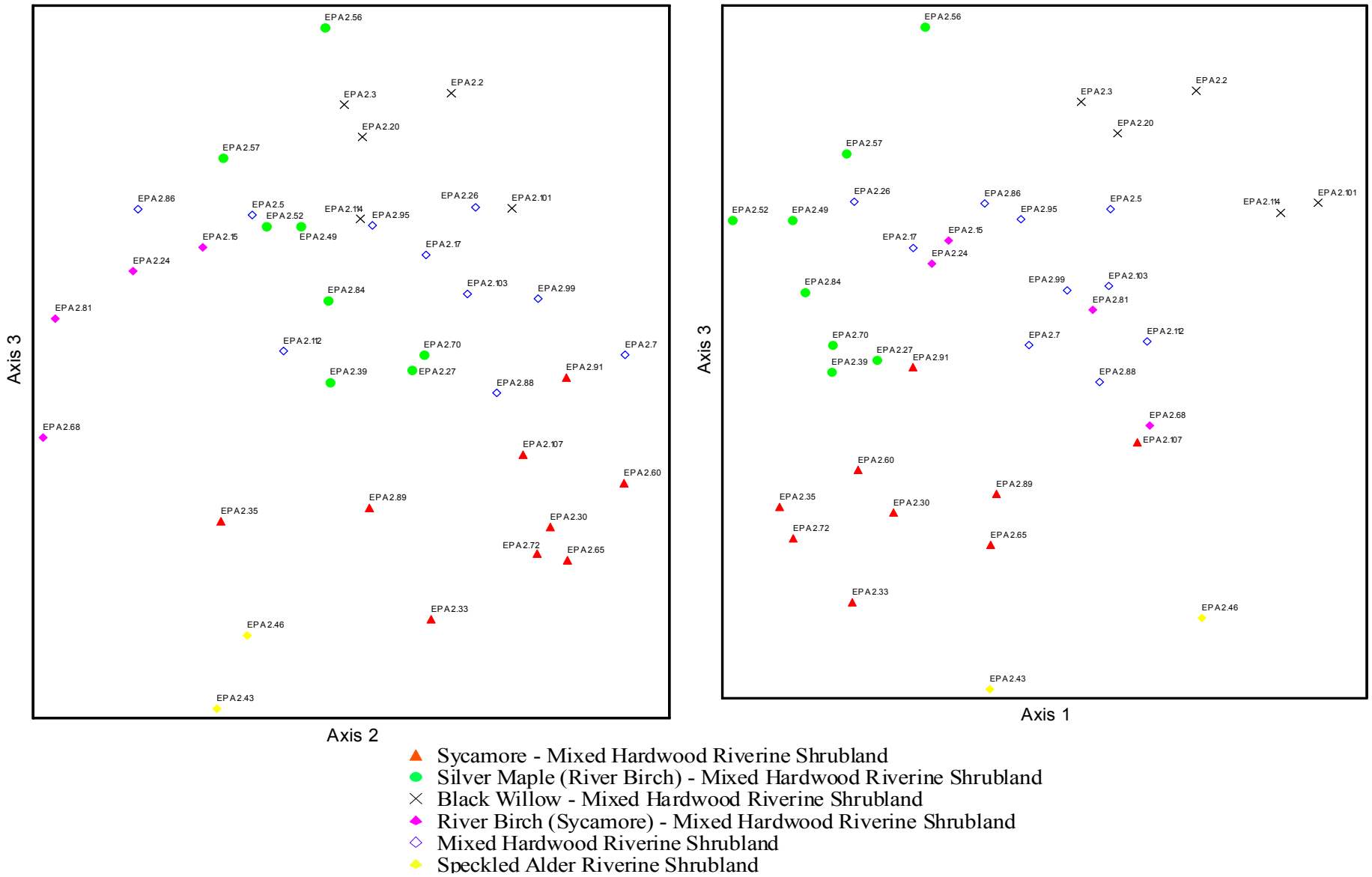

Figure 4. Three-dimensional NMS ordination of 38 plots showing 6 tall shrub-dominated riverine communities. All axes are statistically significant (p=0.0196) with a cumulative r^2 for all three axes equal to 0.781.

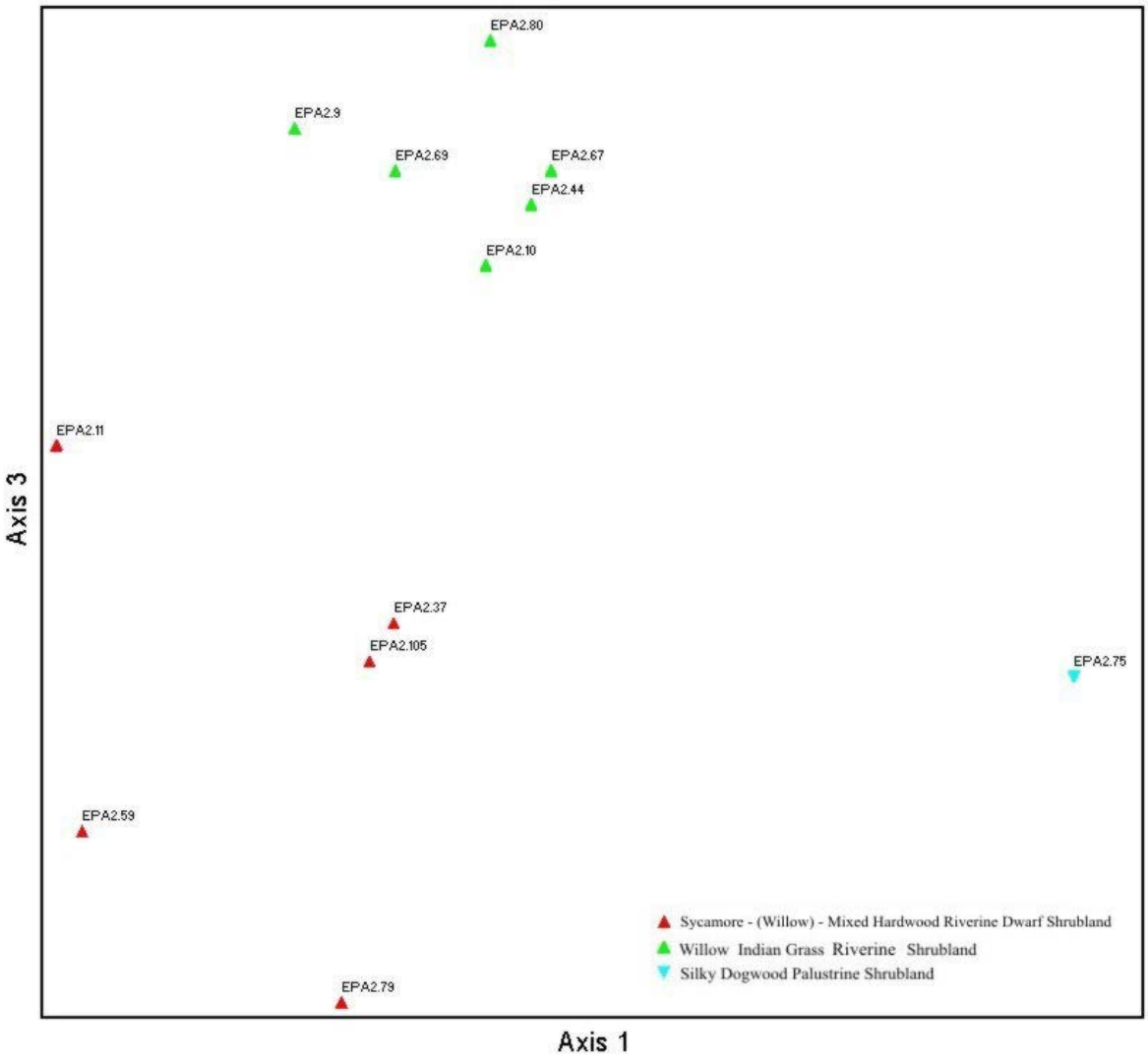

Figure 5. An NMS ordination of 12 plots with significant axes ($p<0.392$) showing three riverine dwarf shrubland communities. The cumulative r^2 for the three axes equals 0.816.

The analyses described above identified 15 non-forested riverine communities. Once group membership had been assigned to all 115 plots, a MRPP indicated that these groups were significantly different from one another ($T = -7.10$, $A = 0.16$, $p = 0.000001$).

An NMS was also performed using data from all study plots. The resulting ordination diagrams (Figure 6) had three significant axises ($p=0.0196$) with the cumulative r^2 for all three axises equal to 0.409 (axis 1, $r^2=0.127$; axis 2, $r^2=0.125$; axis 3, $r^2=0.158$). Axis 1 tended to correlate with percent cover of open water, percent cover of herbaceous species, number of species, height above water, and distance to water. Axis 2 tended to correlate with latitude, longitude and percent cover of tall shrubs. Axis 3 tended to correlate with height above water, number of species and the percent cover of wood, litter, tall shrubs, short shrubs, and herbaceous species.

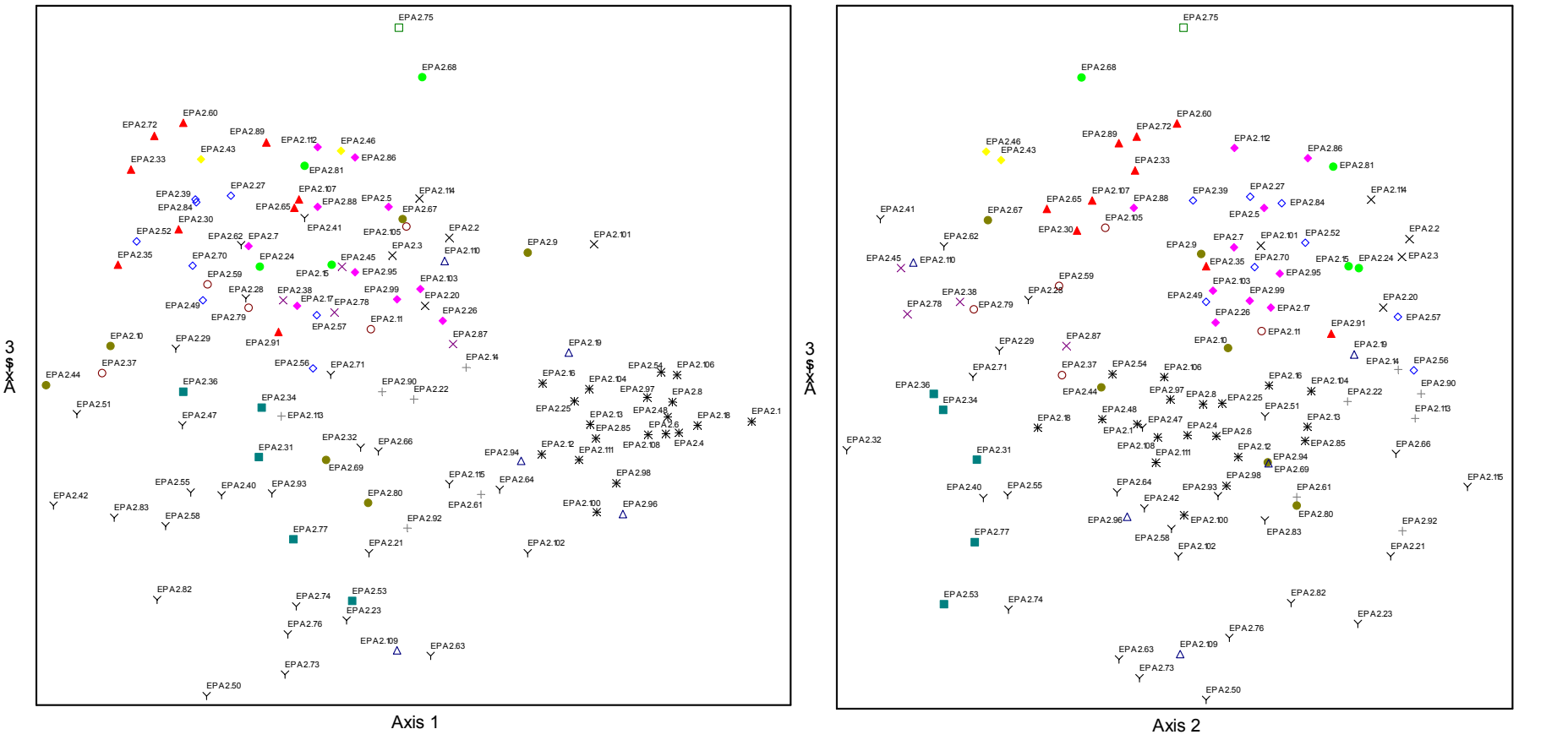

Figure 6. Three-dimensional NMS ordination of 115 plots showing 15 potential riverine communities. All axes are significant (p=0.0196), with the cumulative r^2 for the three axes equal to 0.409.

Plant Community Descriptions

The vegetation data analyses identified 15 non-forested floodplain communities, 13 of which are described in detail below. The environmental setting, characteristic vegetation, distribution, and reference locations of each community are discussed. Each community is also assigned a state rank (see Appendix II for conservation rank definitions). Locations of high quality examples and a crosswalk to a National Vegetation Classification Association are also provided. Two of the 15 identified communities, Silky Dogwood Palustrine Shrubland and Purple Loosestrife Riverine Scour Vegetation, are not included in the following descriptions due to insufficient data or dominance by an invasive species (see discussion section).

SYCAMORE – MIXED HARDWOOD RIVERINE SHRUBLAND

General Description / Ecological Processes: This sycamore-dominated floodplain shrubland typically occurs on intermediate and smaller order tribuaries to the Susquehanna River. They are subject to frequent floods, high stream velocity and ice scour. Sites commonly occur on cobble bars and sand/gravel bars that are adjacent to or contiguous with the riverbank. The Riverine Scour Community or an area of bare cobbles often separates the shrubland from the flowing water. In cases where the bar is attached to the shoreline, a steep forested slope or high terrace floodplain forest typically occurs on the riverbank adjacent to the shrubland. The sycamore shrubland can also occur towards the heads of islands in between dwarf shrublands or herbaceous communities and the floodplain forest.

Characteristic Vegetation: This community is characterized by a thick layer of tall shrubs, dominated by *Platanus occidentalis* (sycamore) that covers at least 30% of the community. *Platanus occidentalis* can also be present as a sparse tree subcanopy. In the West Branch, the co-dominant tall shrub is typically *Salix eriocephala* (diamond willow) or *Salix sericea* (silky willow). In the North Branch of the Susquehanna River and in the Juniata River, common co-dominants are *Acer saccharinum* (silver maple), *Populus deltoides* (cottonwood) and *Betula nigra* (river birch). Similar shrub species are also found in the sparse to dense short shrub layer, along with *Rubus idaeus* (red raspberry), *Ulmus americana* (American elm), *Acer negundo* (box elder), *Cornus sericea* (red-osier dogwood) and *Cephalanthus occidentalis* (buttonbush). The herbaceous layer ranges from sparse to moderately dense and can contain a wide variety of typical wetland and prairie species. Common species include: *Phalaris arudinacea* (reed canary grass), *Solidago gigantea* (smooth goldenrod), *Panicum clandestinum* (deer-tongue grass), *Boehmeria cylindrica* (false nettle), *Pilea pumila* (clearweed), *Eupatorium maculatum* (spotted joe pye weed) and *Verbesina alternifolia* (wingstem). Vines such as *Clematis virginiana* (virgin's bower), *Convolvulus sepium* (hedge bindweed) and *Vitis spp.* (grapevine) are often found throughout this tall sycamore-dominated shrubland. This community is highly susceptible to colonization by *Polygonum cuspidatum* (Japanese knotweed), *Rosa multiflora* (multifloral rose), *Lythrum salicaria* (purple loosestrife), *Coronilla vaira* (crownvetch) and other invasive plants.

Distribution: Entire state

State Rank: S4

High Quality Examples: EPA2.35, EPA2.60, EPA2.65.

National Vegetation Classification Association: Betula nigra - Salix (interior, caroliniana) Shrubland (CEGL003896)

Sources: PNHP field surveys

Reference Locations: EPA2.30, EPA2.33, EPA2.35, EPA2.60, EPA2.65, EPA2.72, EPA2.89, EPA2.91, EPA2.107.

RIVER BIRCH (SYCAMORE) – MIXED HARDWOOD RIVERINE SHRUBLAND

General Description / Ecological Processes: This community occurs along the West Branch and the North Branch of the Susquehanna Riveron islands, bars, and low terraces. The soil is sand and silt, often combined with cobbles. These areas are subject to frequent floods, high stream velocity and ice scour. This community typically occurs immediately down stream or inland from the Willow – Indian Grass Riverine Shrubland or Riverine Scour Vegetation. Floodplain forest is often adjacent to the River Birch – Mixed Hardwood Riverine Shrubland, but at slightly higher elevations.

Characteristic Vegetation: This community is characterized by a dense, tall shrub layer, dominated by *Betula nigra* (river birch) that covers greater than 30% of the community. *Platanus occidentalis* (sycamore) can be co-dominant in the tall shrub layer, with associates *Salix nigra* (black willow), *Acer saccharinum* (silver maple) and *Fraxinus nigra* (black ash). All of the species found in the tall shrub layer may be present in the sparse short shrub layer along with *Populus deltoides* (cottonwood) and a wide variety of tree seedlings. The herbaceous layer can be sparse or dense and contains many typical prairie and wetland species including: *Eupatorium fistulosum* (Joe pye weed), *Sorghastrum nutans* (indian grass), *Andropogon gerardii* (big bluestem), *Oxalis stricta* (wood sorrell), *Leersia virginica* (cut grass), *Spartina pectinata* (prairie cordgrass), *Apocynum cannabinum* (indian hemp), *Hypericum pyramidatum* (great St. John's wort), *Panicum clandestinum* (deer tongue grass), *Bidens frondosa* (beggar's ticks), *Bidens commutata* (beggar's tick) and *Eupatorium perfoliatum* (boneset). Vines are rare to absent, however, the most common vine species are *Vitis riparia* (riverbank grape) and *Clematis virginiana* (virgin's bower). This community is also susceptible to invasion by *Lythrum salicaria* (purple loosestrife) and *Polygonum cuspidatum* (Japanese knotweed).

Distribution: High Allegheny Plateau and upper portions of the Central Appalachian Forest

State Rank: S4

High Quality Examples: EPA2.27, EPA2.70, EPA2.84.

National Vegetation Classification Association: Betula nigra - Salix (interior, caroliniana) Shrubland (CEGL003896)

Sources: PNHP field surveys

Reference Locations: EPA2.27, EPA2.39, EPA2.49, EPA2.52, EPA2.56, EPA2.57, EPA2.70, EPA2.84.

MIXED HARDWOOD RIVERINE SHRUBLAND

General Description / Ecological Processes: This community is found on the main stem, the lower portions of the intermediate tributaries and the upper watershed of the Juniata. It occurs on islands, low terraces and bars separated from the river bank by shallow backwater channels. The soil under this community varies, typically composed of sand, silt and gravel, with some cobbles. The Mixed Hardwood Riverine Shrubland occurs between the Riverine Scour Vegetation and the floodplain forest. Located towards the heads of islands or along low terraces, this community is subject to frequent floods, high stream velocity and ice scour.

Characteristic Vegetation: A dense, tall shrub layer characterizes this community, however, no single species is dominant. The vast majority of the tall shrub layer is composed of a mix of two or more of the following species: *Betula nigra* (river birch), *Platanus occidentalis* (sycamore), *Salix nigra* (black willow) and *Acer saccharinum* (silver maple). All of the species found in the tall shrub layer may be present in the sparse to moderately dense short shrub layer. The herbaceous layer can also be sparse to moderately dense and contains a wide diversity of herbaceous and graminoid species associated with wetlands. Some common species are: *Onoclea sensibilis* (sensitive fern), *Apocynum cannabinum* (indian hemp), *Justicia americana* (water willow), *Boehmeria cylindrica* (false nettle), *Panicum clandestinum* (deer tongue graass), *Phalaris arudinacea* (reed canary grass), *Solidago gigantea* (smooth goldenrod), *Apios americana* (ground nut), *Leersia orzoides* (rice cut grass) and *Lysimachia vulgaris* (garden loosestrife). *Vitis riparia* (riverbank grape) is the most common vine, although it is typically sparse or absent. This community is also frequently colonized by *Lythrum salicaria* (purple loosestrife).

Distribution: Central Applachian Forest and Lower New England/Northern Piedmont

State Rank: S4

High Quality Examples: EPA2.7, EPA2.26, EPA2.88, EPA2.112.

National Vegetation Classification Association: Betula nigra - Salix (interior, caroliniana) Shrubland (CEGL003896)

Sources: PNHP field surveys

Reference Locations: EPA2.5, EPA2.7, EPA2.17, EPA2.26, EPA2.86, EPA2.88, EPA2.95, EPA2.99, EPA2.103, EPA2.112.

BLACK WILLOW – MIXED HARDWOOD RIVERINE SHRUBLAND

General Description / Ecological Processes: This community is found in the lower portion of the Susquehanna Watershed on small and large islands in the river's main stem. The black willow floodplain shrubland is the typically found on the downstream ends of most small islands in the lower Susquehanna drainage. They are subject to frequent floods. However, these areas are likely to experience less ice scour and lower stream velocity than vegetation types on island heads. Due to the reduced stream velocity, the substrates characteristic of this community tend to contain predominantly silt, sand, clay and loam, with little gravel and cobbles. This type is also associated with the heads of large islands between herbaceous- or graminoid-dominated communities and the floodplain forest.

Characteristic Vegetation: A dense tall shrub layer of *Salix nigra* (black willow) covers greater than 30% of the area characterizes this community. Other common tall shrubs include: *Salix lucida* (shining willow), *Betula nigra* (river birch) and *Acer saccharinum* (silver maple). The sparse shrub layer, if present, contains the same species that are found in the tall shrub layer. The herbaceous layer can be sparse or dense and contains *Lythrum salicaria* (purple loosestrife), *Cuscuta gronovii* (common dodder), *Impatiens capensis* (jewelweed), *Lysimachia vulgaris* (garden loosestrife), *Justicia americana* (water willow), *Convolvulus sepium* (hedge bindweed), *Boehmeria cylindrica* (false nettle), *Polygonum amphibium* (water smartweed), and other common herbaceous wetland species.

Distribution: Western Allegheny Plateau, Central Applachian Forest and Lower New England/Northern Piedmont.

State Rank: S4

High Quality Examples: EPA2.101.

National Vegetation Classification Association: Betula nigra - Salix (interior, caroliniana) Shrubland (CEGL003896)

Sources: PNHP field surveys

Reference Locations: EPA2.2, EPA2.3, EPA2.20, EPA2.101, EPA2.114

SILVER MAPLE (RIVER BIRCH) – MIXED HARDWOOD RIVERINE SHRUBLAND

General Description / Ecological Processes: This community is found on the intermediate tributaries and main stem of the Susquehanna River and is subject to frequent floods, high stream velocity and ice scour. Silver maple shrublands commonly occur on low terraces of the river bank and towards the heads of river islands on silt and sand. On islands, the tall shrubland is

located in between the Sycamore (Willow) – Mixed Hardwood Riverine Dwarf Shrubland or Willow – Indian Grass Riverine Shrubland and the floodplain forest.

Characteristic Vegetation: A dense, tall shrub layer dominated by *Acer saccharinum* (silver maple) that covers at least 30% of the area is characteristic of this community. Other species, including *Betula nigra* (river birch), *Platanus occidentalis* (sycamore), *Salix nigra* (black willow) and *Fraxinus pennsylvanica* (green ash) may also be present in the tall shrub layer. The short shrub layer is typically sparse and consists of the same species found in the tall shrub layer. The herbaceous layer is sparse to moderately dense and can contain a variety of wetland and weedy upland species. The most common species are: *Leersia virginica* (cutgrass), *Polygonum amphibium* (water smartweed), *Convolvulus sepium* (hedge bindweed), *Boehmeria cylindrica* (false nettle), *Euphorbia supina* (spurge), *Solanum carolinense* (horsenettle), (*Xanthium strumarium* (common cocklebur), *Echinochloa muricata* (barnyard grass) and *Elymus virginicus* (Virginia wild rye). Vines, predominantly *Vitis riparia* (riverbank grape), can cover up to 40% of the area. Invasive species such as *Lythrum salicaria* (purple loosestrife) and *Polygonum cuspidatum* (Japanese knotweed) often invade this community.

Distribution: Entire State

State Rank: S4

High Quality Examples: EPA2.24, EPA2.68.

National Vegetation Classification Association: Betula nigra - Salix (interior, caroliniana) Shrubland (CEGL003896)

Sources: PNHP field surveys

Reference Locations: EPA2.15, EPA2.24, EPA2.68, EPA2.81

SPECKLED ALDER RIVERINE SHRUBLAND

General Description / Ecological Processes: This community occurs in the upper portion of the West Branch of the Susquehanna River on smaller order streams. The alder-dominated shrubland is found on broad cobble flats within the active channel, typically surrounded by and separated from the low-flow channel by Riverine Scour Vegetation. The Speckled Alder Riverine Shrubland is subject to frequent flooding, high stream velocity and ice scour since it occurs within the active stream channel.

Characteristic Vegetation: The tall shrub layer is moderately dense to dense and is dominated by *Alnus incana ssp. rugosa* (speckled alder). *Salix nigra* (black willow), *Physocarpus opulifolius* (eastern ninebark) and *Cornus amomum* (silky dogwood) are also commonly found in the tall shrub layer. Similar species occur in the sparse short shrub layer along with *Spiraea tomentosa* (steeple-bush) and *Rosa multiflora* (multifloral rose). The moderately dense, diverse herbaceous layer contains many wetland species, such as *Phalaris arudinacea* (reed canary grass), *Panicum*

clandestinum (deer tongue grass), *Leersia virginica* (cut grass), *Solidago gigantea* (smooth goldenrod), *Carex intumescens* (sedge), *Elymus virginicus* (Virginia wild rye), *Glechoma hederacea* (ground ivy), *Teucrium canadensis* (American germander) and *Galium aparine* (bedstraw). *Vitis riparia* (riverbank grape) is often found scattered throughout this community. This community is also susceptible to invasion by *Polygonum cuspidatum* (Japanese knotweed), *Microstegium viminium* (Japanese stilt grass) and *Rosa multiflora*.

Distribution: Western Allegheny Plateau and High Allegheny Plateau

State Rank: S3S4

High Quality Examples: EPA2.46.

National Vegetation Classification Association: Alnus serrulata – Physocarpus opulifolius Shrubland (CEGL006251)

Sources: PNHP field surveys

Reference Locations: EPA2.43, EPA2.46.

SYCAMORE (WILLOW) – MIXED HARDWOOD RIVERINE DWARF SHRUBLAND

General Description / Ecological Processes: This community is found on the small and intermediate tributaries and the upper main stem of the Susquehanna. Most occurrences of this community type are located on low terraces and bars attached to river banks, however, the community can occur on islands as well. The substrate is predominantly cobbles along with sand and gravel. Due to the flooding, high stream velocity and ice scour to which these areas are frequently exposed, the majority of the shrubs remain short statured (<2m in height). This community occurs between the Riverine Scour Vegetation and the floodplain forest along low terraces and toward island heads.

Characteristic Vegetation: This community is characterized by a moderately dense to dense short shrub layer less than 2 m in height. The species composition of the short shrub layer is mixed and varied, with no one species consistently dominating the community. Stunted individuals of *Platanus occidentalis* (sycamore) may be codominant, along with one or more species of *Salix,* including: *S. nigra* (black willow), *S. eriocephala* (diamond willow), *S. lucida* (shining willow), *S. fragilis* (crack willow) and *S. sericea* (silky willow). Other woody species typical of this community are *Acer saccharinum* (silver maple), *Populus deltoides* (cottonwood), *Betula nigra* (river birch), *Acer rubrum* (red maple), along with such shrubs as *Rubus allegheniensis* (common blackberry) and *R. phoenicolasius* (wineberry). Individual tall shrubs (2-5 m in height) of the same species may be scattered throughout the shrubland. The herbaceous layer can be sparse to dense and contains a wide diversity of herbaceous and graminoid species. Some common species are: *Phalaris arudinacea* (reed canary grass), *Eupatorium maculatum* (spotted joe pye weed), *Solidago gigantea* (smooth goldenrod), *Euthamia gramnifolia* (grass-leaved goldenrod), *Equisetum arvensis* (field horsetail), *Boehmeria cylindrica* (false nettle), *Panicum clandestinum*

(deer tongue grass), *Elymus virginicus* (Virginia wild rye), *Eupatorium perfoliatum* (boneset), *Onoclea sensibilis* (sensitive fern) *Justicia americana* (water willow), and *Lysimachia ciliata* (fringed loosestrife). Vines are rare to absent; the two species commonly found in this community are *Vitis riparia* (riverbank grape) and *Clematis virginiana* (virgin's bower). This community is also frequently colonized by *Lythrum salicaria* (purple loosestrife) and *Rosa multiflora* (multifloral rose).

Distribution: High Allegheny Plateau and Central Appalachian Forest

State Rank: S4

High Quality Examples: EPA2.105.

National Vegetation Classification Association: Salix nigra / Carex torta Temporarily Flooded Shrubland (CEGL006065)

Sources: PNHP field surveys

Reference Locations: EPA2.11, EPA2.37, EPA2.59, EPA2.79, EPA2.105.

WILLOW – INDIAN GRASS RIVERINE SHRUBLAND

General Description / Ecological Processes: This community occurs along the North Branch, the West Branch and the upper portions of the main stem of the Susquehanna River. On island heads and river bars, this community is typically found on sand mixed with cobbles situated between the Riverine Scour Vegetation and tall shrub communities or forest. These areas tend to be drier and droughtier due to the slightly higher elevation and rapidly draining, sandy substrate. In times of high water , these areas are subject to frequent floods, high stream velocity and ice scour. This community represents the transition between herbaceous- or graminoid-dominated areas that may be frequently stripped of vegetation and established shrublands from which the vegetation is rarely completely removed by river processes. On islands with long ecotones, this community can be extensive.

Characteristic Vegetation: This community is characterized by a thick herbaceous and graminoid layer with scattered short shrubs (cover between 25-50%). *Salix exigua* (sandbar willow) and *Salix nigra* (black willow) are typically the dominant short shrubs (<2m in height), with occasional *Platanus occidentalis* (sycamore), *Acer saccharinum* (silver maple), *Acer negundo* (box elder), *Spiraea tomentosa* (steeple-bush), *Cornus amomum* (silky dogwood) and *Gleditsia tricanthos* (honey locust). Scattered individuals of these same species may be present as tall shrubs (2-5 m in height). The scattered shrubs occur in a matrix of dense prairie grasses and forbs. The most common species include: *Sorghastrum nutans* (indian grass), *Andropogon gerardii* (big blue stem), *Apocynum cannabinum* (indian hemp), *Apocynum androsaemifolium* (spreading dogbane), *Lysimachia vulgaris* (garden loosestrife), *Polygonum amphibium* (water smartweed), *Phalaris arundinacea* (reed canary grass), *Justicia americana* (water willow), *Eupatorium album* (white boneset), *Eupatorium fistulosum* (joe pye weed), *Eupatorium*

perfoliatum (boneset), *Euphorbia supina* (spurge), and *Polygonum pensylvanicum* (smartweed). *Vitis riparia* (riverbank grape), the only vine species observed in this community, can be absent or moderately dense. This community is also susceptible to colonization by *Lythrum salicaria* (purple loosestrife).

Distribution: Western Allegheny Plateau, High Allegheny Plateau and upper portions of the Central Appalachian Forest

State Rank: S3

High Quality Examples: EPA2.9, 2.10, EPA2.69.

National Vegetation Classification Association: Prunus pumila / Andropogon gerardii – Sorghastrum nutans Herbaceous Vegetation (CEGL006518) and Andropogon gerardii - Panicum virgatum - Baptisia australis Herbaceous Vegetation (CEGL006283)

Sources: PNHP field surveys

Reference Locations: EPA2.9, EPA2.10, EPA2.44, EPA2.67, EPA2.69, EPA2.80.

REED CANARY GRASS RIVERINE GRASSLAND

General Description / Ecological Processes: This community is typically found on cobble bars attached to the banks of smaller tributaries and in the upper portions of the intermediate tributaries in the Susquehanna watershed. These areas are exposed to frequent floods, high stream velocity and ice scour. An area of bare cobbles often separates this community from the flowing water. Floodplain shrublands typically occur on the inland side of this community.

Characteristic Vegetation: This community is characterized by thick herbaceous and graminoid vegetation, dominated by *Phalaris arundinacea* (reed canary grass). A diverse mix of other herbaceous and graminoid species also persists. Some common species are *Leersia virginica* (cut grass), *Boehmeria cylindrica* (false nettle), *Eupatorium maculatum* (spotted joe-pye weed), *Carex torta* (sedge), *Leersia virginica* (cut grass), *Mentha arvensis* (field mint), *Cyperus spp.* (sedge), *Polygonum hydropiper* (water pepper), *Bidens commutata* (beggar's tick) and *Hydrocotyle americana* (marsh pennywort). A few scattered *Betula nigra* (river birch), *Salix spp.* (willow), *Salix fragilis* (crack willow), *Acer saccharinum* (silver maple) and *Platanus occidentalis* (sycamore) may be present as short shrubs; however, their relative cover does not usually exceed 10%.

Distribution: High Allegheny Plateau and Central Appalachian Forest

State Rank: S5

National Vegetation Classification Association: Phalaris arundinacea Eastern Herbaceous Vegetation (CEGL006044)

Sources: PNHP field surveys

Reference Locations: EPA2.38, EPA2.45, EPA2.78, EPA2.87.

SEDGE – SPOTTED JOE PYE WEED RIVERINE HERBACEOUS VEGETATION

General Description / Ecological Processes: This community is found throughout the smaller tributaries of the West Branch and along the Great Bend on the North Branch of the Susquhanna River. It occurs on island heads, bars, backwater channels, low terraces, and low river banks, areas that experience frequent floods, high stream velocity and ice scour. The soil is typically cobbles mixed with silt, sand, often overlain with a thin layer of muck. Bare cobbles or Riverine Scour Vegetation often separate this community from flowing water. Dwarf shrublands or tall shrublands often occur immediately downstream or inland of this community.

Characteristic Vegetation: Characteristic vegetation for this community is a thick layer of graminoid and herbaceous species with scattered short shrubs. *Carex torta* (sedge) and *Eupatorium maculatum* (spotted joe pye weed) are typically the dominant species, covering between 30-100% of the area. A wide variety of other graminoid and herbaceous species can be present. The most common species are: *Schoenoplectus pungens* (chairmaker's rush), *Phalaris arundinacea* (reed canary grass), *Apocynum cannabinum* (indian hemp), *Apocynum androsaemifolium* (spreading dogbane), *Onoclea sensibilis* (sensitive fern), *Solidago gigantea* (smooth goldenrod), *Lycopus uniflorus* (bugleweed), *Panicum clandestinum* (deer tongue grass), *Equisetum arvense* (field horsetail), *Euthamia graminifolia* (grass-leaved goldenrod), *Viola spp*. (violets), *Leersia virginica* (cut grass), *Boehmeria cylindrica* (false nettle), *Eupatorium perfoliatum* (boneset), *Mentha arvensis* (field mint) and *Hydrocotyle americana* (marsh pennywort). Scattered short shrubs may be present, including *Betula nigra* (river birch), *Salix eriocephala* (diamond willow) and *Lindera benzoin* (spicebush).

Distribution: High Allegheny Plateau

State Rank: S3

High Quality Examples: EPA2.31, EPA2.34, EPA2.36.

National Vegetation Classification Association: Carex torta Herbaceous Vegetation (CEGL004103)

Sources: PNHP field surveys

Reference Locations: EPA2.31, EPA2.34, EPA2.36, EPA2.53, EPA2.77.

RIVERINE SCOUR VEGETATION

General Description / Ecological Processes: This community is found throughout the Susquehanna Watershed, on all orders of streams, and in a wide variety of riverine settings. Island heads, bars, spits, low terraces, and river banks are all home to this broadly-defined community. The underlying substrate also varies greatly, although it is often cobbles and sand, with thin deposits of silt, muck, or organic matter. Species composition also varies greatly from site to site. The unifying factor that bridges the differences in environmental factors and species compostion is the frequent scour that these sites experience. This community establishes in areas of the active channel that are underwater for the majority of the year and are exposed only at low water or in drought years. Therefore, these areas are subjected to high water velocities, floods, and ice scour more frequently than the other herbaceous communities or shrublands described in this report (with the exception of the emergent beds). The constant scour removes established vegetation and maintains or creates exposed sediments, cobbles, or bedrock. New seeds and plant propagules are constantly being dispersed to these areas by water, air, and animals. This causes a continual flux in species composition that is characteristic of this community.

Characteristic Vegetation: Frequent disturbance of these areas creates conditions that promote continual colonization by a wide variety of plants. After a disturbance, herbaceous and graminoid species may establish sparsely across bare substrate. As more time elapses between disturbance events, vegetation can become dense, completely covering the area. The species composition of the community varies depending upon the available seed bank, surrounding vegetation, type of substrate, ecoregion, and hydrologic conditions.

Not all of the species listed below will be present at the same site. In general, species composition at a particular site will tend to favor species either towards the beginning of the list or towards the end of the list. However, many combinations and variations in species composition are possible. Some of the common species are: *Cyperus spp.* (nut sedges), *Equisetum arvense* (field horsetail), *Eleocharis spp.* (spike rush), *Schoenoplectus pungens* (chairmaker's rush), *Juncus spp.* (rush), *Justiticia americana* (water willow), *Sagittaria latifolia* (common arrowhead), *Ludwigia palustris* (water purslane), *Rorippa sylvestris* (creeping yellowcress), *Euphorbia supina* (spurge), *Hydrocotyle americana* (marsh pennywort), *Rhexia virginica* (meadow beauty), *Mollugo verticillata* (carpetweed), *Polygonum amphibium* (water smartweed), *Polygonum pensylvanicum* (pinkweed), *Polygonum hydropiper* (water pepper), *Polygonum sagittatum* (tearthumb), *Polygonum caespitosum* (low smartweed), *Polygonum persicaria* (lady's thumb), *Convolvulus sepium* (hedge bindweed), *Pilea pumila* (clearweed), *Galium spp.* (bedstraw), *Onoclea sensibilis* (sensitive fern), *Leersia oryzoides* (rice cut grass), *Leersia virginica* (cut grass), *Setaria spp.* (foxtail), *Senecio aureus* (golden ragwort), *Epilobium glandulosum* (northern willow herb), *Lysimachia vulgaris* (garden loosestrife), *Lysimachia terrestris* (yellow loosestrife), *Lysimachia ciliata* (fringed loosestrife), *Mimulus ringens* (monkey flower), *Lindernia dubia* (false pimpernel), *Apocynum cannabinum* (indian hemp), *Apocynum androsaemifolium* (spreading dogbane), *Bidens frondosa* (beggar's tick), *Bidens commutata* (beggar's tick), *Boehmeria cylindrica* (false nettle), *Impatiens capensis* (jewelweed), *Hibiscus laevis* (rose mallow), *Lythrum salicaria* (purple loosestrife), *Lycopus uniflorus* (bugleweed), *Lobelia cardinalis* (cardinal flower), *Triadenum virginicum* (marsh St. John's wort), *Hypericum*

mutilum (dwarf St. John's wort), *Hypericum ellipticum* (pale St. John's wort), *Solidago gigantea* (smooth goldenrod), *Soligao rugosa* (rough-stemmed goldenrod), *Euthamia graminifolia* (grass-leaved goldenrod), *Viola spp.* (violet), *Mentha arvensis* (field mint), *Mentha gentilis* (red mint), *Eupatorium perfoliatum* (boneset), *Eupatorium maculatum* (spotted joe-pye weed), *Verbena hastata* (blue vervain), *Verbena urticifolia* (white vervain), *Asclepias incarnata* (swamp milkweed), *Heliopsis helianthoides* (ox-eye), *Coreopsis tinctoria* (plains tickseed), *Aster umbellatus* (flat-topped aster), *Aster lateriflorus* (calico aster), *Pycnanthemum virginianum* (mountain mint), *Carex lacustris* (lake sedge), *Carex torta* (sedge), *Sorghastrum nutans* (indian grass), *Andropogon gerardii* (big blue stem), *Echinochloa muricata* (barnyard grass), *Spartina pectinata* (freshwater cordgrass), *Elymus virginica* (Virginia wild rye), *Phalaris arundinacea* (reed canary grass), *Panicum clandestinum* (deer-tongue grass), *Panicum rigidulum* (panic grass), *Oxalis stricta* (wood sorrel) and *Xanthium strumarium* (common cocklebur). Scattered short shrubs or seedlings such as *Platanus occidentalis* (sycamore), *Betula nigra* (river birch), *Acer saccharinum* (silver maple), *Salix nigra* (black willow), *Salix exigua* (sandbar willow), *Salix eriocephala* (diamond willow), *Salix sericea* (silky willow), *Cornus amomum* (silky dogwood), *Alnus incana* (speckled alder), and *Spiraea tomentosa* (steeple-bush) may also be present and cover up to 10% of the area.

Distribution: Entire State

State Rank: S4

High Quality Examples: EPA2.32, EPA2.42, EPA2.47, EPA2.50, EPA2.51, EPA2.63, EPA2.64, EPA2.82, EPA2.83, EPA2.102.

National Vegetation Classification Association: Lysimachia ciliata – Apocynum cannabinum Sparse Vegetation (CEGL006554)

Sources: PNHP field surveys.

Reference Locations: EPA2.21, EPA2.23, EPA2.28, EPA2.29, EPA2.32, EPA2.40, EPA2.41, EPA2.42, EPA2.47, EPA2.50, EPA2.51, EPA2.55, EPA2.58, EPA2.62, EPA2.63, EPA2.64, EPA2.66, EPA2.71, EPA2.73, EPA2.74, EPA2.76, EPA2.82, EPA2.83, EPA2.93, EPA2.102, EPA2.115.

WATER WILLOW EMERGENT BED

General Description / Ecological Processes: This community is found throughout the Susquehanna Watershed on small and intermediate tributaries and the main stem. Water willow emergent beds occur at the heads of islands, along the edges of bars, banks, terraces, and spits, and in shallow sections of the river channel. Since water willow spreads by rhizomes, they can form extensive monocultural colonies. The lower portion of the water willow stems are under water for most of the year, with the tops of the plants emerging above the flowing water. These beds are entirely submerged by most flood events. During extreme low water periods, the soil

below the beds can be exposed, showing a varied mixture of sand, gravel, cobbles, silt, and/or muck.

Characteristic Vegetation: *Justicia americana* (water willow) is the dominant species in this community, and is often the only species present in an extensive colonial bed. Many other herbaceous species may be present. *Lythrum salicaria* (purple loosestrife), *Lysimachia vulgaris* (garden loosestrife), *Saururus cernuus* (lizard's tail), *Schoenoplectus pungens* (chairmaker's rush), *Leersia oryzoides* (rice cut grass), *Cyperus spp.* (nut sedges) and *Eleocharis spp.* (spike rush) may be present in significant numbers. Scattered individuals of *Equisetum arvense* (field horsetail), *Hibiscus laevis* (rose mallow), *Polygonum amphibium* (water smartweed), *Carex lacustris* (sedge), *Euphorbia supina* (spurge), *Mentha arvensis* (field mint) and *Rorripa sylvestris* (creeping yellowcress) may also be present. A few scattered shrub seedlings may also be present, including *Betula nigra* (river birch), *Salix nigra* (black willow), *Acer saccharinum* (silver maple) and *Platanus occidentalis* (sycamore).

Distribution: Entire state

State Rank: S5

High Quality Examples: EPA2.18, EPA2.97, EPA2.106, EPA2.108.

National Vegetation Classification Association: Justicia americana Herbaceous Vegetation (CEGL004286)

Sources: PNHP field surveys, Fike (1999).

Reference Locations: EPA2.1, EPA2.4, EPA2.6, EPA2.8, EPA2.12, EPA2.13, EPA2.16, EPA2.18, EPA2.25, EPA2.48, EPA2.54, EPA2.85, EPA2.97, EPA2.98, EPA2.100, EPA2.104, EPA2.106, EPA2.108, EPA2.111.

LIZARD'S TAIL EMERGENT BED

General Description / Ecological Processes: This community is found in the Juniata drainage and the smaller tributaries of the main stem in the Ridge and Valley province. The emergent beds typically occur near bars, islands, and river banks, or in shallow portions of the river channel. The soil is often sand and silt with cobbles. The lower portion of the lizard's tail stems are under water for most of the year, with the tops of the plants emerging above the flowing water. These beds are frequently entirely submerged by flood events.

Characteristic Vegetation: *Saururus cernuus* (lizard's tail) is the dominant species in this community, often forming monoculture beds. Many other species may be present, including: *Justicia americana* (water willow), *Polygonum amphibium* (water smartweed), *Ludwigia palustris* (water purslane), *Lythrum salicaria* (purple loosestrife), *Poa annua* (annual bluegrass), *Bohemeria cylindrica* (false nettle), *Pilea pumila* (clearweed), *Lysimachia vulgaris* (garden loosestrife), *Leersia oryzoides* (rice cut grass), *Bidens frondosa* (beggar's tick), *Schoenoplectus*

pungens (chairmaker's rush) and *Cyperus spp.* (sedge). A few scattered *Acer saccharinum* (silver maple) seedlings may also be present.

Distribution: Central Appalachian Forest

State Rank: S4

High Quality Examples: EPA2.96, EPA2.109.

National Vegetation Classification Association: variant of Justicia americana Herbaceous Vegetation (CEGL004286)

Sources: PNHP field surveys

Reference Locations: EPA2.19, EPA2.94, EPA2.96, EPA2.109, EPA2.110.

Mammal Surveys

The five sites were surveyed for small mammals (mice, voles, and shrews) for a total of 1,100 trap-nights. The 133 individuals trapped represented four species, four genera and three families of mammals. Table 3 shows the number of specimens of each species captured at the five sites. Although statistical analysis cannot be performed on the data due to low sample sizes and lack of comparative sampling effort, some general trends can be discussed. Colonizers such as the meadow vole (*Microtus pensylvanicus*) seem to do particularly well at establishing populations on islands regardless of the islands' distance from shore. Meadow voles were the only species captured on Green's Island which sits approximately 0.5 km from the shoreline. Meadow voles also dominated Fulmer's Secret and the Loyalsock Creek site, although both of these sites were relatively near the shoreline. This species, normally an inhabitant of grasslands, can occupy marginal and successional habitats and is able to disperse over long distances throughout a variety of habitats. In the case of the Loyalsock Creek site, they were apparently able to disperse across forested habitat to the grassland/shrub-dominated communities found on the island. These animals most likely populated these islands during winter months when ice forms a bridge to the island from the shore. Flooding events would likely depress the population, which would be reinvigorated with new individuals during the following winter.

Table 3. Number of small mammal specimens captured at 5 sites in the Susquehanna River watershed.

Site	Date	Species Captured				Total Trap-Nights	Total Specimens
		Sorex cinereus	Peromyscus leucopus	Microtus pennsylvanicus	Zapus hudsonius		
Green's Island	6/02/2003			32		300	32
Loyalsock Creek	7/10/2003		7	25	5	300	37
Milton State Park	7/23/2003		9			100	9
Byer's Island	7/23/2003		5	1		100	6
Fulmer's Secret	9/10/2003	11		28	10	300	49
Totals	**Totals**	11	21	86	15	1100	133

Species such as the deer mouse (*Peromyscus maniculatus*), smoky shrew (*Sorex fumeus*) and woodland jumping mouse (*Napaeozapus insignis*) were conspicuously absent from the Loyalsock Creek site. Although this site is separated from the forest only by a shallow swale, none of these forest specialists were found there. These three species are common in the northcentral region of Pennsylvania and were found during previous sampling to the northeast of the Loyalsock Creek site (Hart 1999). The proximity of the island to the surrounding forest communities would seem to promote the occurrence of these species. Both forest and openland specialists have been found to move across the interface between a forest and a clearcut at comparable rates during the early stages of succession (Kirkland et al 1985). However, movement between the forest and island does not seem to be occurring at the Loyalsock Creek site. It is possible that moisture requirements of forest species may not be met on the relatively dry, cobblestone substrate of the island.

The absence of the northern short-tailed shrew (*Blarina brevicauda*) is also of note. This species occupies a wide range of habitats from interior forest in low numbers to grasslands in relatively high numbers. It is likely that the isolation of an island from the mainland restricts the movement of this species since dispersal during winter is negligible due to temperature stress and high mortality (George et al 1986).

Fulmer's Secret contained the greatest diversity of habitats, ranging from grass-lined banks to open forest. The diversity of small mammals on this site was also the largest, with three species captured. It is quite likely that a fourth species, the white-footed mouse, would have been found at Fulmer's Secret had sampling been extended.

Three sites were surveyed for bats for a total of 22 net-hours (Table 4). Five bats were captured, including one northern red bat (*Lasiurus borealis*) and one big brown bat (*Eptesicus fuscus*) at the Loyalsock Creek site, and three little brown bats (*Myotis lucifugus*) - two at the Milton State Park site and one at the Loyalsock Creek site. Based on the SKYE bat detector, bats seemed to

be using the river corridor at all sites at a much higher rate than indicated by mist net captures. The three species of bats encountered during this project are all relatively common residents of Pennsylvania. While the little brown and big brown bats occupy a wide range of habitats ranging from agricultural to deep forest, the red bat is primarily a resident of mature forests (Barbour and Davis 1969). All three species use riparian corridors as both travel and foraging lanes during spring through fall.

Table 4. Summary of bat captures at 3 sites in the Susquehanna River watershed.

				Species			
Site Name	**Date**	**Number of Nets**	**Net-hours**	***Myotis lucifugus***	***Lasiurus borealis***	***Eptesicus fuscus***	Total
Milton State Park	7/24/2003	3	6	2			2
Fulmer's Secret	9/10/2003	2	6				0
Loyalsock Creek	9/17/2003	4	10	1	1	1	3
Total		9	22	3	1	1	5

Insect Surveys

From the six insect sampling sites, 10,506 specimens were recorded, of which 9,412 specimens were identified to species level, representing 759 species. The specimens represented at least 464 genera, 84 families, and 10 orders. The number of specimens and number of species collected is summarized by taxa and by sampling site in Tables 5 and 6, respectively. The majority of the specimens were in the order Coleoptera (66.7%), with the second largest number of specimens in the order Lepidoptera (29.2%). The remaining orders were represented by relatively few specimens (Table 5). The largest number of specimens was collected at Milton State Park, and the most species were recorded from Shawville. The least number of specimens and species were collected at Byer's Island.

Of the Coleoptera, the family Carabidae encompassed the vast majority of the specimens (80% of Coleoptera specimens, 53% of total specimens). The most abundant Coleoptera species were (with number of specimens): *Agonum extensicolle* (348), *Agonum melanarium* (282), *Pterostichus melanarius* (184), *Chlaenius impunctifrons* (174), *Bembidion honestum* (172), *Brachinus cyanipennis* (156), and *Elaphropus tripunctatus* (150). Of the 460 Carabidae species recorded from Pennsylvania, this survey captured specimens of 175 of them (38% of the known fauna), plus an additional 13 species not as yet officially recorded from the state. At least five other species are of great interest for new distribution information or new information on the habitat requirements of these species. Of the 187 Carabidae species collected, 114 (61%) are typical of riparian and various wetland habitats and thus represent a significant assemblage of the state's wetland carabid fauna.

The most abundant Lepidoptera species were (with number of specimens): *Lacinipolia meditata* (63), *Xestia dolosa* (61), *Caenurgina crassiuscula* (53), *Orgyia leucostigma* (48), *Orthodes cynica* (45) and *Spilosoma virginica* (45). Species diversity was highest among the Lepidoptera, however, species diversity in the Coleoptera may be underrepresented given that approximately 767 Coleoptera specimens from 12 different families were not determined to species level. Only 129 Lepidoptera specimens from 4 families were undetermined.

Table 5. Summary by taxa of insect abundance and species diversity data from six sampling sites in the Susquehanna River watershed.

Taxa	**Number of Specimens**	**Percent of Total Specimens**	**Number of Species**	**Percent of Total Species**
Coleoptera	7008	66.7	254	33.4
Carabidae	5599	53.3	187	24.6
Diptera	163	1.5	32	4.2
Heteroptera	24	0.2	undetermined	--
Homoptera	6	0.1	undetermined	--
Hymenoptera	14	0.1	undetermined	--
Lepidoptera	3071	29.2	455	59.9
Megaloptera	9	0.1	2	0.3
Odonata	56	0.5	16	2.1
Orthoptera	5	0.1	undetermined	--
Trichoptera	150	1.4	undetermined	--

Table 6. Summary by site of insect abundance and species diversity data from six sampling sites in the Susquehanna River watershed.

Site	Number of Specimens	% of Total Number of Specimens	Number of Specimens IDed to Species	% of Total Number of Specimens IDed to Species	Number of Species	% of Total Number of Species
Shawville	2,161	20.6	1,907	20.3	414	54.5
Milton State Park	2,193	20.9	2,029	21.6	287	37.8
Loyalsock Creek	1,585	15.1	1,303	13.8	293	38.6
Byers Island	1,112	10.6	1,006	10.7	159	20.9
Green's Island	1,479	14.1	1,399	14.9	183	24.1
Fulmer's Secret	1,976	18.8	1,768	18.8	227	29.9
Total in Survey	10,506		9,412		759	

Pitfall trap, blacklight trap and hand collection data were not significantly different between sampling sites or between physiognomic vegetation zones. Numerous NMS analyses failed to find any significant axes, and cluster analyses resulted in very high percent chaining, indicating little or no structure in the data. Despite separating data within trap type by order and the removal of species with low frequency, analyses found no significant differences among sites or zones.

DISCUSSION

Plant Community Classification

The vegetation data analyses identified 15 non-forested floodplain communities, 13 of which are described in detail above. A summary of the descriptions of these 13 communities is found in Table 7. Typically, these communities occur in riparian complexes created by several contiguous communities. Although there is wide variation among these complexes, the classic example of a riparian complex is a river island with a long vegetation gradient from the water's edge to the forested center of the island (Figure 7). In general, the floodplain communities along this gradient are influenced by several interrelated factors: 1) frequency and duration of flooding, as measured by height above water level at base flow; 2) the amount of energy received from the drainage as either water or ice flow; 3) the relative location of the site within the watershed, as measured by stream order or drainage volume; 4) substrate stability, and 5) available propagules. How these factors interact to create the vegetation communities observed in a riparian complex is discussed below.

The communities found on the waters edge, Water Willow Emergent Bed and Lizard's Tail Emergent Bed, are subjected to long periods of inundation, particularly in the mid and lower reaches of relatively large drainages. Water willow (*Justicia americana*) forms extensive colonies through rhizomes and is able to with stand frequent scour and inundation. In the smaller drainages and upper sections of watersheds, emergent beds tend to be less extensive, due to flashier, shorter-duration flood events and the removal of finer sediment particles.

Immediately above the base water level, the Riverine Scour Vegetation occurs on cobble, sand, and gravel bars. Since these areas are close to base water level, they experience frequent, intense scour. However, the periods of inundation are shorter than that experienced by the emergent beds. The frequent scour by water and ice removes established vegetation, exposes new substrate, and brings new propagules. The shorter periods of inundation allow a wider array of species to establish, particularly those species able to colonize exposed substrate. Continual disturbances and shifting seed sources result in the variable species composition characteristic of this community.

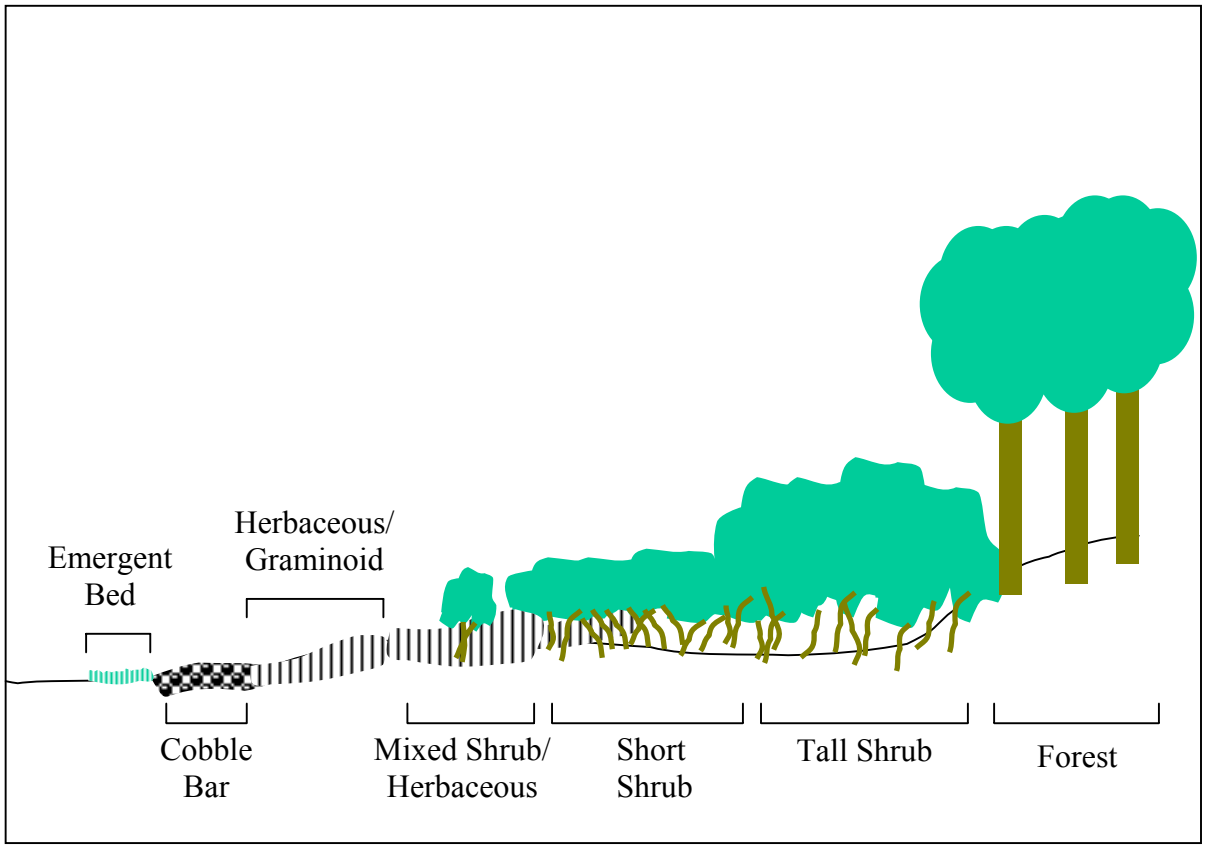

Figure 7. Depiction of a representative riparian complex on a river island with a long vegetation gradient from the water's edge to the forested center of the island.

In the mid to upper reaches of the watershed, graminoid, herbaceous, and dwarf shrub-dominated communities tend to form immediately above the riverine scour zone and below the more developed, often shrub-dominated areas. Communities such as Sedge - Spotted Joe Pye Weed Riverine Herbaceous Vegetation, Reed Canary Grass Riverine Grassland, Willow - Indian Grass Riverine Shrubland, and Sycamore (Willow) – Mixed Hardwood Floodplain Dwarf Shrubland are common in areas that are several feet above base flow and experience scour and inundation only during periods of high water. This reduced scour allows grasses and forbs to establish, however, it prevents woody species from growing past a dwarfed or stunted phase. In the lower reaches of the watershed, Purple Loosestrife Riverine Scour Vegetation tends to dominate the area in between the riverine scour zone and the established shrubland. Alternatively, the Sycamore (Willow) – Mixed Hardwood Floodplain Dwarf Shrubland can form immediately above the scour zone and is often dominated by black willow (*Salix nigra*).

Above the grasslands and dwarf shrublands, somewhat-persistent shrubs tend to establish, creating tall shrublands in front of the floodplain forest. This study identifies five types of floodplain shrublands: Sycamore – Mixed Hardwood Riverine Shrubland, River Birch

(Sycamore) – Mixed Hardwood Riverine Shrubland, Mixed Hardwood Riverine Shrubland, Black Willow – Mixed Hardwood Riverine Shrubland, and Silver Maple (River Birch) – Mixed Hardwood Riverine Shrubland. Although these communities tend to include many of the same species, they occur in different portions of the watershed and on different substrates. They distribute along a gradient from coarse substrates in the smaller streams and upper portion of the watershed to fine sediments in the river's main stem in the lower watershed.

Sycamore – Mixed Hardwood Riverine Shrubland is restricted to cobble, sand and gravel bars in small and intermediate tributaries in the upper portions of the watershed. These conditions favor dominance of sycamore (*Platanus occidentalis*) that requires exposed mineral soil and light for germination. On the intermediate tributaries, such as the North Branch and West Branch of the Susquehanna River, River Birch (Sycamore) – Mixed Hardwood Riverine Shrublands can be found on cobbles mixed with sand and silt. Typical of these environmental conditions, river birch (*Betula nigra*) seeds require moist soils and minimal shade in order to germinate. Found primarily in the middle portions of the watershed, the Mixed Hardwood Riverine Shrubland types represent the middle of the gradient, where species dominance is shared on mixed sediments of cobbles, sand, gravel, and silt. Silver Maple (River Birch) – Mixed Hardwood Riverine Shrubland and Black Willow – Mixed Hardwood Riverine Shrubland occur on finer sediments in the lower portion of the watershed in the main stem and larger tributaries. Silver Maple (*Acer saccharinum*) seeds can germinate from within these finer sediments and require adequate organic content in the sediment for germination. River birch responds to the mechanical stresses of flooding by stump sprouting and therefore can tolerate the frequent inundation experienced in the lower reaches of the watershed. Black Willow – Mixed Hardwood Riverine Shrubland also tends to occupy areas of lower energy and higher accretion of silts, such as the downstream ends of islands in the lower sections of our drainages. Black willow (*Salix nigra*) is dominant in these areas because it requires very moist soil for germination and is extremely tolerant of siltation.

Two of the 15 identified communities, Silky Dogwood Palustrine Shrubland and Purple Loosestrife Riverine Scour Vegetation are not included in the following descriptions of floodplain communities. Silky Dogwood Palustrine Shrubland was represented by only one plot in this study, and the groundstory of that plot was dominated by the invasive Japanese knotweed (*Polygonum cuspidatum*). While this community may occur both in floodplains and other palustrine environments, our data were insufficient to accurately describe its species composition, environmental settings and distribution. The Purple Loosestrife Riverine Scour Vegetation is a degraded example of the Riverine Scour Vegetation described below. Purple loosestrife (*Lythrum salicaria*) is an aggressive invasive exotic species that is common in many parts of the Susquehanna River Watershed. Its dominance in many of this study's plots emphasizes the threat that this species poses to the floodplain vegetation communities of the Susquehanna River.

Although the Reed Canary Grass Riverine Grassland is described as a distinct vegetation type in this study, the aggressive, prolific nature of reed canary grass (*Phalaris arundinacea*) may be cause for concern. The origin and nativeness of reed canary grass are in need of further investigation, as the species may have hybridized with non-native variants. It behaves very

aggressively in many situations, especially within less actively flooded wetlands (wet meadows, marsh borders, etc.). Monotypic stands of reed canary grass were observed within the Susquehanna drainage and in other areas outside of the scope of this study, but its ability to thrive and persist on very active sections of floodplains is not known.

Table 7. Summary descriptions for thirteen non-forested floodplain communities in the Susquehanna River Watershed.

Community Type	Composition	Riparian Position & Substrate	Position in Susquehanna Watershed	State Rank
Sycamore – Mixed Hardwood Riverine Shrubland	Community of dense, tall shrubs. Sycamore (*Platanus occidentalis*) covers at least 30% of total shrub cover. Shrub willows (*Salix spp.*), silver maple (*Acer saccharinum*), eastern cottonwood (*Populus deltoides*) and river birch (*Betula nigra*) individually or together strong associates.	Bars adjacent to or contiguous with the shoreline on cobble and sand.	Small to moderate size streams	S4
River Birch (Sycamore) – Mixed Hardwood Riverine Shrubland	Community of dense, tall shrubs. River birch (*Betula nigra*) cover at least 30% of total shrub cover. Sycamore (*Platanus occidentalis*) often co-dominant with silver maple (*Acer saccharinum*), black willow (*Salix nigra*) and black ash (*Fraxinus nigra*) individually or together as strong associates.	Islands, bars and low terraces on sand and/or silt with mixed cobbles.	Moderate size rivers and streams	S4
Mixed Hardwood Riverine Shrubland	Community of dense, tall shrubs. No single species clearly dominant. Sycamore (*Platanus occidentalis*), silver maple (*Acer saccharinum*), black willow (*Salix nigra*) and river birch (*Betula nigra*) present in combinations of two or more.	Islands, low terraces and bars adjacent to shallow backwater channels on sand, silt and cobble.	Moderate to small size rivers and streams.	S4
Black Willow – Mixed Hardwood Riverine Shrubland	A dense, tall shrub layer of black willow (*Salix nigra)* that covers greater than 30% of the area characterizes this community. Other common tall shrubs include: shining willow *(Salix lucida*), river birch *(Betula nigra*) and silver maple *(Acer saccharinum*).	Downstream ends and heads of islands on deeper soils of silt and loam.	Large rivers	S4
Silver Maple (River Birch) – Mixed Hardwood Riverine Shrubland	A dense, tall shrub layer of silver maple (*Acer saccharinum*) that covers greater than 30% of the area characterizes this community. Sycamore (*Platanus occidentalis*), black willow (*Salix nigra*), river birch (*Betula nigra*) and green ash (*Fraxinus pennsylvanica*) may also be present.	Low terraces and upstream ends of islands on silt and sand.	Moderate and large streams and rivers.	S4
Speckled Alder Riverine Shrubland	Community of moderately dense to dense tall shrubs dominated by speckled alder (*Alnus incana spp. rugosa*). Black willow (*Salix nigra*), eastern ninebark (*Physocarpus opulifolius*), and silky dogwood (*Cornus amomum*) are other common shrubs.	Flats within active channels on cobble substrate.	Small to moderate size streams.	S3S4
Sycamore (Willow) – Mixed Hardwood Riverine Dwarf Shrubland	Communities of moderately dense to dense short shrubs under 2 meters in height, dominated or co-dominated by willows (*Salix nigra and S. eriocephala, Salix fragilis)*) as well as dwarfed sycamore *(Platanus occidentalis*).	Low terraces and bars attached to banks, and islands on sand, gravel and cobble.	Small to moderate size streams.	S4

Willow – Indian Grass Riverine Shrubland	Community characterized by a thick layer of herbaceous and graminoid vegetation containing Indian grass (*Sorgastrum nutans*) and numerous other species including a 25 – 50 % cover of short shrubs, especially black and sandbar willow (*Salix nigra and S. exigua*).	Island heads, low flats and bars on sand and cobbles.	Smaller streams in upper potions of watershed.	S3
Reed Canary Grass Riverine Grassland	Community characterized by dense herbaceous and graminoid vegetation dominated by reed canary grass (*Phalaris arundinacea*). Numerous other species present with some short shrubs.	Bars attached to banks on cobble.	Small streams and upper portions of moderate size streams.	S5
Sedge – Spotted Joe Pye Weed Riverine Herbaceous Vegetation	Community characterized by dense herbaceous and graminoid vegetation dominated by twisted sedge (*Carex torta*) and spotted joe-pye weed (*Eupatorium maculatum*). Numerous other species present with some short shrubs.	Island heads, bars and backwater channels, low terraces and river banks on cobbles mixed with silt, sand or sometimes muck.	Smaller streams in upper potions of watershed.	S3
Riverine Scour Community	Community characterized by sparse to dense herbaceous and graminoid vegetation that includes a great number and variety of species. Community composition shaped by frequent scour from ice and water and variable seed sources.	Island heads, bars, spits, low terraces and river banks on various substrate, especially cobble and sand.	Throughout on all order streams.	S4
Water Willow Emergent Bed	Community of emergent vegetation dominated, often exclusively, by water willow (*Justicia americana*).	Emergent beds on island heads, edges of bars, terraces and spits on variable substrate.	Throughout on all order streams.	S5
Lizard's Tail Emergent Bed	Communities of emergent vegetation dominated, often exclusively, by lizard's tail (*Saururus cernuus*).	Emergent beds on island heads, edges of bars, terraces or shallow channels often on sand or silt with cobbles.	Moderate size streams and rivers within selective drainages.	S4

Comparision to Existing Pennsylvania Non-forested Floodplain Wetland Community Classification

The current Pennsylvania plant community classification (Fike 1999) recognizes five non-forested floodplain wetland communities: 1) River birch – sycamore floodplain scrub, 2) Black willow scrub/shrub wetland, 3) Water-willow (*Justicia americana*) – smartweed riverbed community, 4) Riverside ice scour community and, 5) Big bluestem – Indian grass river grassland. The classification also recognizes one community complex (River Bed – Bank – Floodplain Complex) that includes, in varying combination, both forested and non-forested floodplain wetland communities.

Data collected and analyzed for this study provided the basis for recognizing eight shrub-dominated communities and five herbaceous communities that refine the original five communities listed in Fike (1999). The original River birch – sycamore floodplain scrub and Black willow scrub/shrub wetland are further divided and described by the Sycamore – Mixed Hardwood Riverine Shrubland, River Birch (Sycamore) – Mixed Hardwood Riverine Shrubland, Mixed Hardwood Riverine Shrubland, Black Willow – Mixed Hardwood Riverine Shrubland, and Silver Maple (River Birch) – Mixed Hardwood Riverine Shrubland. While these five communities tend to contain many of the same species, they are distinct based on species dominance, stream order and substrate, as discussed in the previous section.

The original classification does not contain a comparable community type to the Speckled Alder Riverine Shrubland type recognized here. The existing Alder – ninebark shrubland is not found specifically within riparian zones and does not represent a community subject to seasonal flooding and scour.

The existing Big bluestem – Indian grass river grassland herbaceous community did not fully capture what we sampled within the Susquehanna watershed. The Willow – Indian Grass Riverine Shrubland is a variation of the widely recognized "riverside prairie" type, but includes a strong shrub component, as described above. Other major drainages in Pennsylvania may better reflect the currently described graminoid-dominated community type.

The current classification recognizes a Water-willow (*Justicia americana*) – smartweed riverbed community, analogous to the Water Willow Emergent Bed described here. Included within the list of associates for the Water-willow (*Justicia americana*) – smartweed riverbed community is lizard's tail (*Saururus cernuus*). We frequently found near monotypic patches of Lizard's Tail in our sampling and propose that it is sufficiently discrete and prevalent to be recognized as a separate community type, Lizard's Tail Emergent Bed.

The original Riverside ice scour community described in Fike (1999) occurs on bedrock outcrops along the banks of major rivers and can contain several rare species. One plot (EPA2.102) sampled in this study fits that description. The Riverine Scour Vegetation described in this study occurs primarily on cobbles and sand, and is composed of a wide range of common species. We propose that both communities be retained in the state classification, and that the Riverside ice scour community name be changed to Riverside scour bedrock outcrop to reflect the unique

environmental setting that provides habitat for several rare plant species. The two other graminoid-dominated community types proposed in this study, Sedge - Spotted Joe Pye Weed Riverine Herbaceous Vegetation and Reed Canary Grass Riverine Grassland, have no equivalents in Fike (1999) and represent newly-described communties for the state.

Comparision to Other State Non-forested Floodplain Classifications

Most state vegetation classifications recognize that the structure and composition of non-forested sections of the floodplain are governed by the four interrelated organizing factors: frequency of flooding, the amount of energy received as water or ice flow, the relative location within the watershed, and substrate stability. However, the dynamic and transitional nature of floodplain vegetation and the approach taken in categorizing/classifying vegetation communities often leads to difficulties in making comparisons between states.

We compared the communities described in this study with the state classifications from New Hampshire, Vermont, Virginia and New York, as well as those from New Jersey and West Virginia that base their classifications on the National Vegetation Classification (NVC) system. In addition, further field studies by the New Hampshire Natural Heritage Program (Nichols et al 2001) yielded refinement to the community types described in their original community classification (Nichols et al 2000) and we will reference those as applicable.

Emergent and low elevation community types

The emergent community types are typical of the mid and lower reaches of relatively large drainages and are subject to long periods of inundation. Under this revised classification for Pennsylvania's non-forested floodplain wetlands, the "Water Willow Emergent Bed" and the "Lizard's Tail Emergent Bed" communities occupy this zone within the riparian corridor. These community types correspond to Virginia's "Sand/Gravel/Mud Bars and Shores" (Virginia 2001) and are described in West Virginia as the NVC's "Justicia Americana Herbaceous Vegetation Alliance" (West Virginia draft). New Hampshire's "Herbaceous sandy river channel" (Nichols et al 2000) describes a similar topographic position with different species composition, since *Justicia* and *Saururus* do not range into that state. Similarly, Nichols (2001) recognizes a "Hydric sandy river channel" community as an analogue to the emergent bed, but again, with state-specific species composition. Vermont does not specifically address this community type (Thompson and Sorenson 2000). New Jersey's classification best accommodates this type under the NVC's "Peltandra - Saururus cernuus - Carex crinita/Climacium americanum Herbaceous Vegetation Association" and describes their distribution as, in part, mountain floodplains (Breden et al 2001).

The community types that occupy low-lying cobble bars and shores often occur in the next elevation zone above the emergent bed areas. This highly variable zone provides habitat for the "Riverine Scour Vegetation" and in higher portions of the watershed, the "Sycamore (Willow) – Mixed Hardwood Riverine Dwarf Shrubland". Other states recognize these highly variable areas with varying degrees of refinement. Virginia's "Rocky Bars and Shores" includes areas that are completely herbaceous to those that are densely shrubby (Virginia 2001). Vermont recognizes two types; "River Sand and Gravel Shore" and "River Cobble Shores" that include both sparsely

vegetated and more densely shrub-dominated areas (Thompson and Sorenson 2000). New Hampshire recognizes at least three community types that span the continuum of open sparsely vegetated near-shores to shrubby inner shores. Their "Herbaceous sandy river channel" type describes the largely herbaceous near-shore areas and the "Cobble-sand river channel" captures the more shrub-dominated aspects of this zone (Nichols et al 2000). Nichols et al (2001) expands these types somewhat to include additional types that are high-energy, frequently scoured communities: "Sparsely vegetated boulder-cobble river channel", "Undifferentiated gravel-cobble channel", and "Undifferentiated herbaceous high energy low riverbank". New York describes two community types that broadly capture the concept of low cobble areas along streams and rivers: "Riverside Sand/Gravel Bar" and "Cobble Shores" (New York 2002). Neither of these types is well defined and the need for more data is recognized.

Along smaller drainages and upper sections of the Susquehanna Basin, the "Sedge-Spotted Joe Pye Weed Riverine Herbaceous Vegetation" occupies the zone immediately above open cobbles or along banks just above the normal summer water line. This type corresponds to New Hampshire's "Twisted sedge low riverbank" (Nichols et al 2000). Vermont's "River Cobble Shores" includes the sedge component of this type (*Carex torta* especially) but includes a broader species composition and environmental range (Thompson and Sorenson 2000). West Virginia uses the NVC's "Carex Torta Temporarily Flooded Herbaceous Alliance" to characterize this community type (West Virginia draft).

Successional mid-elevation grassland community types

Grasses, especially the prairie warm season grasses like big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), switch grass (*Panicum virgatum*) and indian grass (*Sorgastrum nutans*) are important components of floodplain wetlands. These communities tend to lie in a transitional zone above sparsely-vegetated scour zones and below tall shrublands. Some classifications recognize community types specified as grasslands, others include the association of prairie grasses within other types. Within the Susquehanna watershed, we captured the grassland component with the "Willow - Indian Grass Riverine Shrubland" and the "Reed Canary Grass Riverine Grassland", possibly a degraded version of the former. In the areas that we sampled, stands of warm season grasses were never monotypic or extensive but intermixed with shrubs, particularly willows.

Virginia recognizes a "Riverside Prairie" type and considers it globally rare (Virginia 2001). They describe a dense grassland with sparse shrubs, including dogwoods and willows, along major rivers. This corresponds to Pennsylvania's "Willow - Indian Grass Riverine Shrubland" but also includes a number of associated species not found in Pennsylvania. Vermont also recognizes a "Rivershore Grassland" along major rivers that grades into sand and gravel communities found closer to the river (Thompson and Sorenson 2000). Shrubs are mentioned as a component of this type, but without the strong association with willows as we describe for the Susquehanna Watershed. New Hampshire's "Big bluestem variant" of their "Herbaceous – wooded riverbank/floodplain" best describes these parts of the floodplain with a strong prairie grass component (Nichols et al 2000). Nichols et al (2001) redefines this type as "Big bluestem/sparsely wooded riverbank/floodplain" and also recognizes a separate "Reed canary grass riverbank/floodplain" type. New York's "Riverside Ice Meadow" (dry meadow sub-type)

is comparable in topographic position and dominance of warm-season grasses, but it includes some drier species not typical of Pennsylvania (New York 2002). None of New Jersey's NVC types adequately captures these floodplain grasslands. "Calamagrostis canadensis Seasonally Flooded Herbaceous Alliance" and "Calamagrostis canadensis – Phalaris arundinacea Herbaceous Vegetation Association" are the closest comparable communities (Breden et al 2001). West Virginia chooses the NVC's "Andropogon gerardii – (Sorgastrum nutans) Temporarily Flooded Herbaceous Alliance" and "Andropogon gerardii – Panicum virgatum – Baptisa australis Herbaceous association" to represent these floodplain grasslands (West Virginia draft).

Successional mid-elevation shrubland community types

With increasing elevation and distance from the base water level, a variety of shrublands tend to form on increasingly stable substrates that are still strongly influenced by frequent scouring and flooding. In the Susquehanna basin, we recognize a number of mixed hardwood types: "Sycamore (Willow) – Mixed Hardwood Riverine Dwarf Shrubland", "Sycamore – Mixed Hardwood Riverine Shrubland", "River Birch – Mixed Hardwood Riverine Shrubland", and "Mixed Hardwood Riverine Shrubland", that represent a range of species composition and positions in the watershed.

Virginia's "River-Scour Woodland" and "Rocky Bars and Shores", when considered together, seem to correspond to this range of communities both in species composition and position in the river channel (Virginia 2001). New Hampshire's "Boulder-cobble river channel", "Willow low riverbank" and "Herbaceous – wooded riverbank/floodplain" span the successional, mid-elevation portion of the floodplain comparable to Pennsylvania's mixed hardwood shrub types (Nichols et al 2000). Nichols' et al (2001) "Undifferentiated shrub moderate-energy riverbank/floodplain" corresponds closely with our mixed hardwood shrub types. The "Willow low riverbank" type includes scyamore (*Platanus occidentalis*) in some southern locations, and corresponds to our "Sycamore (Willow) – Mixed Hardwood Riverine Dwarf Shrubland" community (Nichols et al 2001). Vermont does not explicitly recognize these kinds of floodplain shrublands, but includes descriptions of transitional shrub communities in their "River Sand and Gravel Shore" and "River Cobble Shores" (Thompson and Sorenson 2000). New York does not describe shrubland community types that are explicitly associated with rivers. Their "Shrub Swamp" community may be the most closely related, but it is broadly applied to lakeshores and rivers (New York 2002). West Virginia selects the NVC type "Salix nigra Temporarily Flooded Shrubland Alliance" and "Salix nigra Temporarily Flooded Shrubland Association" to capture this transitional section of their floodplains (West Virginia draft).

The "Speckled Alder Riverine Shrubland" recognized in Pennsylvania has several equivalents in other state classifications, though they are often more broadly defined to include a wider-range of variation. Virginia's "Rocky Bars and Shores" is quite broad, including both purely herbaceous and densely shrub-dominated areas (Virginia 2001). New York's "Shrub Swamp" includes more organic soil types and lakeshore communities (New York 2002), while New Jersey's NVC type "Alnus incana Seasonally Flooded Shrubland Alliance" is also quite broad (Breden et al 2001). West Virginia's "Alnus serrulata Temporarily Flooded Shrubland Alliance" and "Alnus serrulata-Physocarpus opulifolius Association" (West Virginia draft) correlate fairly

well with Pennsylvania's described type. New Hampshire's "Alder alluvial shrubland" and "Alder-dogwood-arrowwood riverbank/floodplain" (Nichols et al 2000, Nichols et al 2001) correspond favorably with our "Speckled Alder Riverine Shrubland".

Moderately persistent, low terrace community types

In the Susquehanna watershed, "Silver Maple (River Birch) – Mixed Hardwood Riverine Shrubland" and "Black Willow – Mixed Hardwood Riverine Shrubland" tend to occur lower in the watershed, on low terraces, and in positions in the river channel with a higher accretion of silt and fine sediment. These communities that occur in deeper soils in the transition zone between successional grass/shrublands and forest are not well represented in other states' classification systems.

Virginia recognizes a "River-Scour Woodland" type, however, it is located on very active zones of boulder substrate bars and shores (Virginia 2001). Vermont does not describe a comparable type, best capturing this concept in their "River Cobble" type (Thompson and Sorenson 2000). New Hampshire likewise has no directly corresponding community type, however their "Willow low riverbank" type is somewhat affiliated (Nichols et al 2000). New Jersey recognizes no comparable community type (Breden et al 2001). West Virginia's closest associated communities are the NVC types "Betula nigra Temporarily Flooded Shrubland Alliance" and "Betula nigra- Salix interior Association" (West Virginia draft).

Insect Assemblages in Non-forested Floodplain Communities

Several multivariate statistical analyses failed to find significant differences between sites and physiognomic vegetation zones in the insect data collected during this study. There are numerous possible explanations for this result. First, riparian systems are dynamic and the resulting fluctuations in water level continually expose or inundate a wide variety of macro- and microhabitats. Insects move between vegetation types and microhabitats as necessary, associating with numerous communities and vegetation zones at different times. Second, seasonal differences in insect presence or abundance may be confounding the analyses. Third, the number of sample sites may have been too small to detect any significant differences. There was also a wide range of variation between sampling site characteristics. The sites were intentionally located in different ecoregions, represented, various stream orders and contained a variety of vegetation communities. The landscape surrounding the sampling sites also varied from predominantly forest to predominantly rural suburban and agriculture.

Despite these confounding factors, the survey was extremely productive in documenting and describing the insect fauna associated with floodplain communities in the Susquehanna River Watershed. General discussion of insect fauna follows.

COLEOPTERA

Pitfall and hand-collection data were dominated by Coleoptera (beetles) associated either with water (hygrophilus) or with dry, sandy or disturbed sites. Hygrophilus and dry habitat species were found in all pitfall traps regardless of the traps' distance from water level, reflecting the effect of variable river hydrology on the distribution of invertebrate fauna. In general,

hygrophilus species are assumed to stay relatively close to the river water line while the dry site species occupy positions upslope on dry sand, gravel and cobble substrates. When water levels rise and fall, the guilds of hygrophilus and dry site species appear to respond by migrating upslope and downslope. As a result, pitfall traps that initially captured dry site species may subsequently capture hygrophilus species, or, in extreme cases, aquatic species (i.e., the traps are temporarily submerged) and vice versa. This contributed to the failure to find significant differences between the insects captured in different physiognomic vegetation zones.

Aquatic species

The presence of Elmidae spp. (riffle beetle) and Dryopidae spp. (dryopid beetles) was unexpected, as these groups consist of obligate aquatic beetles (Stewart et al 2003, Fowler 2002, Fossati et al 2001). Presumably they entered the pitfalls during periods of high water when the pitfalls were either flooded or nearly flooded. Elmidae feed on decayed plant material and algae (Epler 1996). The presence of dryopids and elmids is generally indicative of fairly good water quality, so their numbers on this survey is an encouraging sign. While undetermined, there was an obvious diversity of species of both families represented.

Hygrophilus Species

Abundant hygrophilus species included: *Agonum aeriginosum*, *Agonum extensicolle, Agonum melanarium, Agonum palustre, Agonum punctiforme, Anisodactylis harrisi, Bembidion americanum, Bembidion castor, Bembidion chalceum complex b, Bembidion honestum, Brachinus cyanipennis, Brachinus fumans, Chlaenius cordicollis, Chlaenius aestivus, Chlaenius impunctifrons, Chlaenius pennsylvanicus, Chlaenius sericeus, Chlaenius tricolor, Diplous rugicollis, Elaphropus anceps, Elaphropus tripunctatus, Elaphropus vivax, Hoplia modesta, Omophron americana, Pterostichus caudicalis, Sphaeroderus stenostomus* (Lindroth 1961-1969, Rivard 1964a, Rivard 1964b).

The hygrophilus *Agonum* species and *Anisodactylis harrisi* typically prefer soft, wet soil with abundant clay and organic matter, often with moderate to abundant vegetation cover. *Agonum extensicolle* is an exception, preferring open habitat near water where vegetation is sparse or absent (Lindroth 1961-1969, Kleintjes 2002). The *Bembidion* species prefer open to sparsely vegetated sandy to gravelly shorelines (Rivard 1964a). *Brachinus* species (*B. cyanipennis* and *B. fumans*) prefer floodplain soils and have aquatic larvae that are ectoparasites of aquatic beetles (Milne et al 1980). Also known as bombardier beetles, *Brachinus* mix hydrogen peroxide and hydroquinone in the presence of catalytic enzymes to produce a boiling chemical steam which it sprays at potential predators. *Chlaenius* species are predatory beetles that prefer sunny conditions along well-vegetated shorelines (occasionally floodplain forest as well) (Lindroth 1961-1969, Rivard 1964b, Larochelle 1974). *Elaphropus* species are predatory beetles with habitat requirements similar to the above *Bembidion* species, preferring open shores with low vegetation cover. *Hoplia modesta* is a root-feeding beetle whose grubs can be a major pest species in cranberry bogs. *Omophron americanum* is a very widespread species (Atlantic coast of North America west to Arizona, Utah and Idaho) and prefers sandy soils near standing or slow moving water (Lindroth 1961-1969). *Pterostichus caudicalis* prefers shaded soft soils with abundant organic material, often near eutrophic pools and ponds. *Sphaeroderus stenostomus* prefers forested shorelines and banks, often with moss and leaf litter, where it preys upon snails.

Terrestrial or Dry Habitat Species
Abundant species associated with dry habitats included *Agonum muelleri, Amara exarata Amara ovata, Anisodactylis discoideus, Cyclotrachelus furtivus*, *Poecilius lucublandus, Pterostichus melanarius, Pterostichus mutus, Pterostichus stygius, Scarites quadriceps*, and *Scarites subterraneus.* Species typical of dry fields, grasslands, and prairies include generalist invertebrate predators such as *Amara exarata*, *Cyclotrachelus furtivus*, and *Poecilius lucublandus* (Beyers et al 2000, Strong et al 2002, Larsen and Williams 1999). Many island heads and some portions of shoreline have suitable habitat for this group (patches of sedge and dry prairie grasses in Riverine Scour Community and Willow – Indian Grass Riverine Shrubland). *Anisodactylis discoideus, Pterostichus stygius* and *Scarites subterraneus* prefer dry, sandy and/or barren ground (Lindroth 1961-1969, Carmona and Landis 1999, Varchola and Dunn 2001, Beyers et al 2000, Strong et al 2002). This habitat is common along the shoreline and on island heads where river scouring has left sand, gravel and cobble deposits. Species typical of dry, open woodland and forests include *Pterostichus mutus* and *Scarites quadriceps* (Barlow 1970, Lindroth 1961-1969). The open shrublands typical of floodplains within the Susquehanna River likely provide excellent habitat for these species.

Of the dry habitat species, four (*Anomala orientalis Pterostichus melanarius*, *Agonum muelleri*, *Amara ovata*) are non-native Eurasian beetles associated with agricultural and other dry, disturbed land (roadsides, quarries, pastures, gardens, etc.) (Kutasi et al 2004, Raworth et al 2004, Pearce et al 2002, Anderson and McFerran 2001, Lindroth 1961-1969). *Anomala orientalis* is an invasive insect that feeds on the roots of grasses and sedges (Grewal et al 2002, Lee et al 2002), which was abundant at one site (Green's Island). Green's Island is adjacent to rural homes and extensive farmland in Lancaster County, which may be a source of this beetle.

Additional Taxa
Also abundant in pitfalls were several taxa (*Nitulidae, Curculionidae, Chrysomelidae, Elateridae, Necrophila americana*) not closely associated with dry or wet habitats, but rather with specific food sources. Nitulidae typically feed at wounds in trees and other woody vegetation, but many will feed on a wide range of food (flowers, decaying fruit, fungi, fermenting plant and animal tissue, as well as sap) (USDA, Forest Service 1985).

Curculionidae (weevils) and *Chrysomelidae* (leaf beetles) were not determined to species, so it is not known whether they were primarily native or exotic species or what their preferred foods were. These groups are, in general, herbivores and include many potentially harmful agricultural and sylvicultural pest species. The Chrysomelidae also include some species considered beneficial for the control of pest plant species. For example, *Galerucella calmariensis* and *Galerucella pusilla* feed on the leaf, stem and bud tissues of purple loosestrife (*Lythrum salicaria*) (Blossey et al 1994).

Elateridae (click beetles, wireworms) live in soil, decaying vegetation, under bark and other places where they are not exposed to light (Lindroth 1961-1969). Numerous debris piles on the floodplain of the Susquehanna River drainage likely provide excellent habitat for this beetle family. *Elateridae* can vary greatly in their feeding ranging from destructive plant pest species

(e.g., root herbivores, Ohsawa 2004, Hemerik et al 2003), to scavengers to predators (Milne et al 1980).

The most abundant species collected in some pitfall traps was *Necrophila americana* (carrion beetle), which is a habitat generalist (equally likely in riparian and terrestrial habitats, Watson and Carlton 2003, Werner and Raffa 2000). *N. americana* was common at several sites and may reflect the abundance of carrion deposited along island and river shorelines.

DIPTERA

The *Tipulidae* (crane fly fauna) collected in this survey represented a mixture of species that would usually be found in bottomland forest and wetlands with nearby aquatic habitats. Species that typically inhabit moist decaying wood at the water's edge or on land were well represented by specimens of *Epiphragma (Epiphragma) fasciapennis, Limonia (Discobola) annulata, Limonia (Limonia) tristigma, Limonia (Metalimnobia) cinctipes, Limonia (Metalimnobia) hudsonica, Limonia (Metalimnobia) immature,* and *Limonia (Metalimnobia) novaeangliae*. Water edge and swamp species are *Tipula (Nippotipula) abdominalis, Tipula (Yamatotipula) caliptera, Tipula (Yamatotipula) concava, Tipula (Yamatotipula) furca, Tipula (Yamatotipula) jacobus, Tipula (Yamatotipula) noveboracensis, Tipula (Yamatotipula) sayi and Tipula (Yamatotipula) tephrocephala*. Larvae of these species usually occur in the mud, sand, and mosses at or near edges of rivers and ponds. Many ecotonal species typically found between small grassy fields and forest edges were also collected, including: *Tipula (Lunatipula) bicornis, Tipula (Platytipula) ultima, Nephrotoma ferruginea Nephrotoma tenuis,* and *Nephrotoma virescens*. Other common woodland species are *Tipulidae (Beringotipula) borealis, Tipulidae (Lunatipula) duplex, Tipula (Lunatipula) mallochi,* and *Tipula (Pterelachisus) trivittata*, and the late fall species *Tipula (Savtshenkia) fragilis* and *Cladura flavoferruginea*. None of the carnivorous species were recorded during the study. One true aquatic species, *Antocha (Antocha) saxicola*, was collected from Green's Island.

LEPIDOPTERA

In general, most moth species collected in this survey are typical for forest and riparian habitats in Pennsylvania. There is rich representation of species feeding on willow (*Salix spp*.) and poplars (*Populus spp*.), as well as sycamore (*Platanus occidentalis*), hackberry (*Celtis occidentalis*), black locust (*Robinia pseudoaccacia*) and other woody plants. The noctuid fauna is characterized by predominantly univoltine borers in *Apameini* (formerly *Amphipyrinae* and so treated here) including species of *Luperina*, *Hydraecia*, *Papaipema*, *Oligia*, and *Apamea*. In addition, a rich fauna of detritivorous species in the subfamily *Herminiinae* persist, including species of *Renia*, *Idia*, *Zanclognatha*, *Chytolita, Bleptina, Lascoria, Palthis, Phalaenophana, Macrochilo, Phalaenostola*, and *Tetanolita*. These feed as larvae on dead leaves, masses of which are accumulated in rotting piles in floodplain habitats.

The ten most abundant moth species found in this survey (Appendix III) are common to abundant throughout Pennsylvania. Not surprisingly, these moths utilize one or more life history characteristics that increase their distribution, frequency, and abundance. Some of these characteristics include:

Multiple Broods: Many of our top ten moth species have multiple broods. One complete generation of a moth from egg to adult is one brood. Single brooded species have one adult flight period which may only last a couple of weeks, consequently decreasing the odds of capturing individuals of these species. Multiple brooded species complete the egg to adult cycle multiple times from early spring through late fall. This increases the odds of catching the adults throughout a sampling season, and increases the dominance of these species in the samples. Three good examples of multiple brooded moths are the Grape Leaffolder Moth (*Desmia funeralis*), the Bristly Cutworm Moth (*Lacinipolia renigera*), and the European Corn Borer Moth (*Ostrinia nubilalis*), all of which can have 3 broods a year.

Lavae that are foodplant generalists: Moths with larvae that can feed on a wide variety of trees and/or herbaceous plants can be found in almost any habitat. For example, the larvae of the White-Marked Tussock Moth (*Orgyia leucostigma*) are known to feed on over 140 different plant hosts.

Larvae that use agricultural foodplants: Some of the top ten moth species have larvae that feed on agricultural crops. Contemporary farms tend to cultivate large areas of a monocrop, which can support large populations of the moth larvae that feed on that crop. Floodplains have rich soils due to the cycles of flooding and deposition of sediments, and many farms take advantage of these good floodplain soils. Even some of the larger islands in the Susquehanna River are farmed, despite the logistics of getting equipment to and from the island. The larvae of moths such as the Smeared Dagger Moth (*Acronicta oblinita*), the Bristly Cutworm Moth (*Lacinipolia renigera*), the European Corn Borer Moth (*Ostrinia nubilalis*), and the Greater Black-Letter Dart (*Xestia dolosa*) feed on crops such as barley, beans, clover, corn, cotton, orchard fruit trees, potatoes, and tobacco.

At Shawville, a mix of common species was collected, with only one real agricultural pest, the Clover Looper Moth (*Caenurgina crassiuscula*). The Pale Phalaenostola (*Phalaenostola metonalis*) moth was an interesting abundant species at Shawville. This species feeds on dead grasses and dead tree leaves, which are an abundant resource in floodplain habitats. Three moth families were represented in the ten most abundant species at this site.

At Milton State Park, several species associated with agriculture were identified, including the Bristly Cutworm Moth (*Lacinipolia renigera*), the Dock Rustic (*Luperina passer*), and the Greater Black-Letter Dart (*Xestia dolosa*). Four families were represented in the ten most abundant species at this site.

At Loyalsock Creek, five different moth families were represented in the ten most abundant species. The presence of the Larch Tolype (*Tolype laricis*) and the Chocolate Prominent (*Peridea ferruginea*) indicates a northern affinity of this site. This site had more of the 'weedy' moth species associated with forests, including the Hemlock Looper Moth (*Lambdina fiscellaria*) and the Forest Tent Caterpillar Moth (*Malacosoma disstria*). The Forest Tent Caterpillar is a defoliator of a wide variety of deciduous hardwood trees. Like many other forest pest species,

populations of forest tent caterpillars periodically explode. During these outbreaks, the larvae relentlessly consume their hostplants until there is little left and the moth population crashes. The hostplant recovers over a period of years, and eventually when conditions are right, a new moth outbreak can occur.

At Byers Island, several agriculture-associated species such as the Bristly Cutworm Moth (*Lacinipolia renigera*), the European Corn Borer Moth (*Ostrinia nubilalis*), and the Virginian Tiger Moth (*Spilosoma virginica*) were found in the survey. With seven different families, this site had the greatest number of moth families represented in its ten most abundant species. The presence of the Ailanthus Webworm Moth (*Atteva punctella*) indicates the presence of the exotic and invasive Tree-of-Heaven (*Ailanthus altissima*). This handsome, orange moth with white leopard spots was a native in the United States only in southern Florida, feeding on the Paradise Tree (*Simarouba glauca*). In the late 1700s, Tree-of-Heaven was introduced to the U.S. from central China. Tree-of-Heaven, like the Paradise Tree, is a member of the Simaroubaceae family. The Ailanthus Webworm Moth was able to jump host plants, and rapidly expanded north along with its new host plant.

Greens Island was the southern-most site and had the most unique assemblage of abundant species, sharing only one species of its top ten most abundant with any other site. Two interesting abundant species that were not nearly as common elsewhere were the Dark Phalaenostola (*Phalaenostola eumelusalis*) and the Flowing-Line Bomolocha (*Bomolocha manalis*). This site had four families represented in the ten most abundant species.

Fulmer's Secret was the northern-most site and had the most 'shared' abundant species, with five species also found in the top ten most abundant list of one of the other sites. These were some of the very common agricultural and forest species: the Virginian Tiger Moth (*Spilosoma virginica*), the Forest Tent Caterpillar Moth (*Malacosoma disstria*), the Clover Looper Moth (*Caenurgina crassiuscula*), the Bristly Cutworm Moth (*Lacinipolia renigera*), and the Greater Black-Letter Dart (*Xestia dolosa*). Additional 'weedy' species were the Bicolored Sallow (*Sunira bicolorago*) and the Green Cloverworm Moth (*Plathypena scabra*). An interesting abundant species at this site was the Filament Bearer (*Nematocampa resistaria*), named after the distinctive larvae which bear two pairs of white-tipped tendrils on their backs. This species is local and uncommon in the eastern U.S. Four families were represented in the ten most abundant species at this site.

Species of Special Interest

Certain taxa included in this study are of particular interest because they are listed as rare or endangered (see Appendix II for definitions of conservation rank). For example, three dragonfly and two damselfly species of special concern were found during this survey. Other taxa are noteworthy for reasons not involving conservation status. In some cases, this study has produced new information about a species range, distribution, or abundance. In other instances, a taxon may be involved in recent changes relative to the systematics of certain groups or revisions in nomenclature. In some cases, the species are known to be invasive and their presence in this study may alert managers to potential pest problems that may exist or develop.

COLEOPTERA

The survey was incredibly productive and interesting in studying the Carabidae family, capturing 38% of the known fauna, plus an additional 13 species not as yet officially recorded from the state. At least five other species are of great interest for new distributional data or new information on habitat requirements. Of the 13 new records for the state, the following 7 are of interest since they are common eastern species well known from adjacent states: *Acupalpus pumilus*, *Bradycellus nigriceps*, *Badister neopulchellus*, *Agonum tenue*, *Bembidion coxendix*, *Paratachys oblitus* and *Paratachys* sp. (morphospecies whose name is uncertain). The remaining six carabid state records and five species of special interest are worth individual mention:

Amara ovata (Fabricius) is an introduced European species that is known from a handful of northern states, but had not yet been recorded from Pennsylvania. It was taken in some numbers (58 specimens) but only at Loyalsock Creek. In general, *Amara* are herbivorous grass-seed specialists occurring in open drier habitats in fields and meadows.

Badister flavipes laticeps (Blatchley) is similar in rarity and habitat requirements to *Leptotrachelus dorsalis* (below). It is also a specialist in reeds and cattails and forages in similar ways. However, it is probably a specialist on snails, as are other members of its tribe. A single specimen was taken at Byers Island.

Bembidion chalceum (Dejean) is actually a complex of five species recently recognized (but as yet unpublished) from careful morphological study and DNA analysis. At least three of these species should occur in Pennsylvania. The two species taken during this study have been labeled "chalceum complex species A" and "chalceum complex species B." One of these is certainly *B. chalceum* proper, already recorded from Pennsylvania. The other species is by default a new record. There seems to be no difference in habitat between the two species since both species were found at Fulmer's Secret, Loyalsock Creek, Milton State Park, and Byers Island, co-occurring at nearly all the same vegetation zones.

Bembidion fugax (LeConte) is closely related to *B. planum* and *B. rolandi* and is quite difficult to distinguish from the former. The habitats and ranges of *B. fugax* and *B. planum* are therefore confused and literature records can be unreliable. Good series of all three species were taken in this survey. *B. fugax* and *B. rolandi* co-occur in good numbers at Fulmer's Secret and Byers Island, whereas (with a single exception) *B. planum* occurred only at Loyalsock Creek. It appears from this (and from study of *B. rolandi* elsewhere) that these two species prefer larger bodies of water, big rivers and lakes, where they favor different stone sizes. *B. rolandi* is common in beds of large cobble, but *B. fugax* probably has a broader tolerance of stone size down to finer gravel. *B. planum*, on the other hand, is common in gravel beds of small streams and creeks, probably overlapping in places with *B. fugax* on intermediately-sized bodies of water.

Bembidion muscicola (Hayward) is a more northern species known from as far south as New York and New Jersey. The Pennsylvania record collected in this study represents the southern edge of its range. A single specimen of this species was collected at Shawville.

Bembidion rusticum rusticum (Casey) is common in the sterile gravel of fast-moving streams to the north. It is relatively rare in Pennsylvania where it is at the southern edge of its range. Three specimens were taken at Loyalsock Creek.

Clivina fossor (Linnaeus) was collected at Fulmer's Secret, establishing the southern limit of this species range. It is a common and now widespread introduced species from Europe that was previously unknown from Pennsylvania.

Clivina ferrea (LeConte) is a native species was previously unknown from Pennsylvania. It is a southern species known as far north as Ohio and Maryland. Several specimens were taken at Loyalsock Creek, Milton State Park and Byers Island, establishing the northern extremity of its current range.

Leptotrachelus dorsalis (Fabricius) is widespread east of the Mississippi but is always rather elusive. It is very difficult to collect in any numbers because it lives only in cattail and reeds, often in several feet of water. They cruise the leaves after dark and hide deep inside the crevices during the day. One specimen of this species was taken at Fulmer's Secret.

Ophonus puncticeps (Stephens) is an European introduction that is very common over its current range and specializes in the seeds of Queen Anne's lace (*Daucus carota*). It has already been recorded from Pennsylvania and is now very common in some areas. One specimen each was taken at Loyalsock Creek and Milton State Park.

Pterostichus (Argutor) n. sp. was collected at Shawville, Byer's Island and Green's Island. *Pterostichus* (Argutor) *commutabilis* has long been thought to be a single variable species inhabiting swamps and wetlands. Some specimens were noted to have dark femora, and recently Canadian specialists have begun treating that morph as a distinct species. It is very similar to the true *Pterostichus* (Argutor) *commutabilis* (Motschulsky) that occurs in Pennsylvania but was not taken in this survey. All 21 specimens of this complex collected in this survey are of the new species to be described by the Canadian specialists.

In addition, a state listed tiger beetle, *Cicindela ancocisconensis*, with a conservation rank of G3 and S1 was also captured in this study. *Cicindela ancocisconensis* is a reddish-bronze tiger beetle with white markings, found in northeastern U.S. and ranging south though the Appalachian Mountains. Adults and larvae live along the edges of clear, forested streams and rivers. The adults are typically found on sunny days in bare sandy and cobbly areas within 5 meters of the water's edge. They are predatory insects of great speed and agility. The larvae are found in sandy-loamy soils further away from the water's edge. Peak adult activity is generally in June (USGS 2004, USDA 2004).

One cerambycid species of special interest was collected during this study. *Tylonotus bimaculatus* Haldeman, a borer in living ash trees, is not rare in nature, however, it is not commonly encountered. This native species could face an uncertain future due to the recent accidental introduction to the United States of *Agrilus planipennis* Fairmaire, a serious pest of ash. The invasion of *Agrilus planipennis*, a buprestid native to Asia, has induced the cutting of ash stands and the destruction of nursery stock in the Great Lakes region in attempts to stop its spread. Whether

this could lead to the reduction in numbers of native species utilizing ash as a host is yet to be determined.

One psephenid species of special interest was collected during this survey. *Psephenus herricki* (DeKay), named the "water penny beetle" due to the flat, yellowish, circular-shaped larvae, is fairly intolerant of low-quality waters, preferring clear, cool, fast-flowing riffles. The aquatic larvae can be found on the underside of partially submerged rocks, while the adults can be found crawling on the tops of exposed rocks.

Anomala orientalis (Waterhouse) is an introduced Asian scarab that is now fairly common throughout northeastern states. In the larval stage, it has the capacity to be a pest of turf, and the adults have been known to defoliate several species of trees. The capture of numerous specimens in pitfall traps is enigmatic, suggesting that the adults were flying low along the ground searching for oviposition sites, and thereby encountering the traps.

LEPIDOPTERA

Three state listed moths, *Hydraecia stramentosa, Parahypenodes quadralis, Sphinx gordius*, were found during this survey. *Hydraecia stramentosa* (Guenée) is an uncommon to rare moth in Pennsylvania ranked G4 and SU. The larvae have been reported as borers in figwort (*Scrophularia spp*.), and the species has been collected in western Pennsylvania by specialists from the Carnegie Museum of Natural History only a few times in recent years. A few specimens have also been taken in a few counties in New York and Ohio. Its apparent rarity may be due to inadequate sampling methods as it may be active only in close proximity to the host plant and may not be easily attracted to standard light traps.

Parahypenodes quadralis is a small gray moth in the Noctuidae family with conservation ranks of G4 and SU. It has been found at various sites from Maine to Florida, but it's full distribution and life history is poorly known (USGS 2001).

Sphinx gordius (apple sphinx) is a member of the sphinx/hawk moth family (Sphingidae) and is ranked G4 and S1S3. Sphinx moths are large and fast-flying moths. Many species have very long probosces adapted for sipping nectar from deep, tubular flowers, and they can be observed feeding at flowers at dusk. The larvae of *Sphinx gordius* feed on the vegetation of american larch (*Larix laricina*), apple (*Malus spp*.), blueberries (*Vaccinium spp*.), huckleberries (*Gaylussacia spp*.), sweetfern (*Comptonia peregrina*), and white spruce (*Picea glauca*). In eastern U.S., this species is more common to the north, and becomes rare in the south (Covell 1984).

Unfortunately, the moth fauna is increasingly characterized by species introduced in the last few decades from Europe. Several introduced moth species that were collected in this survey are discussed below.

Apamea ophiogramma (Esper) is an introduced noctuid moth that is a borer feeding on the common reed (*Phragmites australis*). First noted in British Columbia in 1989, then later in

Ontario and adjacent United States, the species is now known from throughout the northeastern Nearctic. It was first noted in by Carnegie Museum specialists in Pittsburgh in 1997, but must have occurred in Pennsylvania since the early 1990's. It can be common in habitats where *Phragmites* is abundant.

Calophasia lunula (Hufnagel) is a specialized noctuid species intentionally introduced to control a potentially troublesome European weed, *Linaria biennis*. The moth is now widespread in the state although its impact on *Linaria* is limited. Other noctuids have become established in the last 10 years, and are now widespread. These include the cutworm moth *Noctua pronuba* Linnaeus. It was recently introduced from Europe by way of Canada and appeared in the Pittsburgh area first in 1996. It is now abundant and perhaps even a pest, a status it frequently attains in Europe.

Idaea dimidiata (Hufnagel) is a European introduction, a small geometrid, the single-dotted wave moth, that was collected at Fulmer's Secret in early July. Carnegie Museum specialists first encountered Pennsylvania populations of this species in the Allegheny National Forest in mid-July 1995 (possibly the first Pennsylvania record) and it now occurs sporadically across the northern half of the state as well as elsewhere in northern United States, Canada, and the Pacific Northwest. The native distribution is Palearctic, and it is common throughout Europe. In England, the larvae feed on burnet (*Pimpinella spp*.) and chervil (*Anthriscus spp*.), but will accept withered leaves of other forbs, including dandelion (*Taraxacum spp.*).

Rhizedra lutosa (Hübner) is a large sedentary noctuid moth, of which a single female was taken on 3 November at Fulmer's Secret. The species is also dependent on common reed, (*Phragmites australis*), on which it is thought to be monophagous as a rhizome borer. It originally occurred in the western Palearctic. It is known from records dating back to 1967 in Ohio, but we have not previously seen Pennsylvania specimens although it may have become established in the state as early as the 1960's.

CONSERVATION IMPLICATIONS

Sites of State Significance

A number of sites in this study were considered to be good to excellent quality examples of their respective plant community types based upon size, condition and landscape context. For each community, these sites are listed under "High Quality Examples" in the "Plant Community Descriptions" section above. In accordance with the policies of the Pennsylvania Natural Heritage Program, all sites with a rank of S3 or higher will be entered in the Pennsylvania Natural Diversity Inventory database for reference and tracking as examples of state significant community types (see Appendix II for definitions of conservation rank).

Site size was evaluated on a relative scale, given that communities more common on smaller tributaries are limited in extent by the narrowness of the floodplain or river channel. Also,

because much of the floodplain within the watershed has been substantially altered or eliminated, few sizable areas remain.

The condition of many floodplain communities has been compromised by a range of disturbances including invasive (typically non-native) species and altered flow regimes. Invasive species are a particularly widespread problem, as discussed below. Site condition was considered excellent if anthropogenic disturbances were not evident and exotic/invasive species were few or absent.

Landscape context refers to the relation of the site to its surrounding landscape. Context was considered excellent if the surrounding landscape supported primarily natural communities and fragmenting features (e.g., roads, power lines, agricultural fields, developed land) were minor or absent.

In addition to the sites specified above for each community, there are several noteworthy sections of the watershed that generally house high quality examples of riparian areas. The tributaries to the West Branch of the Susquehanna River and the upper portions of the West Branch itself support numerous intact natural floodplain communities. In particular, the Sinnemahoning Creek and the Lycoming Creek have a low prevalence of invasive exotic species and abundant examples of floodplain communities. Unfortunately, many sections of the West Branch and its tributaries have been severely affected by acid mine drainage. Those areas that have experienced less impact from acid mine drainage are considered to have a higher conservation value.

Conservation Strategies

Given the small patch nature of most riparian communities and the dynamic nature of riparian systems, the best way to consider floodplain community conservation is as a riverine complex whose individual community components will change over time (Nichols 2001). One goal of riparian conservation is to maintain diverse assemblages of floodplain communities that contain a variety of species and whose components are structurally diverse. Three strategies that will contribute to the maintenance of diverse riparian areas are: 1) maintain or approximate natural flow regimes, 2) reduce the spread and prevalence of invasive species, and 3) protect high quality examples of riparian communities. In addition, riverine complexes have conservation value as habitat for numerous insect species.

In order to preserve diverse assemblages of floodplain communities, hydrologic regimes that are natural or that approximate natural flow regimes must be maintained. In the Susquehanna River Watershed, the severity of flow alteration and the resulting impacts are variable across different sections of the watershed. In the lower portions of the river, several hydroelectric dams and the associated reservoirs severely dampen fluctuations in flow. The decreased duration and intensity of flood flows promotes succession in riparian areas from open and herbaceous-dominated to shrub- and forest-dominated communities. Extensive riparian forests can form in previously open or herbaceous-dominated riparian areas during extended periods of low flow (Shafroth et al

2002). In the upper portions of the watershed, flood control structures such as levees and dikes amplify flood flows, by increasing the volume of water being funneled downstream during storm events. Similarly, changing land use from natural plant communities to agriculture and developed land increases the volume of water entering streams and tributaries during flood events. Fortunately, stream flow regimes are increasingly being managed with the restoration of riparian plant communities in mind (Scott et al 1997, Rood et al 1998).

Another pervasive threat to floodplain communities in the Susquehanna watershed is invasive exotic and native species. Purple loosetrife (*Lythrum salicaria*) grows in almost all riparian community types and can become the dominant species even in actively scoured cobble bars. This species is currently the most abundant and prolific invasive plant in non-forested floodplain communities. Many other invasive exotic species are common in non-forested riparian communities, however, their proliferation is often limited by the frequent scour. Some of these species include: garlic mustard (*Alliaria petiolata*), Japanese and Giant knotweed (*Polygonum cuspidatum* and *P. sachalinense*), mile-a-minute weed (*Polygonum perfoliatum*), moneywort (*Lysimachia nummularia*), Japanese stilt grass (*Microstegium vimineum*), Autumn olive (*Elaeagnus umbellata*), Japanese barberry (*Berberis thunbergii*), reed canary grass (*Phalaris arundinacea*), Tatarian honeysuckle (*Lonicera tatarica*), and teasel (*Dipsacus sylvestris*). Several of these species are severe pests in the forested floodplain communities that do not experience the same intensity of scour as the non-forested communities.

Distribution patterns of invasive species are not homogeneous throughout the Susquehanna basin. For example, purple loosestrife seems to be absent or less abundant in the upper drainages of the West Branch and its tributaries (Lycoming Creek, Loyalsock Creek, Pine Creek, Kettle Creek, and Sinnemahoning Creek). Japanese knotweed also appears much less abundant in the middle and upper sections of Pine Creek, Loyalsock Creek and Lycoming Creek. A reasonable approach to controlling these species is to prevent their establishment in the upper sections of these drainages and work progressively downstream to eradicate these species. In addition, high nutrient inputs can encourage the growth of invasive species. Reed canary grass (*Phalaris arundinacea*) seems to respond dramatically to the increased nutrients in stormwater and it may take advantage of the loss of native diversity caused by increased siltation (Maurer et al 2003). Therefore, overall watershed management, including the management of nutrients from urban and agricultural sources, remains relevant even if stream flow regimes are not directly affected.

Protecting high quality examples of floodplain communities and the surrounding undeveloped habitat will be critical to large-scale conservation plans in the Susquehanna Basin. Strategies should focus on restoring large patches of riparian communities and providing contiguously linked riparian areas (Freeman et al 2002). The Susquehanna Greenway Plan is a good example of ongoing efforts to provide context to regional land use and to promote conservation of the Susquehanna River (Susquehanna Greenway Partnership). Numerous land use planning recommendations have been proposed to reduce the negative impacts of changing land use on riparian systems. These include: protect riparian buffer habitat, retain natural areas in developed landscapes, compensate for lost habitat, exclude livestock grazing from riparian areas, provide corridors between riparian and upland habitats, avoid constructing roads and utility lines through riparian habitat areas, and restore degraded riparian habitat (Knutson and Naef 1997).

Riverine complexes and non-forested floodplain plant communities have conservation value beyond the plant biodiversity itself. Floodplain complexes that contain structurally diverse and species-rich communities provide critical habitats for other organisms. In particular, floodplain communities in the Susquehanna River Watershed provide habitat for a significant assemblage of the state's wetland carabid beetles. Since insects respond to variation in plant structure and species composition, diversity in riparian complexes can also affect insect diversity. The diverse vegetation gradient from open cobble to forest typical of floodplain complexes can provide a wide variety of microhabitats and vegetation structures. This structural and microhabitat diversity that exists within riparian complexes is essential to sustaining significant insect diversity.

Thus, non-forested floodplain wetlands are fundamental elements of the diversity of riparian ecosystems and provide critical habitat for associated organisms. This report provides essential baseline data that define and characterize non-forested floodplain community types in the Susquehanna River Watershed. The information provided here on the variation, geographic extent, quality, rarity and value of these plant communities can be used to assess and monitor the ecological integrity of riparian communities. It also can be used by a variety of stakeholders to identify, investigate and protect the floodplain wetlands remaining in the Susquehanna River Watershed.

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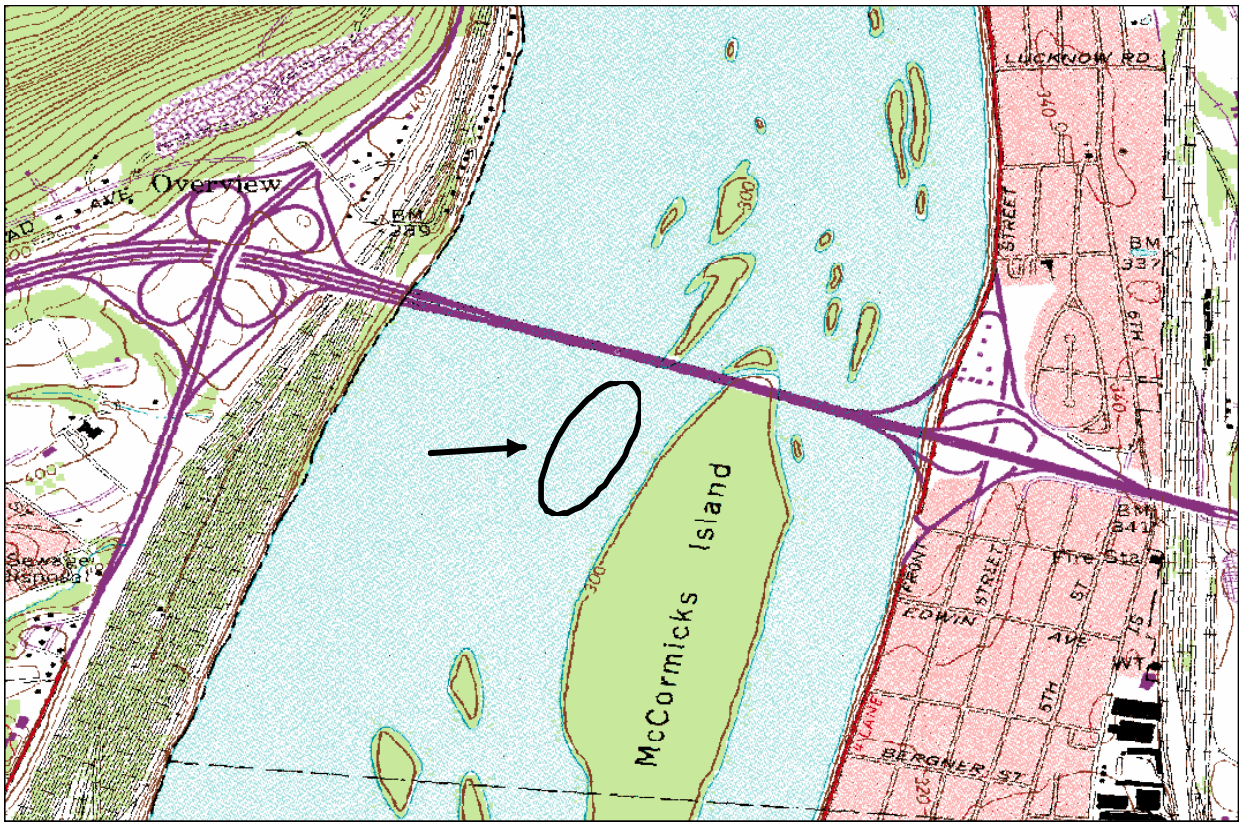
APPENDICES

Appendix I. Location of Non-Forested Floodplain Wetland Sites in the Susquehanna River Watershed

Site: EPA 2.1, 2.2, 2.3

USGS 7.5' Quadrangle: Harrisburg West, PA
Dauphin County, Susquehanna Twp.
Location: Harrisburg, 2.3 km NNE

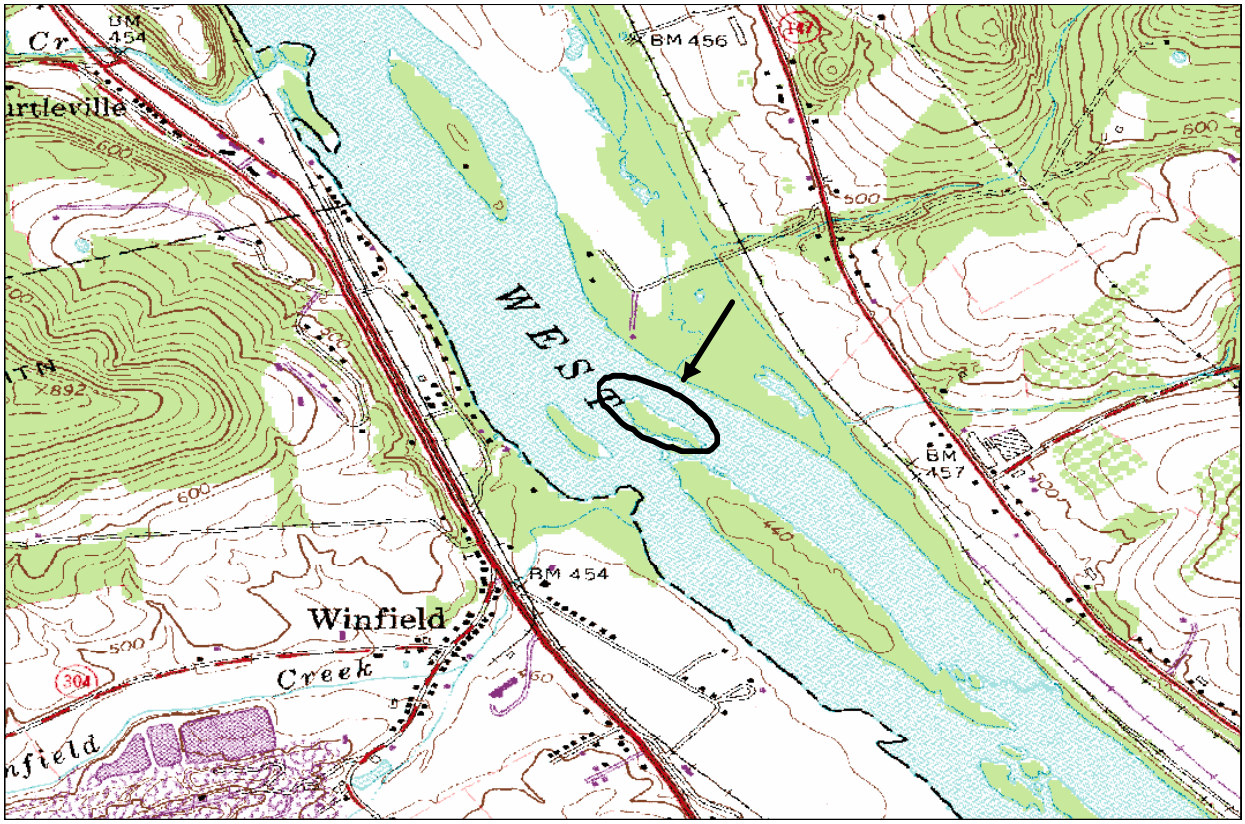
EPA 2.1, 2.2, 2.3 lie within TNC's Central Appalachian Forest Ecoregion on small islands in the Susquehanna River east of Harrisburg, PA, Dauphin County. The site is representative of the smaller silt-sand textured alluvial bars in the Susquehanna River and exhibits three distinct vegetation zones. **Plot 2.1 (Water Willow Emergent Bed)** represents the emergent herbaceous bed that circles the perimeter of the island and consists of homogenous cover of *Justicia americana*. **Plot 2.2 (Black Willow – Mixed Hardwood Riverine Shrubland)** represents the low, frequently flooded patches of mixed herbaceous-shrub species dominated by *Salix nigra* and *Betula nigra*; herbaceous species include *Polygonum amphibium*, and *Lythrum salicaria*. **Plot 2.3 (Black Willow – Mixed Hardwood Riverine Shrubland)** represents the areas highest in elevation on the islands composed of a 3-5 m tall S. *nigra, B. nigra,* and *Acer saccharinum* canopy; herbaceous species include *P. amphibium* and *L. salicaria*.



Site: EPA 2.4, 2.5

USGS 7.5' Quadrangle: Northumberland, PA
Northumberland County, Point Twp.
Location: Winfield, 0.8 km NE

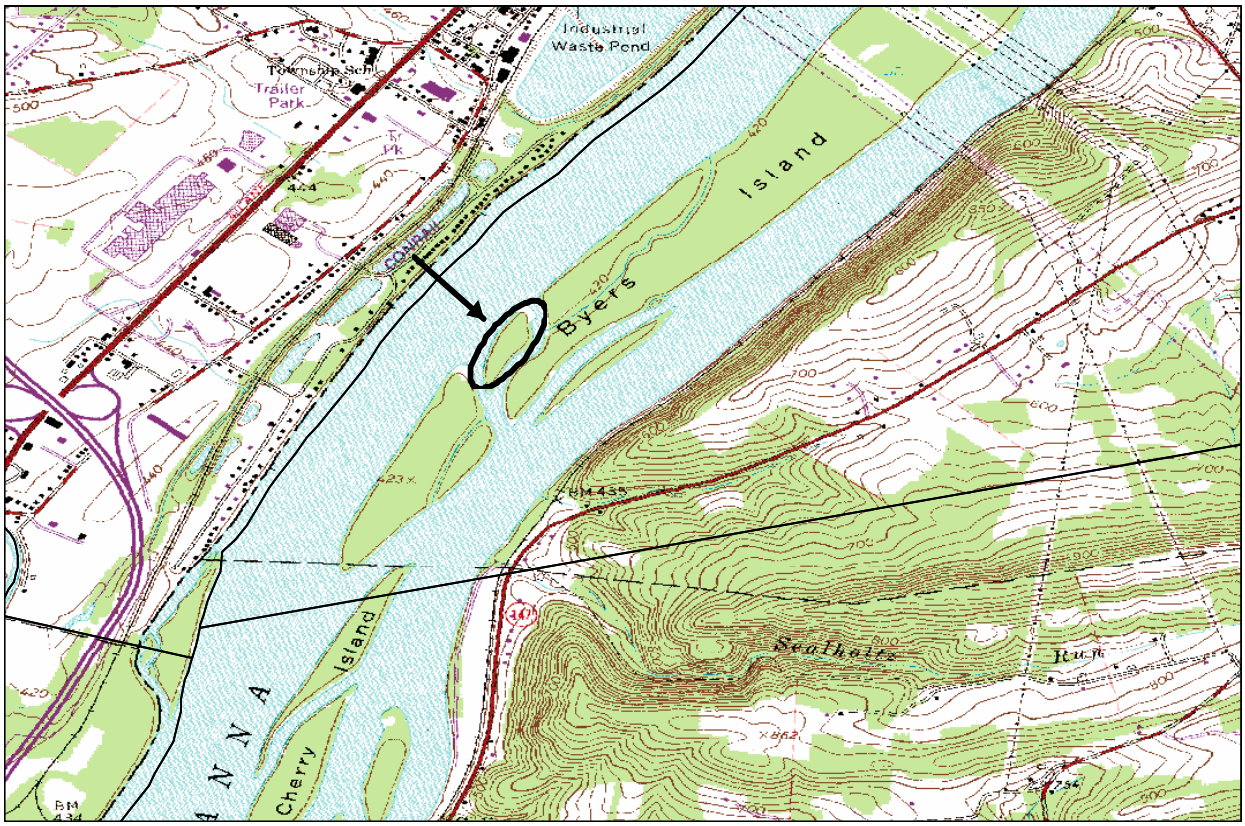
EPA 2.4, 2.5 lie within TNC's Central Appalachian Forest Ecoregion on the west side of a small island in the West Branch of the Susquehanna River, Northumberland County. The hydrology of this site is probably affected by impoundment at Sunbury/Shamokin Dam. **Plot 2.4 (Water Willow Emergent Bed)** represents the herbaceous emergent zone in permanently flooded silty-gravel and muck dominated by *Justicia americana*. **Plot 2.5 (Mixed Hardwood Riverine Shrubland)** represents the vegetative zone dominated by shrub and tree species 2-5 m tall; woody species include *Acer saccharinum, Betula nigra, Salix nigra; Onoclea sensibilis* and *Apios americana* are significant herbaceous species.



Site: EPA 2.6, 2.7, 2.8, 2.9, 2.10

USGS 7.5' Quadrangle: Sunbury, PA
Northumberland County, Upper Agusta Twp.
Location: Industrial Waste Pond, 1.3 km SSE Byers Island

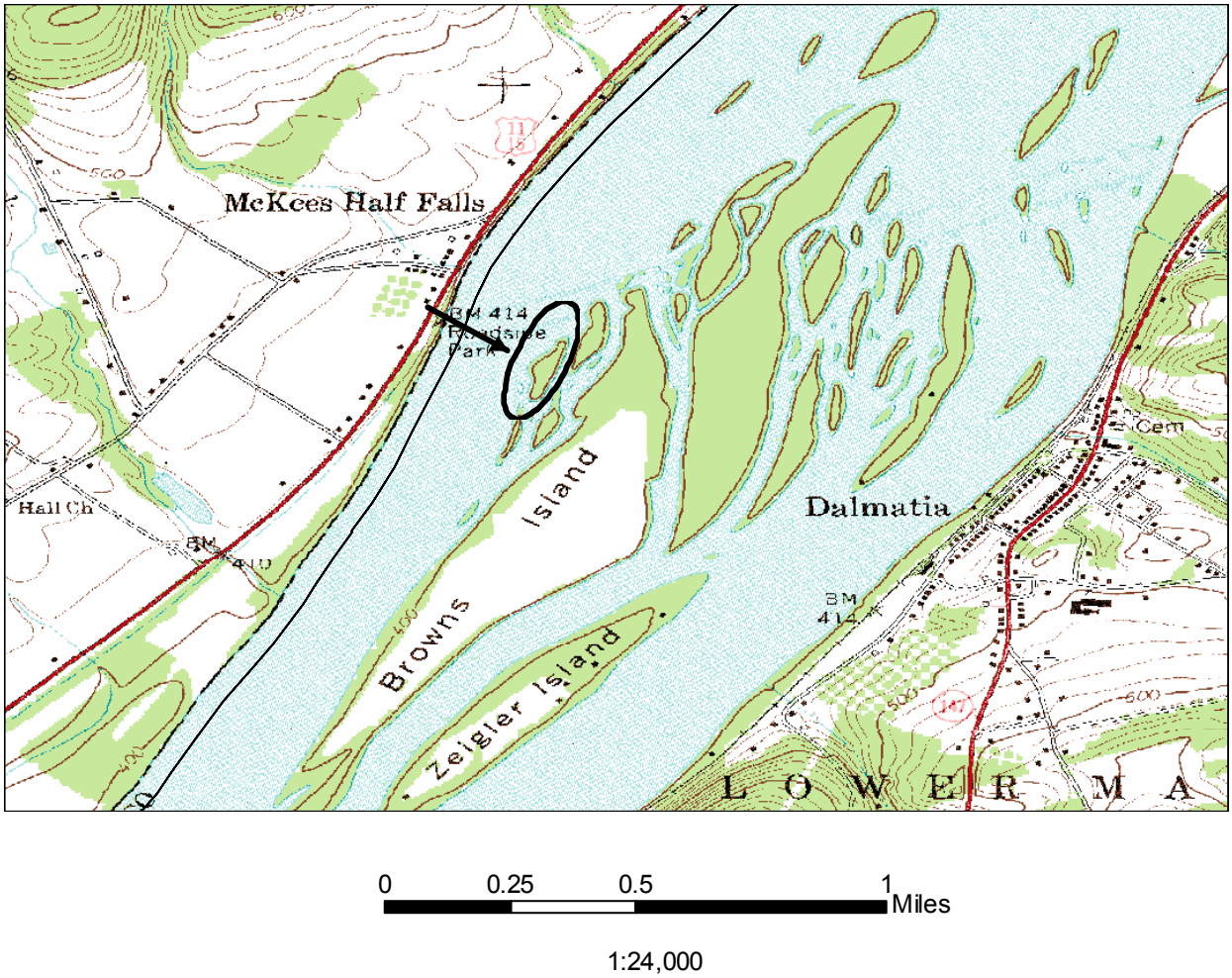
EPA 2.6, 2.7, 2.8, 2.9, 2.10 lie within TNC's Central Appalachian Forest Ecoregion near Byer's Island in the Susquehanna River, Northumberland County. **Plot 2.6 (Water Willow Emergent Bed)** represents an herbaceous bed dominated by *Justicia americana* along the sandy-cobble island-head zone; areas of sparsely vegetated cobble are present. **Plot 2.7 (Mixed Hardwood Riverine Shrubland)** represents a narrow band of shrubs, small trees, and intermittent herbaceous patches growing on sand and cobble; woody species include *Platanus occidentalis* and *Salix nigra*; herbaceous species include *Apocynum cannabinum* and *Sorghastrum nutans*. **Plot 2.8 (Water Willow Emergent Bed)** represents an herbaceous bed dominated by *Justicia americana*. **Plot 2.9 (Willow – Indian Grass Riverine Shrubland)** represents a shrubland mosaic that includes clumps of *Platanus occidentalis* and *Salix nigra* in an area dominated by herbaceous and graminoid species such as *Sorghastrum nutans, A. cannabinum, J. americana*. **Plot 2.10 (Willow – Indian Grass Riverine Shrubland)** represents a zone of mixed shrubs and herbaceous species comprised primarily of *Salix* spp, *Eupatorium album, S. nutans,* and *Apocynum sibiricum*.



Site: EPA 2.11, 2.12

USGS 7.5' Quadrangle: Dalmatia, PA
Northumberland County, Lower Mahanoy Twp.
Location: Dalmatia 1.2 km WNW

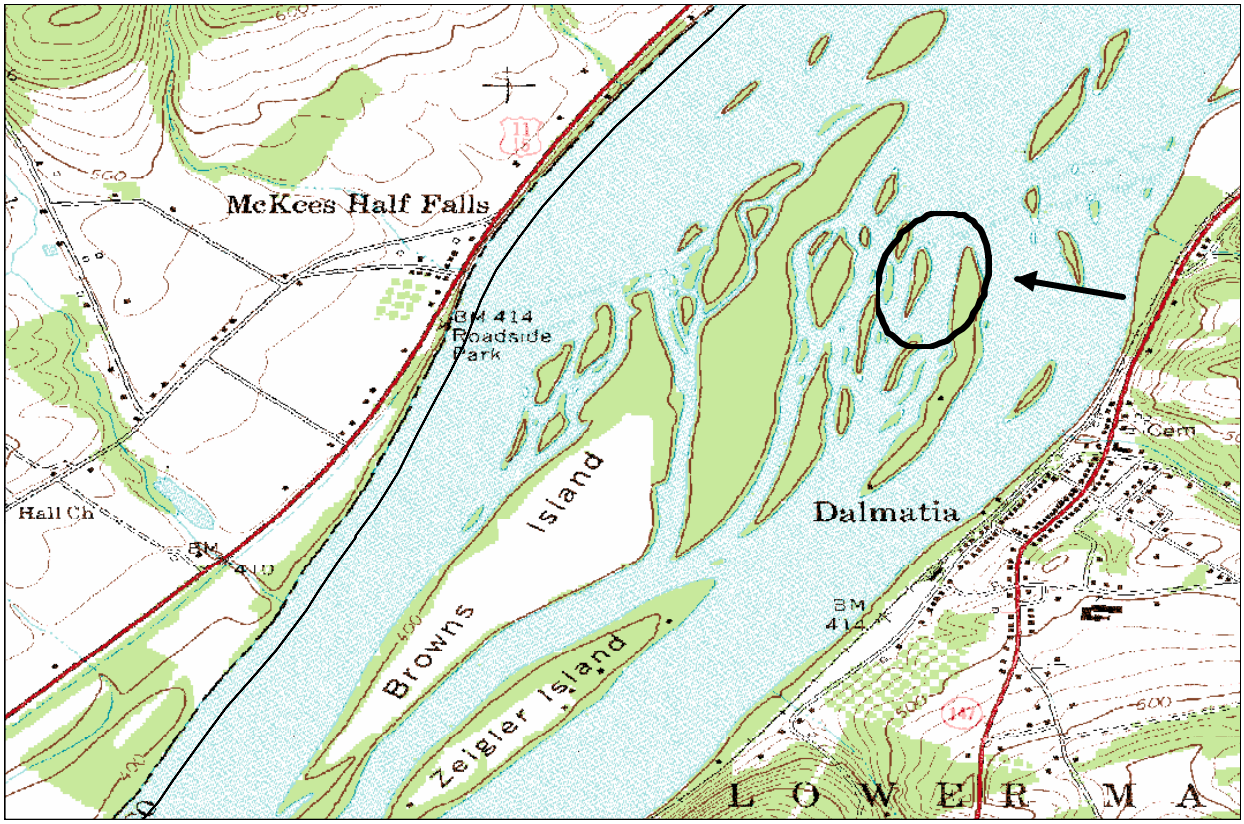
EPA 2.11, 2.12 lie within TNC's Central Appalachian Forest Ecoregion on small islands in the McKees Half Falls area of the Susquehanna River, Northumberland County. **Plot 2.11 (Sycamore (Willow) – Mixed Hardwood Riverine Dwarf Shrubland)** represents a limited band of short to tall shrubs and herbaceous species on a frequently flooded, high scour zone dominated by *Betula nigra, Platanus occidentalis*, and *Acer saccharinum*; herbaceous species include *Polygonum spp*, and *Lythrum salicaria*. **Plot 2.12 (Water Willow Emergent Bed)** represents the edge of the scour zone that is exposed to a strong current when high water covers the falls. The plot is dominated by herbaceous species: *Justicia americana* and *L. salicaria.*



Site: EPA 2.13, 2.14, 2.15

USGS 7.5' Quadrangle: Dalmaita, PA
Northumberland County, Lower Mahanoy Twp.
Location: Dalmatia 0.8 km NNW

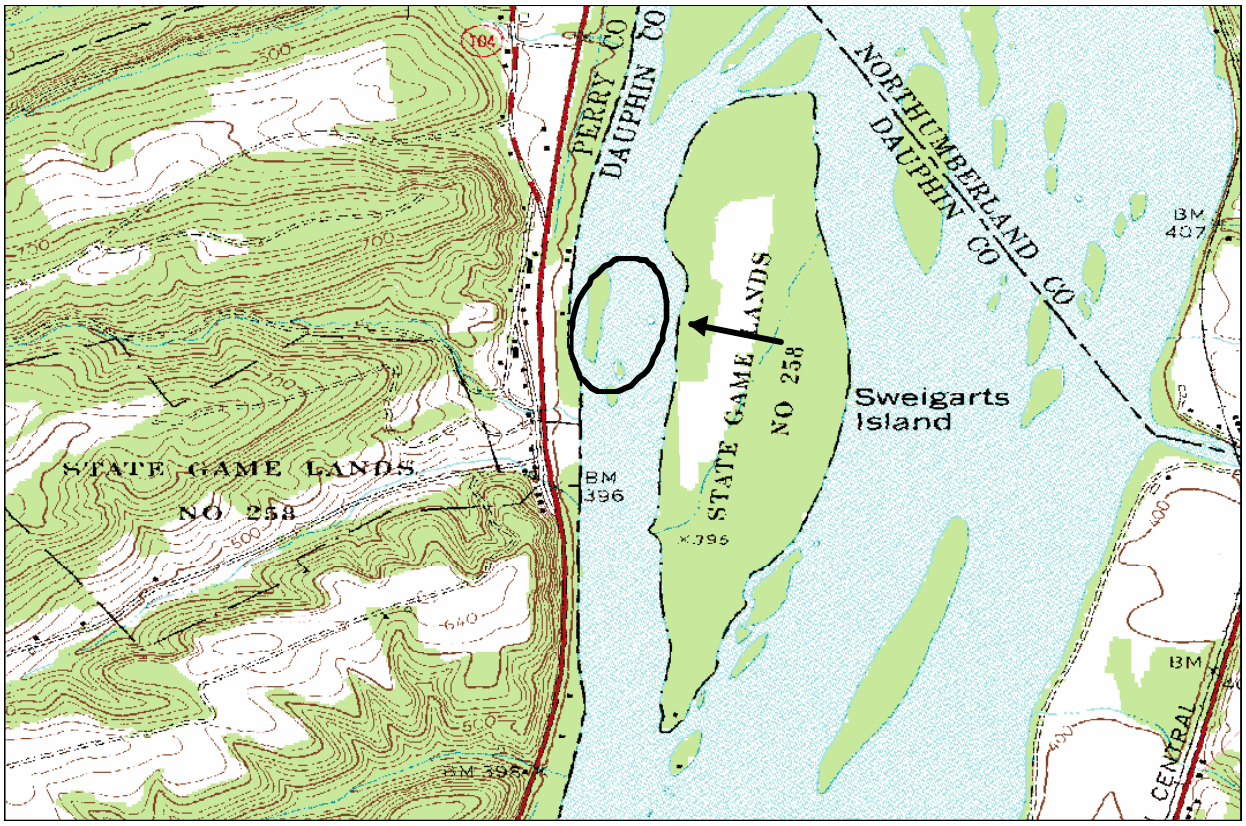
EPA 2.13, 2.14, 2.15 lie within TNC's Central Appalachian Forest Ecoregion on small islands in the McKees Half Falls area of the Susquehanna River, Northumberland County. **Plot 2.13 (Water Willow Emergent Bed)** represents an herbaceous bed dominated by *Justicia americana* and is situated on a cobble bed back-channel. **Plot 2.14 (Purple Loosestrife Riverine Scour Vegetation)** represents a second herbaceous-dominated zone adjacent to and slightly higher in elevation than the *Justicia* bed; *Lythrum salicaria* is dominant. **Plot 2.15 (Silver Maple (River Birch) – Mixed Hardwood Riverine Shrubland)** represents the mixed herbaceous shrub zone on sandy alluvium and is dominated by 5-8 m tall *Acer saccharinum, Betula nigra,* and *Platanus occidentalis*; the dominant herbaceous species is *L. salicaria*.



Site: EPA 2.16, 2.17

USGS 7.5' Quadrangle: Dalmaita, PA
Dauphin County, Liverpool Twp.
Location: Paxton, 2.5 km NW

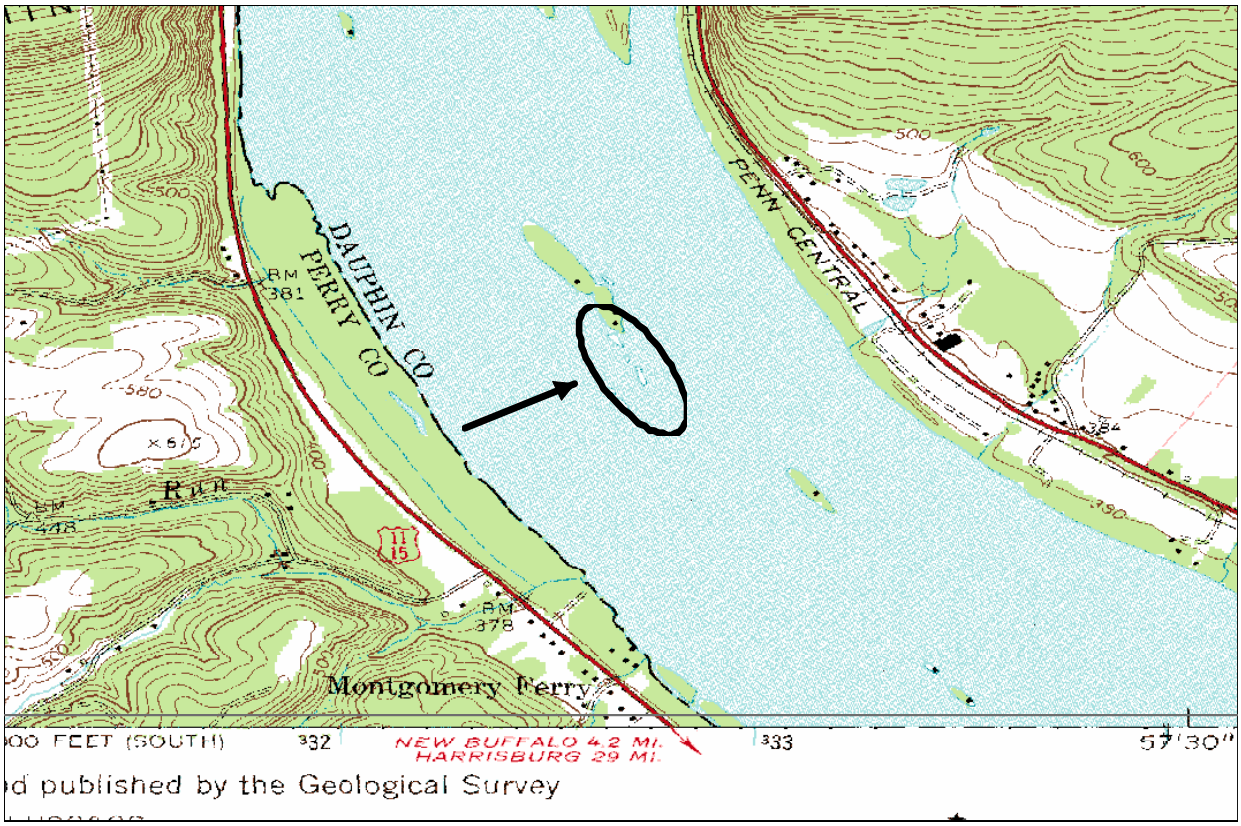
EPA 2.16, 2.17 lie within TNC's Central Appalachian Forest Ecoregion on a small island in the Susquehanna River west of Sweigart's Island, Dauphin County. **Plot 2.16 (Water Willow Emergent Bed)** represents a low herbaceous bed dominated by *Justicia americana*. **Plot 2.17 (Mixed Hardwood Riverine Shrubland)** represents a mixed herbaceous-shrub zone that includes *Platanus occidentalis* and *Betula nigra*; *Onoclea sensibilis* and *Lythrum salicaria* comprise the greatest proportion of the herbaceous component.



Site: EPA 2.18, 2.19, 2.20

USGS 7.5' Quadrangle: Millersburg, PA
Dauphin County, Halifax Twp.
Location: Millersburg, 3.5 km SW

EPA 2.18, 2.19, 2.20 lie within TNC's Central Appalachian Forest Ecoregion on small island bars in the Susquehanna River, Dauphin County. The site is situated on the bars downstream of larger islands and exhibits the progression from zones dominated by herbaceous species to shrub dominated areas, which contain small patches of herbaceous species. **Plot 2.18 (Water Willow Emergent Bed)** represents the herbaceous patches over sand/gravel substrate at the water level containing only *Justicia americana*. **Plot 2.19 (Lizard's Tail Emergent Bed)** is situated at a slightly higher elevation than the herb-dominated type. *Polygonum amphibium* dominates this type that also includes moderate proportions of *Salix nigra* as well as other herbaceous species such as *Justicia americana* and *Lythrum salicaria.* **Plot 2.20 (Black Willow – Mixed Hardwood Riverine Shrubland)** represents the patches of dense shrub cover on the small islands and bars at this site; prominent shrub species include *S. nigra, Betula nigra*; herbaceous species include *L. salicaria*, and *P. amphibium*.



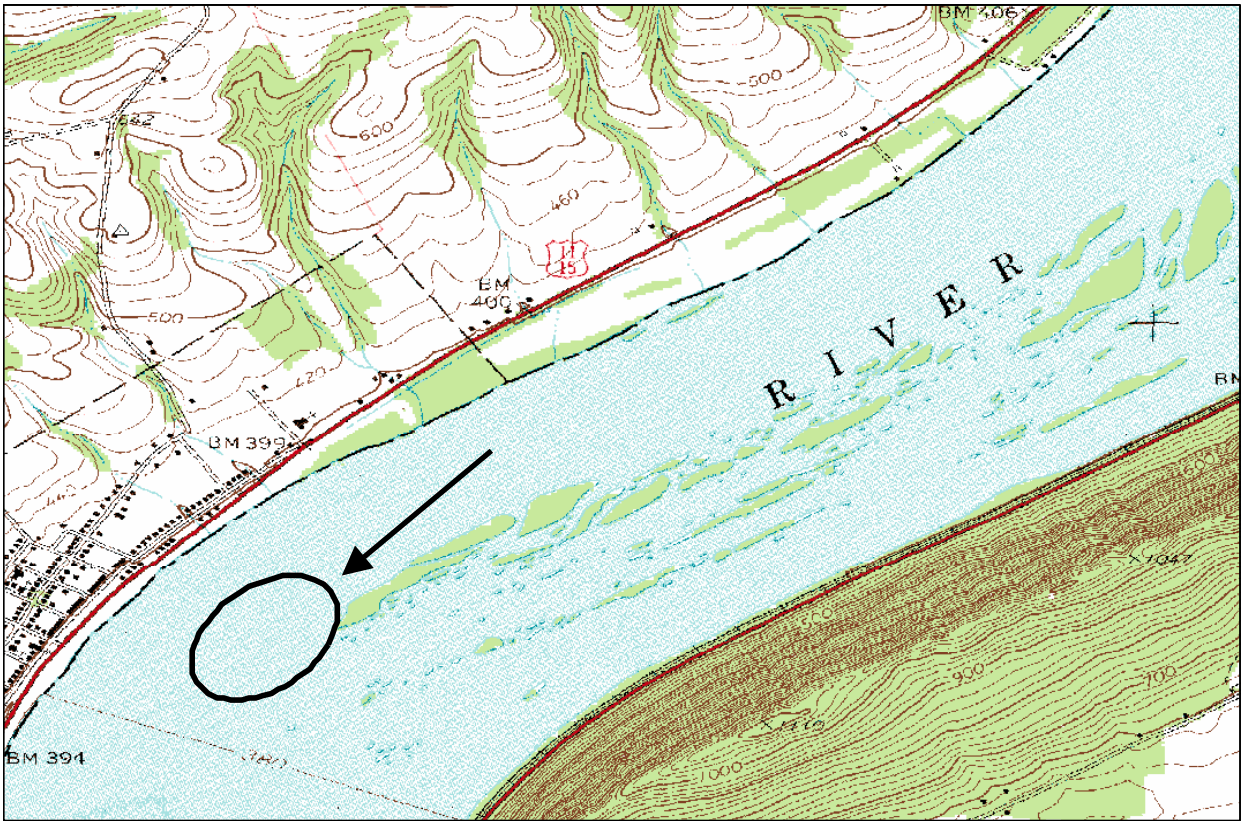
0 0.25 0.5 1 Miles

1:24,000

Site: EPA 2.21, 2.22

USGS 7.5' Quadrangle: Millersburg, PA
Dauphin County, Upper Paxton Twp.
Location: Liverpool, 0.8 km E

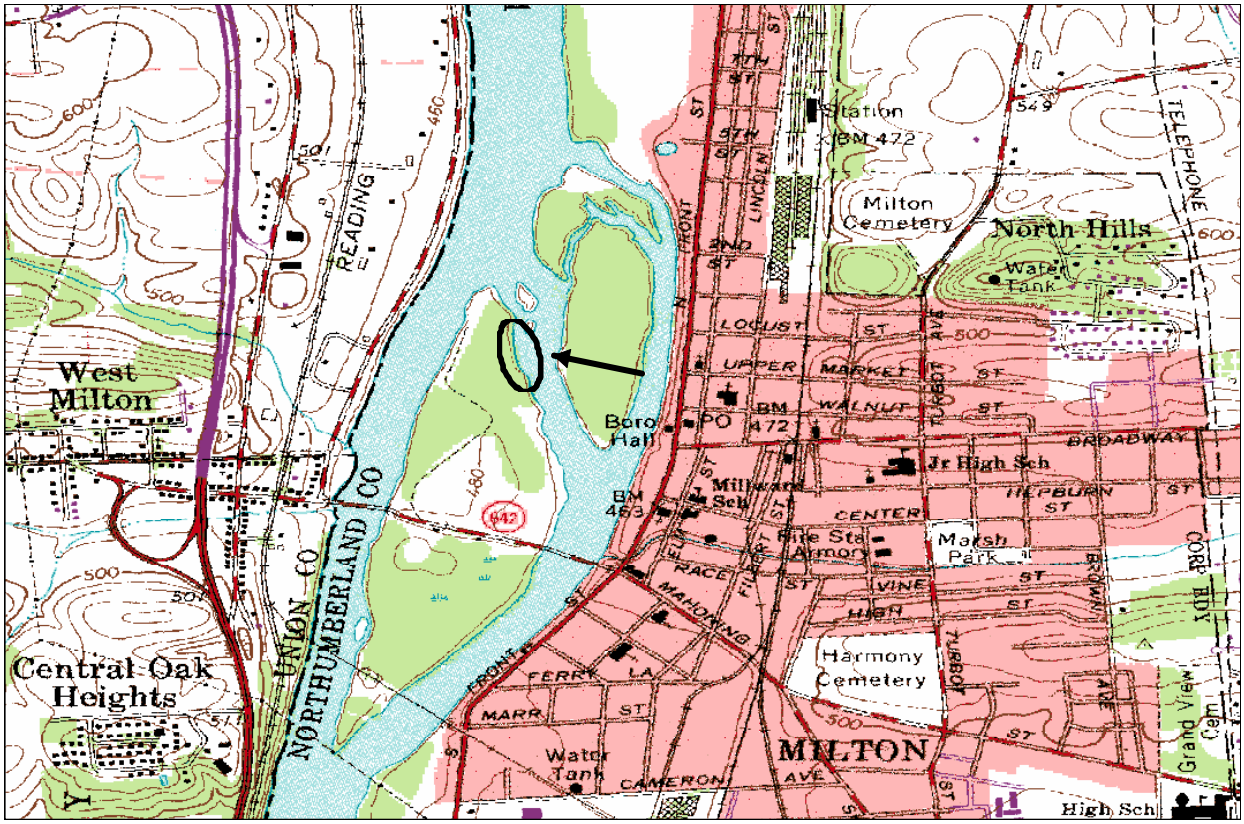
EPA 2.21, 2.22 lie within TNC's Central Appalachian Forest Ecoregion on a series of bars and open cobble spits associated with larger islands in the Susquehanna River channel, Dauphin County. The islands exhibit a pattern of open cobble spits that transition to zones of herbaceous vegetation on alluvial soil to forests on the larger islands; all are prone to frequent flooding. **Plot 2.21 (Riverine Scour Vegetation)** represents a graminoid-dominated zone on sandy-silt alluvium. **Plot 2.22 (Purple Loosestrife Riverine Scour Vegetation)** represents the sparsely vegetated (~50 %) low cobble spits situated in the channel between the larger islands that are dominated by *Salix nigra* and *Betula nigra*; *Lythrum salicaria* is the most abundant herbaceous plant species.



Site: EPA 2.23, 2.24

USGS 7.5' Quadrangle: Milton, PA
Northumberland County, Milton Borough.
Location: Boro Hall 0.5 km NW

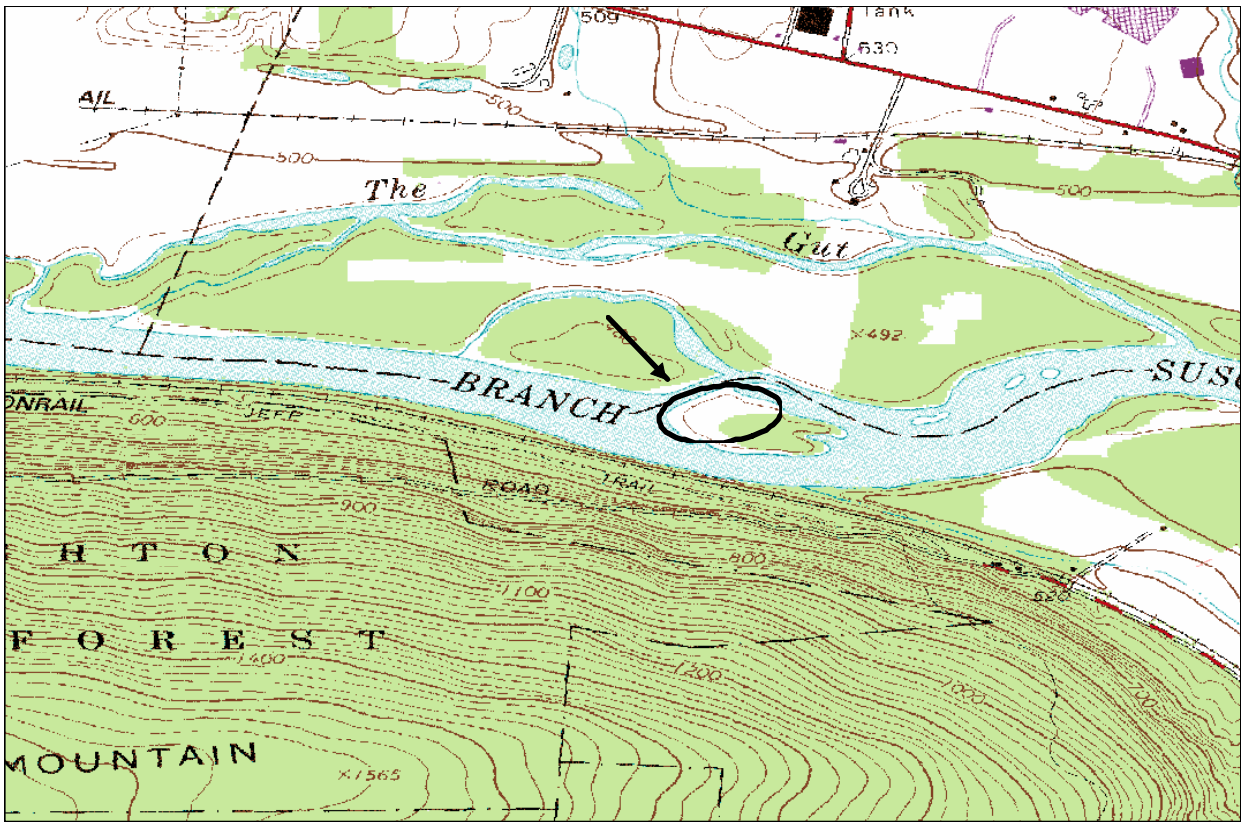
EPA 2.23, 2.24 lie within TNC's Central Appalachian Forest Ecoregion on the protected edge of the Milton State Park island in the West Branch of the Susquehanna River, Northumberland County. Included in the site are areas of exposed unvegetated silt-loam alluvial flats followed by a series of vegetation zones that progress from graminoid-dominated areas to shrub-dominated areas to forest with a dense understory of *Polygonum cuspidatum*. **Plot 2.23 (Riverine Scour Vegetation)** represents the graminoid-dominated zone just above the unvegetated silt-loam flats; prominent graminoid species common to this area include *Eleocharis spp.* and *Cyperus strigosus*. **Plot 2.24 (Silver Maple (River Birch) – Mixed Hardwood Riverine Shrubland)** represents the protected side channel dominated by tree and shrubs species such as *Acer saccharinum* and *Betula nigra*; herbaceous species occupy less than 15% of the plot.



Site: EPA 2.25, 2.26, 2.27

USGS 7.5' Quadrangle: Muncy, PA
Lycoming County, Clinton Twp.
Location: Halls, 1.8 km WSW

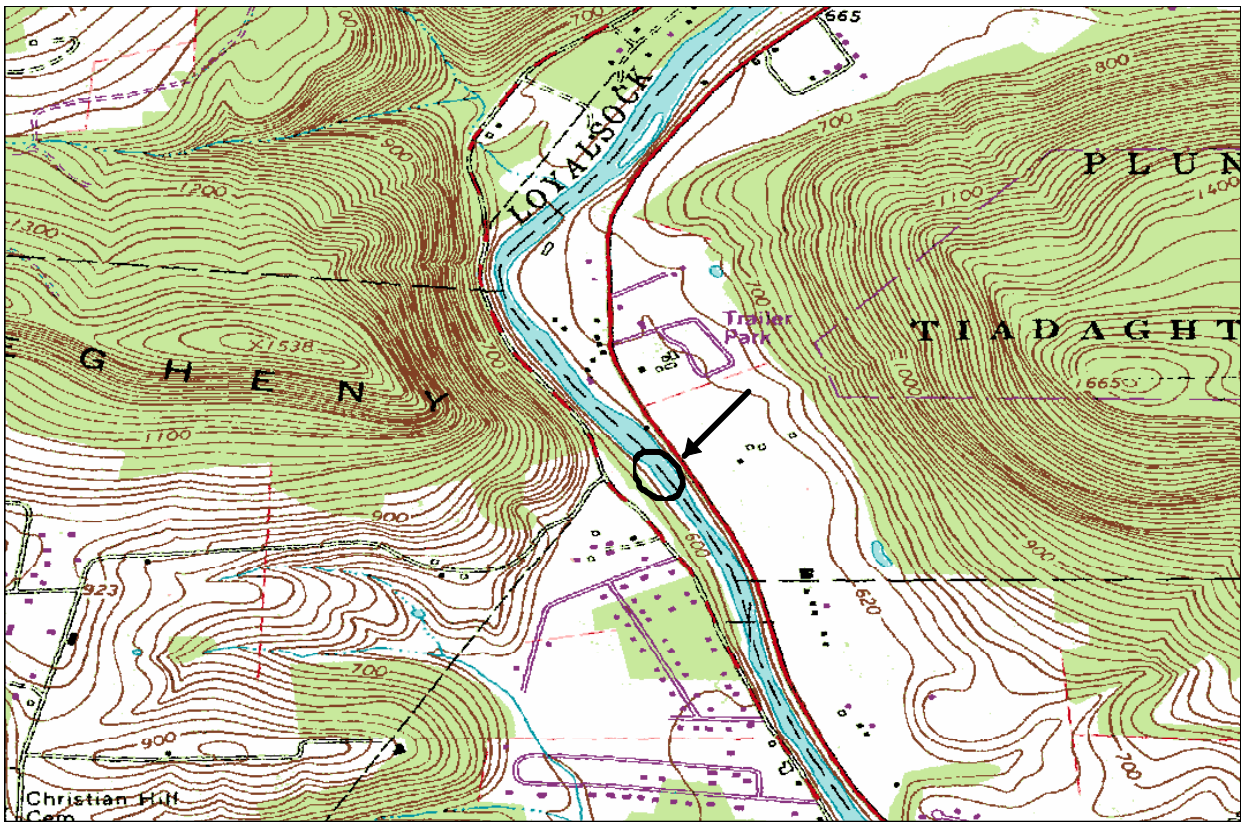
EPA 2.25, 2.26, 2.27 lie within TNC's Central Appalachian Forest Ecoregion on a large island in the West Branch of the Susquehanna River, Lycoming County. The island contains broad vegetation zones that range from sparsely vegetated cobble shores to a zone dominated by young trees and tall shrubs, predominantly cobble substrate. **Plot 2.25 (Water Willow Emergent Bed)** represents the low, exposed emergent herbaceous zone on the island head dominated by *Justicia americana.* **Plot 2.26 (Mixed Hardwood Riverine Shrubland)** represents the shrub/mixed herbaceous zone of the island. The most abundant woody species include *Platanus occidentalis, Betula nigra, Acer saccharinum* in addition to vines (*Vitis sp.*)*; J. americana, Apocynum cannabinum,* and *Senna hebecarpa* are the most prevalent herbaceous species. **Plot 2.27 (River Birch (Sycamore) – Mixed Hardwood Riverine Shrubland)** represents the tall shrub - young tree component dominated by *P. occidentalis,*and *B. nigra*; common vines are *Vitis riparia* and *Toxicodendron radicans*; *Polygonum cuspidatum* dominates the herbaceous component.



Site: EPA 2.28

USGS 7.5' Quadrangle: Montoursville North, PA
Lycoming County, Eldred Twp.
Location: Loyalsockville, 2.5 km NNW

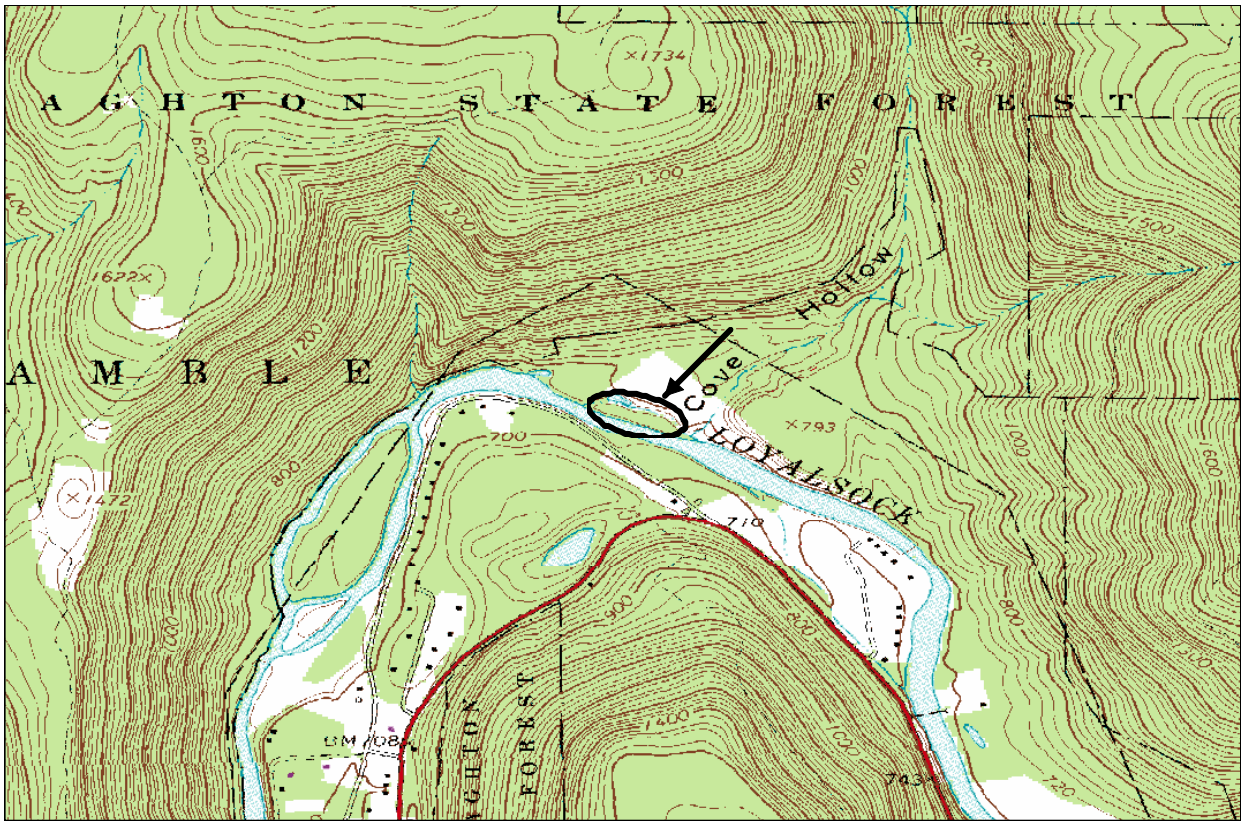
EPA 2.28 lies within TNC's High Allegheny Plateau Ecoregion on a cobble-scour zone along the west bank of Loyalsock Creek, Lycoming County. The site transitions rapidly from open cobbles to a shrub-dominated zone. Flooding is common as indicated by a substantial amount of debris. **Plot 2.28 (Riverine Scour Vegetation)** represents the herbaceous zone between the open, frequently scoured cobbles and shrub-dominated zone located at a slightly higher elevation. The herbaceous zone is composed primarily of *Apocynum cannabinum, Eupatorium maculatum, Phalaris arundinacea,* and *Mentha arvense* among others; *Salix nigra* comprises a small proportion (<10%) of the vegetation.



Site: EPA 2.29, 2.30, 2.31

USGS 7.5' Quadrangle: Barbours, PA
Lycoming County, Plunket's Creek Twp.
Location: Proctor 4.7 km SW

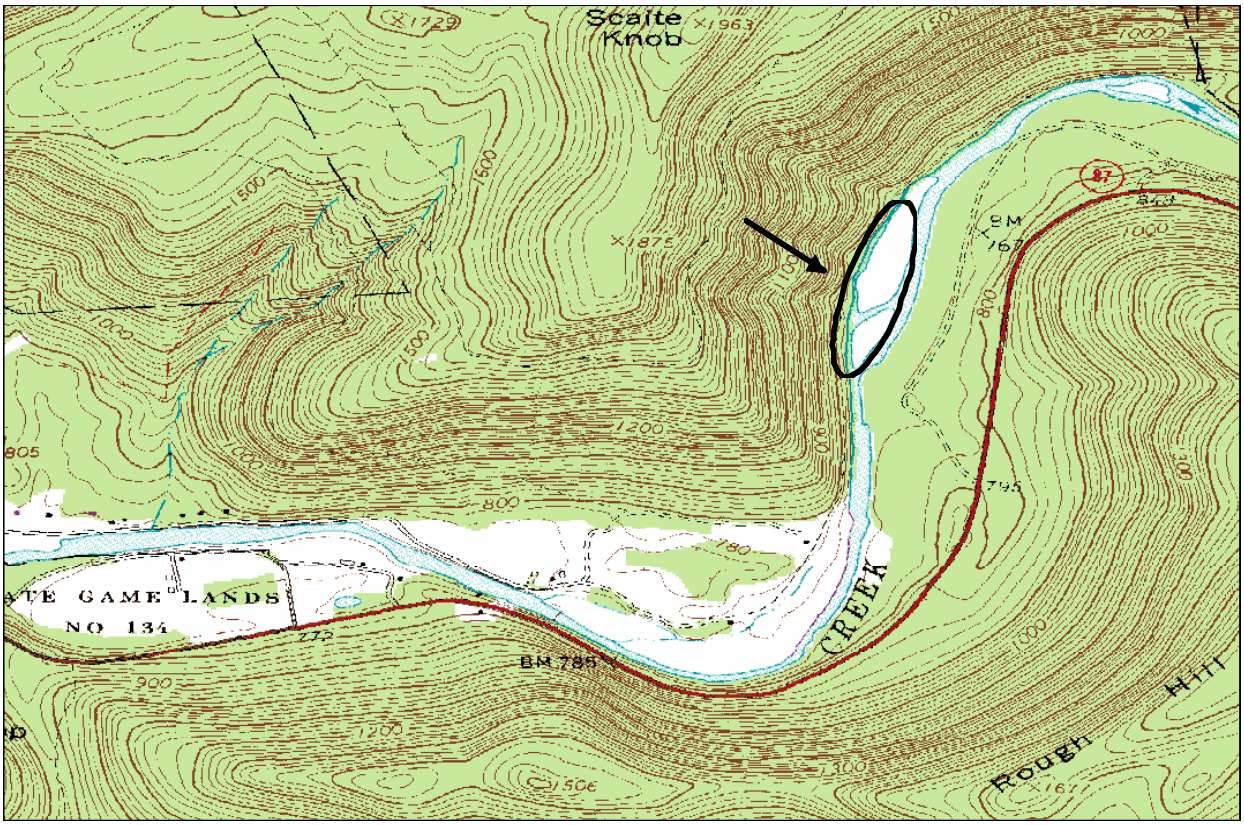
EPA 2.29, 2.30, 2.31 lie within TNC's High Allegheny Plateau Ecoregion on an island and shoreline along Loyalsock Creek, Lycoming County. The island is separated from the shoreline by an exposed cobble back-channel. The site is composed of a substrate of large cobbles and exhibits well defined sparse herbaceous, mixed herbaceous/shrub, graminoid-herbaceous back channel, and upland shoreline herbaceous zones. **Plot 2.29 (Riverine Scour Vegetation)** represents the herbaceous-graminoid zone dominated by *Eupatorium maculatum, Apocynum cannabinum,* and *Phalaris arundinacea*. **Plot 2.30 (Sycamore – Mixed Hardwood Riverine Shrubland)** represents the shrubby component of the site dominated by *Platanus occidentalis* and *Salix sericea*; prevalent herbaceous species include *Polygonum cuspidatum* and *E. maculatum*. **Plot 2.31 (Sedge – Spotted Joe Pye Weed Riverine Herbaceous Vegetation)** captures the back channel area dominated by herbaceous species and includes a small seep run and associated pools; common species include *Carex torta* and *E. maculatum*.



Site: EPA 2.32, 2.33

USGS 7.5' Quadrangle: Barbours, PA
Lycoming County, Plunket's Creek Twp.
Location: Scaite Knob, 1.1 km SE

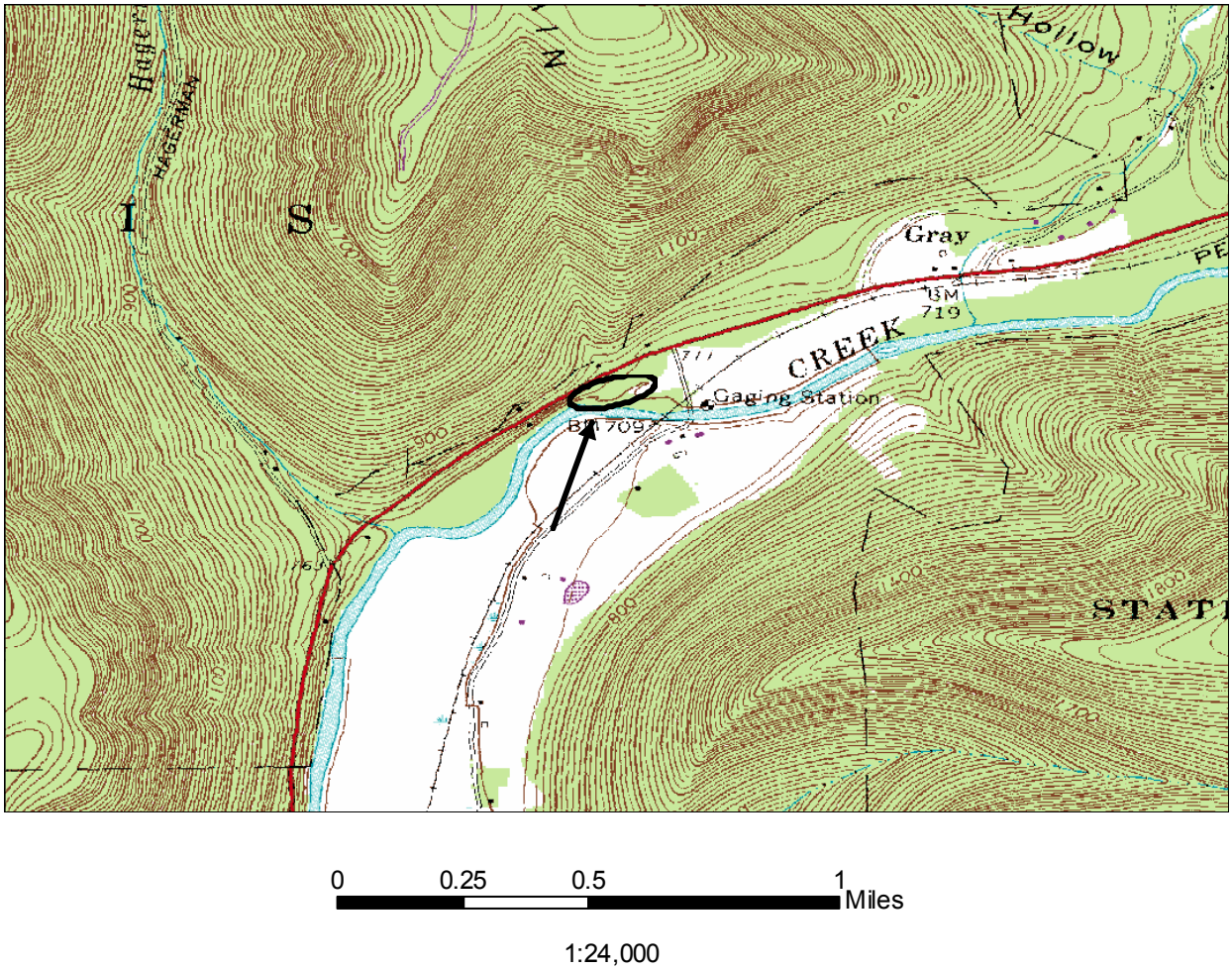
EPA 2.32, 2.33 lie within TNC's High Allegheny Plateau Ecoregion on a large island in Loyalsock Creek, Lycoming County. The site contains numerous patches of vegetation ranging from sparsely vegetated cobbles on the island head, to linear patches of shrub/young forest that parallel the creek, to an extensive back channel wetland dominated by a mix of graminoids and herbaceous species. **Plot 2.32 (Riverine Scour Vegetation)** represents the graminoid-dominated section of the backwater channel on silty-sand alluvium; most prominent species include *Ludwigia palustris, Scirpus cyperinus, Juncus effusus,* and *Mimulus ringens*. **Plot 2.33 (Sycamore – Mixed Hardwood Riverine Shrubland)** represents the tall shrub/young forest on sandy loam soil co-dominated by *Platanus occidentalis* and *Salix eriocephala; Polygonum cuspidatum*, *Alliaria petiolata*, and *Tanacetum vulgare* comprise the majority of the herbaceous cover.



Site: EPA 2.34, 2.35

USGS 7.5' Quadrangle: Trout Run, PA
Lycoming County, Lewis Twp.
Location: Gray, 1 km WSW

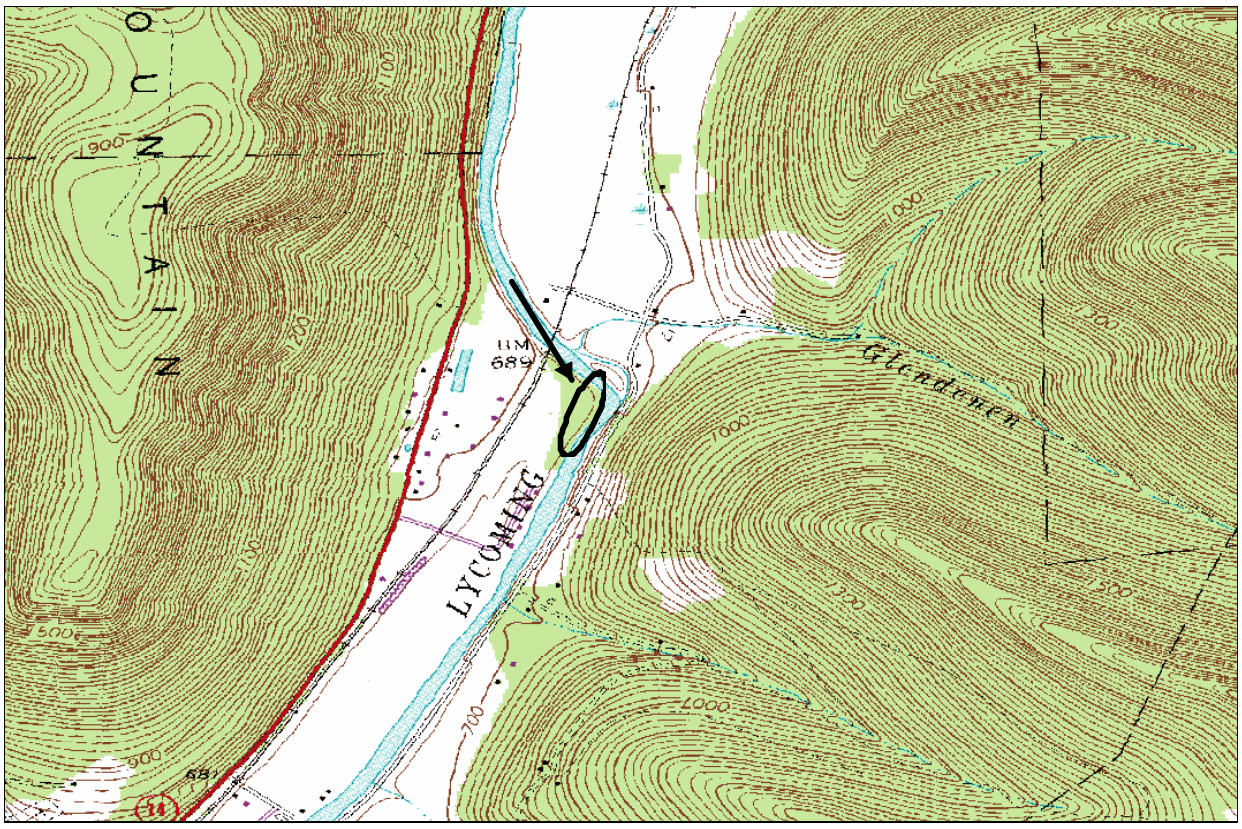
EPA 2.34, 2.35 lie within TNC's High Allegheny Plateau Ecoregion on a moderately sized island/cobble bar with a small back channel in Lycoming Creek, Lycoming County. Distinct vegetative zones progress from a sparsely vegetated cobble bar and herbaceous perimeter to a young Sycamore Floodplain Forest. **Plot 2.34 (Sedge – Spotted Joe Pye Weed Riverine Herbaceous Vegetation)** represents the narrow herbaceous/graminoid perimeter on the cobble bar dominated by *Eupatorium maculatum; Carex torta, Onoclea sensibilis*, and *Phalaris arundinacea* are also present. **Plot 2.35 (Sycamore – Mixed Hardwood Riverine Shrubland)** represents the dense shrub zone dominated by *Salix nigra, Betula nigra, Platanus occidentalis* and *Rosa multiflora*; associate herbaceous species include *Solidago gigantea* among others.



Site: EPA 2.36, 2.37

USGS 7.5' Quadrangle: Trout Run, PA
Lycoming County, Lewis Twp.
Location: Trout Run, 2.2 km NE

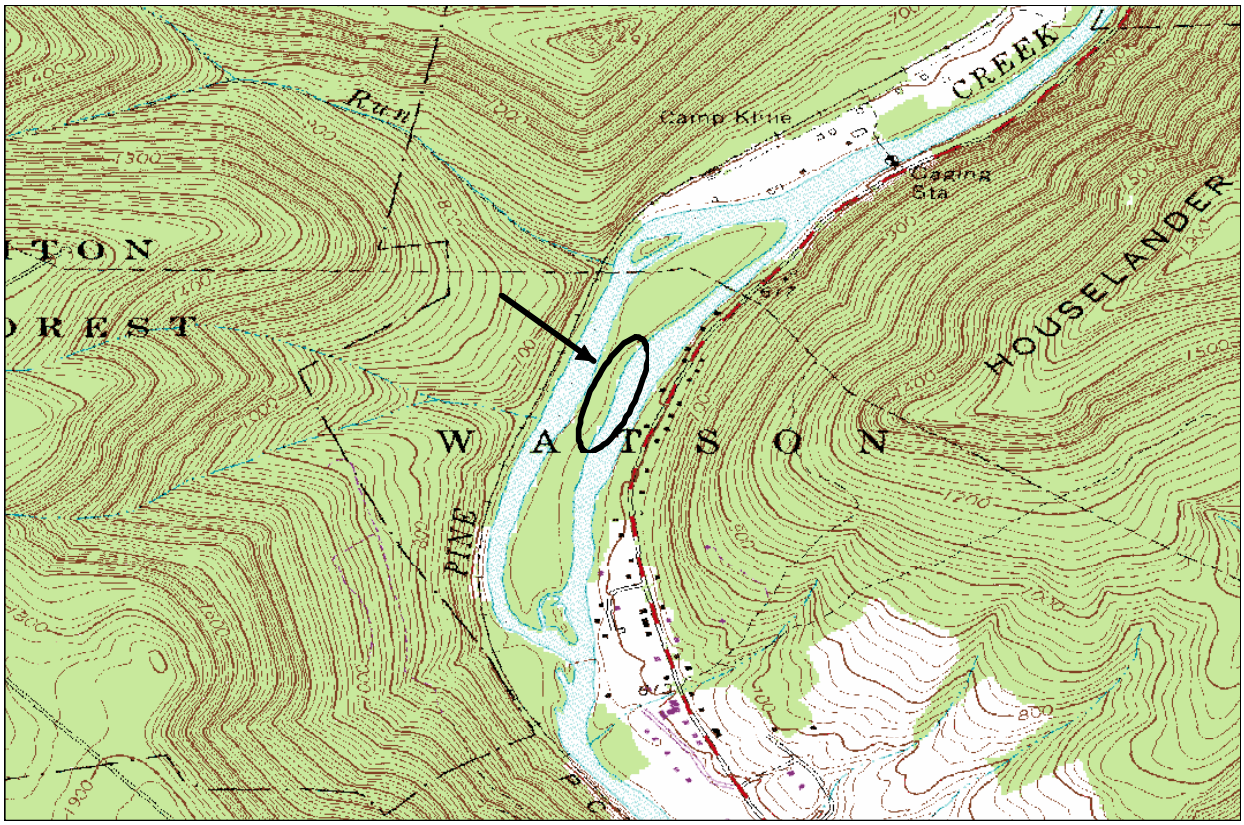
EPA 2.36, 2.37 lie within TNC's High Allegheny Plateau Ecoregion along the shoreline of Lycoming Creek, Lycoming County. The shoreline consists of open cobbles and a perimeter of herbaceous vegetation transitioning to a low shrub interior with a high percentage of exotic species. **Plot 2.36 (Sedge – Spotted Joe Pye Weed Riverine Herbaceous Vegetation)** represents the herbaceous zone adjacent to cobble shoreline; *Eupatorium maculatum, Apocynum cannabinum, Carex torta*, and *Euthamia graminifolia* are the most prominent species. **Plot 2.37 (Sycamore (Willow) – Mixed Hardwood Dwarf Shrubland)** represents the low shrub component of the shoreline on sand and cobble substrate. *Salix eriocephala, Rosa multiflora*, and several species of *Rubus* comprise the dominant short shrub layer; associated herbaceous species cover approximately 40% of the plot.



Site: EPA 2.38, 2.39

USGS 7.5' Quadrangle: Waterville, PA
Lycoming County, Watson Twp.
Location: Tombs Run, 1.2 km NNW

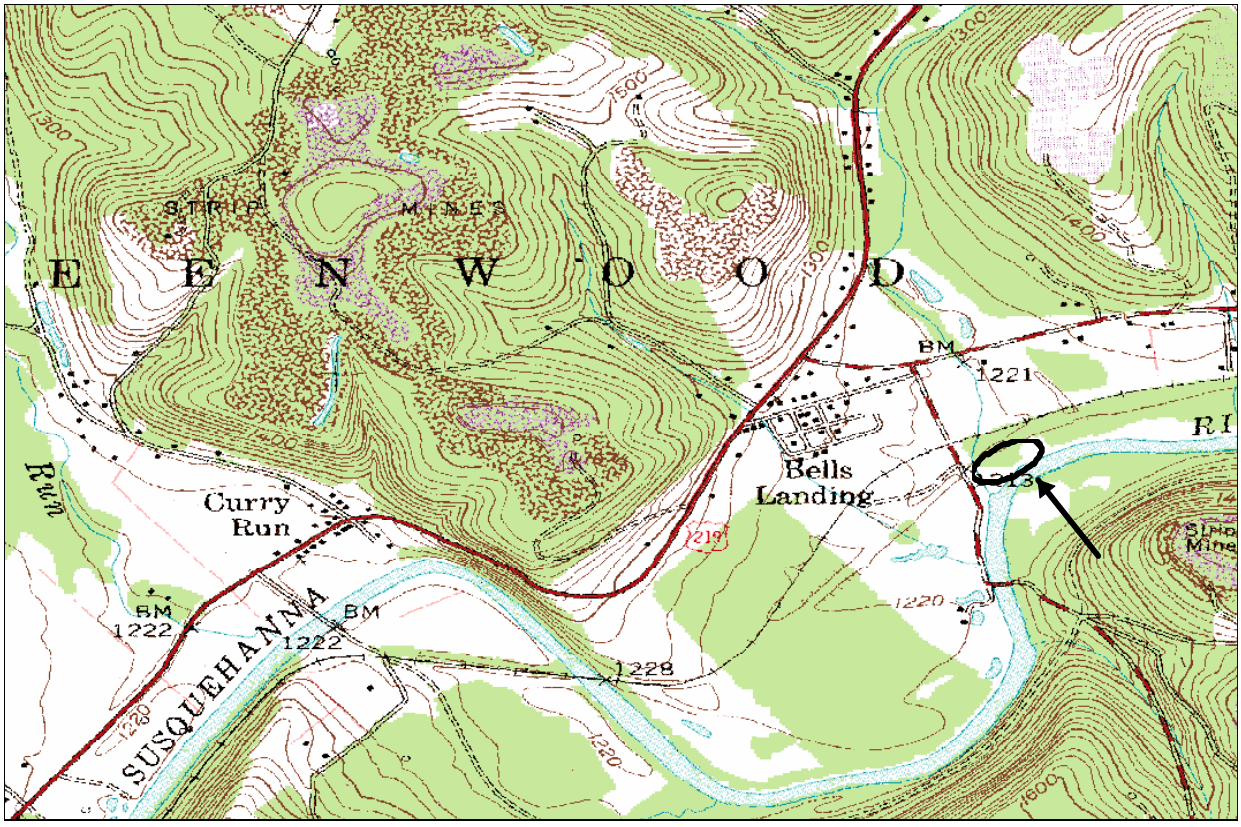
EPA 2.38, 2.39 lie within TNC's High Allegheny Plateau Ecoregion on broad cobble shorelines along Pine Creek, Lycoming County. Vegetation zones progress from open cobbles and emergent *Justicia* beds to an herbaceous perimeter above the scour bed, to a shrub-dominated zone, and finally to an abrupt rise in elevation to the upland zone. **Plot 2.38 (Reed Canary Grass Riverine Grassland)** represents the herbaceous/graminoid zone on the cobble shore that includes *Phalaris arundinacea* and *Eupatorium maculatum*. **Plot 2.39 (River Birch (Sycamore) – Mixed Hardwood Riverine Shrubland)** is characteristic of the tall shrub zone on sandy loam soil co-dominated by *Betula nigra* and *Platanus occidentalis; Panicum clandestinum* and *Solidago gigantea* are prevalent herbaceous species.



Site: EPA 2.40, 2.41

USGS 7.5' Quadrangle: Mahaffey, PA
Clearfield County, Greenwood Twp.
Location: Bells Landing, 0.4 k ESE

EPA 2.40, 2.41 lie within TNC's Western Allegheny Plateau Ecoregion on cobble bars and along low banks of the West Branch of the Susquehanna River, Clearfield County. **Plot 2.40 (Riverine Scour Vegetation)** is situated on a narrow, sparsely vegetated cobble bar. Both cobble bars and river banks are dominated by herbaceous species such as *Eupatorium perfoliatum, E. maculatum, Lysimachia terrestris, Hypericum muticum,* and *Carex torta*. Short shrubs comprise 20% cover and include *Cornus amomum, Acer saccharinum,* and *Salix* species. Plot 2.41 **(Riverine Scour Vegetation)** represents the riverbank herbaceous zone with scattered shrubs on sandy-loam soil; *Agrimonia gryposepala* is the dominant herbaceous species.



0 0.25 0.5 1 Miles

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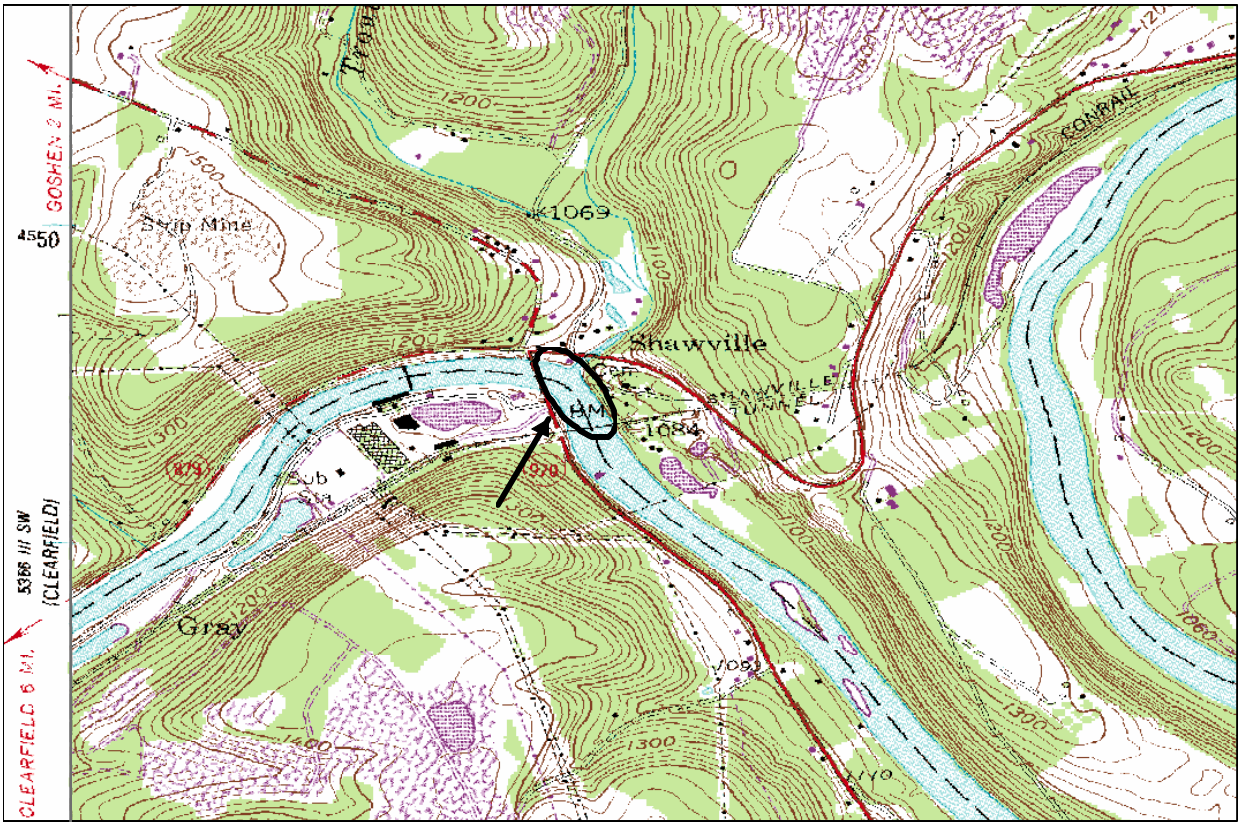
Site: EPA 2.42, 2.43, 2.44

USGS 7.5' Quadrangle: Lactones Mills, PA
Clearfield County, Goshen Twp.
Location: Shaw Ville, 0.2 km S

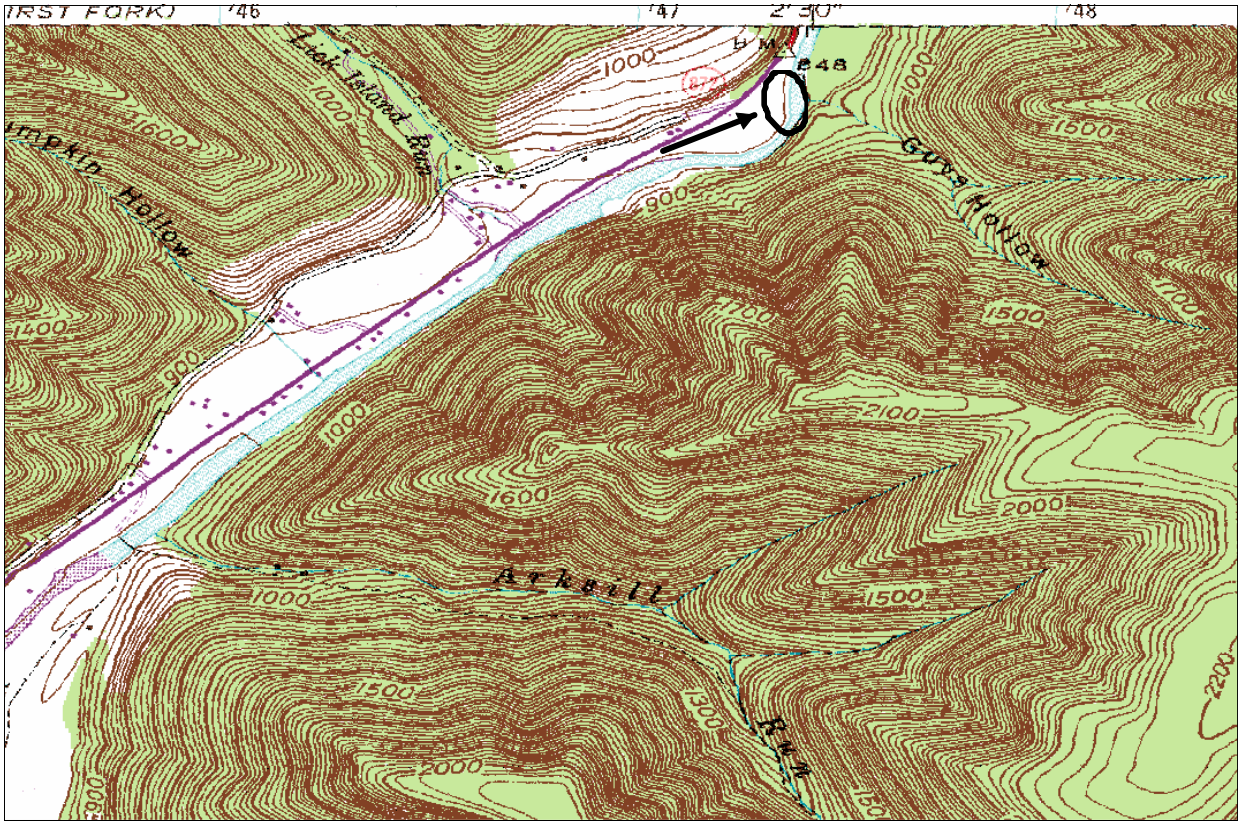
EPA 2.42, 2.43, 2.44 lie within TNC's Western Allegheny Plateau Ecoregion on broad cobble shorelines that include conspicuous patches of prairie habitat and shrub-dominated zones along the West Branch of the Susquehanna River, Clearfield County. **Plot 2.42 (Riverine Scour Vegetation)** represents the vegetative patch over cobbles that consists primarily of graminoids and herbaceous species including *Andropogon gerardii, Sorghastrum nutans, Apocynum sibiricum*; scattered shrub species included *Spiraea latifolia, Physocarpus opulifolius,* and *Salix sp*. **Plot 2.43 (Speckled Alder Riverine Shrubland)** represents shrub pockets embedded within the floodplain; the substrate was covered with leaf litter. Shrub species included *Alnus incana spp rugosa*, *Physocarpus opulifolius, Cornus amomum,* and species of *Salix*; 5-6 m tall *Robinia pseudoacacia* were also present. The herbaceous layer was primarily composed of *Polygonum cuspidatum, Solidago gigantea,* and *Panicum clandestinum*. **Plot 2.44 (Willow – Indian Grass Riverine Shrubland)** represents sites typical of the cobble beds composed of both shrub and herbaceous species rather than grasses as in 2.43; prominent shrub and forb species include *Spiraea tomentosa, Salix spp*., and *Apocynum sibiricum*.



Site: EPA 2.45, 2.46

USGS 7.5' Quadrangle: Sinnemahoning, PA
Cameron County, Grove Twp.
Location: Sinnemahoning, 7.4 km NE

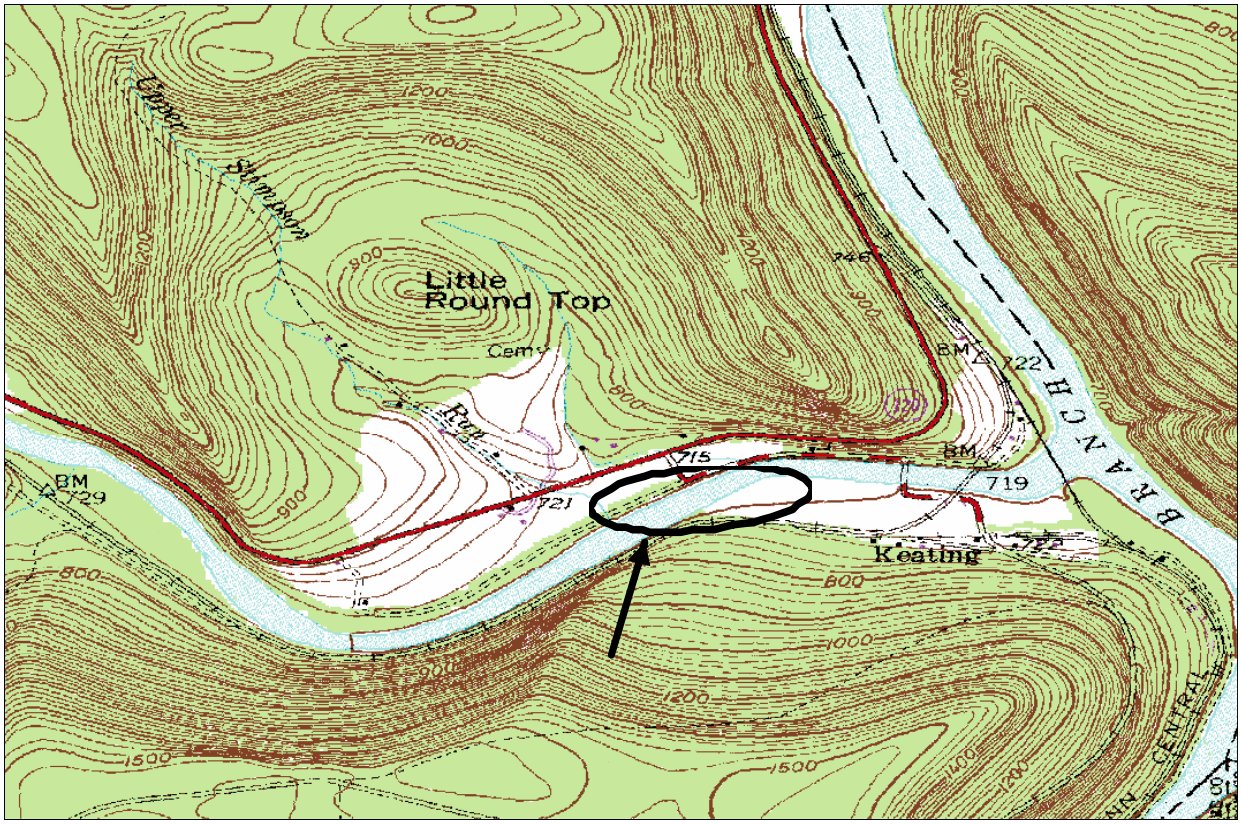
EPA 2.45, 2.46 lie within TNC's High Allegheny Plateau Ecoregion on a broad expanse of low cobble and sand shoreline and island bars in Sinnemahoning Creek, Cameron County. Vegetation cover consists of distinct patches of graminoid/herbaceous species interspersed with patches of shrubs. **Plot 2.45 (Reed Canary Grass Riverine Grassland)** represents the dominant cover type on the cobble-scour zone/channel bed consisting of graminoids and herbaceous species; *Phalaris arundinacea* covers over 50% of the plot. **Plot 2.46 (Speckled Alder Riverine Shrubland)** represents the shrub thickets on silt loam soil, slightly higher in elevation, composed primarily of *Alnus incana* sub. *rugosa* and *Rosa multiflora*; herbaceous species *Microstegium vimineum*, *Phalaris arundinacea,* and *Leersia virginica* are also moderately abundant.



Site: EPA 2.47, 2.48, 2.49, 2.58

USGS 7.5' Quadrangle: Keating, PA
Clinton County, East Keating Twp.
Location: Keating, 0.5 km WNW

EPA 2.47, 2.48, 2.49, 2.58 lie within TNC's High Allegheny Plateau Ecoregion in the scour zone and cobble banks on both sides of the Sinnemahoning Creek, near the confluence of Sinnemahoning and West Branch of the Susquehanna River, Clinton County. **Plot 2.47 (Riverine Scour Vegetation)** represents the mixed graminoid/herbaceous cobble scour zone on the south shore of Sinnemahoning Creek composed primarily of *Hypericum muticum, Carex sp.,* and *Mentha arvense; Platanus occidentalis* also occurred in the plot. **Plot 2.48 (Water Willow Emergent Bed)** captures the herbaceous cobble channel bed zone on the north side of the creek dominated by *Justicia americana*. **Plot 2.58** (**Riverine Scour Vegetation)** represents the graminoid/herbaceous cobble scour zone on the north shore co-dominated by *Spartina pectinata*, *Andropogon gerardii*, and other grasses. **Plot 2.49 (River Birch (Sycamore) – Mixed Hardwood Riverine Shrubland)** represents the mixed shrub-herbaceous zone on the north shore dominated by 2-6 m tall *Betula nigra* and *Platanus occidentalis*; prominent herbaceous/graminoid species include *Spartina pectinata*, *Carex spp.,* and *Apocynum cannabinum*.



0 0.25 0.5 1 Miles

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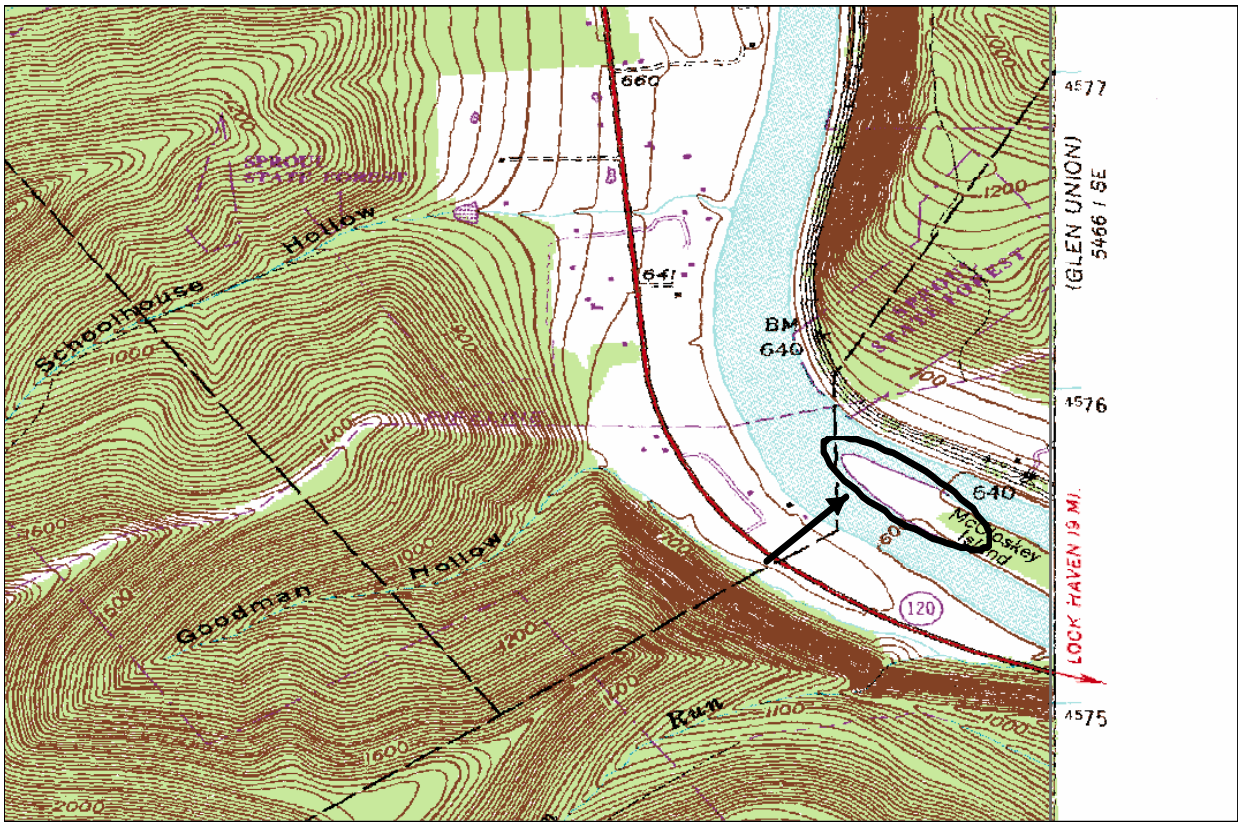
Site: EPA 2.50, 2.51, 2.52, 2.53

USGS 7.5' Quadrangle: Renovo East, PA
Clinton County, Chapman and Grugan Twps.
Location: Hyner, 3.2 km SSE

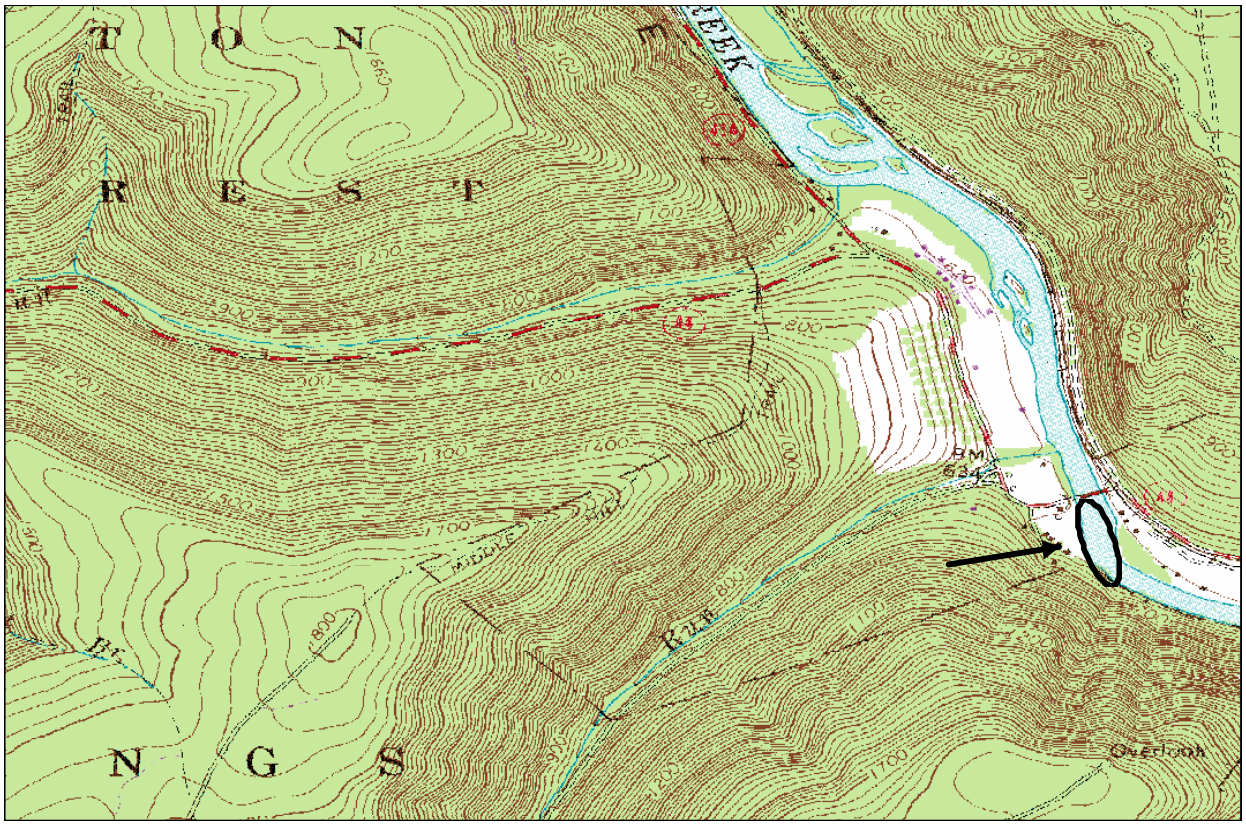
EPA 2.50, 2.51, 2.52, 2.53 lie within TNC's High Allegheny Plateau Ecoregion on the cobble beds and shorelines of McClosky Island in the West Branch of the Susquehanna River, Clinton County. **Plot 2.50 (Riverine Scour Vegetation)** represents the sparsely vegetated cobble bars that are typically under water in most seasons. Vegetative cover is less than 50% and includes *Cyperus strigosus, Lysimachia terrestris, Hypericum ellipticum,* and *Juncus spp*. **Plot 2.51 (Riverine Scour Vegetation)** represents the graminoid-dominated cobble scour zone with a slightly higher percent of vegetative cover (65%) that includes species such as *Panicum rigidulum, Rhexia virginica, H.ellipticum,* and *Andropogon gerardii*. **Plot 2.52 (River Birch (Sycamore) – Mixed Hardwood Riverine Shrubland)** represents the shrub component of the floodplain complex on silty-sand textured soil, dominated by *Betula nigra*; the herbaceous component is dominated by *Eupatorium fistulosum*. **Plot 2.53 (Sedge – Spotted Joe Pye Weed Riverine Herbaceous Vegetation)** represents the graminoid-dominated shoreline community on silty-muck over sand and cobbles, co-dominated by *Schoenoplectus pungens* and *Carex torta.*



Site: EPA 2.54, 2.55

USGS 7.5' Quadrangle: Jersey Mills, PA
Lycoming County, Cummings Twp.
Location: Jersey Mills, 4.3 km SSE

EPA 2.54, 2.55 lie within TNC's High Allegheny Plateau Ecoregion on the cobble spits and extended cobble/bedrock shores along Pine Creek, Lycoming County. Beds of *Justicia*-dominated herbaceous vegetation cover cobbles on inter-channel spits and herbaceous species dominate the shore growing between large cobbles and exposed bedrock. **Plot 2.54 (Water Willow Emergent Bed)** represents the herbaceous beds on cobble spits dominated by *Justicia americana*. **Plot 2.55 (Riverine Scour Vegetation)** represents the herbaceous shoreline zone composed of *Thelypteris palustris, Onoclea sensibilis*, *Sium suave,* along with other herbaceous and graminoid species.



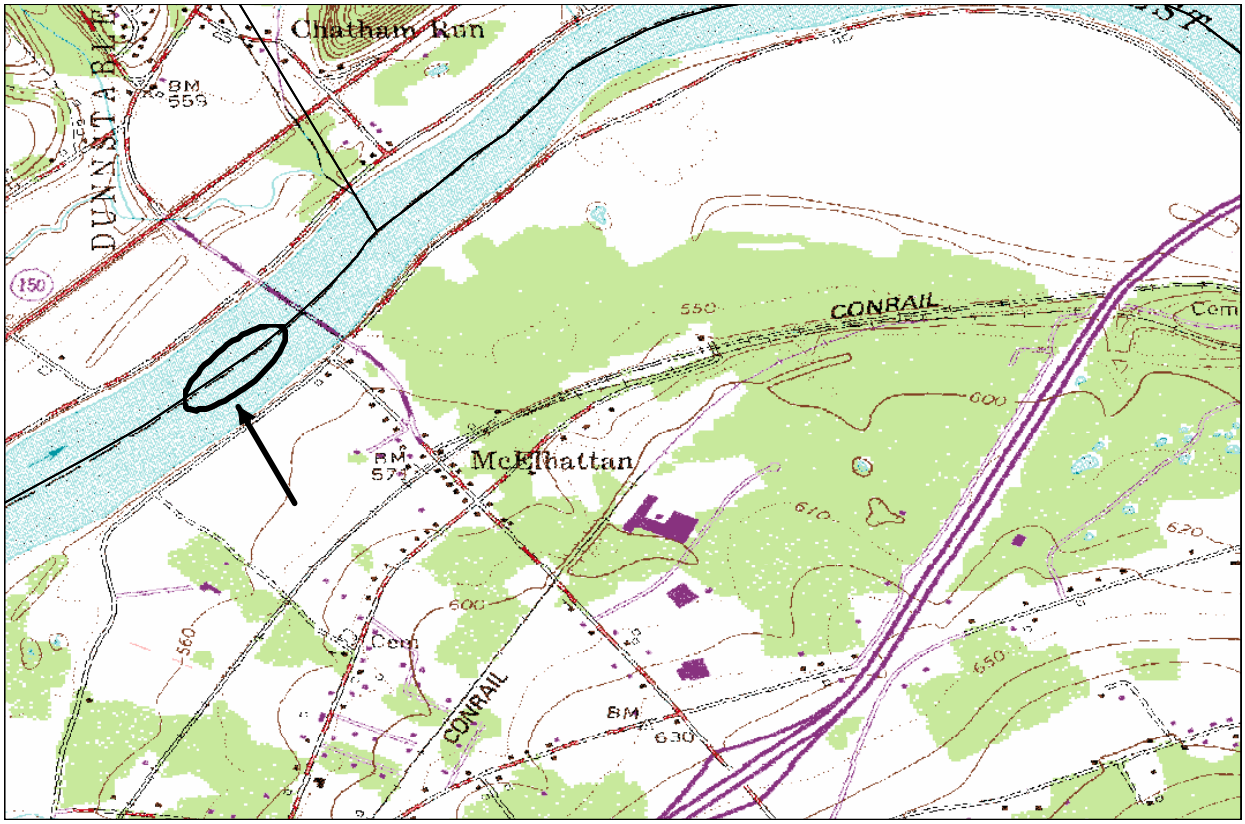
0 0.25 0.5 1 Miles

1:24,000

Site: EPA 2.56, 2.57

USGS 7.5' Quadrangle: Jersey Shore, PA
Clinton County, Wayne Twp.
Location: McElhattan, 0.8 km W

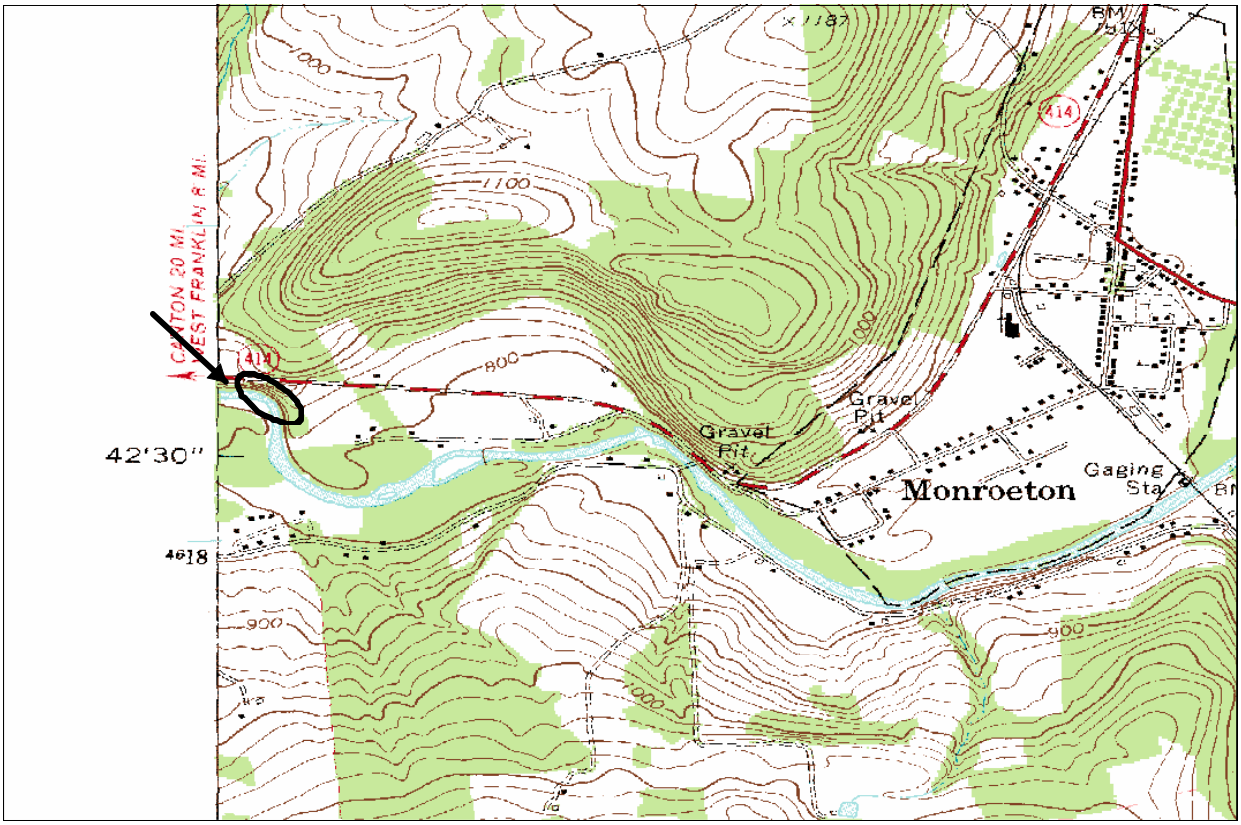
EPA 2.56, 2.57 lie within TNC's Central Appalachian Forest Ecoregion on a small island and sand and cobble shores along the West Branch of the Susquehanna, Clinton County. The shore and island are largely dominated by shrub species with narrow, sparsely vegetated, cobble perimeters. **Plot 2.56 (River Birch (Sycamore) – Mixed Hardwood Riverine Shrubland)** represents the narrow herbaceous and shrub perimeter adjacent to the river channel dominated by *Betula nigra* and *Lythrum salicaria*; other associated herbaceous species include *Bidens frondosa, Scirpus sp.,*and *Hypericum pyramidatum* among others. **Plot 2.57 (River Birch (Sycamore) – Mixed Hardwood Riverine Shrubland)** represents the tall shrub component on the center of the sandy island dominated by *Betula nigra*; other prominent species include *Acer saccharinum* and *Lythrum salicaria*.



Site: EPA 2.59, 2.60, 2.62

USGS 7.5' Quadrangle: Monroeton, PA
Bradford County, Monroe Twp.
Location: Monroeton, 2.0 km W

EPA 2.59, 2.60, 2.62 lie within TNC's High Allegheny Plateau Ecoregion along the north and south banks of Towanda Creek near Monroeton, Bradford County. The site consists of an open cobble channel, gravel bars and stream banks dominated by grasses and forbs, which transitions to a mixed shrub/herbaceous zone and then to a zone dominated by shrubs. **Plot 2.59 (Sycamore (Willow) – Mixed Hardwood Riverine Dwarf Shrubland)** represents the mixed herbaceous-short shrub zone co-dominated by *Platanus occidentalis, Populus deltoides*, and *Salix sericea*; *Eupatorium maculatum* and *Apocynum androsaemifolium* are primary herbaceous species. **Plot 2.60 (Sycamore – Mixed Hardwood Riverine Shrubland)** represents the tall shrub zone on cobble substrate dominated by *Platanus occidentalis*; *Coronilla varia* dominates the groundcover. **Plot 2.62 (Riverine Scour Vegetation)** is situated on the sand/cobble bar on the inner bank of the meander; vegetation consists primarily of herbaceous species including *Tussilago farfara* and *Phalaris arundinacea*.



0 0.25 0.5 1 Miles

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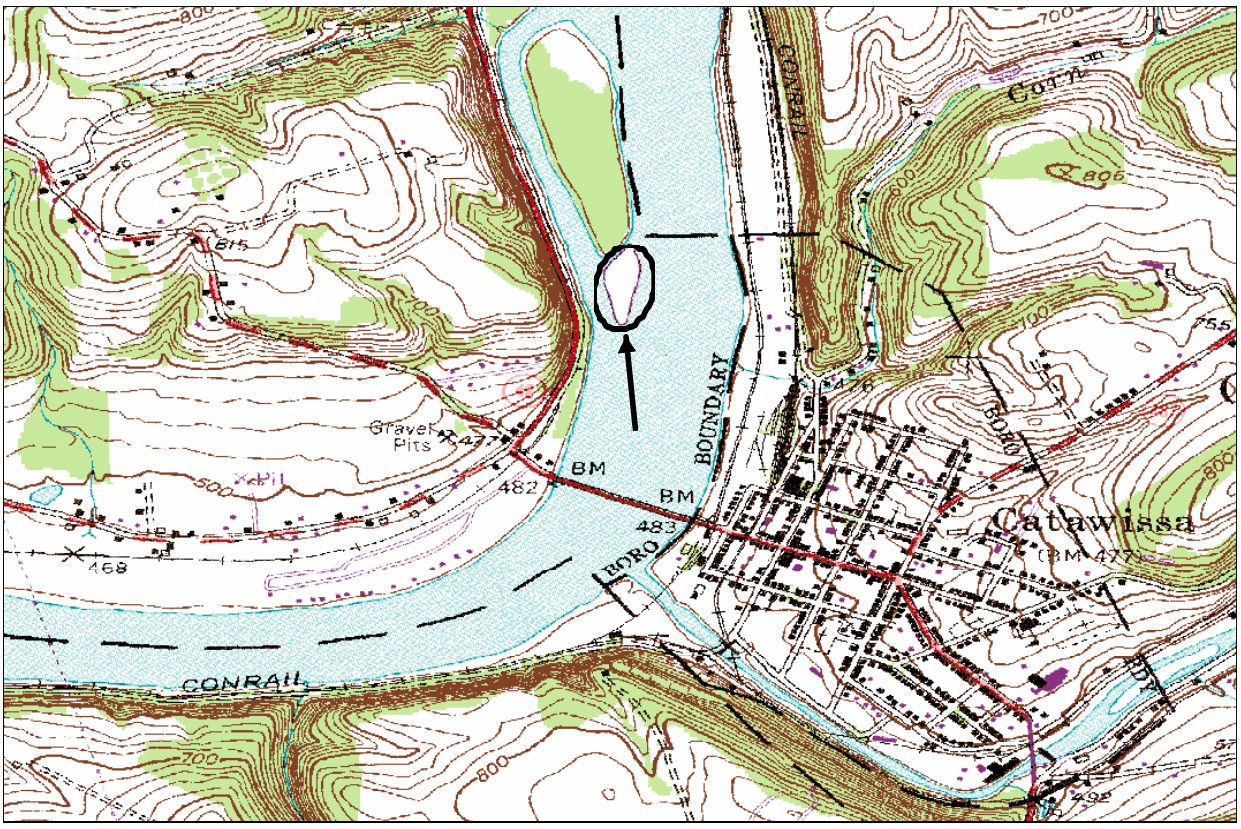
Site: EPA 2.61

USGS 7.5' Quadrangle: Catawissa, PA
Columbia County, Montour Twp.
Location: Catawissa, 1 km NW

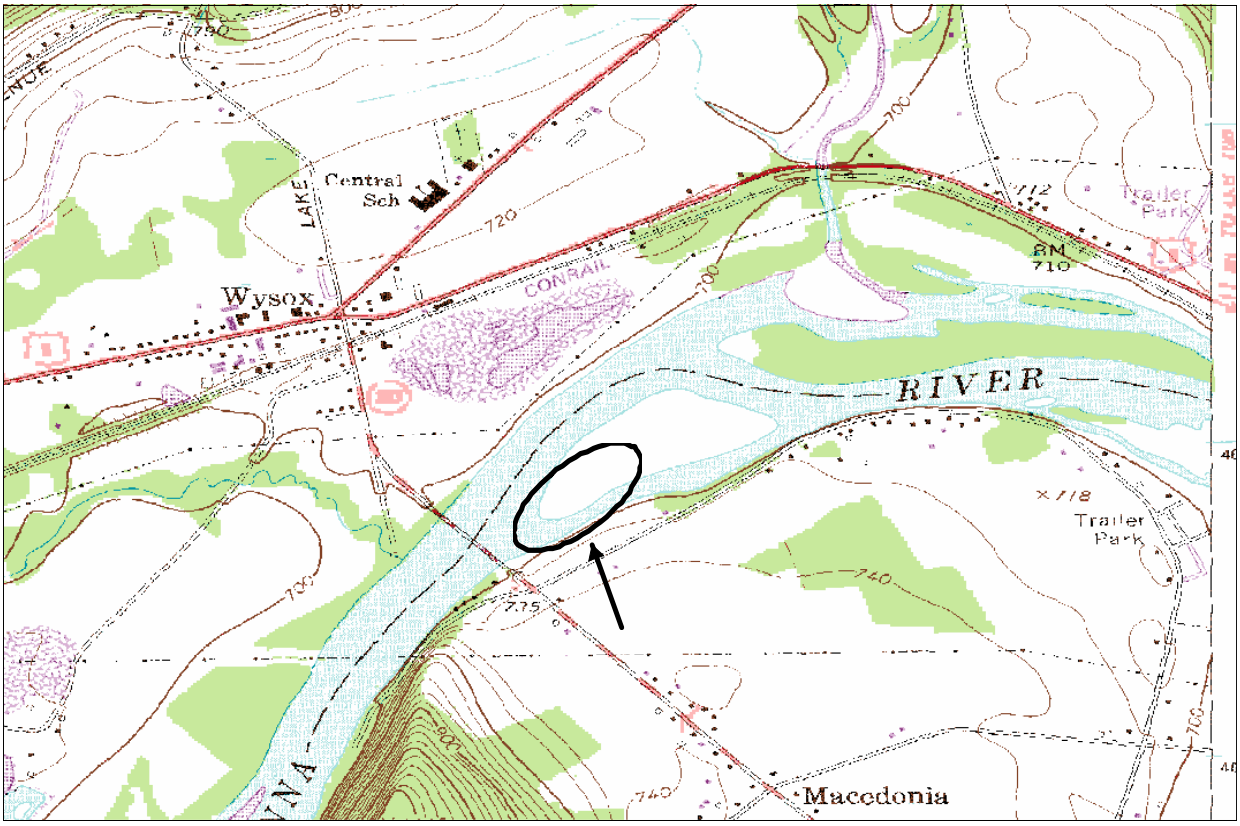
EPA 2.61 lies within TNC's Central Appalachian Forest Ecoregion on Catawissa Island in the Susquehanna River, Columbia County. Distinct vegetation zones include an exposed herbaceous bed, intermixed with other herbaceous species rising to a small shrub border at the edge of the forest zone. **Plot 2.61 (Purple Loosestrife Scour Vegetation)** represents the herbaceous bed and sandy island border zone dominated by *Justicia americana* and *Lythrum salicaria,* along with several graminoid species.



Site: EPA 2.63, 2.64, 2.65

USGS 7.5' Quadrangle: Towanda, PA
Bradford County, Asylum Twp.
Location: Towanda, 4.2 km E

EPA 2.63, 2.64, 2.65 lie within TNC's High Allegheny Plateau Ecoregion on an island in the Susquehanna River, Bradford County. Three distinct zones of vegetation exist on the island and attached shoreline. **Plot 2.63 (Riverine Scour Vegetation)** represents a sparsely vegetated cobble channel co-dominated by *Equisetum arvense* and *Polygonum amphibium*. **Plot 2.64 (Riverine Scour Vegetation)** represents a mixed graminoid/herbaceous patch on cobble substrate adjacent to the cobble bar; common species are *Lysimachia vulgaris, Carex lacustris,* and *Justicia americana*. **Plot 2.65 (Sycamore – Mixed Hardwood Riverine Shrubland)** represents the tall shrub-graminoid patch on the island; *Platanus occidentalis* and *Fraxinus pennsylvanica* dominate the shrub component; *Phalaris arundinacea* covers over 50% of the plot.



0 0.25 0.5 1 Miles

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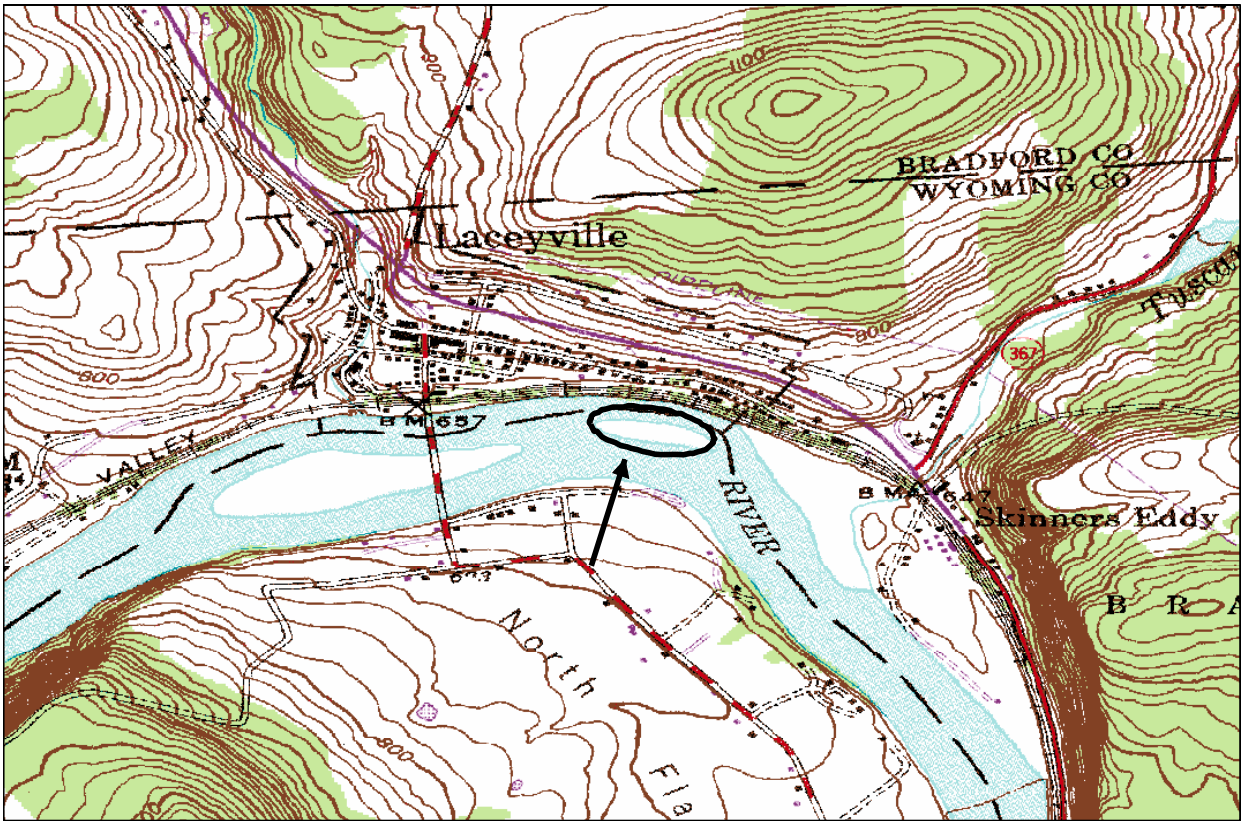
Site: EPA 2.66, 2.67, 2.68

USGS 7.5' Quadrangle: Laceyville, PA
Wyoming County, Braintrim Twp.
Location: Laceyville, 0.2 km S

EPA 2.66, 2.67, 2.68 lie within TNC's High Allegheny Plateau Ecoregion on long islands in the Susquehanna River, Wyoming County. Prominent vegetation zones include exposed cobble shores, herbaceous beds, and small terraces with short shrubs and mixed graminoids that grade into shrublands. **Plot 2.66 (Riverine Scour Vegetation)** represents the herbaceous bed on sandy alluvium composed primarily of *Lysimachia vulgaris, Apocynum cannabinum*, and *Lythrum salicaria*. **Plot 2.67 (Willow – Indian Grass Riverine Shrubland)** represents a mixed vine, shrub, and graminoid strip situated between the herbaceous beds and shrub dominated zones; prominent species include *Vitis riparia, Salix exigua,* and *Sorghastrum nutans*. **Plot 2.68 (Silver Maple (River Birch) – Mixed Hardwood Riverine Shrubland)** represents the tall shrub component of this floodplain complex composed primarily of 2-6m tall *Acer saccharinum* and *Platanus occidentalis,* as well as moderate cover of *Vitis riparia*; *Leersia virginica* is a prominent graminoid species in the plot.



0 0.25 0.5 1 Miles

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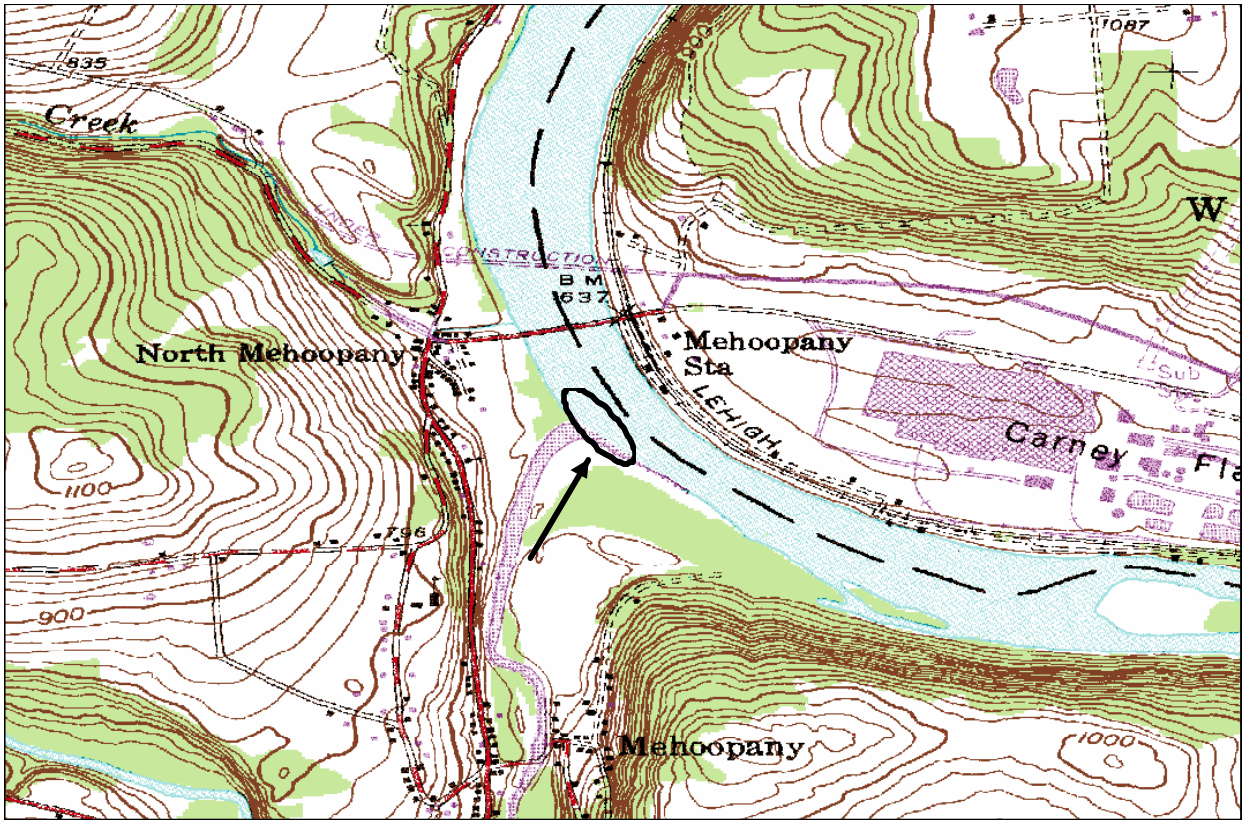
Site: EPA 2.69, 2.70

USGS 7.5' Quadrangle: Meshopen, PA
Wyoming County, Mehoopany Twp.
Location: Mehoopany, 0.9 km N

EPA 2.69, 2.70 lie within TNC's High Allegheny Plateau Ecoregion on the cobble shoreline and delta of Mehoopany Creek at its confluence with the Susquehanna River, Wyoming County. The site is composed of an extended shoreline of open, sparsely vegetated cobbles to an extensive zone dominated by herbaceous and graminoid species and scattered low shrubs, which eventually transitions to a zone of dense, tall shrubs and young forest adjacent to the upland forest. **Plot 2.69 (Willow – Indian Grass Riverine Shrubland)** represents the herbaceous-low shrub zone. Prominent woody species include *Salix nigra* and *S. exigua*; herbaceous/graminoid species include *Sorghastrum nutans, Echinochloa muricata,* and *Lythrum salicaria*. **Plot 2.70 (River Birch (Sycamore) – Mixed Hardwood Riverine Shrubland)** represents the tall shrub component of the complex co-dominated by 2-6m tall *Betula nigra* and *Platanus occidentalis; Sorghastrum nutans* is the most abundant herbaceous/graminoid species.



0 0.25 0.5 1 Miles

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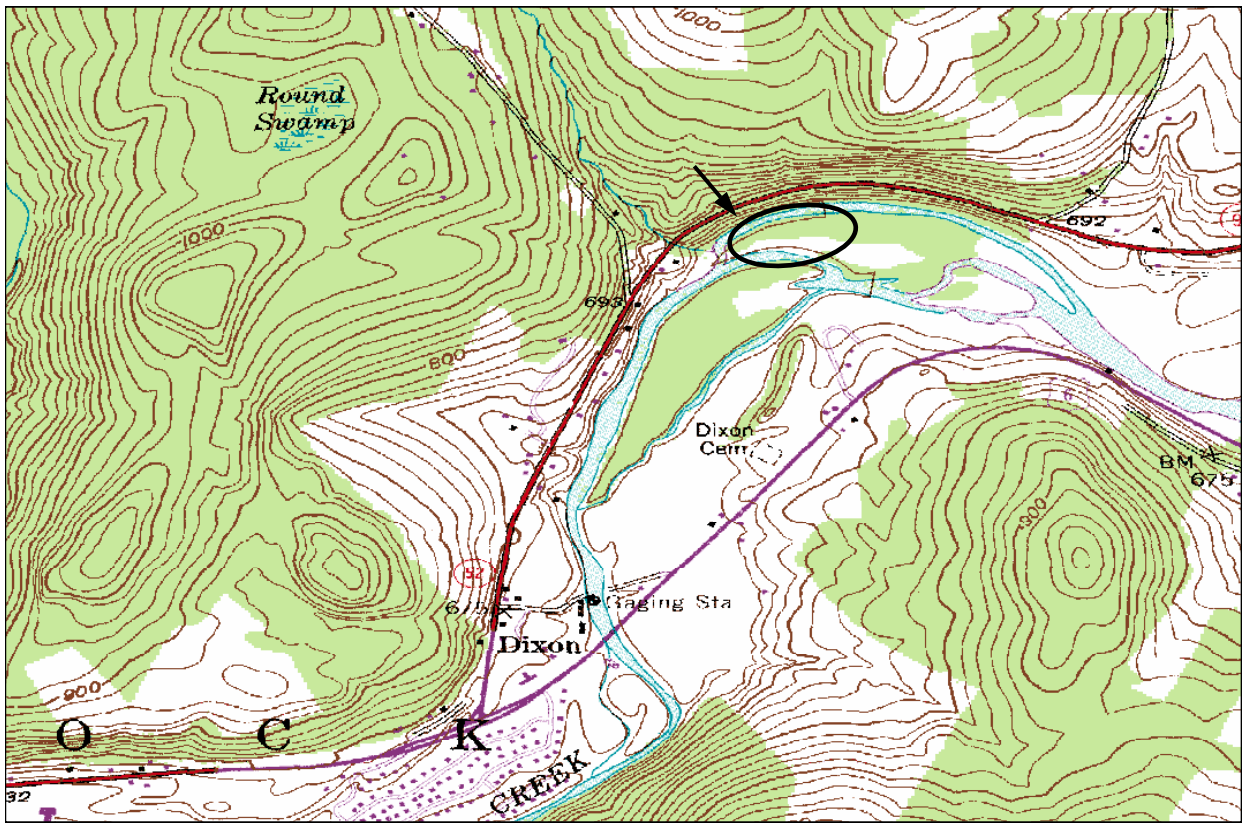
Site: EPA 2.71, 2.72

USGS 7.5' Quadrangle: Tunkhannock, PA
Wyoming County, Tunkhannock Twp.
Location: Dixon, 0.7 km NNE

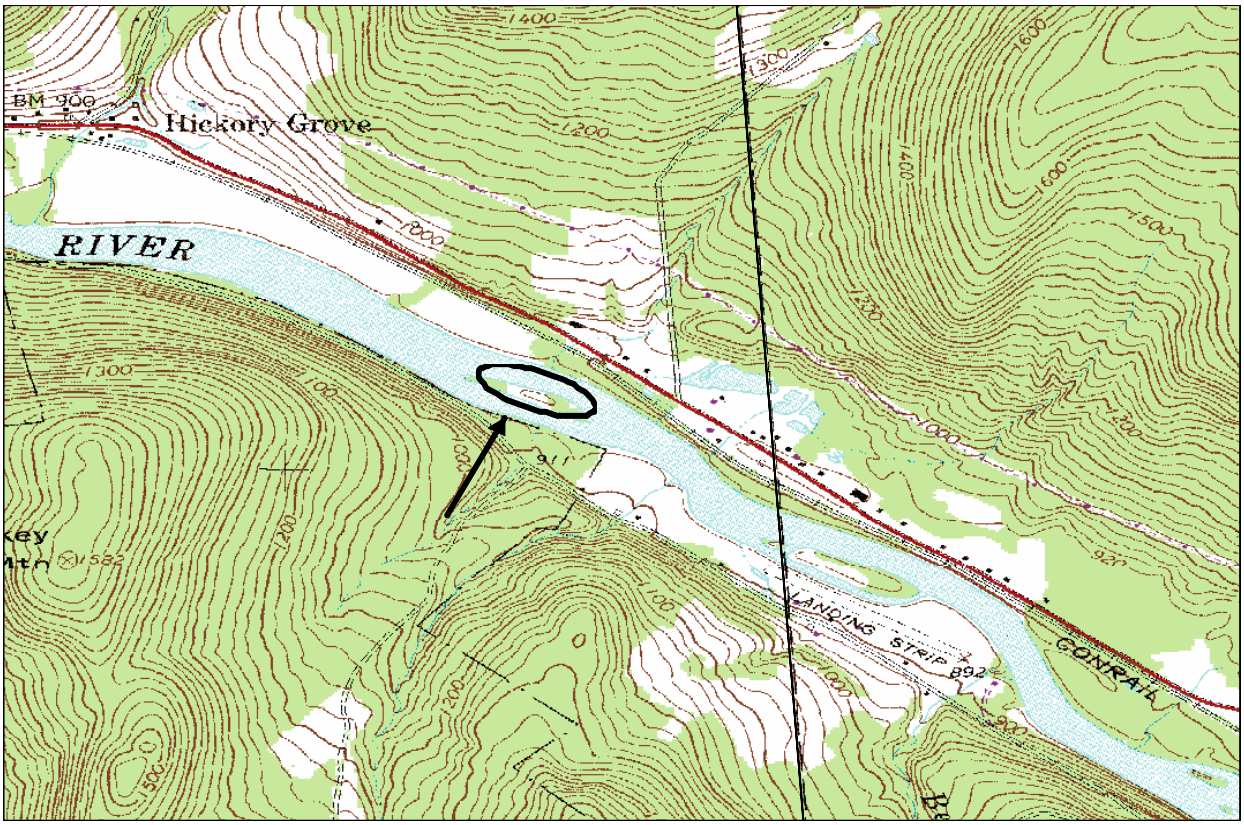
EPA 2.71, 2.72 lie within TNC's High Allegheny Plateau Ecoregion on a small exposed cobble island situated in the channel of Tunkhannock Creek, Wyoming County. Vegetation zones include an area of primarily herbaceous vegetation with scattered shrubs on the head of the island, which slowly transitions into a zone of denser, tall shrubs and eventually to young forest at the island center. **Plot 2.71 (Riverine Scour Vegetation)** represents the herbaceous-dominated island head; prominent species include *Onoclea sensibilis, Phalaris arundinacea*, and *Carex torta*. **Plot 2.72 (Sycamore – Mixed Hardwood Riverine Shrubland)** represents the tall shrub transition along the perimeter of the small island composed primarily of *Platanus occidentalis* to 5m tall; *Rubus idaeus, Rosa multiflora*, and *Elaeagnus umbellata* are also abundant along with numerous herbaceous species.



Site: EPA 2.73, 2.74, 2.75

USGS 7.5' Quadrangle: Great Bend, PA
Susquehanna County, Great Bend Twp.
Location: Hickory Grove, 1.3 km ESE

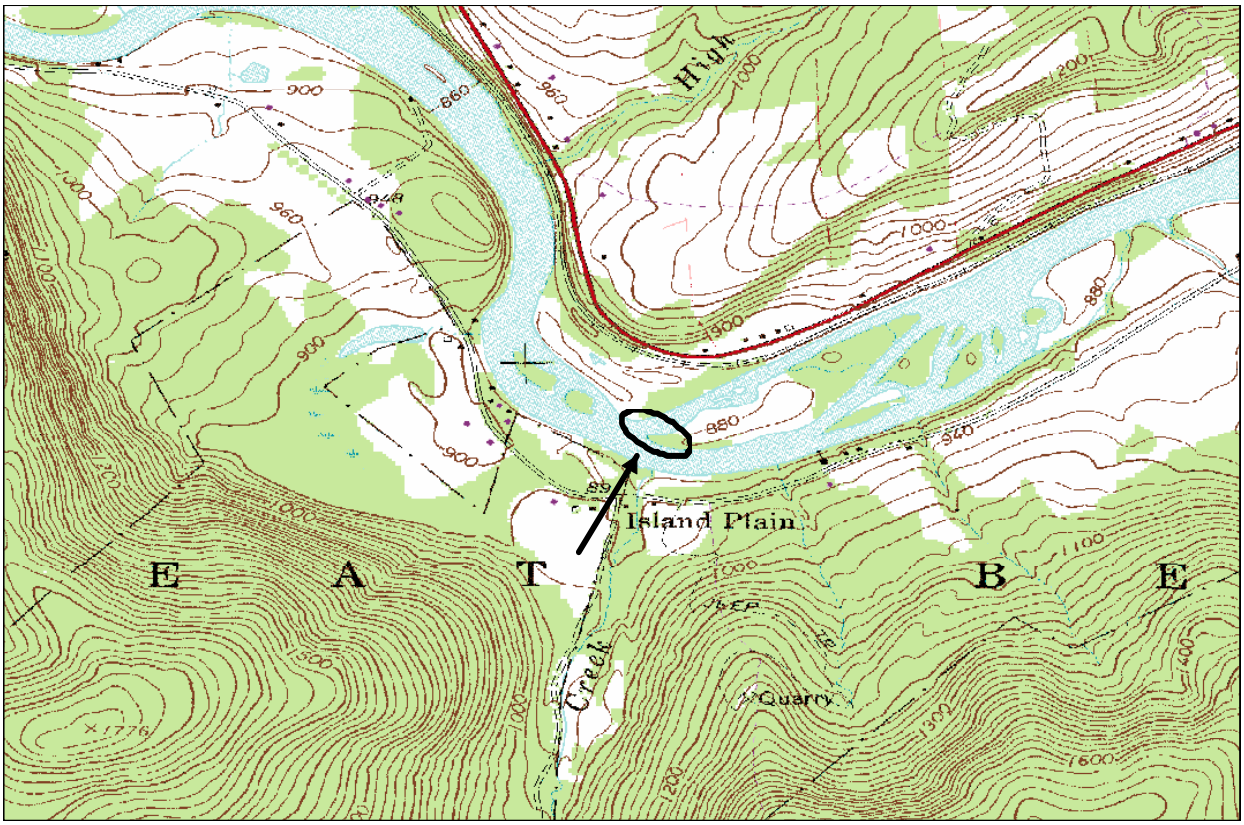
EPA 2.73, 2.74, 2.75 lie within TNC's High Allegheny Plateau Ecoregion on an island in the Susquehanna River, Susquehanna County. Vegetation zones progress from a sparsely vegetated cobble zone at the island head to a zone of perennial herbaceous vegetation that grades into a shrubland. Following a noticeable change in elevation, the shrubland transitions into upland forest. **Plot 2.73 (Riverine Scour Vegetation)** represents the sparsely vegetated cobble island head comprised of *Apocynum androsaemifolium, Polygonum pensylvanicum, Equisetum arvense*, and others. **Plot 2.74 (Riverine Scour Vegetation)** represents the mixed herbaceous/scattered-shrub zone above the exposed cobble perimeter; prominent woody and herbaceous species include *Salix exigua, A. androsaemifolium*, and *Carex torta*. **Plot 2.75 (Silky Dogwood Palustrine Shrubland)** represents the shrub areas dominated by *Cornus amomum* interspersed with solid patches of *Polygonum cuspidatum*.



Site: EPA 2.76, 2.77

USGS 7.5' Quadrangle: Great Bend, PA
Susquehanna County, Great Bend Twp.
Location: Island Plain, 0.4 km NW

EPA 2.76, 2.77 lie within TNC's High Allegheny Plateau Ecoregion on a long narrow cobble island in the Great Bend section of the North Branch of the Susquehanna River, Susquehanna County. The island consists of a narrow zone of exposed cobbles, a sparsely vegetated herbaceous cobble zone on the island head, an extensive area of graminoid cover, and a zone dominated by *Polygonum cuspidatum* along with scattered shrubs. **Plot 2.76 (Riverine Scour Vegetation)** represents the herbaceous zone on the island head dominated by *Apocynum cannabinum*; associates include *Equisetum arvense* and *Cyperus strigosus*. **Plot 2.77 (Sedge – Spotted Joe Pye Weed Herbaceous Vegetation)** represents the graminoid zone composed primarily of *Carex torta* that comprises a substantial proportion of the island area.



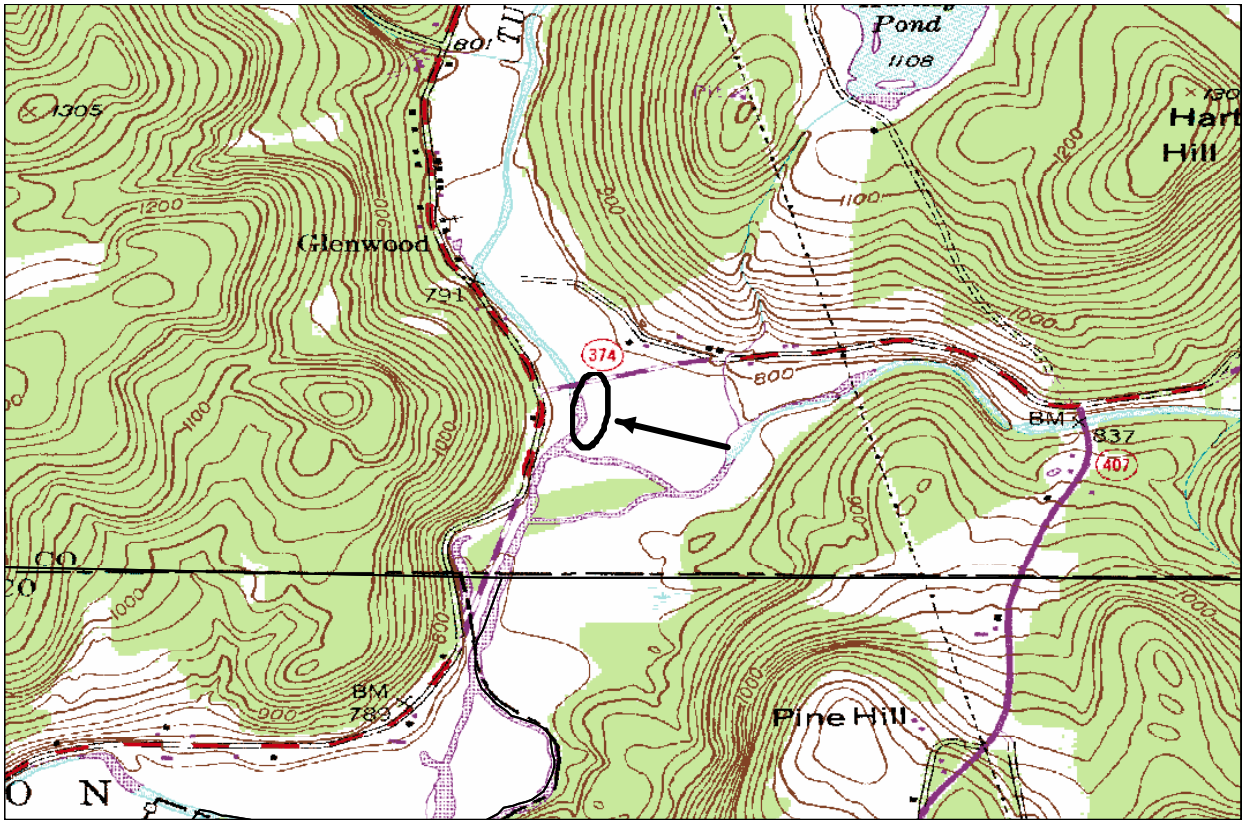
0 0.25 0.5 1 Miles

1:24,000

Site: EPA 2.78, 2.79

USGS 7.5' Quadrangle: Lenoxville, PA
Susquehanna County, Lenox Twp.
Location: Glenwood, 0.6 km SE

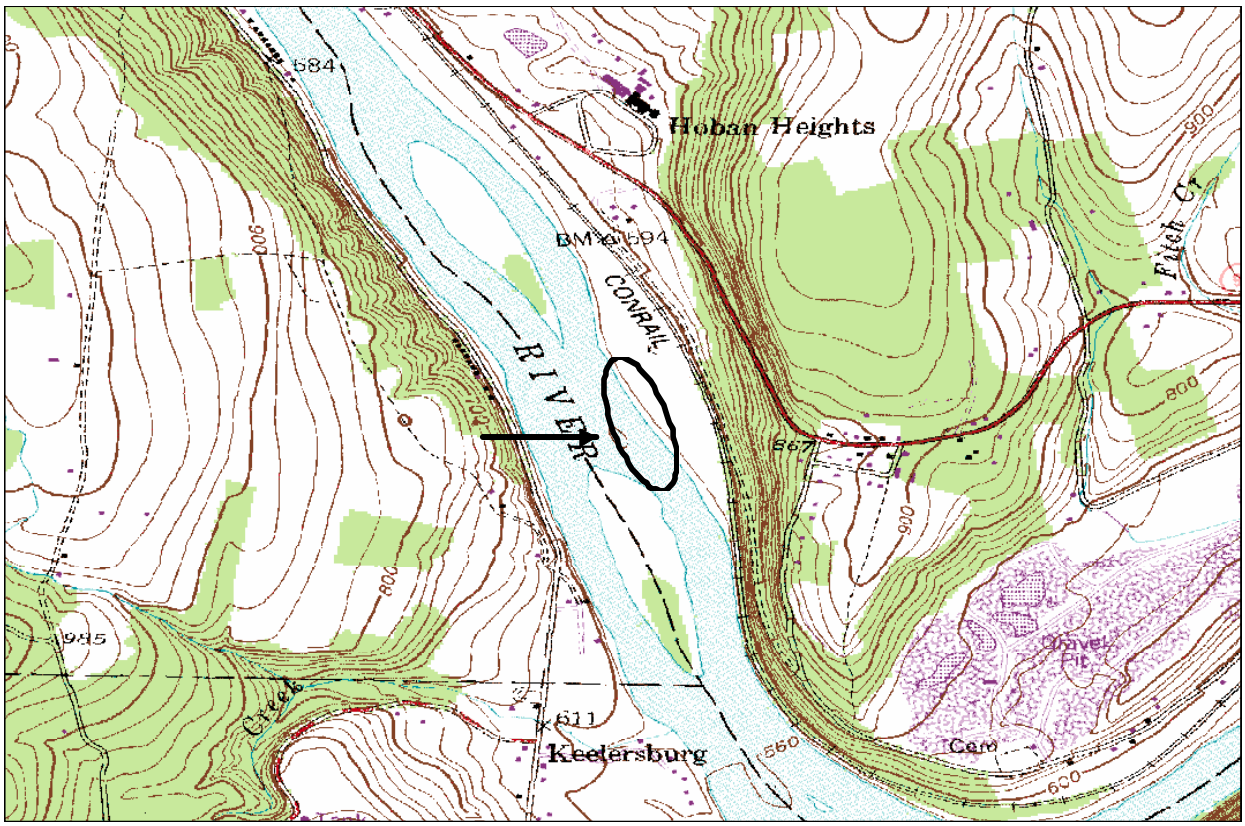
EPA 2.78, 2.79 lie within TNC's High Allegheny Plateau Ecoregion on the cobble shoreline along Tunkhannock Creek, Susquehanna County. The narrow vegetation zones situated along the cobble shore progress from a compressed zone of exposed or sparsely vegetated cobbles to a zone of dense graminoid/herbaceous plant cover, to a mixed shrub/*Polygonum cuspidatum* zone before transitioning to upland. **Plot 2.78 (Reed Canary Grass Riverine Grassland)** represents the graminoid-herbaceous zone dominated by *Phalaris arundinacea*; *Salix fragilis* also is present along with several other subordinate herbaceous species. **Plot 2.79 (Sycamore (Willow) – Mixed Hardwood Riverine Dwarf Shrubland)** represents a low band of shrub/sparse shrubland/herbaceous vegetation; *S. fragilis* and *Platanus occidentalis* comprise the shrubby component and *Phalaris arundinacea, Solidago gigantea*, and *Euthamia graminifolia* are the most abundant herbaceous species in addition to large colonies of *P. cuspidatum* (not represented in the plot).



Site: EPA 2.80, 2.81

USGS 7.5' Quadrangle: Center Moreland, PA
Wyoming County, Falls Twp.
Location: Hoban Heights, 0.9 km SSW

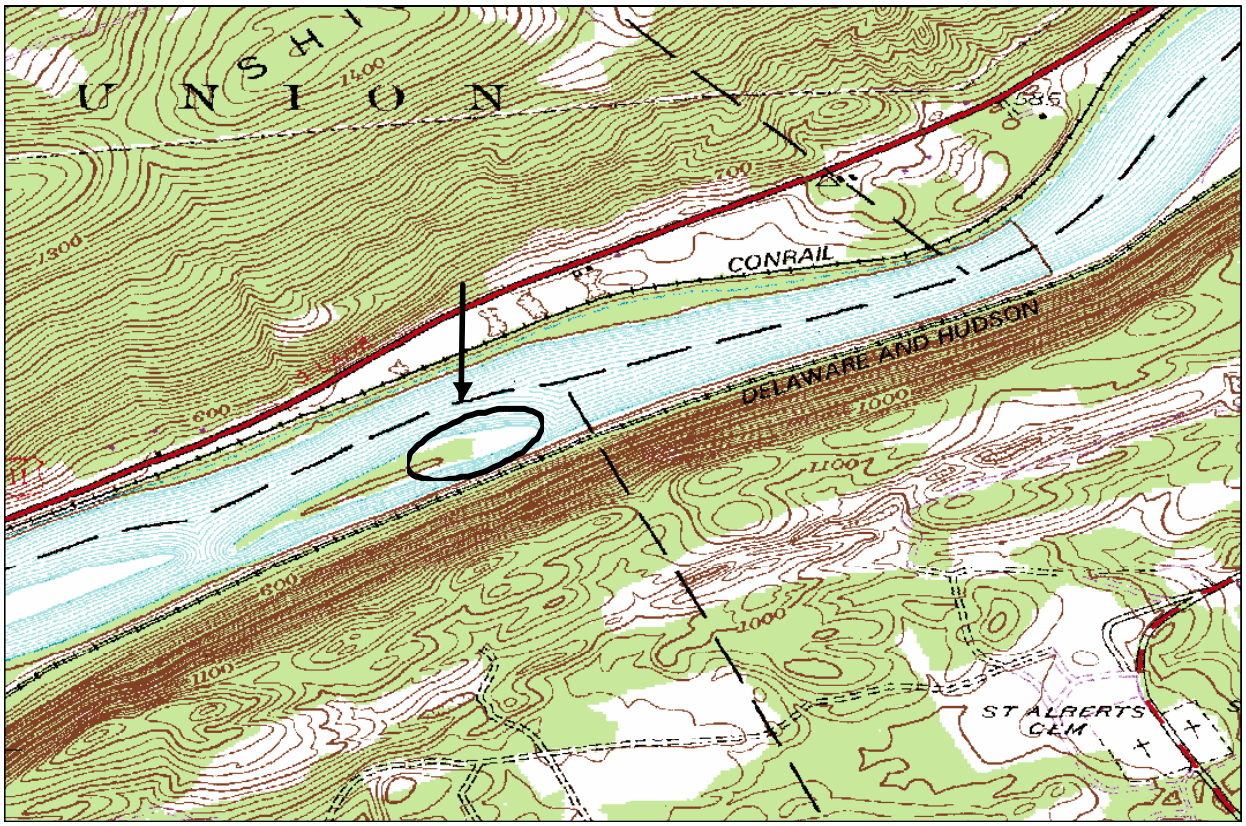
EPA 2.80, 2.81 lie within TNC's High Allegheny Plateau Ecoregion among a series of forested and shrub-dominated islands and banks in the Susquehanna River, Wyoming County. The site is situated on an island in the Susquehanna that contains an exposed cobble head, a narrow zone of mixed graminoid and herbaceous species, and a forested patch on the downstream end. Other zones along the river banks at this site include exposed cobble bars and zones dominated by mixed herbaceous and graminoid species. **Plot 2.80 (Willow – Indian Grass Riverine Shrubland)** represents a mixed herbaceous-graminoid zone that contains *Lysimachia vulgaris, Apocynum cannabinum, Andropogon gerardii, Sorghastrum nutans*, and *Lythrum salicaria; Salix exigua* and *Vitis riparia* are also moderately abundant. **Plot 2.81 (Silver Maple (River Birch) – Mixed Hardwood Riverine Shrubland)** represents a shrub zone along the vegetated river bank, dominated by *Acer saccharinum* between 2-6m tall; *Polygonum amphibium* is the most common herbaceous species in the understory.



Site: EPA 2.82, 2.83, 2.84

USGS 7.5' Quadrangle: Nanticoke, PA
Luzerne County, Conyngham Twp.
Location: Glen Lyon, 2.6 km WNW

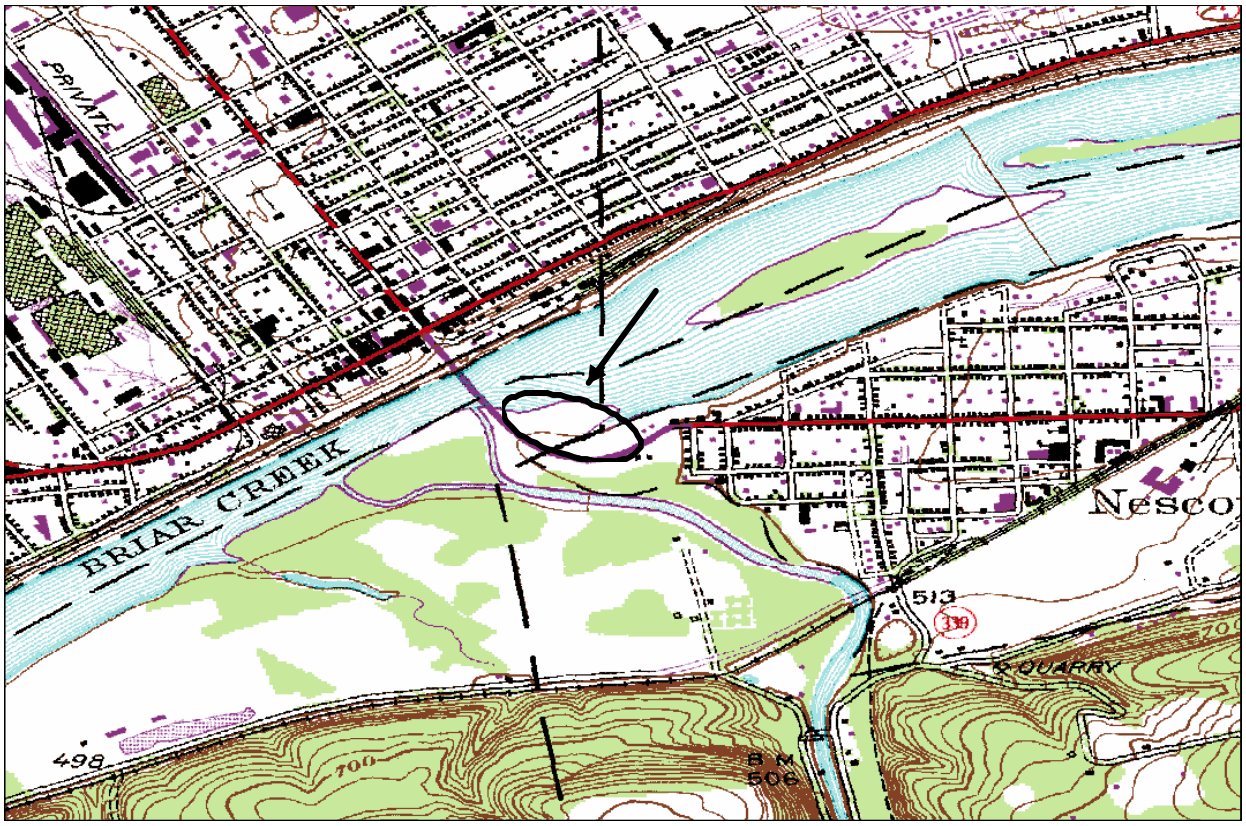
EPA 2.82, 2.83, 2.84 lie within TNC's Central Appalachian Forest Ecoregion on a long island in the Susquehanna River, Luzerne County. Distinct vegetation zones occur on the island that progress from cobble with varying degrees of cover to a dense tall shrub-dominated zone before transitioning to a forested island interior. **Plot 2.82 (Riverine Scour Vegetation)** represents a sparse-to-moderately vegetated cobble zone composed primarily of *Apocynum cannabinum* and two species of *Setaria*. **Plot 2.83 (Riverine Scour Vegetation)** captures the transition between a graminoid zone on cobble and sand dominated by *Sorghastrum nutans* and a zone that exhibits a higher proportion of woody cover, primarily *Platanus occidentalis*. **Plot 2.84 (River Birch (Sycamore) – Mixed Hardwood Riverine Shrubland)** represents a tall shrub/small tree-dominated zone on silt-loam soil dominated by *Betula nigra* with a moderate amount of *P. occidentalis*; *Leersia virginica* is the most abundant herbaceous/graminoid species.



Site: EPA 2.85, 2.86

USGS 7.5' Quadrangle: Berwick, PA
Luzerne County, Mifflin Twp.
Location: Nescopeck, PA

EPA 2.85, 2.86 lie within TNC's Central Appalachian Forest Ecoregion along the banks of the Susquehanna River in Nescopeck, Pennsylvania; Luzerne County. The site consists of an herbaceous zone situated on an extensive flat of alluvial silt over cobbles in the delta of Black Creek. The silt/cobble flat grades into a dense shrub-dominated zone on sandy soil on which there exists a significant accumulation of woody debris. **Plot 2.85 (Water Willow Emergent Bed)** represents the herbaceous zone on the silt/cobble flats dominated by *Justicia americana*, which contains moderate cover of *Lythrum salicaria* and *Lysimachia nummularia*. **Plot 2.86 (Mixed Hardwood Riverine Shrubland)** represents a shrub/young tree zone dominated by *Acer saccharinum* and *Betula nigra*.



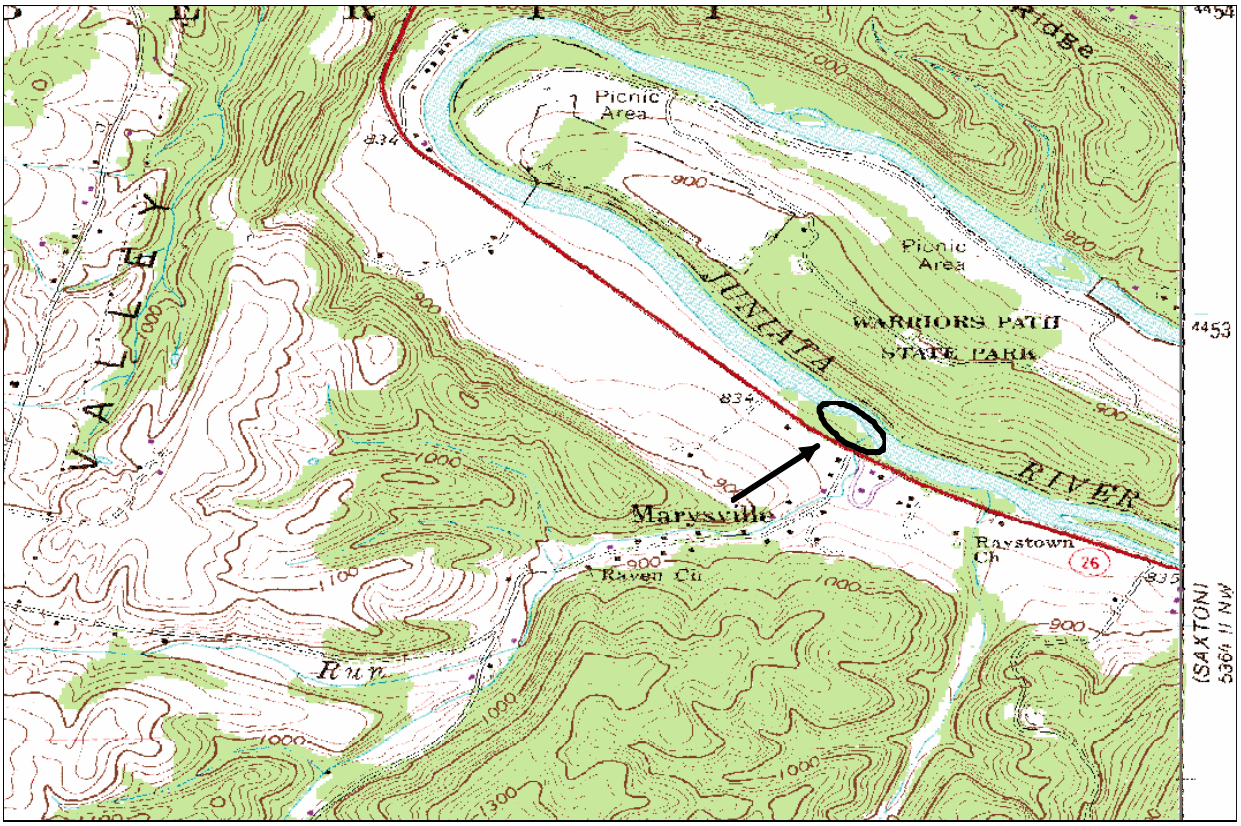
0 0.25 0.5 1 Miles

1:24,000

Site: EPA 2.87, 2.88, 2.89

USGS 7.5' Quadrangle: Hopewell, PA
Bedford County, Liberty Twp.
Location: Marysville, 0.4 km NE

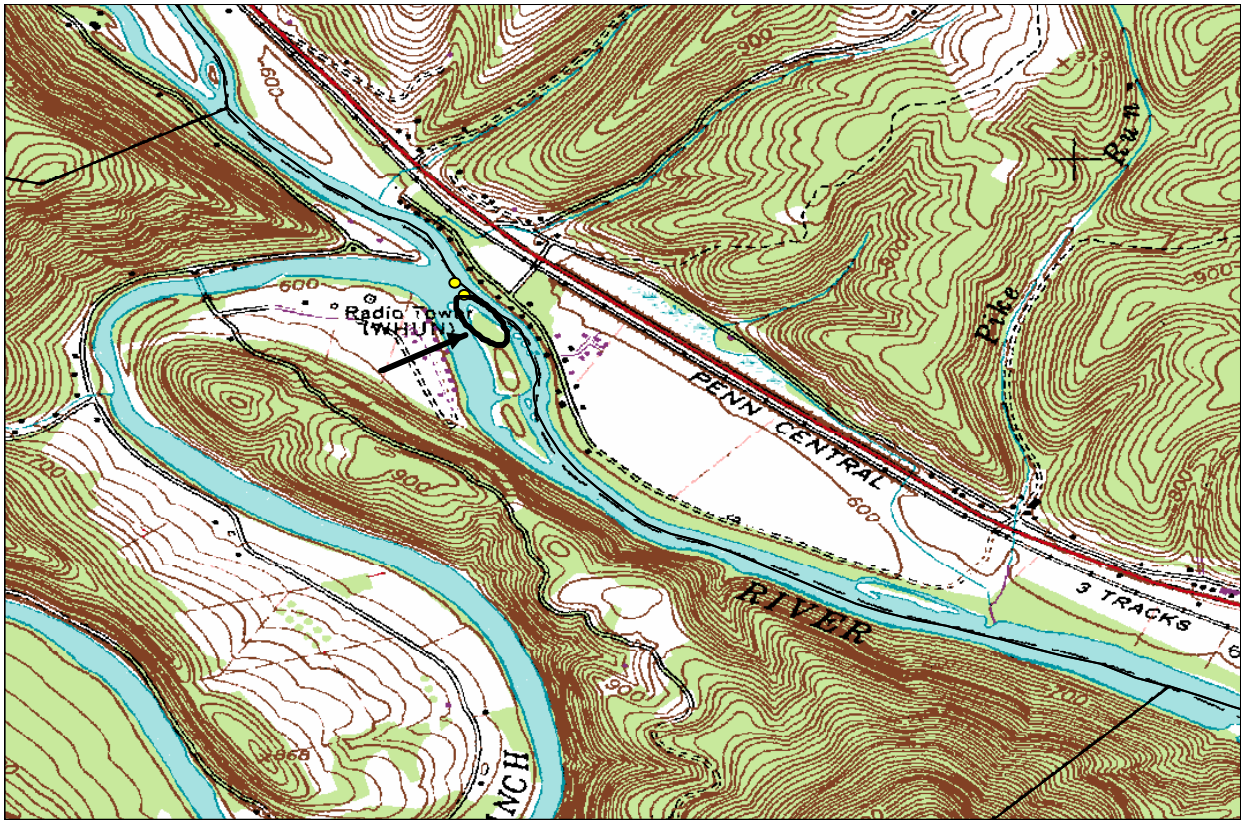
EPA 2.87, 2.88, 2.89 lie within TNC's Central Appalachian Forest Ecoregion along the Juniata River in Warrior's Path State Park, Bedford County. The site consists of three distinct floodplain zones that exhibit the typical progression from open, sparsely vegetated cobble to graminoid-herbaceous perimeter to tall shrub-forest transition. **EPA 2.87 (Reed Canary Grass Riverine Grassland)** represents the herbaceous perimeter dominated by *Phalaris arundinacea* and *Justicia americana*. **Plot 2.88 (Mixed Hardwood Riverine Shrubland)** represents the low shrub-shoreline zone on cobble and sand substrate, co-dominated by *Salix nigra* and *Platanus occidentalis*; *Phalaris arundinacea* is present in the groundcover. **Plot 2.89 (Sycamore – Mixed Hardwood Riverine Shrubland)** represents the tall shrub-forest transition zone dominated by *Platanus occidentalis* and *Acer saccharinum*. *Phalaris arundinacea* and *Verbesina alternifolia* are the most abundant herbaceous species.



Site: EPA 2.90, 2.91

USGS 7.5' Quadrangle: Mount Union, PA
Huntingdon County, Juniata Twp.
Location: WHUN Radio tower, 0.2 km E

EPA 2.90, 2.91 lie within TNC's Central Appalachian Forest Ecoregion on a long island in the Juniata River at the confluence of the Raystown Branch and the Juniata River, Huntingdon County. The island exhibits a progression of vegetation zones from open, sparsely vegetated cobbles, to strips of shrubby growth, to *Platanus occidentalis*-dominated floodplain forest. **Plot 2.90 (Purple Loosestrife Scour Vegetation)** represents the sparsely vegetated herbaceous type dominated by *Lythrum salicaria*. **Plot 2.91 (Sycamore – Mixed Hardwood Riverine Shrubland)** represents the shrub-small tree-dominated zone comprised primarily of *P. occidentalis*; *L. salicaria* is the most abundant herbaceous species.



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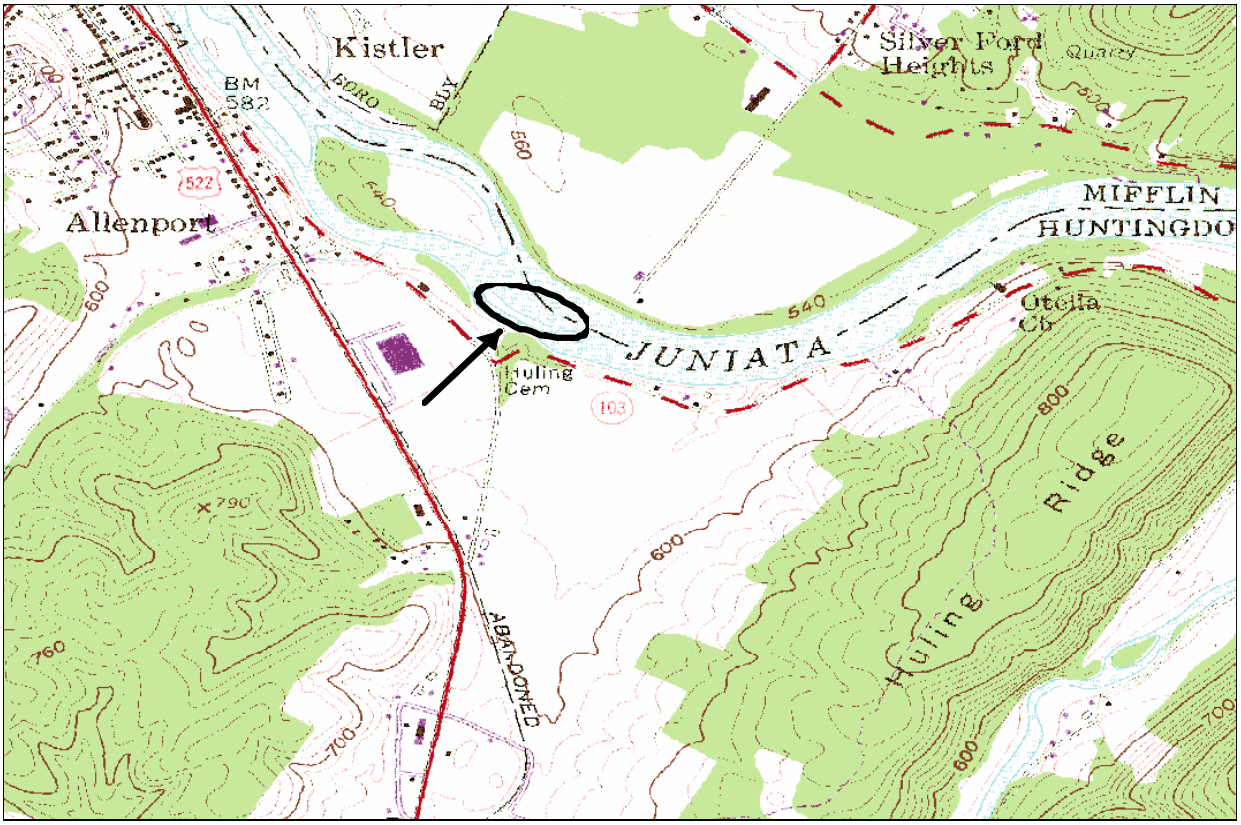
1:24,000

Site: EPA 2.92, 2.93

USGS 7.5' Quadrangle: Aughwick, PA
Huntingdon County, Shirley Twp.
Location: Allenport, 1.7 km ESE

EPA 2.92, 2.93 lie within TNC's Central Appalachian Forest Ecoregion on an island in the Juniata River, Huntingdon County. Several herbaceous patch types are associated with the sand and cobble island and associated shorelines. **Plot 2.92 (Purple Loosestrife Scour Vegetation)** represents the herbaceous-graminoid zone dominated by *Lythrum salicaria, Cyperus bipartitus,* and *C. strigosus* growing on the coarse sand of the island head. **Plot 2.93 (Riverine Scour Vegetation)** represents the cobble scour zone and captures the variation within the herbaceous shores of the island. This area receives less scour due to its position on the inner side of the island. Dominant species include *Boehmeria cylindrica, Apocynum cannabinum, Pilea pumila,* and *Leersia virginica*.



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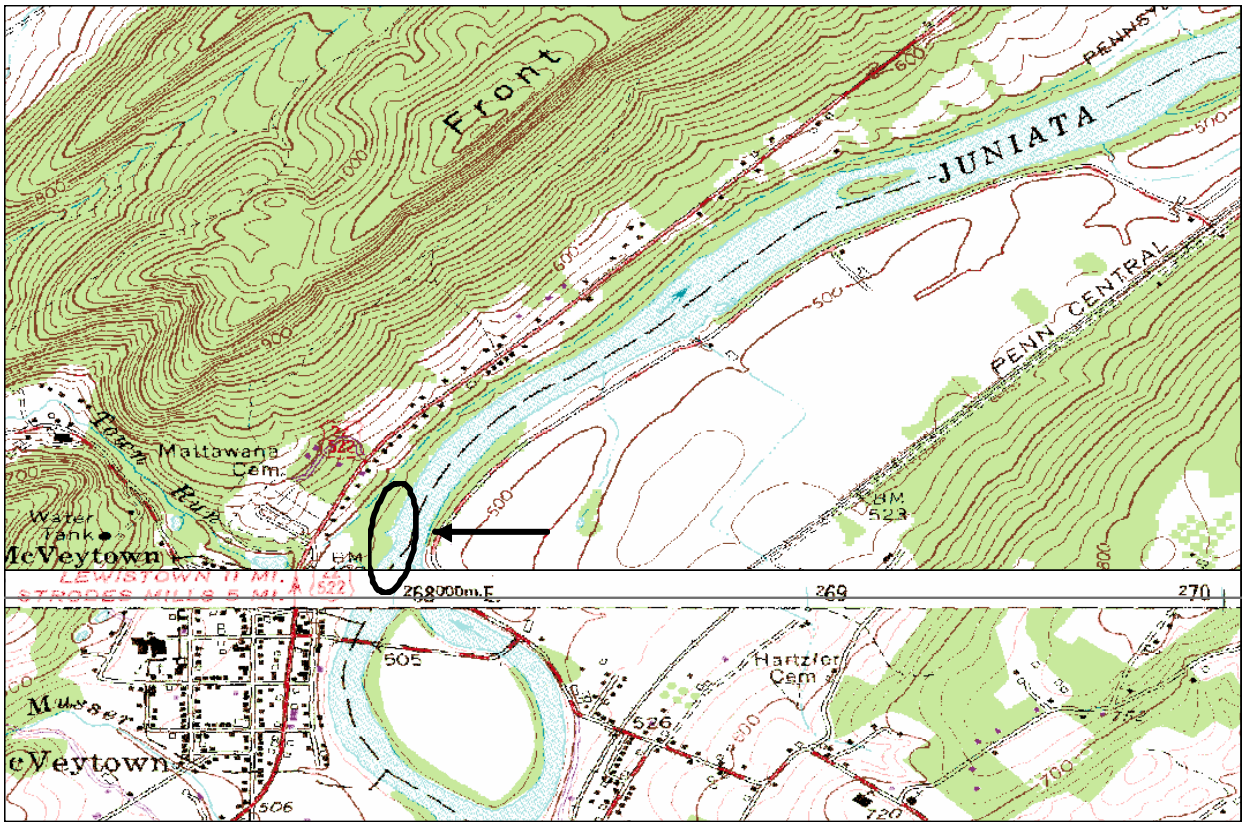
Site: EPA 2.94, 2.95

USGS 7.5' Quadrangle: Belleville PA
Mifflin County, Oliver Twp.
Location: Water Tank (McVeytown) 0.7 km E

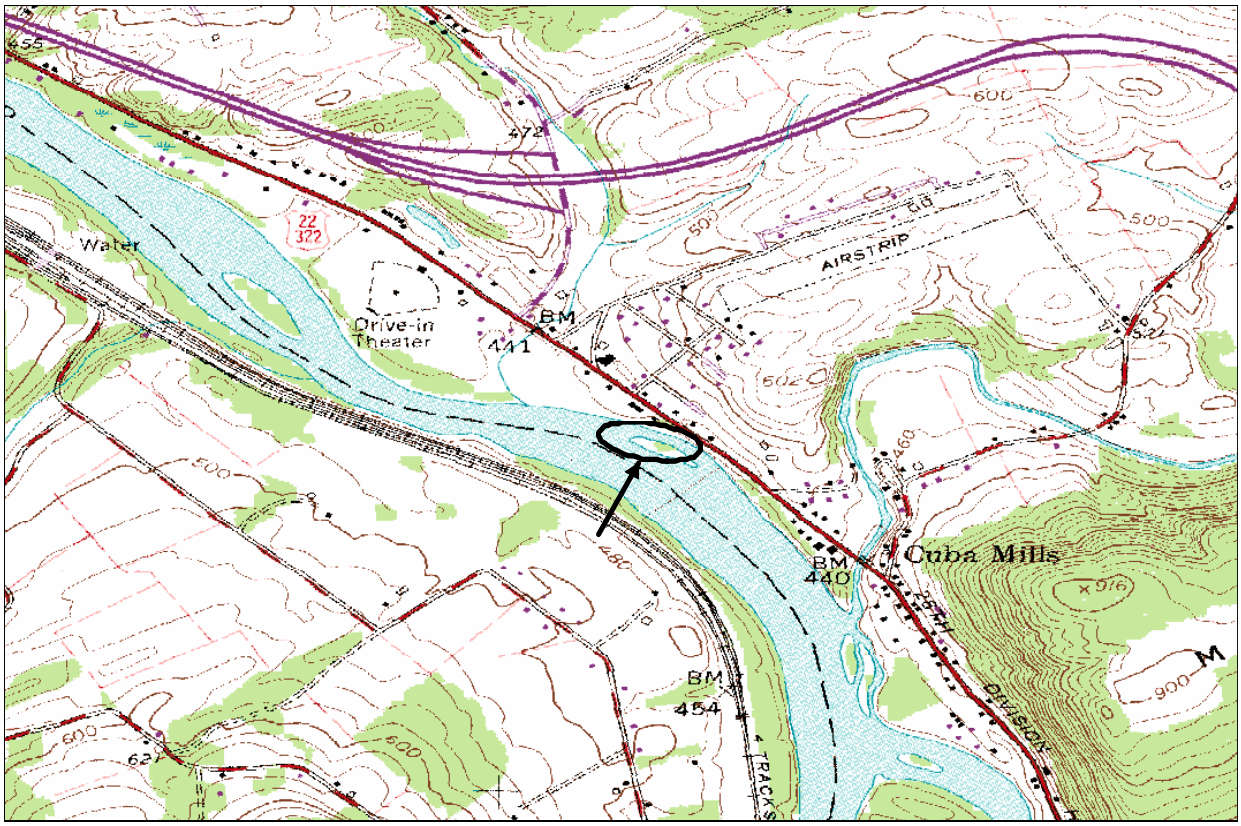
EPA 2.94, 2.95 lie within TNC's Central Appalachian Forest Ecoregion on numerous cobble bars and emergent beds along the shoreline of the Juniata River, Mifflin County. Vegetation zones at this site range from large emergent herbaceous beds to herbaceous patches to narrow bands of shrubs. **Plot 2.94 (Lizard's Tail Emergent Bed)** represents the emergent herbaceous cobble beds comprised of *Saururus cernuus, Justicia americana,* and *Lythrum salicaria*. **Plot 2.95 (Mixed Hardwood Riverine Shrubland)** represents the shrub zone composed of *Betula nigra, Platanus occidentalis, Acer saccharinum,* and *Salix nigra*.



Site: EPA 2.96

USGS 7.5' Quadrangle: Mifflintown, PA
Juniata County, Farmanagh Twp.
Location: Cuba Mills, 0.8 km NNW

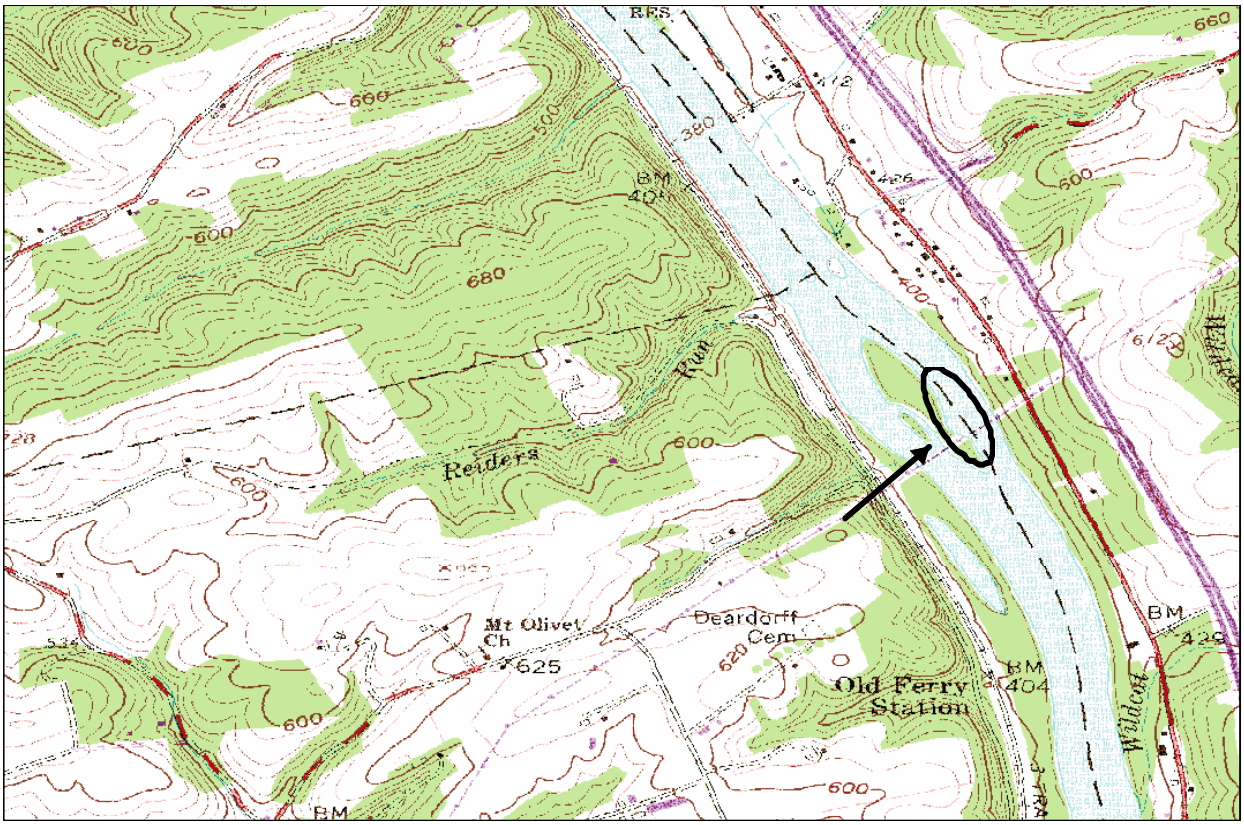
EPA 2.96 lies within TNC's Central Appalachian Forest Ecoregion on an island in the Juniata River, Juniata County. The island and associated cobble flats exhibit very little diversity in vegetation. Emergent herbaceous beds on sand-cobble substrate grade quickly into Silver Maple Floodplain Forest; there is very little shrub cover**. Plot 2.96 (Lizards' Tail Emergent Bed)** represents the emergent herbaceous bed co-dominated by *Saururus cernuus* and *Justicia americana*.



Site: EPA 2.97

USGS 7.5' Quadrangle: Millerstown, PA
Perry County, Greenwood Twp.
Location: Old Ferry Station, 0.8 km N

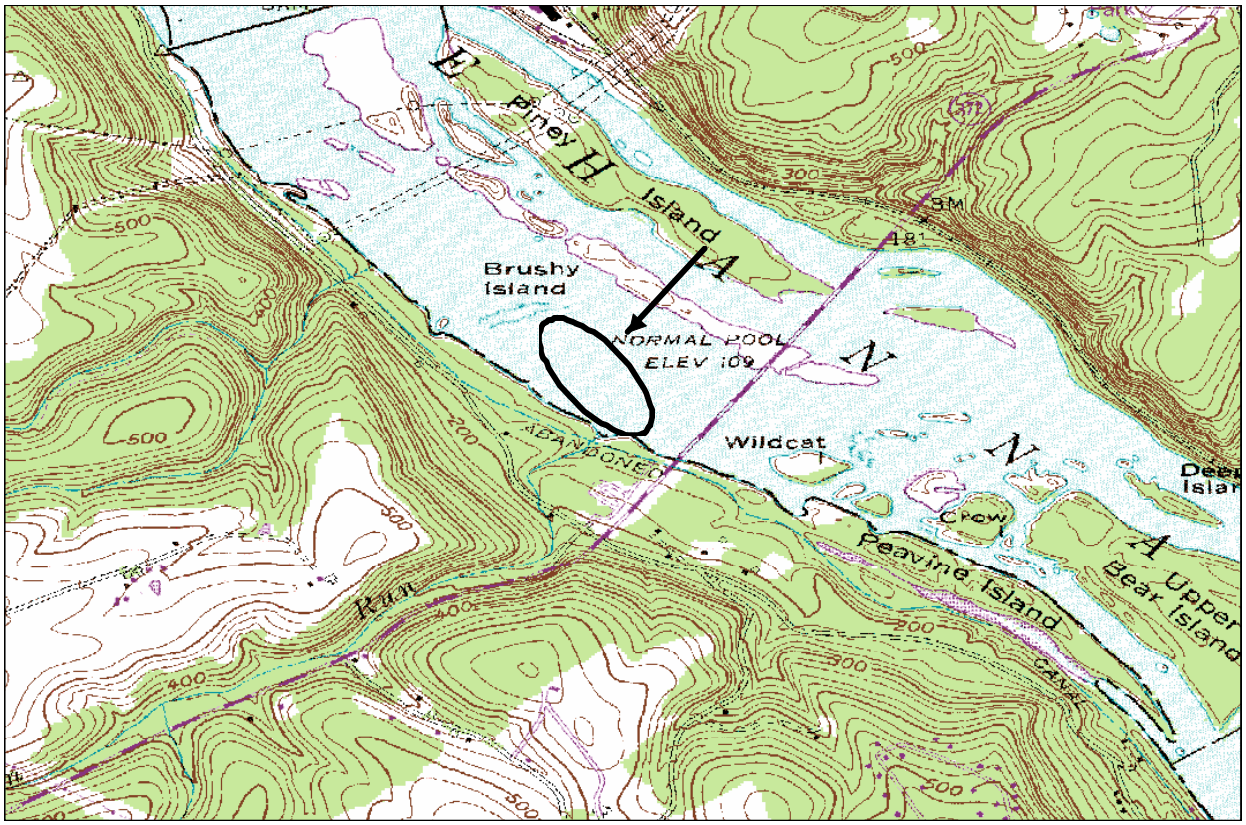
EPA 2.97 lies within TNC's Central Appalachian Forest Ecoregion on the shoreline of small cobble and silt-loam islands in the Juniata River, Perry County. Long emergent beds of herbaceous vegetation and narrow shrubby zones comprise the vegetation zones on the islands. **Plot 2.97 (Water Willow Emergent Bed)** represents the emergent herbaceous bed dominated by *Justicia americana*.



Site: EPA 2.98. 2.99

USGS 7.5' Quadrangle: Holtwood, PA
Lancaster County, Martic Twp.
Location: Holtwood Power Station, 1.3 km SSE

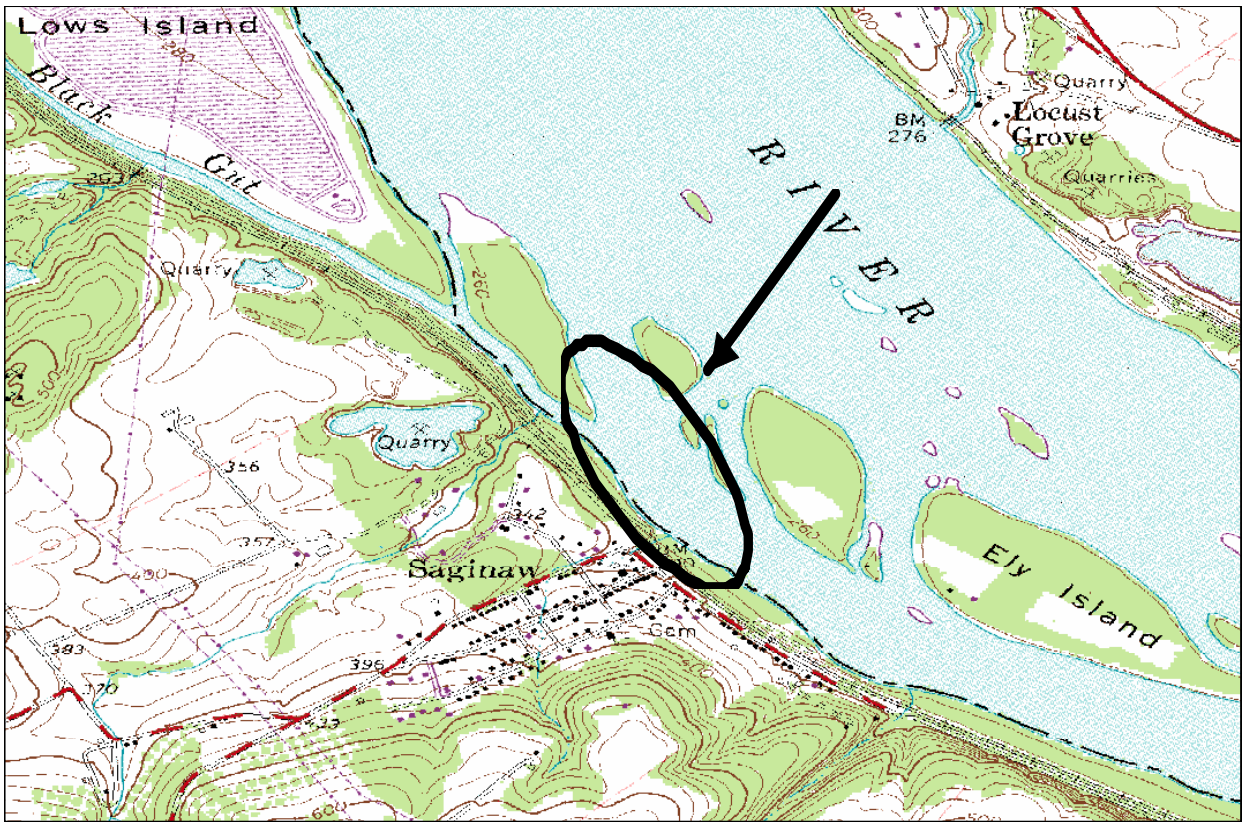
EPA 2.98, 2.99 lie within TNC's Lower New England/Northern Piedmont Ecoregion on an extensive, broad flat river channel south of the Holtwood Dam in the Susquehanna River, Lancaster County. The river channel substrate is bedrock and cobbles over bedrock. Vegetation is characterized by a zone composed predominantly of herbaceous species interspersed with small patches of shrubs, grading into a shrub-dominated zone that eventually transitions to forest. **Plot 2.98 (Water Willow Emergent Bed)** represents the herbaceous component of the complex, composed primarily of *Justicia americana, Schoenoplectus pungens,* and *Spartina pectinata*. **Plot 2.99 (Mixed Hardwood Riverine Shrubland)** represents a shrub zone on cobble substrate dominated by *Salix nigra* and *Platanus occidentalis; Lythrum salicaria* is moderately abundant.



Site: EPA 2.100, 2.101, 2.102

USGS 7.5' Quadrangle: York Haven, PA
York County, Conoy Twp.
Location: Saginaw, 0.3 km NE

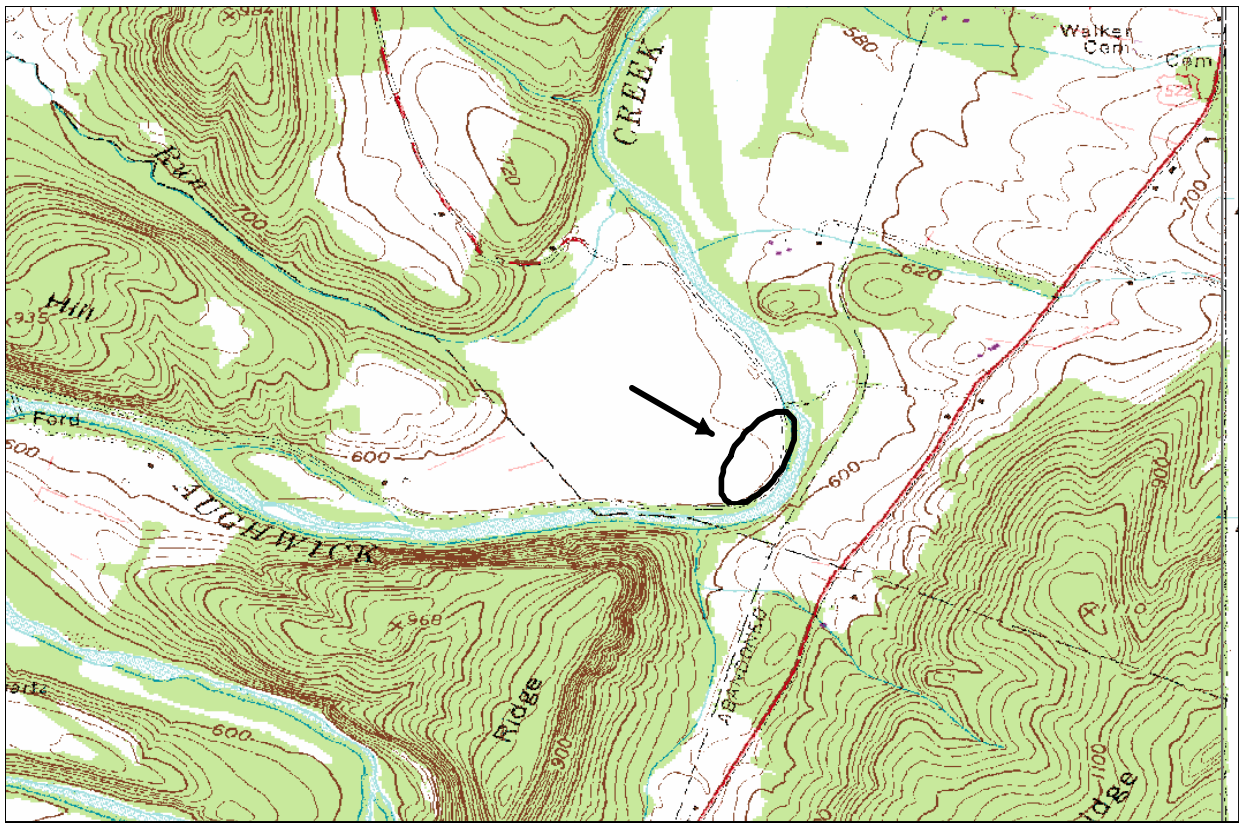
EPA 2.100, 2.101, 2.102 lie within TNC's Lower New England/Northern Piedmont Ecoregion on the shore and within a chain of large, long islands in the Susquehanna River, on the border of Lancaster and York Counties. Vegetation zones on the islands include several herbaceous-dominated zones, emergent beds and shrub zones; shorelines along the river are primarily composed of exposed bedrock that support sparse patches of herbaceous vegetation. **Plot 2.100 (Water Willow Emergent Bed)** represents the herbaceous emergent zone composed of *Justicia americana*, *Hibiscus laevis*, *Lysimachia vulgaris* and other herbaceous species. **Plot 2.101 (Black Willow – Mixed Hardwood Riverine Shrubland)** represents the shrub dominated component situated slightly higher in elevation on the islands; 2-4m tall *Salix nigra* dominate in these patches. **Plot 2.102** represents sparsely vegetated zones on the exposed the bedrock shoreline of the Susquehanna River composed of *J. americana* and several grasses. This plot is characteristic of the **Riverside scour bedrock outcrop** mentioned in the discussion section above.



Site: EPA 2.103, 2.104

USGS 7.5' Quadrangle: Butler Knob, PA
Huntingdon County, Shirley Twp.
Location: Shirleysburg, 2.2 km SSW

EPA 2.103, 2.104 lie within TNC's Central Appalachian Forest Ecoregion in the channel bed and cobble bars of Aughwick Creek, Huntingdon County. The site is a moderately large herbaceous/shrub cobble bar in the creek channel and adjacent floodplain. **Plot 2.103 (Mixed Hardwood Riverine Shrubland)** represents the mixed herbaceous/shrub type on the cobble bar, which supports *Platanus occidentalis, Salix nigra, Alnus serrulata*, and *Acer saccharinum*. Herbaceous cover is low (1%) and is occupied primarily by *Lythrum salicaria*. **Plot 2.104 (Water Willow Emergent Bed)** represents the herbaceous zone dominated by *Justicia americana, L. salicaria*, and *Saururus cernuus* typical of the Juniata River drainage.



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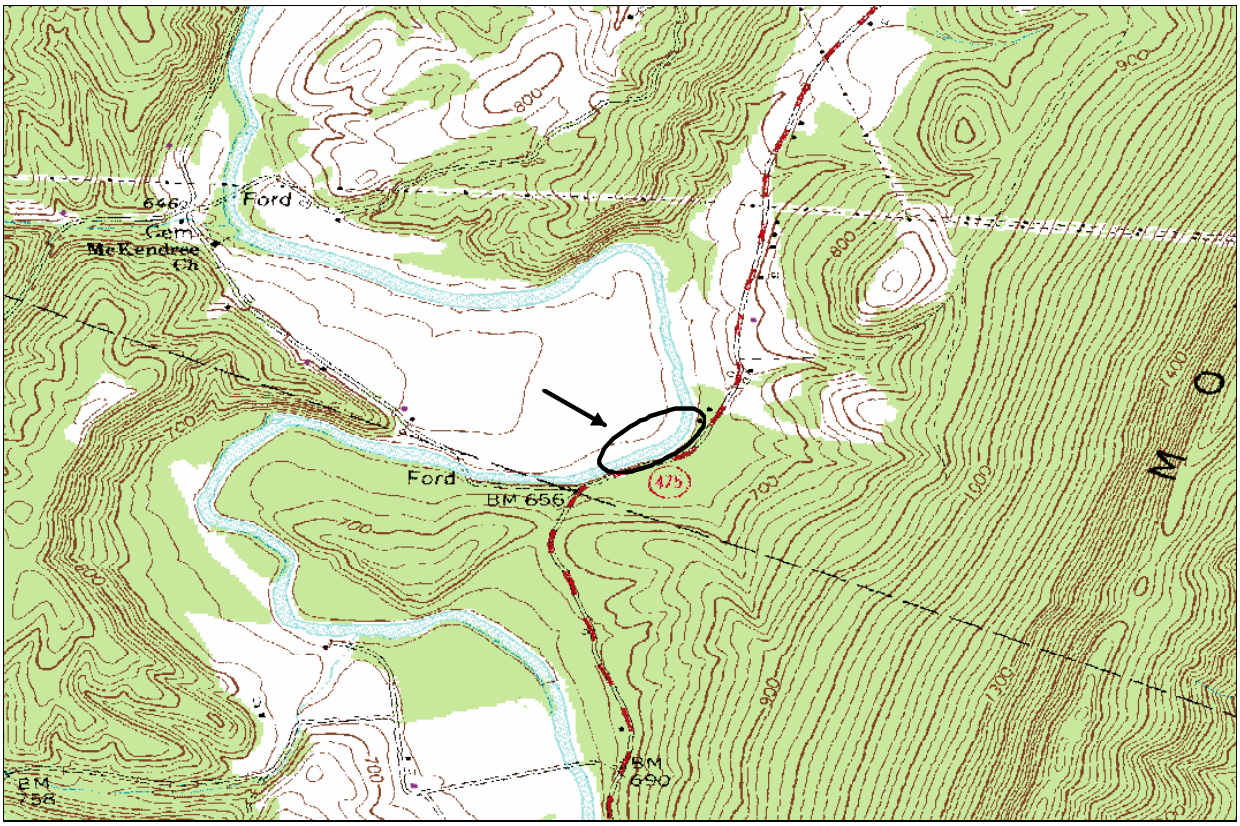
Site: EPA 2.105, 2.106

USGS 7.5' Quadrangle: Orbisonia, PA
Huntingdon County, Cromwell Twp.
Location: McKendree ESE

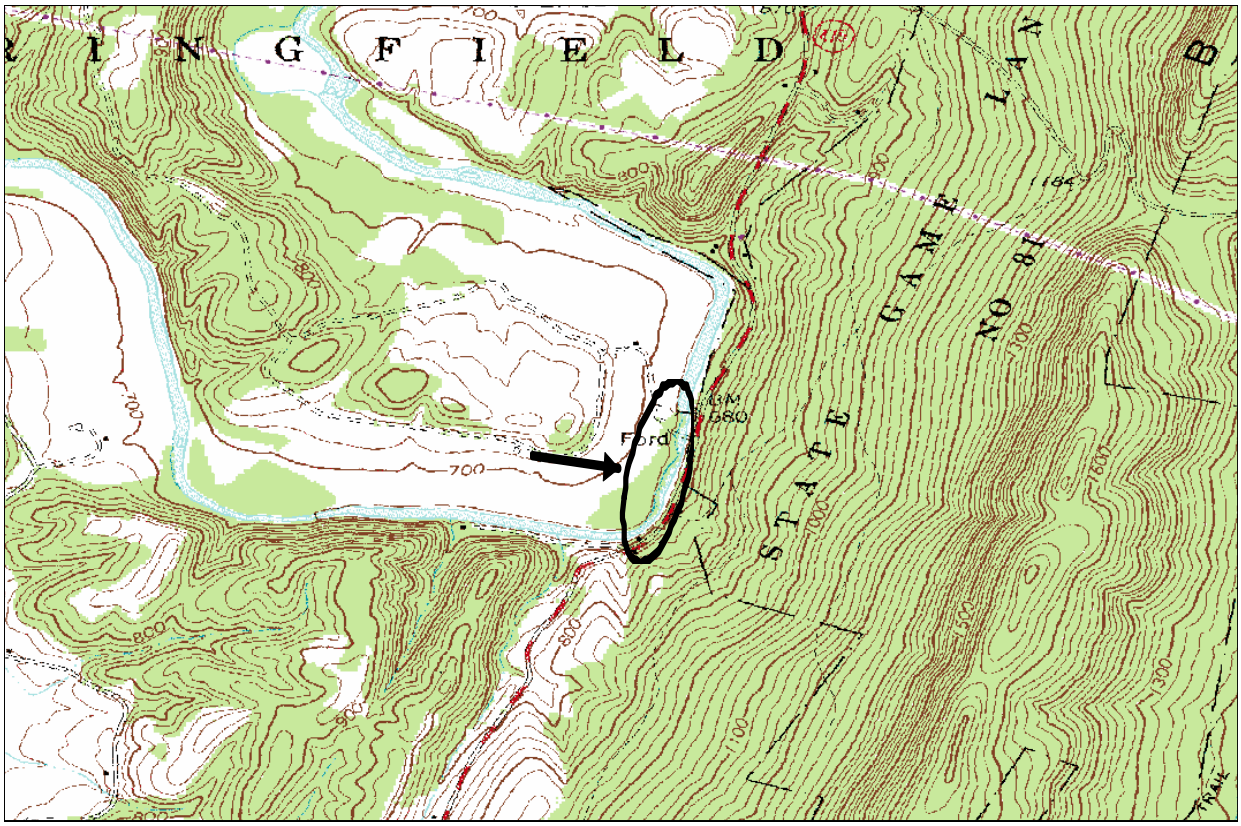
EPA 2.105, 2.106 lie within TNC's Central Appalachian Forest Ecoregion in the channel bed and cobble bars of the Aughwick Creek floodplain, Huntingdon County. The site is situated on a broad complex of emergent beds and linear shrub/herbaceous-dominated cobble zones that are frequently inundated. **Plot 2.105 (Sycamore (Willow) – Mixed Hardwood Riverine Dwarf Shrubland)** represents the mixed herbaceous/short-shrub zone on gravel substrate dominated by *Salix nigra, Acer saccharinum,* and *Platanus occidentalis* less than 2m tall. *Phalaris arundinacea* comprises the largest proportion of the herbaceous component. **Plot 2.106 (Water Willow Emergent Bed)** represents the extensive herbaceous beds of *Justicia americana* and other herbaceous species characteristic of this section of the creek.



Site: EPA 2.107, 2.108

USGS 7.5' Quadrangle: Orbisonia, PA
Huntingdon County, Springfield Twp.
Location: Meadow Gap, 1.7 km SSW

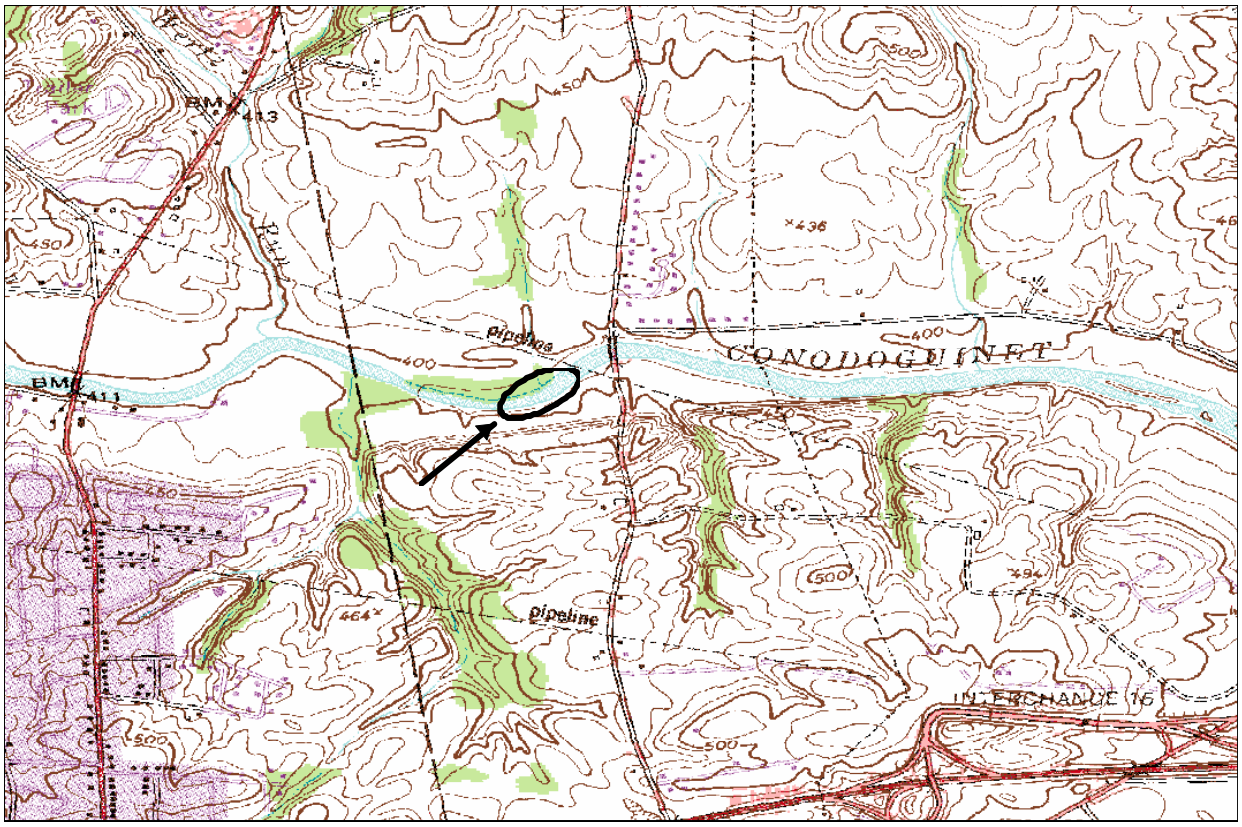
EPA 2.107, 2.108 lie within TNC's Central Appalachian Forest Ecoregion on the broad channel bed and cobble bars of the Aughwick Creek floodplain, Huntingdon County. **Plot 2.107 (Sycamore – Mixed Hardwood Riverine Shrubland)** is located on a large cobble bar along the creek and represents the mixed herbaceous-shrub zone dominated by *Platanus occidentalis, Salix nigra,* and *Salix lucida* less than 2.5 m tall. *Phalaris arundinacea* comprises the largest percent of the herbaceous component that includes numerous other species. **Plot 2.108 (Water Willow Emergent Bed)** represents the extensive emergent bed dominated by *Justicia americana*.



Site: EPA 2.109

USGS 7.5' Quadrangle: Carlisle, PA
Cumberland County, Middlesex Twp.
Location: Carlisle, 4.7 km NE

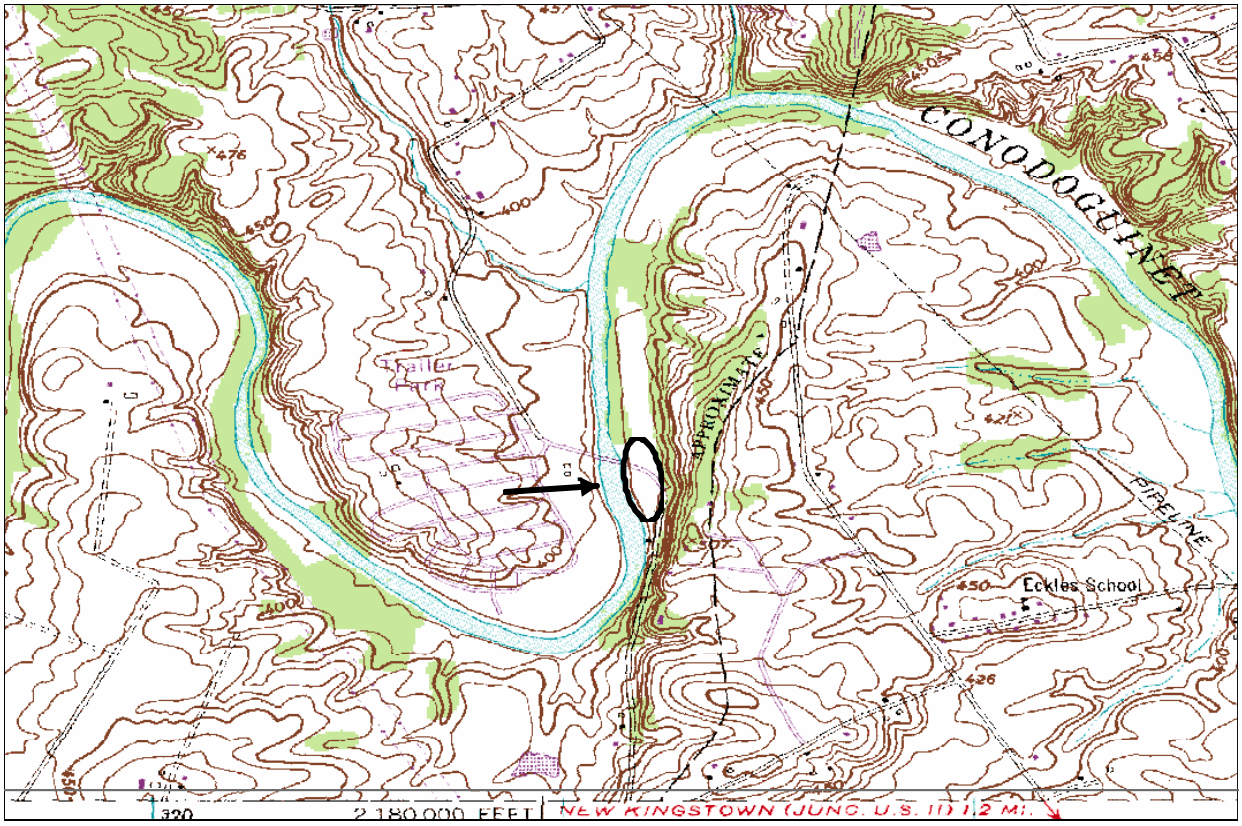
EPA 2.109 lies within TNC's Central Appalachian Forest Ecoregion along the Conodoguinet Creek, Cumberland County. This section of the creek channel is surrounded by forested slopes and banks with occasional herbaceous beds dominated by patches of *Saururus cernuus* and smaller patches of herbaceous/graminoid-dominated vegetation. Soils have a sand-silt texture. **Plot 2.109 (Lizard's Tail Emergent Bed)** captures both *S. cernuus* and herbaceous graminoid-dominated patches. Other species within plot 2.109 include *Polygonum amphibium, Lythrum salicaria*, *Poa annua* and other grasses.



Site: EPA 2.110, 2.111

USGS 7.5' Quadrangle: Wertzville, PA
Cumberland County, Middlesex Twp.
Location: Eckles School, 1 km WNW

EPA 2.110, 2.111 lie within TNC's Central Appalachian Forest Ecoregion along sand and cobble bars in the channel of the Conodoguinet Creek, Cumberland County. The site contains two herbaceous zones that abruptly transition to forest. **Plot 2.111 (Water Willow Emergent Bed)** represents the mixed herbaceous-graminoid bed along the cobble river channel dominated by *Justicia americana, Saururus cernuus, Leersia oryzoides*, and other grasses. **Plot 2.110 (Lizard's Tail Emergent Bed),** which occupies the largest area, is slightly higher in elevation on the sand and cobble bar and is dominated by *S. cernuus*, *Phalaris arundinacea* and associated herbaceous species.



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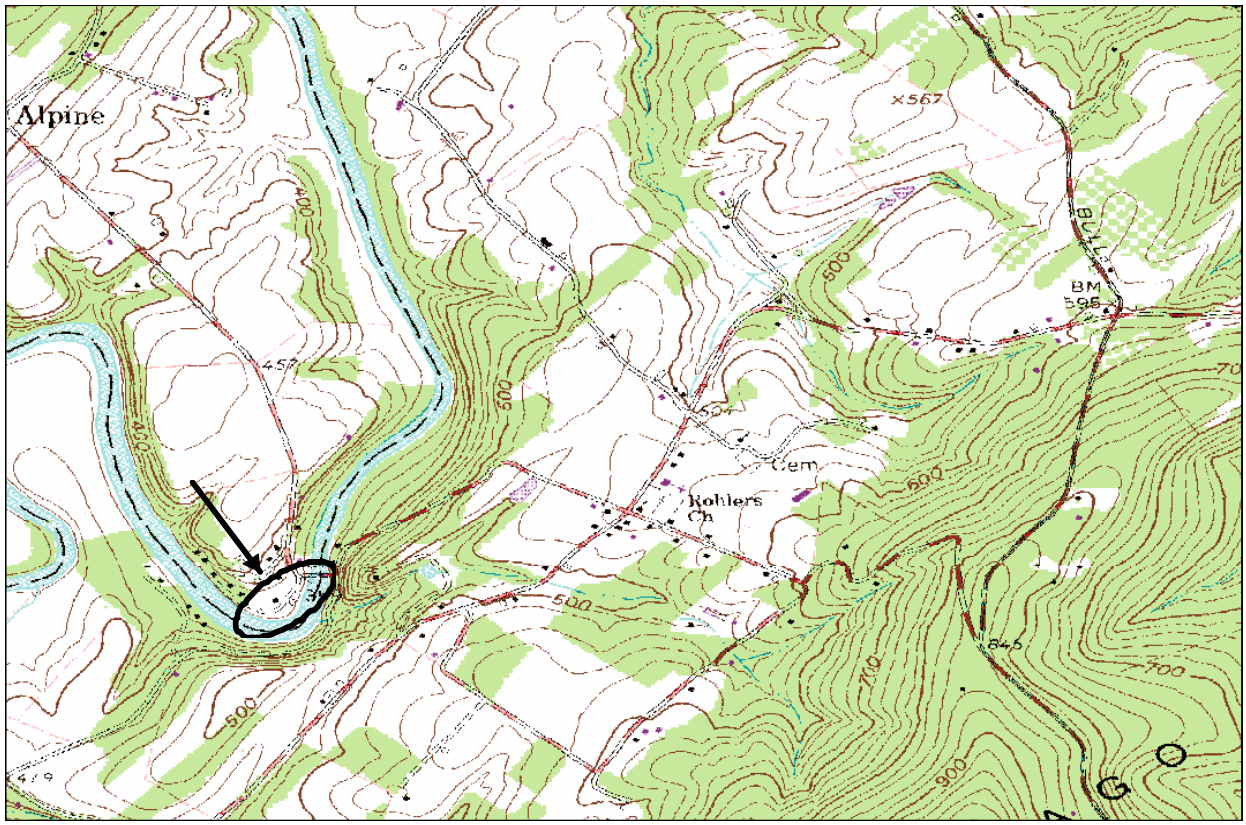
1:24,000

Site: EPA 2.112

USGS 7.5' Quadrangle: Dover, PA
York County, Warrington Twp.
Location: Rohlers Church, 1 km WSW

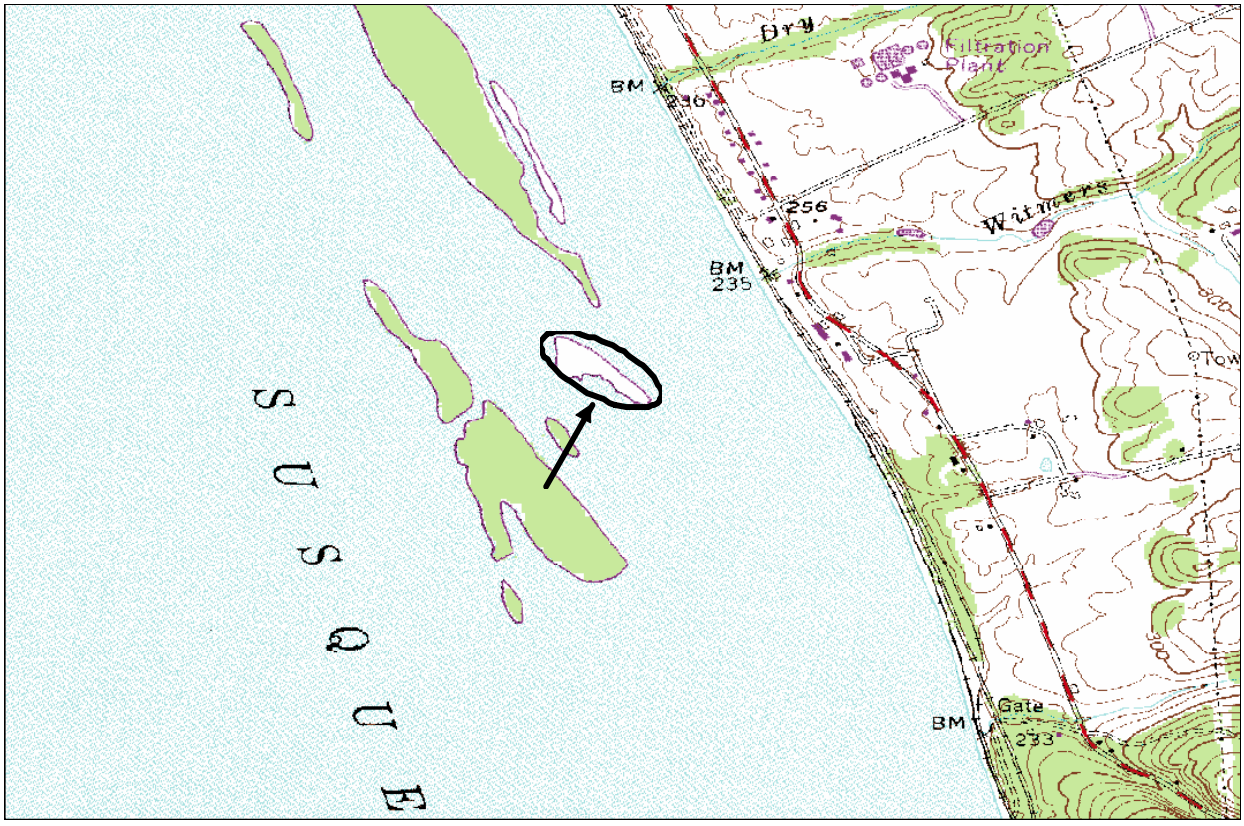
EPA 2.112 lies within TNC's Lower New England/Northern Piedmont Ecoregion on a small bars along the forested slopes of the Conewago Creek, York County. Vegetation zones include emergent herbaceous beds, shrublands, and patches of mixed herbaceous-/shrub-dominated vegetation situated on lower terraces. **Plot 2.112 (Mixed Hardwood Riverine Shrubland)** captures the mixed shrub/herbaceous component of the complex. Shrub and tree species include *Salix nigra, Acer saccharinum, Platanus occidentalis, Betula nigra,* and *Alnus serrulata*; prominent herbaceous species include *Polygonum caespitosum* and *Solidago gigantea*.



Site: EPA 2.113, 2.114, 2.115

USGS 7.5' Quadrangle: Safe Harbor, PA
Lancaster County, Manor Twp.
Location: Turkey Hill, 2.4 km NNW

EPA 2.113, 2.114, 2.115 lie within TNC's Lower New England/Northern Piedmont Ecoregion on an island in the Lake Clarke portion of the Susquehanna River, Lancaster County. The site is composed of several vegetation zones varying from an herbaceous zone on silty-sand bars to a tall shrub-dominated interior. **Plot 2.113 (Purple Loosestrife Scour Vegetation)** represents a broad expanse of tall herbaceous vegetation on the edge of the sandy island, dominated by *Lythrum salicaria, Calystegia sepium, Boehmeria cylindrica, Polygonum sagittatum,* and *P. perfoliatum.* **Plot 2.114 (Black Willow – Mixed Hardwood Riverine Shrubland)** occurs on silty-loam soil and represents a mosaic of shrub-dominated patches composed of *Salix nigra, S. lucida, and Acer saccharinum*, and herbaceous patches dominated by *Impatiens capensis, Lythrum salicaria*, and *Cuscuta gronovii*. **Plot 2.115 (Riverine Scour Vegetation)** captures the outermost edge of the island just beyond the densely vegetated, *Lythrum*-dominated shore. Vegetation includes *Cyperus sp.* and *Ludwigia palustris,* in addition to *Lythrum salicaria*.



Appendix II. Conservation Rank Definitions

GLOBAL ELEMENT RANKS

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

G2 = Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3 = Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range or because of other factors making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100.

G4 = Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.

G5 = Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.

GH = Of historical occurrence throughout its range, i.e., formerly part of the established biota, with the expectation that it may be rediscovered (e.g., Bachman's Warbler).

GU = Possibly in peril range wide but status uncertain; need more information.

GX = Believed to be extinct throughout its range (e.g., Passenger Pigeon) with virtually no likelihood that it will be rediscovered.

STATE ELEMENT RANKS

S1 =Critically imperiled in state because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation from the state.

S2 = Imperiled in state because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.

S3 = Rare or uncommon in state (on the order of 21 to 100 occurrences).

S4 = Apparently secure in state, with many occurrences.

S5 = Demonstrably secure in state and essentially ineradicable under present conditions.

SA = Accidental in state, including species which only sporadically breed in the state.

SE = An exotic established in state; may be native elsewhere in North America (e.g., house finch).

SH = Of historical occurrence in the state with the expectation that it may be rediscovered.

SN = Regularly occurring, usually migratory and typically non-breeding species for which no significant or effective habitat conservation measures can be taken in the state.

SR = Reported from the state, but without persuasive documentation which would provide a basis for either accepting or rejecting (e.g., misidentified specimen) the report.

SRF = Reported falsely (in error) from the state but this error persisting in the literature.

SU = Possibly in peril in state but status uncertain; need more information.

SX = Apparently extirpated from the state.

Appendix III. Top Ten Most Common Lepidoptera Species Found at Six Sites in the Susquehanna River Watershed

Site	Family	Scientific Name	Common Name	Larval Host Plant	Abundance (Eastern US); Adult flight period; Comments
Site 1	Geometridae	Anavitrinella pampinaria	Common Gray	1: Apples, ashes, citrus, clover, cotton, elms, pear, poplars, and willows.	1: Common to abundant; April-Oct.
Site 1	Noctuidae	Caenurgina crassiuscula	Clover Looper Moth	1: Clover, grasses, lupines.	1: Abundant; Mar-Nov; several broods; adults active day & night.
Site 1	Geometridae	Digrammia (Semiothisa) ocellinata	Faint-spotted Angle	1: Locust trees.	1: Common to abundant; April-Oct.
Site 1	Geometridae	Eusarca confusaria	Confused Eusarca	1: Asters, clover, dandelion, goldenrod, other composites.	1: Very common; April-Oct.
Site 1	Arctiidae	Hypoprepia fucosa	Painted Lichen Moth	1: Lichens	1: Common; May-Sept.
Site 1	Noctuidae	Idia americalis	American Idia	1: Lichens	1: Very common; April-Nov.
Site 1	Geometridae	Macaria (Itame) pustularia	Lesser Maple Spanworm Moth	1: Maples. Larvae sometimes a pest.	1: Locally abundant; May-July.
Site 1	Noctuidae	Orthodes cynica	Cynical Quaker	1: Plantain?	1: Common; May-Aug.
Site 1	Geometridae	Pero honestaria	Honest Pero	1: Black locust, American larch, wild cherry.	1: Common; April-Sept.
Site 1	Noctuidae	Phalaenostola metonalis	Pale Phalaenostola	1: Dead leaves.	1: Uncommon; June-Aug.
Site 2	Noctuidae	Bomolocha baltimoralis	Baltimore Bomolocha	1: Maples	1: Common; April-Oct.
Site 2	Geometridae	Campaea perlata	Pale Beauty	1: Variety of trees; alders, birches, firs, elms, maples, oaks, poplars & willows.	1: Common; May-Sept., 2 broods.
Site 2	Geometridae	Eutrapela clemataria	Curve-toothed Geometer	1: Ash, aspen, basswood, birches, elms, fir, maples, poplars, willows, other trees.	1: Common; April-Aug.
Site 2	Noctuidae	Lacinipolia renigera	Bristly Cutworm Moth	1: Wild & cultivated plants such as apple trees, cabbage, clover, corn & tobacco.	1: Common; May-Oct, 2 or more broods.
Site 2	Noctuidae	Luperina passer	Dock Rustic	1: Roots of dock (Polygonaceae, buckwheat family)	1: Common; May-Sept, two broods.
Site 2	Noctuidae	Parallelia bistriaris	Maple Looper Moth	1: Yellow birch, red & white maples, black walnut.	1: Common; April-Sept.
Site 2	Geometridae	Pero hubneraria	Hubner's Pero	1: Alder, buffalo berry, willows.	1: Common; March-Sept.
Site 2	Geometridae	Prochoerodes lineola (transversata)	Large Maple Spanworm	1: Apple, blueberries, cherries, currant, geranium, grasses, maples, oaks, soybean, sweetfern, walnut, other plants.	1: Common; April-Oct.
Site 2	Tortricidae	Tortricidae undetermined	NA	1: Larvae are leaf rollers, leaf tiers, or borers in roots, stems or fruits. Many are serious forest and orchard pests.	
Site 2	Noctuidae	Xestia dolosa	Greater Black-Letter Dart	1: 'Spotted Cutworm' larvae. Many crops such as apple, barley, clovers, corn, maples, tobacco, other plants.	1: Common; May-Oct, two broods.

Site	Family	Scientific Name	Common Name	Larval Host Plant	Abundance (Eastern US); Adult flight period; Comments
Site 3	Geometridae	Euchlaena tigrinaria	Mottled Euchlaena	1: Oak, quaking aspen, white birch.	1: Common; April-Aug.
Site 3	Arctiidae	Halysidota tessellaris or harrisii	Banded Tussock Moth	1: Alder, ashes, birches, elms, hazelnut, hickories, oaks, tulip-tree, walnut, willows, other trees & shrubs.	1: Common-abundant; May-Oct, 2 broods.
Site 3	Geometridae	Lambdina fiscellaria	Hemlock Looper Moth	1: Firs, hemlocks, oaks & spruces	1: Common; Aug.-Oct.
Site 3	Lasiocampidae	Malacosoma disstria	Forest Tent Caterpillar Moth	1: Many trees & shrubs, especially aspens & maples. Do not make a tent.	1: Common locally; April-Sept.
Site 3	Notodontidae	Misogada unicolor	Drab Prominent	1: Cottonwood and sycamore.	1: Locally common; April-Sept.
Site 3	Noctuidae	Orthodes cynica	Cynical Quaker	1: Larvae have been reared on plantain.	1: Common; May-Aug.
Site 3	Noctuidae	Panopoda rufimargo	Red-lined Panopoda	1: Beeches and oaks.	1: Common; May-Sept.
Site 3	Notodontidae	Peridea ferruginea	Chocolate Prominent	1: Birches.	1: Rare southward; May-Aug.
Site 3	Lasiocampidae	Tolype laricis	Larch Tolype	1: Larches, firs, pines, other conifers.	1: July-Sept; a more northern species.
Site 3	Noctuidae	Xestia dolosa	Greater Black-Letter Dart	1: Larvae called 'Spotted Cutworm'. Feed on many crops such as apple, barley, clovers, corn, maples, tobacco, and other plants.	1: Common; May-Oct, two broods.
Site 4	Geometridae	Anavitrinella pampinaria	Common Gray	1: Apples, ashes, citrus, clover, cotton, elms, pear, poplars, and willows.	1: Common to abundant; April-October.
Site 4	Yponomeutidae	Atteva punctella	Ailanthus Webworm Moth	1: Ailanthus and paradise tree. Larvae live in communal webs.	1: Common; March-Nov.
Site 4	Notodontidae	Datana drexelii	Drexel's Datana	1: Birches, blueberry, linden, sassafras, witch-hazel.	1: Common; June-Sept.
Site 4	Pyralidae	Desmia funeralis	Grape Leaffolder Moth	1: Evening-primrose, redbud, wild & domestic grapes.	1: Common; April-Sept, 2-3 broods; adults fly during day.
Site 4	Arctiidae	Halysidota tessellaris or harrisii	Banded Tussock Moth	1: Alder, ashes, birches, elms, hazelnut, hickories, oaks, tulip-tree, walnut, willows, other trees & shrubs.	1: Common-abundant; May-Oct, 2 broods.
Site 4	Noctuidae	Lacinipolia renigera	Bristly Cutworm Moth	1: Eat many wild and cultivated plants such as apple trees, cabbage, clover, corn, and tobacco.	1: Common; May-Oct, 2 or more broods.
Site 4	Geometridae	Macaria (Semiothisa) aemulataria	Common Angle		
Site 4	Pyralidae	Ostrinia nubilalis	European Corn Borer Moth	1: Larvae tunnel into stalks of corn & cut leaves off at bases, serious corn pest. Also feed on asters, beans, dahlias, potato & other plants.	1: Common; April-Oct, 1-3 broods.
Site 4	Arctiidae	Spilosoma virginica	Virginian Tiger Moth	1: Larvae called Yellow Bear. Feed on many plants such as birches, cabbage, corn, maples, Prunus & Ribes spp., squash, sunflowers, tobacco, walnuts & willows.	1: Common; April-Oct, two broods.
Site 4	Lasiocampidae	Tolype vellada	Large Tolype	1: Apple, ash, birch, elm, oak, plum, other trees.	1: Common; Sept-Oct.

Site	Family	Scientific Name	Common Name	Larval Host Plant	Abundance (Eastern US); Adult flight period; Comments
Site 5	Noctuidae	Acronicta oblinita	Smeared Dagger Moth	1: Larvae called the 'Smartweed Caterpillars'. A pest of apple and other fruit trees. Also reported on clover, corn, cotton, elms, grasses, pines, smartweed, strawberry, plants, & willows	1: Common; April-Sept, 2 or more broods
Site 5	Noctuidae	Bomolocha manalis	Flowing-Line Bomolocha	1: Unrecorded.	1: Uncommon; March-Oct.
Site 5	Noctuidae	Eudryas unio	Pearly Wood-Nymph	1: Ampelopsis, buttonbush, grapes, hops, and Virginia creeper.	1: Common; May-Aug., 2 broods in the south.
Site 5	Lymantriidae	Orgyia leucostigma	White-Marked Tussock Moth	1: Over 140 hosts, including alder, apple, balsam fir, birches, and larch. Sometimes a pest on Christmas tree plantations in the north.	1: Common; June-Nov., usually 2 broods.
Site 5	Noctuidae	Palthis asopialis	Faint-Spotted Palthis	1: Beans, coralberry, corn, oaks, and Spanish needles.	1: Common southward; May-Nov or first frost.
Site 5	Noctuidae	Phalaenostola eumelusalis	Dark Phalaenostola		
Site 5	Geometridae	Prochoerodes lineola (transversata)	Large Maple Spanworm	1: Apple, blueberries, cherries, currant, geranium, grasses, maples, oaks, soybean, sweetfern, walnut, other plants.	1: Common; April-Oct.
Site 5	Noctuidae	Stiriodes obtusa	Obtuse Yellow	1: Unrecorded.	1: Common; June-Aug.
Site 5	Tortricidae	Tortricidae undetermined	NA	1: Larvae are leaf rollers, leaf tiers, or borers in roots, stems or fruits. Many are serious forest and orchard pests.	
Site 5	Geometridae	Xanthorhoe lacustrata	Toothed Brown Carpet	1: Birches, blackberries, other Rubus spp., hawthorns, impatiens, willows.	1: Common; March-Sept, 2 broods.
Site 6	Noctuidae	Caenurgina crassiuscula	Clover Looper Moth	1: Clover, grasses, lupines.	1: Abundant; Mar-Nov, several broods. Adults active day & night.
Site 6	Noctuidae	Lacinipolia renigera	Bristly Cutworm Moth	1: Eat many wild and cultivated plants such as apple trees, cabbage, clover, corn, and tobacco.	1: Common; May-Oct, 2 or more broods.
Site 6	Lasiocampidae	Malacosoma disstria	Forest Tent Caterpillar Moth	1: Many trees & shrubs, especially aspens & maples. Do not make a tent.	1: Common locally; April-Sept.
Site 6	Geometridae	Nematocampa resistaria (limbata)	Filament Bearer	1: apple, birches, lindens, hickories, maples, oaks, pear, Ribes spp., strawberry, other low plants & trees. 2: Douglas-fir and western hemlock, western red cedar, Engelmann spruce, white spruce, western larch, tamarack, western white pine, subalpine fir and grand fir. Numerous hardwood and shrub hosts have also been recorded.	1: Local and uncommon in eastern U.S.; May-Aug. 2: July-Sept. 5: common & widespread in western N. America
Site 6	Noctuidae	Ochropleura implecta	Flame-shouldered Dart	3: Cranberries. 4: Clover, willow, beet and chicory in Quebec.	3: May-Aug., 2 broods.

Site	Family	Scientific Name	Common Name	Larval Host Plant	Abundance (Eastern US); Adult flight period; Comments
Site 6	Geometridae	Orthonama obstipata	The Gem	1: Wide variety of plants, including chrysanthemums, dock, elms, mayweed, Polygonum spp., Senecio spp.	1: Very common; April-Oct.
Site 6	Noctuidae	Plathypena scabra	Green Cloverworm Moth	1: Clover, alfalfa, beans, other legumes; also strawberry & raspberry plants. A pest, but not serious.	1: Abundant; adults fly any warm period in the year.
Site 6	Arctiidae	Spilosoma virginica	Virginian Tiger Moth	1: Larvae called Yellow Bear. Feed on many plants such as birches, cabbage, corn, maples, Prunus & Ribes spp., squash, sunflowers, tobacco, walnuts & willows.	1: Common; April-Oct, 2 broods.
Site 6	Noctuidae	Sunira bicolorago	Bicolored Sallow	1: Black cherry, cabbage, crabapple, dock, lawn grasses, maples, scrub oak, tobacco, and other plants.	1: Common to abundant; Sept-Dec.
Site 6	Noctuidae	Xestia dolosa	Greater Black-Letter Dart	1: Larvae called 'Spotted Cutworm'. Feed on many crops such as apple, barley, clovers, corn, maples, tobacco, and other plants.	1: Common; May-Oct, two broods.

Site 1 – Shawville
Site 2 – Milton State Park
Site 3 – Loyalsock Creek
Site 4 – Byers Island
Site 5 – Green's Island
Site 6 – Fulmer's Secret

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