Western Pennsylvania Conservancy

ALLEGHENY COUNTY PARKS ECOLOGICAL ASSESSMENT AND ACTION PLAN

HARRISON HILLS PARK

Prepared for the Allegheny County Parks Foundation
February, 2023

FOREWARD

With nine parks encompassing over 12,000 acres, Allegheny County boasts one of the largest regional park systems in the country. While recreational activities make each park a unique destination, nature is the common thread that connects our parks and is our most treasured – and jeopardized – asset. The abundant resources found in our parks' forests, meadows and streams provide vital habitat for flora and fauna that clean our air and water, pollinate our plants, and connect the web of life. We are stewards of these natural sanctuaries and are working to protect them for future generations.

In 2022, the Allegheny County Parks Foundation received a contribution from the granting trust of Caroline Fredricka Holdship to advance our stewardship efforts. The Parks Foundation, together with the Allegheny County Parks, partnered with the Western Pennsylvania Conservancy (WPC) to conduct an Ecological Assessment and Action Plan in Harrison Hills Park. This study evaluates the park's natural resources and ecological assets and recommends an implementation plan for protecting, preserving, and improving the environmental health of the park.

The earliest aerial photographs of Harrison Hills Park from 1939 show that about 80% of the park area was cleared for agriculture. Some steep slopes and tributary valleys remained partially forested, including the steepest slopes above the Allegheny River. By 1967, regenerating forest can be seen in some of the previously cleared areas. Today most of the park is forested, except areas maintained for recreational use such as soccer fields, shelters, and playgrounds.

WPC's work revealed that Harrison Hills Park contains several populations of plant species that are rare in Pennsylvania and Allegheny County, and conservation should be a management goal, including natives such as ramps, paw paw, bladdernut, and the butternut or white walnut tree. Thin bands of limestone outcroppings on the cliffs above the Allegheny River also support unique calcareous cliff dwelling vegetation. Areas of invasive species populations such as Mile-a-minute and Japanese angelica tree have also been observed and mapped for removal.

Using the data gathered by WPC, areas of the park have been mapped as best, good, or poor based on their ecological integrity. Unfortunately, no areas of Harrison Hills were designated as "best". The challenge ahead is to raise the ecological integrity of the "good" areas to "best" and improve the "poor" areas using the recommendations provided.

Gaps in the forest canopy have been noted within the study and their elimination should be prioritized. There is risk that these gaps will degrade the surrounding forest, especially when they exist within high quality forest. Invasive species also frequently establish populations in these favorable gap conditions. The invasives are often vines that pull down trees, which not only increases the size of the gap, but it can spread the gap and invasives into adjacent higher-quality areas.

The report also suggests installing deer fencing, to protect sensitive areas from extensive over browsing, and trail management. WPC identified trail management as a recommendation because Harrison Hills Park includes a segment of the Rachel Carson Trail which sees very heave use.

We are deeply grateful to the granting trust of Caroline Fredricka Holdship for providing the funding to make this report possible. We also thank the outstanding staff at the Western Pennsylvania Conservancy and Allegheny County Parks Department for their expertise and insightful contributions to this effort. We look forward to collaborating with the County Parks staff and other partners to prioritize, fund, and implement these recommendations and to continue this type of important ecological work in all nine of the Allegheny County Parks.

Joey-Linn Ulrich
Executive Director
February 2023

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1,750
875
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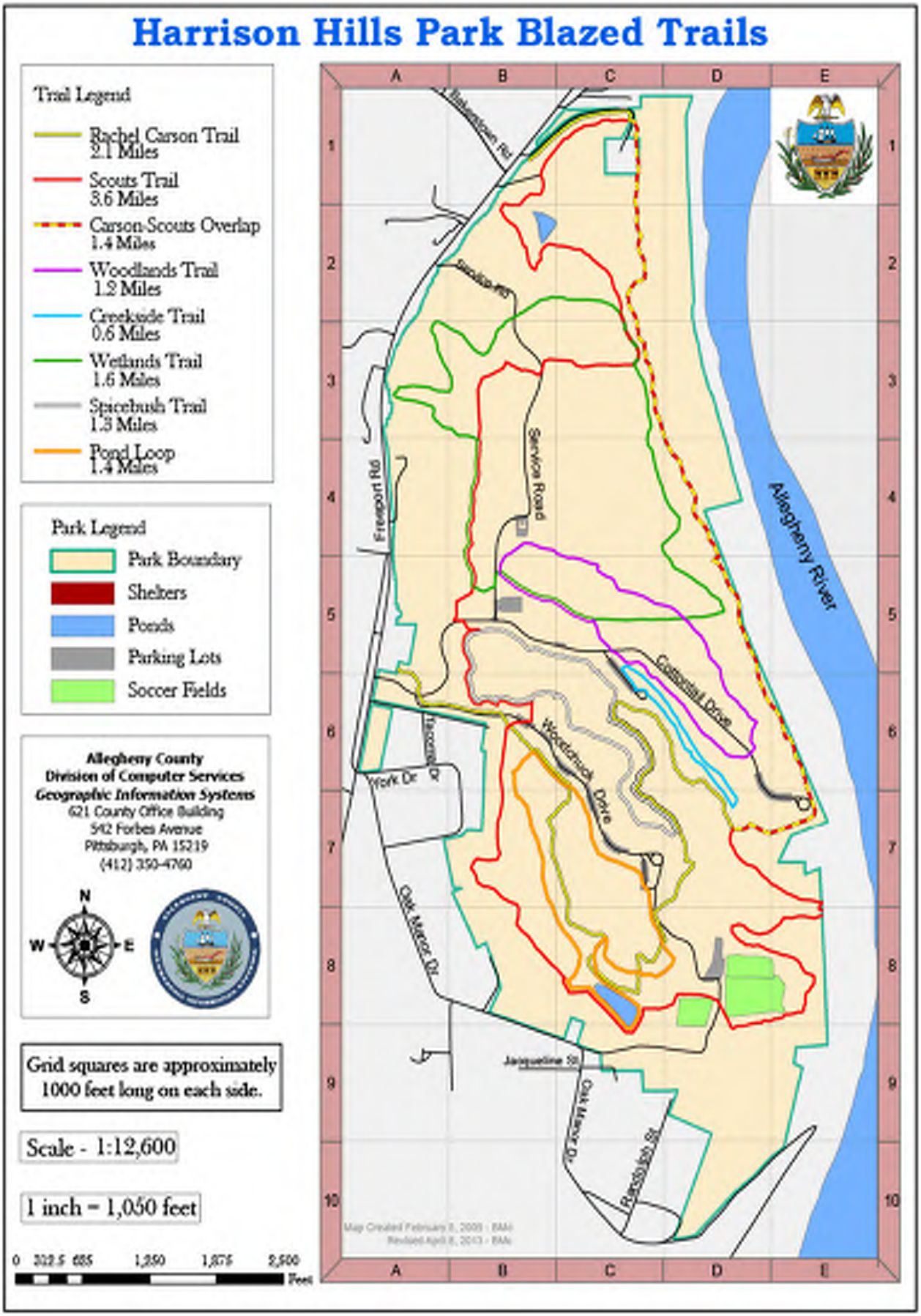
Harrison Hills Park Blazed Trails



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1.1 ECOLOGICAL OVERVIEW

This section provides an overview of the ecology of Harrison Hills Park. The state of ecosystems today in the park is due to the interaction of the basic environmental conditions in the park; the plants, animals and other living organisms that inhabit our region; and the land management activities of people. **Allegheny County's Ecological Heritage** provides a background for understanding Harrison Hills Park natural communities in a regional context, while **Land Use and Ecological History of Harrison Hills** describes the ways in which human activities have affected the development of natural communities in the park. The state of the natural communities is the result of historic land-use, most notably surface mining and agriculture. Soils and geology are the foundations of the web of life, providing nutrients and shaping growing conditions for plants, which are the base of the food chain. The **Geology** and **Soils** sections below describe these features of the park in more detail.

Southern Pond at Harrison Hills Park

At Harrison Hills Park, about 80% of the park area is in natural condition (not developed or actively managed), while 12% is managed and maintained for recreational use, and 2% is developed for roads, parking, or buildings. The character of the area in natural condition is primarily determined by past land use. Most of the natural areas of the park were previously cleared and farmed, while about 20% of the park (1/4 of the natural area) has been continuously forested since the first aerial photographs available (1939).

The previously cleared areas today contain forests that are characterized as "modified successional" or "early successional" depending on their maturity. When land uses entail soil turnover and complete removal of living forest plant material and seed banks, the forest communities that regenerate post-disturbance are typically much lower in diversity than undisturbed natural communities, and include few "conservative" forest species. If the regeneration occurred in the last 3-4 decades, rather than earlier, it is likely that invasive non-native species have high cover, due to the general ubiquity of invasive species seed in that timeframe. In Harrison Hills Park, about half the "modified successional forest" areas are highly invaded by non-native species, while half is not yet invaded. This is fairly positive, as some other county parks are much more ubiquitously invaded in previously tilled lands.

The continuously forested area includes 91 acres along Rachel Carson Run, 18 acres along the steep slope above the Allegheny River, plus 5-10 acres along other stream ravines in the park. These areas tend to have large, mature trees, some of which are quite visibly impressive.

These areas today have fairly high-quality forest communities, and should be a special focus for management to maintain and enhance their diversity and integrity.

1.2 ALLEGHENY COUNTY'S ECOLOGICAL HERITAGE

This region's natural ecosystems have developed over tens of thousands of years. Further south, the Southern Appalachian Mountains are one of the world's biodiversity hot spots, in part because of a hospitable climate and in part because ecological development was never reset by glaciation. Southwestern Pennsylvania is at the northern edge of this bioregion; the character and diversity of its plant and animal life show both an Appalachian and Midwestern influence, and it is markedly different than previously glaciated ecosystems just a short distance to the north. Southern influences extend into Allegheny County in particular because of the moderate climates along the major river corridors: the Ohio, Allegheny, Monongahela, and Youghiogheny.

There are no detailed descriptions of the region's ecosystems preserved before about 1900. Historical ecological assessment techniques such as pollen analysis conducted in other areas of the northeast show that significant ecosystem changes were set in motion in the 1600 and 1700s by the arrival of Europeans and the decimation of Native American societies, who had influenced and managed natural landscapes for several thousand years previous to the arrival of European colonists. Furthermore, by the early 1900s, clearcutting for agricultural development and timber sale was already well advanced in the region, and early documentarians could only assess the remaining forest areas. However, despite these limitations, their work remains the best reference we have available for the original character of our region's forest ecosystems.

In the early 1900s, E. Lucy Braun catalogued the natural forest ecosystems of eastern North America, in a definitive work that can never be replicated because these systems have been so extensively altered in the years since. She placed southwestern Pennsylvania within the Cumberland and Allegheny Plateaus section of the original Mixed Mesophytic forest region (Braun, 1950). This region extends from northern Alabama to glaciated northeastern Pennsylvania; Allegheny County is at the far northern end. The Mixed Mesophytic Forest is characterized by an exceptionally diverse tree canopy, and by a rich Appalachian-influenced herbaceous layer. Dominant species of the climax forest in this region are the American beech (*Fagus grandifolia*), tulip tree (*Liriodendron tulipifera*), basswood (*Tilia sp.*), sugar maple (*Acer saccharum*), American chestnut (*Castanea dentata*), sweet buckeye (*Aesculus octandra*), red oak (*Quercus rubra*), white oak (*Q. alba*), and hemlock (*Tsuga canadensis*). According to Braun's work, Allegheny County lies within a subdivision of this region called the Low Hills Belt, characterized by a larger proportion of oak than is typical for Mixed Mesophytic Forest.

Otto Jennings of the Carnegie Museum of Natural History also wrote pioneering baseline ecological descriptions for the region in the early 1900s. He described two forest types for the region, a "White Oak Association" and a "Sugar maple – Beech Association". The White Oak Association is found on rolling uplands and rounded hills, and it is dominated by white oak, shagbark hickory, red maple, and other oak species. The Sugar maple – Beech Association is found on richer, moister soils such as floodplains, valleys, and lower slopes, and the canopy dominants are sugar maple, American beech, hickories (*Carya spp.*), red oak, white oak, white ash (*Fraxinus americana*), and American basswood.

In the last few centuries, since European colonization, this ecological baseline has undergone unprecedented changes; today's landscape reflects both the rich ecological heritage of the region, and the impact of many modern challenges such as forest pests, fragmentation, invasive species, and post-agricultural forest recovery. Tree species that were once a ubiquitous part of

our region's forests, such as the American chestnut, American elm, white ash, and green ash, have been eliminated or greatly reduced in our forests by the introduction of exotic forest pests and diseases. More species may still be lost; oak species, hemlock, and American beech are threatened by the gypsy moth, hemlock wooly adelgid, and beech bark disease complex, respectively. Invasive plant species have been introduced that are displacing native species on a large scale. Excessive deer browse is also a modern problem that threatens forest regeneration and diversity, as deer were previously held in check by keystone predators such as wolves. At Harrison Hills Park, deer browse is a significant problem that has depleted the diversity of the native mesic forest communities. However, there are significant remainders worth protecting, especially in steep areas inaccessible to deer. Our challenge in landscapes such as the Allegheny County Parks is to safeguard and improve the health of our remaining natural diversity, and to restore ecological health where it has been impaired.

1.3 LAND USE & ECOLOGICAL HISTORY OF HARRISON HILLS PARK

We examined historic aerial photos (Penn Pilot 2022) of Harrison Hills Park. Historic aerial photos from 1939, 1949, and 1967 were georeferenced in ArcPro. Modern aerial photos (ESRI basemap imagery 2022) were used to make inferences about current land use practices and natural community composition.

In 1939, about 80% of the present-day park area was cleared for agriculture (**Figure I**). Some steep slopes and tributary valleys remained at least partially forested (either mature forest or successional forest), including the steepest slopes above the Allegheny River, a large portion of Rachel Carson Run, and small remnants in other ravines. In 1949 little had changed, with the elapse of only 10 years (**Figure II**). One significant change is the appearance of the glass dumping area, as a large cleared area.

By 1967, regenerating forest can be seen in some of the previously cleared areas (**Figure III)**. Forest has regrown adjacent to the Allegheny River slopes, creating a wider band along that edge of the park. Forest has also regrown adjacent to the lower portion of the Rachel Carson Run ravine, across the entire width of the park. The glass dumping area is still clear of woody vegetation, but appears to have herbaceous vegetation over it at this time. However, at this time the roads running parallel to Rachel Carson Run had also been widened, and two usage areas had been cleared in the midst of the larger forested area. Forest along the upper portion of the Rachel Carson Run (currently the Wetland Trail) had also expanded more narrowly.

FIGURE I

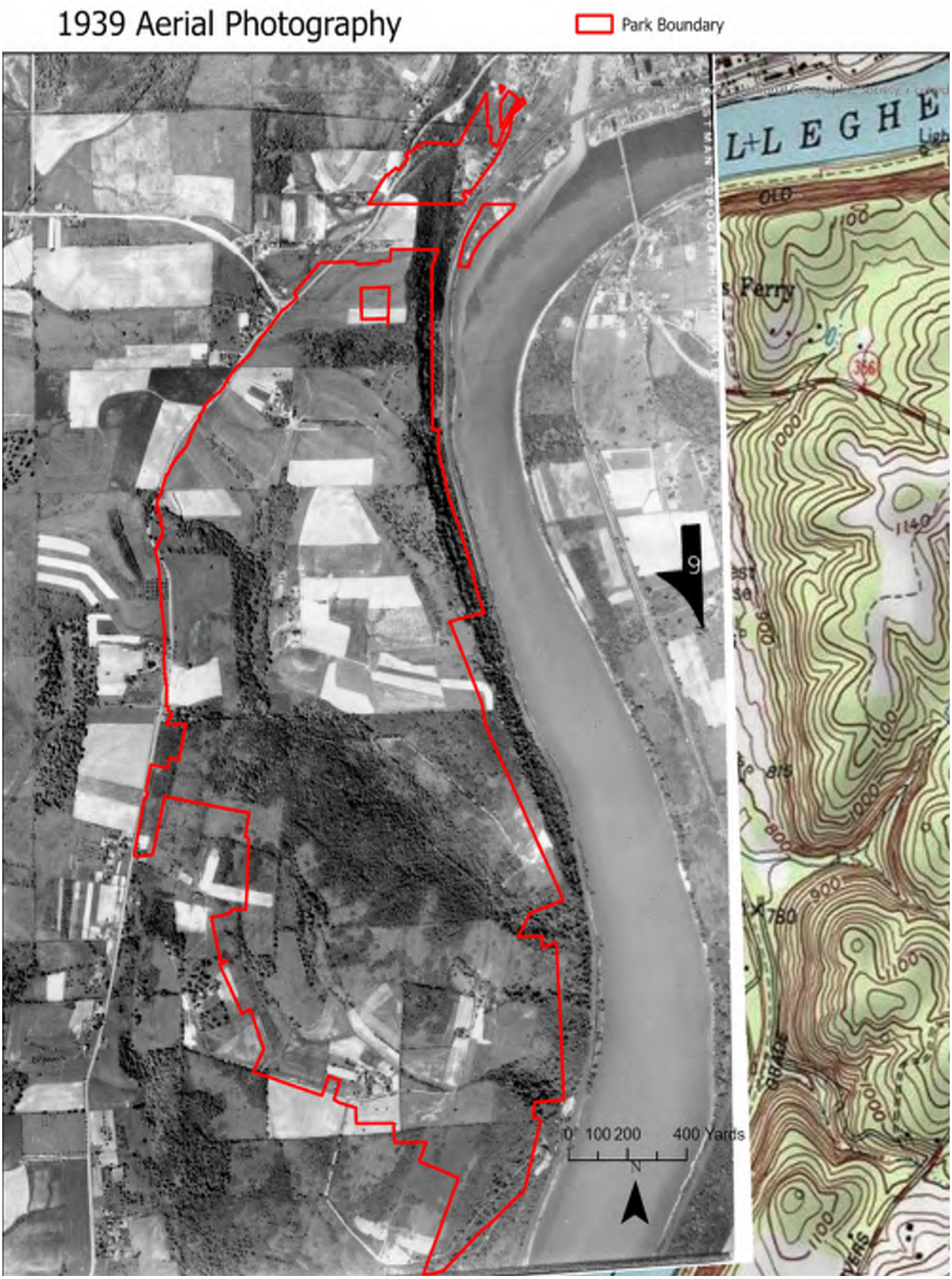
1939 Aerial Photography
Park Boundary
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FIGURE II

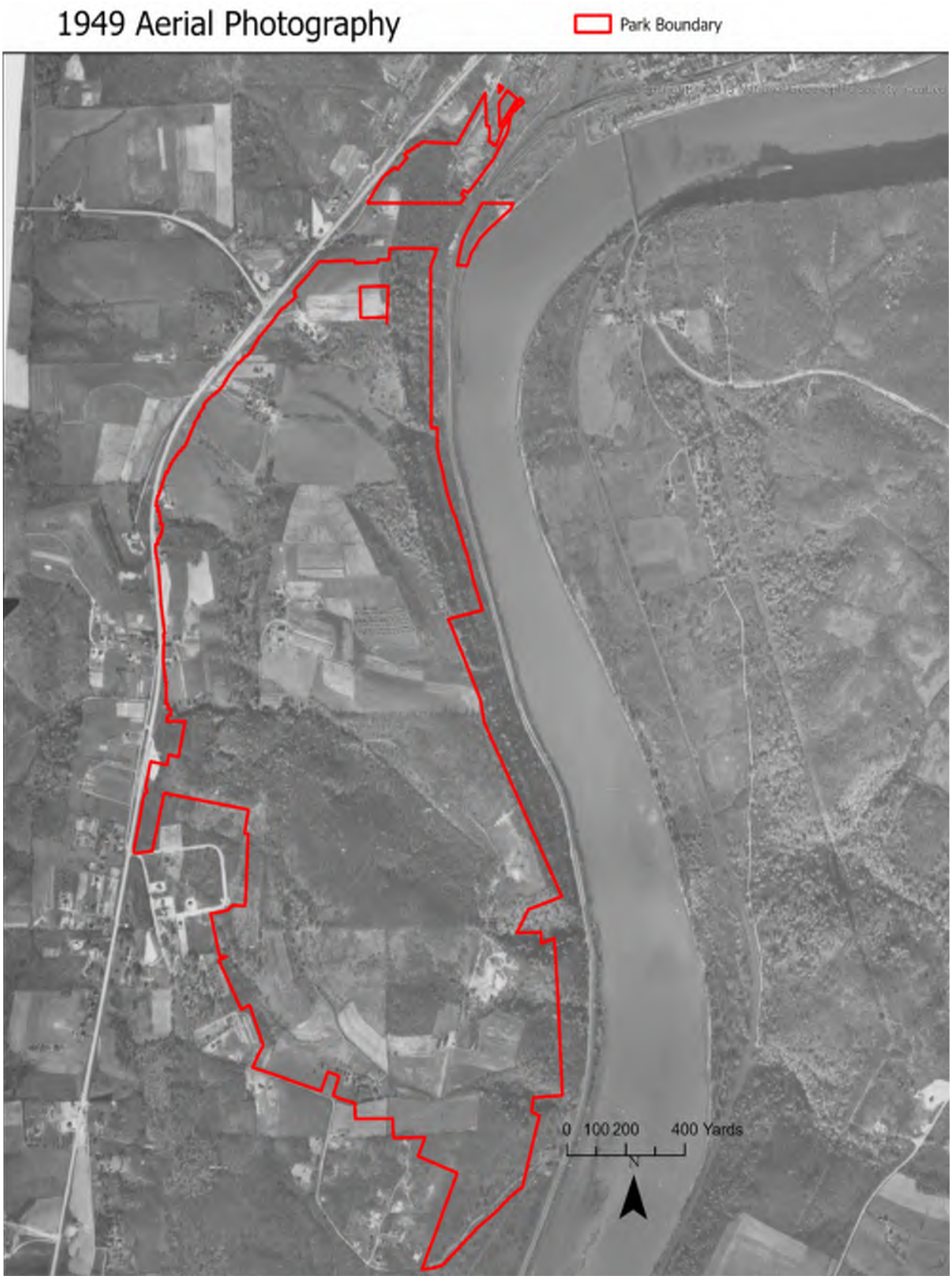


FIGURE III

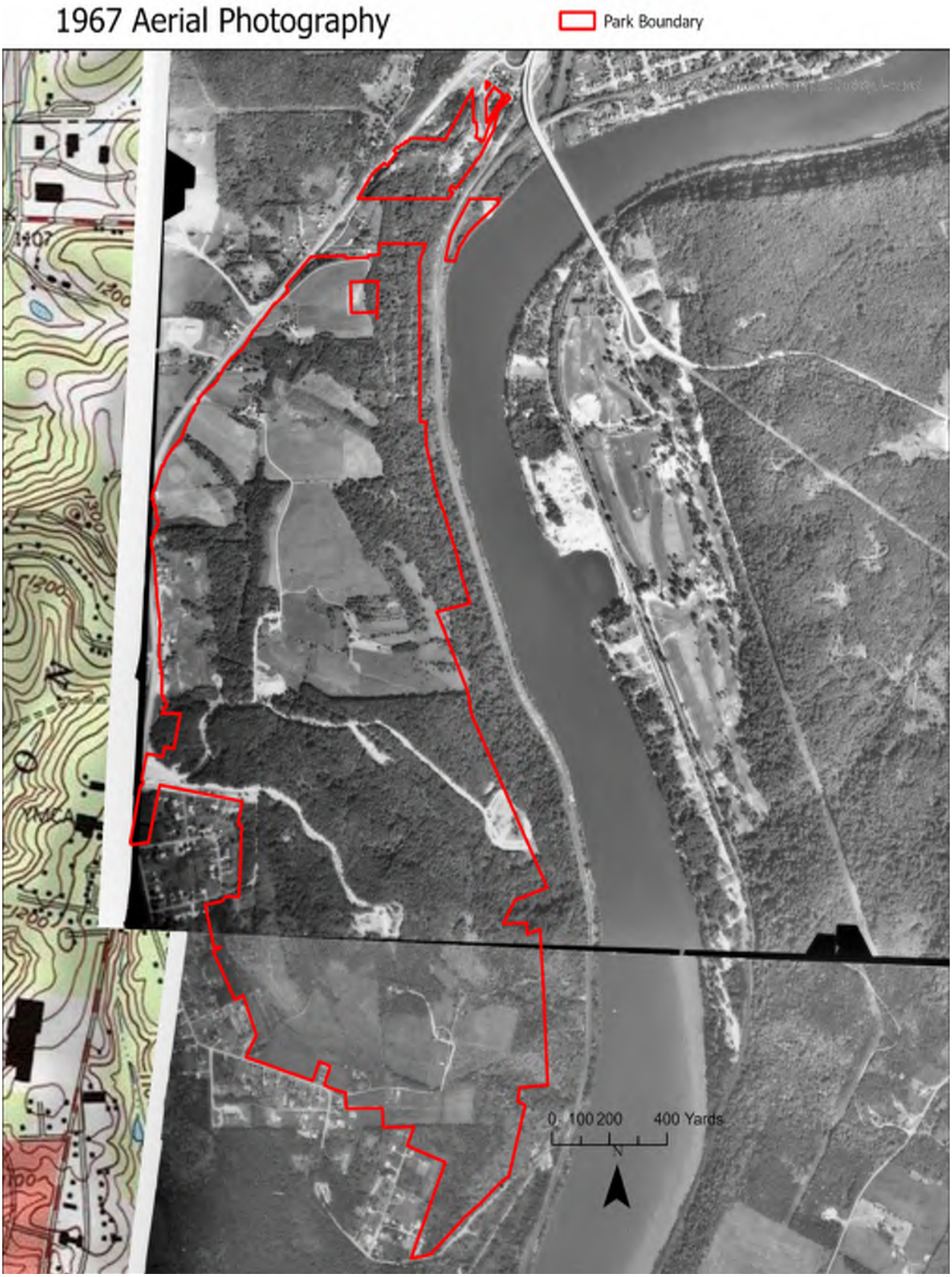
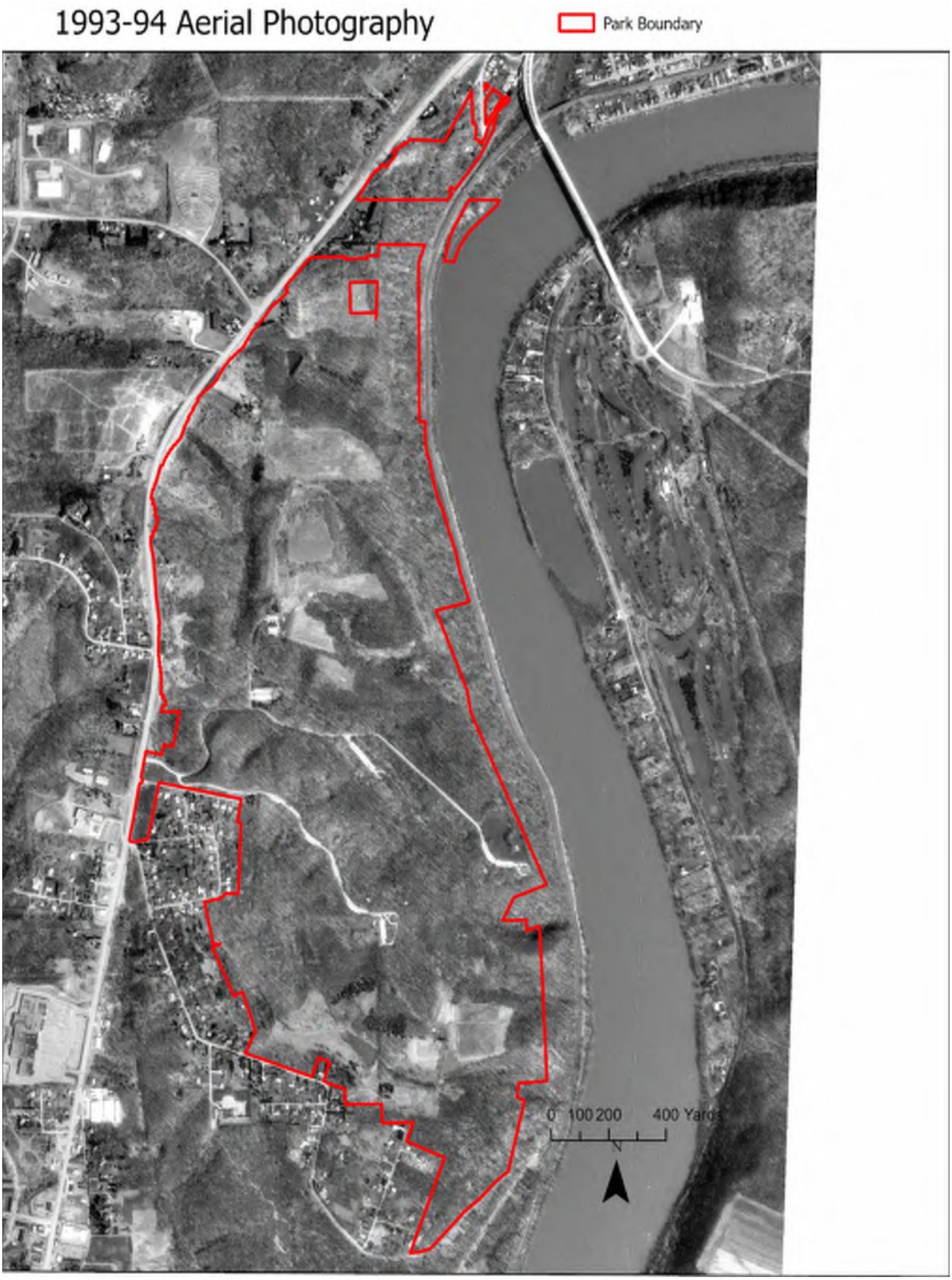


FIGURE IV


1993-94 Aerial Photography
Park Boundary
0 100 200 400 Yards

By 1993-95, a third wave of forest regrowth had occurred (**Figure IV**). At this point, most of the park is forested, except areas maintained for recreational use such as the soccer fields, shelters, and playgrounds. This third wave of forest has a heavier presence of invasive species, as invasive species propagules were more common at the time it was regenerating. The glass dumping area has thin forest cover in these images.

Since then, land use has not changed significantly. Existing forests continued to mature, and invasive species also continued to spread, changing the character of some forests. Today, most of the glass dumping area at has young forest cover; the glass waste is intermixed with soil, organic matter, and vegetation, creating a difficult remediation challenge.

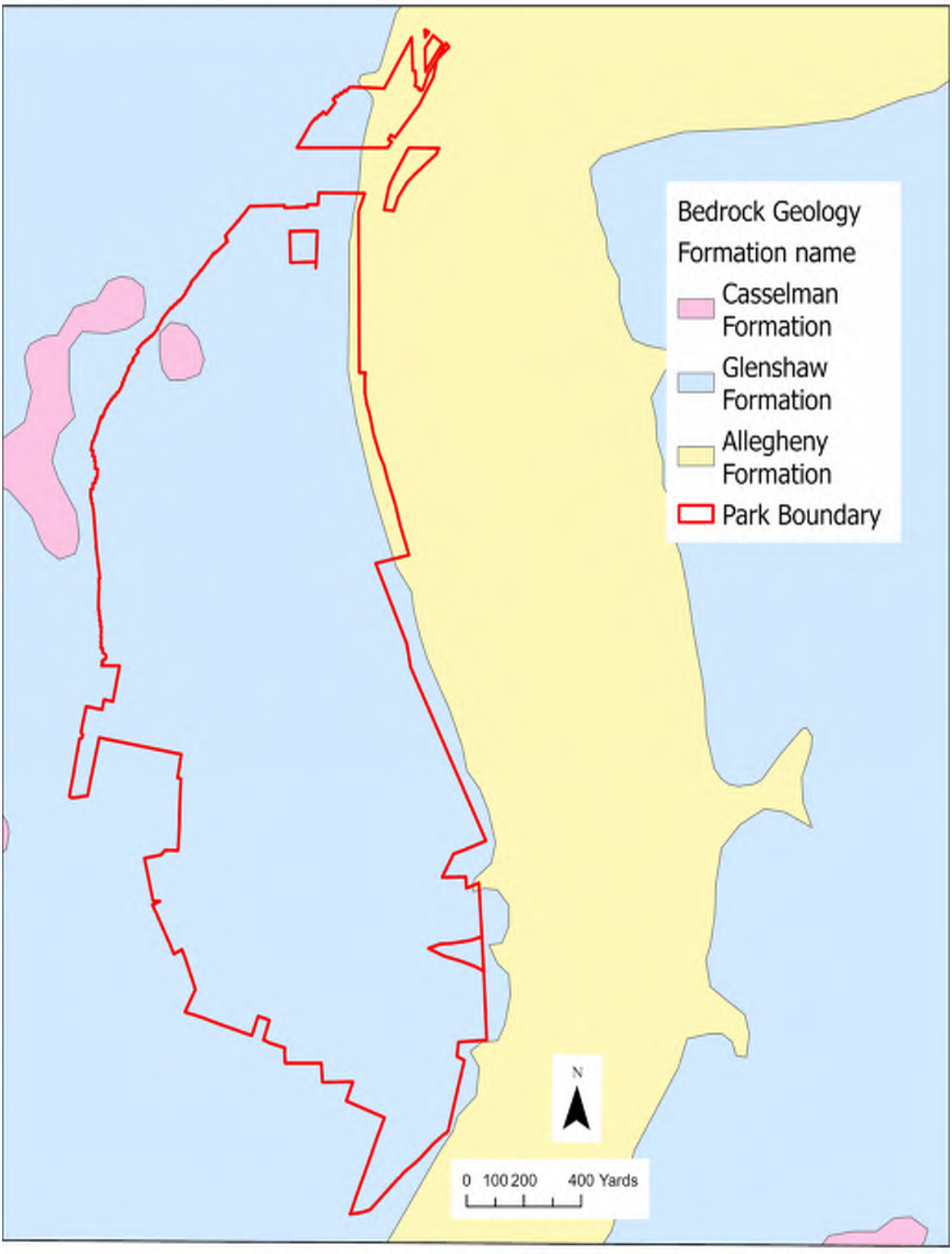
1.4 GEOLOGY

Surface geology refers to the bedrock layers closest to the surface of the earth. Bedrock is the foundation material for soil, and also greatly influences the chemistry of water bodies such as streams, rivers, and lakes. Surface geology can be a determining factor in the diversity of plant life on land, and animal life in streams and lakes.

Pennsylvania is divided into physiographic regions based on landforms and geological history. Harrison Hills Park is located in the Pittsburgh Low Plateau section of the Appalachian Plateau province, characterized by low rolling hills that formed by the gradual erosion of stream valleys, rather than the tectonic upheavals that formed the Allegheny and Appalachian ranges. In this region, the surface geology layers were formed through sedimentary processes, and they have not been extensively folded by subsequent tectonic activity; today they lie horizontally or gently undulate over large distances. The Pittsburgh Low Plateau is within the unglaciated portion of the Appalachian Plateau province.

Geologists classify rock layers into groups and formations based on the time period in which they formed. Formations are also described according to their mineral composition, which greatly influences soil materials and plant life. The surface geology of Harrison Hills Park is almost entirely the Glenshaw formation, with a few small areas of Casselman formation and Allegheny Formation.

Harrison Hills Park Surface Geology



The Glenshaw and Casselman formations consist of layers of shale, siltstone, sandstone, red beds, thin impure limestone, and thin nonpersistent coal. They contain very little calcareous material, except for a limestone layer called the Ames limestone, which occurs at the boundary of the two formations. This 2-4' thick layer can form small outcroppings, and is notably rich in marine fossils. Where the Ames limestone is exposed on slopes by erosion that has cut through the geological layers, it may create a local zone roughly 5' to 10' in width that is enriched by calcareous materials. Besides this layer, the overwhelming character of the surface geology is acidic and mineral-poor.

However, it is clear that some calcareous layers are exposed on some of the outcrops above the rivers. The tall riverside outcrops offer an unusual view of surface geology because they cross-section the various sedimentary layers of a formation. Even a thin band of limestone may support unique vegetation when cliff-dwelling plants can be directly in contact with the mineral, while in a less steep, soil-covered setting the influence of a thin band would be so diluted it would have very little impact on soil chemistry. The outcrops at the northern end of the park show some calciphile vegetation, while in the central and southern portion of the park the outcrop vegetation generally indicates acidic substrate.

Wild hydrangea (*Hydrangea arborescens*), calcareous substrate indicator

Pinxter-Flower (*Rhododendron periclymenoides*), acidic substrate indicator

1.5 SOILS

Soil types vary according to topographic position (USGS 1981). The lowest topographic positions, along the floodplains of major stream channels, have Newark silt loam soils. Gilpin, Weikert, and Culleoka channery silt loam (a map unit including several undifferentiated types) found on lower slopes, often adjacent to the Newark silt loams of the floodplains. Dormont Silt Loams are another major soil type in the park, found on lower to mid-slope positions, adjacent to and upslope of the Gilpin-Weikert-Culleoka type. Culleoka channery silt loams and Culleoka-Weikert channery silt loams are found on upper slopes and ridgetops.

Soil Testing at Harrison Hills Park

Successional communities are extensive in the park across a variety of topographic settings, and found on all of the park's major soil types. Interpreting the association between soils and natural communities, with the exception of successional communities in strip mined areas, should be approached with caution. In this setting, natural communities are more likely associated with disturbance history, aspect, and slope, rather than soil types.

1.6 NEW ADDITIONS TO THE LANDSCAPE AT HARRISON HILLS PARK

We observed two species in the natural landscapes of Harrison Hills Park which are somewhat ambiguouural, and should be watched to determine if they show invasive characteristics.

American holly (*Ilex opaca*):


American holly (*Ilex opaca*)

American holly is a species that is native to eastern North America, historically present to south of our region in West Virginia. It is also sold in the horticultural trade. The American Holly Association, the stock sold in nurseries is straight-species selections; material was collected from the wild somewhere it its range, and it has not been bred for desired characteristics. Horticultural plantings have led to the species being ubiquitously present, although not in great numbers, in Pennsylvania cities and suburbs

American holly has also been documented to be naturally moving north, likely due to the effects of climate change (Zhu, Woodall, and Clark 2012). The berries are consumed by American Robins, a species which can actually move north during the winter at times due to its highly weather-responsive movements. At forest plots that have been monitored for several decades, American holly seedlings and saplings are now present where they were not present before. This is the same pattern we see in the forests of Harrison Hills Park; scattered seedlings and saplings are now present, but were not historically present. However, as Harrison Hills Park is in close proximity to residential areas, it is unknown whether these seedlings are growing from seeds produced by landscape plantings or by wild populations further south.

Ecological factors also favor American holly; it is fire-sensitive, and fire has been ubiquitously suppressed for decades. It is resistant to deer browse, unlike many other tree species that are unable to regenerate due to browse pressure. In some portions of eastern Maryland and southeastern Pennsylvania,

this combination of factors has led to the development of American holly understories in forests which may historically have had none or much less of this species. Over time, if the same pattern occurs in Western Pennsylvania, we may eventually want to manage its growth to create balance with other species.

Cockspur hawthorn (*Crataegus persimilis "prunifolia"*)

Cockspur hawthorn (*Crataegus persimilis "prunifolia")* was observed to be somewhat common in an early successional forested area of the park. The identification of these plants is tentative; hawthorns are very difficult to ID, and there is no comprehensive source for cultivated material. Much like American holly, although less well-known, *Crataegus persimilis* is a species native to eastern North America that has also been cultivated and sold in the horticultural industry. The native species has a broad geographic distribution, but only occurs sporadically within it; it is known from Ohio, but not from Pennsylvania (Flora of North America). The horticultural cultivar "prunifolia" has bright red autumn fruits, attractive orange autumn foliage, and smooth bark. While it is plausible that *Crataegus persimilis* could be native in Pennsylvania, the plants growing in Harrison Hills Park are thornless, and such attractive specimens it seems more likely that they are escaped from horticultural plantings.

Cockspur hawthorn (*Crataegus persimilis "prunifolia"*)

Hawthorns have wildlife value and are certainly preferable to the invasive shrub and vine species that are presently growing alongside the cockspur hawthorn in the early successional forest setting where it was observed. It is most likely that no action is needed in regards to this species. However, it is worth monitoring to see how aggressively it grows and spreads. Unlike American holly, it is not ubiquitously present in our region, and could possibly be eradicated should control be deemed desirable due to invasiveness.

1.7 CONSERVATIVE PLANT SPECIES OF HARRISON HILLS PARK

The following table lists plant species found in Harrison Hills Park that require intact natural habitats with little disturbance. The "Coefficient of Conservatism" (C-Value) is a rating developed to estimate how strongly a plant requires such a habitat; a species rated "10" will almost never be found outside of a very intact natural habitat, while a species rated "1" can easily colonize disturbed areas. The presence of species rated "5" or above can serve as a guide to indicate good quality natural habitats (Swink and Wilhelm 1994). They are also important conservation targets because many of the species rated "6" or above generally re-establish extremely slowly once lost (this is especially true for herbaceous species, less so for woody species).

Some natural habitats depend on natural disturbances, such as floodplains or fire. Although species that inhabit these ecosystems generally have low coefficients of conservatism, this does not diminish their ecological importance.

Harrison Hills Park has a typical number of conservative plant species (102) in comparison with other Allegheny County Parks, in part because of the diversity of habitats in the park with mature native plant communities. Wetlands, cliffs, and forest communities each host their own set of conservative plants. The number of forest species is somewhat lower than other parks, as the mature forest communities have been heavily overbrowsed.

Scientific Name	**Common Name**	**Growth Form**	**C-Value**
Asplenium trichomanes	maidenhair spleenwort	herb	10
Polypodium virginianum	Common polypody	herb	10
Campanula rotundifolia	Harebell	herb	9
Carex albursina	Sedge	herb	8
Carex platyphylla	Broad-leaf sedge	herb	8
Carex prasina	Sedge	herb	8
Gaylussacia baccata	Black huckleberry	herb	8
Trillium grandiflorum	Large-flowered trillium	herb	8
Allium tricoccum	Ramp	herb	7
Arabis laevigata	Smooth rockcress	herb	7
Aralia nudicaulis	Wild sarsaparilla	herb	7
Asarum canadense	Wild ginger	herb	7
Cardamine bulbosa	Bittercress	herb	7
Cardamine diphylla	Two-leaved toothwort	herb	7
Carex communis	Sedge	herb	7

Scientific Name	**Common Name**	**Growth Form**	**C-Value**
Carex laxiculmis	Sedge	herb	7
Carex leptonervia	Sedge	herb	7
Caulophyllum giganteum	Early blue cohosh	herb	7
Chelone glabra	Turtlehead	herb	7
Claytonia caroliniana	Carolina spring-beauty	herb	7
Deparia acrostichoides	Silvery glade fern	herb	7
Dicentra sp.	Dutchman's breeches	herb	7
Juglans cinerea	Butternut	tree	7
Lysimachia terrestris	Swamp-candles	herb	7
Medeola virginiana	Indian cucumber-root	herb	7
Ostrya virginiana	Hop-hornbeam	tree	7
Polygonatum biflorum	N/A	herb	7
Quercus montana	Chestnut oak	tree	7
Silene virginica	Fire pink	herb	7
Solidago flexicaulis	Zigzag goldenrod	herb	7
Staphylea trifolia	Bladdernut	shrub	7
Tilia americana	American basswood	tree	7
Trillium erectum	Red trillium	herb	7
Acer saccharum	Sugar maple	tree	6
Amelanchier arborea	Shadbush	tree	6
Apios americana	Ground-nut	herb	6
Aquilegia canadensis	Wild columbine	herb	6
Cardamine pensylvanica	Pennsylvania bittercress	herb	6
Carex gracillima	Sedge	herb	6
Carpinus caroliniana	Hornbeam	tree	6
Carya glabra	Pignut hickory	tree	6
Carya ovalis	Red hickory	tree	6
Carya ovata	Shagbark hickory	tree	6
Carya tomentosa	Mockernut hickory	tree	6
Dryopteris marginalis	Marginal wood fern	herb	6
Fagus grandifolia	American beech	tree	6
Heuchera americana	Alum-root	herb	6
Hydrangea arborescens	Sevenbark	shrub	6
Hydrocotyle umbellata	Water pennywort	herb	6
Hydrophyllum virginianum	Virginia waterleaf	herb	6

Scientific Name	**Common Name**	**Growth Form**	**C-Value**
Nyssa sylvatica	Sourgum	tree	6
Osmunda claytoniana	Interrupted fern	herb	6
Oxalis violacea	Violet wood-sorrel	herb	6
Packera obovata	Ragwort	herb	6
Polygonatum pubescens	Solomon's-seal	herb	6
Quercus alba	White oak	tree	6
Quercus rubra	Northern red oak	tree	6
Quercus velutina	Black oak	tree	6
Rhododendron periclymenoides	Pinxter-flower	shrub	6
Rosa carolina	Pasture rose	shrub	6
Sambucus racemosa 'pubens'	Red-berried elder	shrub	6
Sedum ternatum	Wild stonecrop	herb	6
Silene stellata	Starry campion	herb	6
Solidago caesia	Bluestem goldenrod	herb	6
Symphyotrichum lateriflorum	Calico aster	herb	6
Thalictrum thalictroides	Rue anemone	herb	6
Vaccinium pallidum	Lowbush blueberry	shrub	6
Vaccinium stamineum	Deerberry	shrub	6
Viburnum acerifolium	Maple-leaved viburnum	shrub	6
Alnus serrulata	Smooth alder	shrub	5
Arisaema triphyllum	Jack-in-the-pulpit	herb	5
Athyrium filix-femina	lady fern	herb	5
Betula lenta	Black birch	tree	5
Boehmeria cylindrica	False nettle	herb	5
Botrychium virginianum	Rattlesnake fern	herb	5
Cardamine concatenata	Toothwort	herb	5
Carex pensylvanica	Sedge	herb	5
Claytonia virginica	Spring-beauty	herb	5
Corylus americana	American filbert	shrub	5
Dryopteris intermedia	Evergreen wood-fern	herb	5
Eurybia divaricata	White wood aster	herb	5
Floerkea proserpinacoides	False-mermaid	herb	5
Galium triflorum	bedstraw	herb	5

Scientific Name	**Common Name**	**Growth Form**	**C-Value**
Geranium maculatum	Wood geranium	herb	5
Hamamelis virginiana	Witch-hazel	shrub	5
Laportea canadensis	Wood-nettle	herb	5
Lindera benzoin	Spicebush	herb	5
Liriodendron tulipifera	Tuliptree	tree	5
Luzula multiflora	Field woodrush	herb	5
Lysimachia quadrifolia	Whorled loosestrife	herb	5
Maianthemum racemosum	False solomon's-seal	herb	5
Mimulus sp.	Monkeyflower	herb	5
Osmorhiza sp.	Wild licorice	herb	5
Platanus occidentalis	Sycamore	tree	5
Podophyllum peltatum	Mayapple	herb	5
Polystichum acrostichoides	Christmas fern	herb	5
Prunus virginiana	Choke cherry	tree	5
Sanguinaria canadensis	Bloodroot	herb	5
Symplocarpus foetidus	Skunk cabbage	herb	5
Thelypteris noveboracensis	New York fern	herb	5
Ulmus americana	American elm	tree	5
Vaccinium angustifolium	Low sweet blueberry	shrub	5
Viola cucullata	Blue marsh violet	herb	5

Pinxter Flower (*Rhododendron periclymenoides)*

Virginia waterleaf (*Hydrophyllum virginianum*)

Wild hydrangea (*Hydrangea arborescens*)

1.8 RARE SPECIES AT HARRISON HILLS PARK

The park contains several populations of plant species that are rare in the state or region. Conservation of these species should be a management priority. All of these species are found only in calcareous soils.

Ramps *(Allium tricoccum, Allium sp.)*:

Ramps (*Allium tricoccum*)

Ramps are a conservative species of rich mesic forest habitats; they are also an edible plant with great cultural significance in Appalachia. In recent years, culinary use of ramps has become more widespread, and harvesting for sale at farmers' markets and to restaurants has increased. However, the plant grows fairly slowly, requiring 7 years to reach flowering maturity from seed. Although this species can sometime be found growing very abundantly in large patches, research (Rock et al 2004) has shown that only very modest harvesting is sustainable: 10% of the population every ten years (i.e, with 9 years in between for recovery). This species is listed on the PNHP Watch List because of its cultural value and concern about overharvesting.

Although our Pennsylvania ramps have generally been viewed as a single species in the past (*Allium tricoccum*), research on populations further south has shown that there may actually be several distinct species. Local researchers are currently undertaking genetic and ecological studies of Pennsylvania ramps to determine what species we have and where they are distributed within the state. The plants observed in Harrison Hills Park fit the classic form of *Allium tricoccum.*

Management Recommendations:

- The population in Harrison Hills Park is small in size, and it is near heavily used trails; harvest pressure could be a significant threat.
- Post generic signs in the park to encourage users to take only photographs and leave only footprints and to convey the message that harvesting any plant materials is not sustainable in a park with a large number of public users.
- The main other threat to this species is the expansion of invasive plant species in the stream ravine where it grows; see recommendations for stewardship of the Rachel Carson Run Good Ecological Integrity Area.

Paw paw *(Asimina triloba)*:

The paw paw is a forest understory tree that produces a tasty fruit. It has long been part of Native American diets and highly esteemed in rural Appalachia. It reaches the northern extent of its geographic range in Pennsylvania, becoming very scarce in the northern half of the state. It also indicates fairly rich, often calcareous soils. In the southern half of Pennsylvania, it is somewhat limited by relative scarcity of such habitats in good condition, but not so uncommon as to be legally listed. Ecologically, conditions appear to favor the expansion of paw paw; it is deer resistant (where many other species are limited by browse pressure), it is fire-sensitive but fire suppression is widespread, and climate change may be expanding the range of climatically appropriate habitat northwards.

Paw paw (*Asimina triloba*)

Human-assisted propagation may also be increasing due to a recent uptick in interest in this species. Paw paw forms clonal stands which may all be a single genetic individual; however, they are not self-pollinating. Multiple genetic individuals must be present for fruit to set, and conversion of flowers to fruit can be naturally low even under those conditions. Male flowers sometimes occur on separate trees from female flowers, although plants can switch from producing one type of flower to the other, or produce both; in that case they are still not self-pollinating, though.

Management Recommendations:

- Observe trees to determine if they are setting fruit. If they are not, introduction of another genetic individual may facilitate fruit set.
- Paw paw are deer resistant due to the presence of bitter compounds in leaves and bark, and do not need special protection from browse.

Butternut (*Juglans cinerea*):


Butternut (*Juglans cinerea*)

The butternut, or white walnut, is a tree species related to the black walnut. It has declined greatly over the last several decades because of a butternut canker, a disease caused by an introduced fungus, and is now fairly rare. While the butternut was never extremely common, it had a regular presence in forests across a broad range of North America. "For over two centuries, North American butternut (*Juglans cinerea L.*) was cherished for its exceptional wood properties and was sought after for the manufacture of fine furniture, musical instruments, and boats (Woeste & Pijut, 2009).

The species was also valued for its sweet, oily nuts that were desired by both Native Americans and European settlers and are also a source of large mast utilized by various wildlife species"(Morin et al. 2017). Research into butternut conservation is ongoing, and suggests that there may be some degree of natural resistance to the fungal disease. Furthermore, butternut reproduction is inhibited in some settings because it requires open conditions with little competition to establish. One butternut tree was observed in a mesic ravine in Harrison Hills Park.

Management recommendations:

- Surviving trees should not be cut down, even if they have signs of disease. The disease may infect resistant trees without killing them; death occurs when the disease causes girdling, and if the tree can contain the infection to prevent this from occurring it will survive even with damage. Exposure is likely already ubiquitous as the pathogen produces abundant spores distributed by wind (Parks et al. 2013).
- Investigate the potential to use resistant butternut (cuttings or seeds from surviving trees) in canopy gap restoration. Habitat requirements are fairly similar to white ash, which has recently died en masse and left canopy gaps that need active attention to prevent further forest decline.

Some research indicates that comparatively higher, drier sites may enhance survival of butternut (Morin et al. 2017); while surviving trees are most often observed in floodplains in our areas, mesic upland sites should be considered for potential restoration attempts.

Bladdernut *(Staphylea trifolia)*:

Bladdernut is a native shrub with affinity for calcareous soils. It is on the PNHP Watch List as an indicator of mesic calcareous forest habitat, often found on floodplains and lower slopes. In Harrison Hills Park, one shrub was found along a mesic ravine in the park, and several shrubs were found along the Allegheny River outcrops.

Bladdernut (*Staphylea trifolia*)

Management recommendations:

- Consider augmenting the ravine population with seed source from the river outcrop populations, as a single individual does not provide good genetic viability even if it were able to reproduce.

1.9 PLANT COMMUNITY TYPES AT HARRISON HILLS PARK

Community types are assigned using the Pennsylvania Natural Heritage Program's plant community classification system and the U.S. National Vegetation Classification. When possible, community types were assigned using the Pennsylvania Natural Heritage Program's plant community classification system (PNHP 2018). In certain situations, we utilized the National Vegetation Classification (USNVC 2018) if a similar, but more accurate community type was available for natural or successional communities at Harrison Hills Park. There were many successional areas that were not easily classified by the Pennsylvania or Natureserve classifications, and are closely associated with disturbance history; these were separated by age and canopy cover in the "Successional Communities" section, but we did not attempt to further subdivide them based on species composition.

1.9.1 Terrestrial Communities

Western Allegheny Dry - Mesic Oak - Hardwood Forest (CEGL002059)

This forest type is found in mid-slope positions on non-calcareous substrates. Stands are dominated by white oak (*Quercus alba*), red oak (*Quercus rubra*), and sugar maple (*Acer saccharum*). Chestnut oak (*Quercus montana*) is often present and occasionally codominant. Other minor associates include red maple (*Acer rubrum*), shagbark hickory (*Carya ovata*), American beech (*Fagus grandifolia*), Tuliptree (*Liriodendron tulipifera*), and black gum (*Nyssa sylvatica*). The shrub and small-tree layer includes shadbush (*Amelanchier arborea*), American hornbeam (*Carpinus caroliniana*), American hazelnut (*Corylus americana*), flowering dogwood (*Cornus florida*), and American hop-hornbeam (*Ostrya virginiana*). Heath shrubs may be uncommon. The herbaceous layer includes a range of dry-mesic to mesic herbs. See the descriptions for the Good Ecological Integrity areas Upper Rachel Carson Run and Lower Rachel Carson Run for more detail.

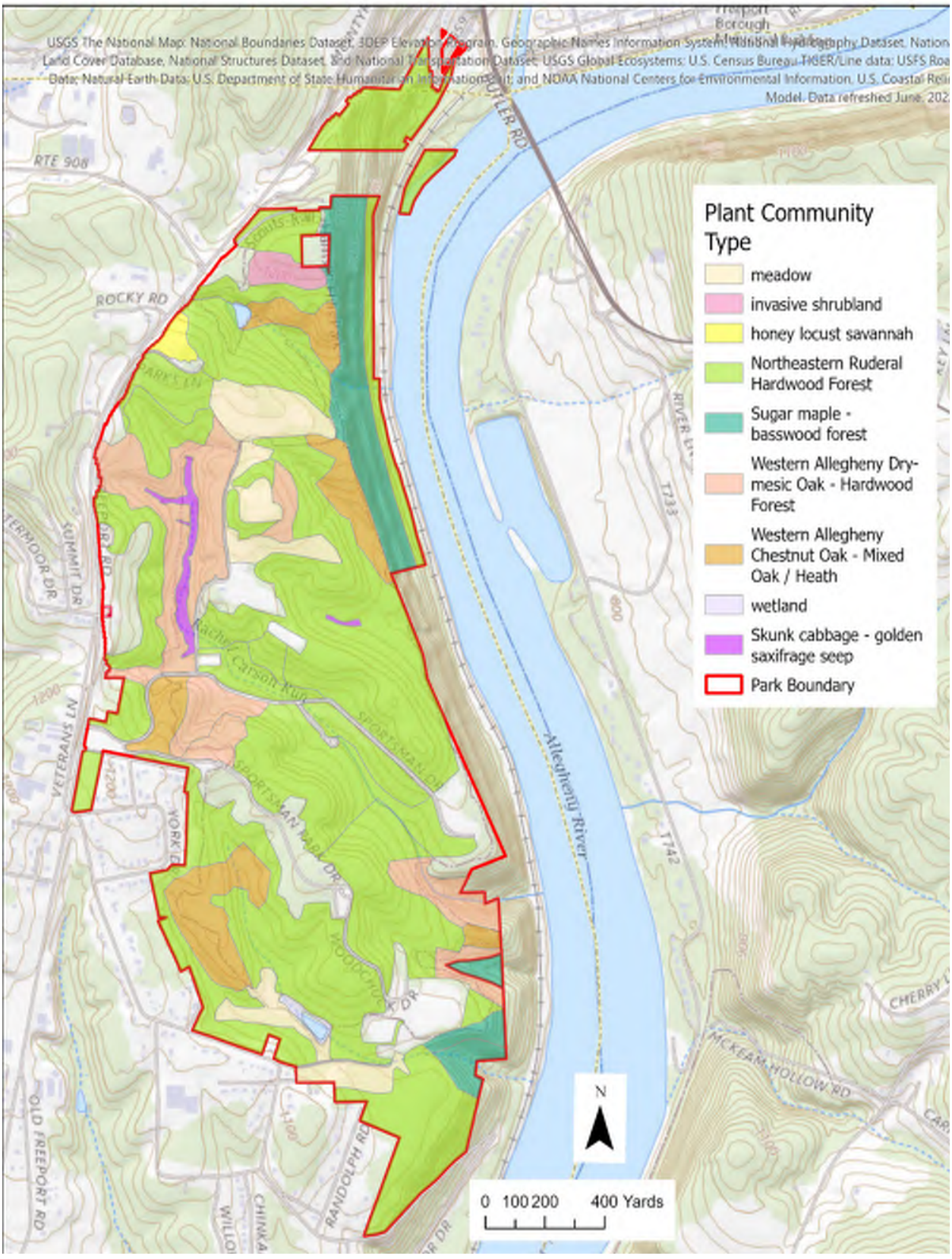
Western Allegheny Chestnut Oak – Mixed Oak / Heath Forest (CEGL005023)

This type is found on the driest settings in the park, the uppermost slopes and hilltops. It is differentiated from the dry – mesic oak – hardwood forest by having more chestnut oak and black oak in the canopy, more heath shrubs (blueberry, huckleberry, and azalea species), and generally lacking mesic herbs. In Harrison Hills, the herb layers were extremely sparse in these communities, but they were also very little invaded as of yet. See the Good Ecological Integrity Area “Southern Oak Forest” for more detail.

Sugar Maple - Basswood Forest

This type was documented in the most mesic forested settings I the park, stream ravines and on the slope above the Allegheny River. The canopy typically is dominated by sugar maple, with basswood also present. Typically, this community has a fairly rich herbaceous layer, although this is diminished in many examples by disturbance or deer browse. The examples in Harrison Hills Park have much lower diversity than expected and very small populations of perennial, long-lived species such as Trillium, wild ginger, and waterleaf species. See descriptions of the following Good Ecological Integrity areas: Allegheny Slope, Middle Tributary, and Southern Tributary.

Plant Community Types



1.9.2 Palustrine Communities

Skunk Cabbage - Golden Saxifrage Seep

This wetland type occurs in small patches along stream and tributary floodplains or mid-slope seepage areas, often nested within Sugar maple – mixed hardwood floodplain forest or another mesic upland forest type. It provides valuable habitat for amphibians, insects, and burrowing crayfish.

Wetland

The area around the southern pond is a zoned wetland that contains several different types in units too small to map at the scale of the whole park. There is an arrowleaf zone, a cattail zone, a spatterdock zone (open water), and a zone of mixed herbaceous marsh species.

1.9.3 Successional Communities

Northeastern Ruderal Hardwood Forest (CEGL006599)

Occurs on mesic to dry-mesic sites that are becoming reforested after having been cleared for agriculture or otherwise heavily modified in the past. Physiognomy of this vegetation is highly variable, ranging from closed forest, open forest, tall dense shrubland, to more open tall shrubland. Early-successional woody species dominate the canopy in a widely variable mix, depending on geographic location. In Harrison Hills Park, most of these forests are dominated by black cherry with red maple; tuliptree, sassafrass, red oak, and sugar maple are all mixed in occasionally, sometimes more dominant in local patches. These forests range in age from fairly mature to quite young and early successional. The younger forests often have incomplete canopy closure.

The shrub layer is dominated by spicebush, or by non-native invasive shrubs, most commonly Amur honeysuckle (*Lonicera maackii*) but also multiflora rose (*Rosa multiflora)*, and privet (*Ligustrum sp.*).

The herbaceous layer is variable, often containing grasses and forbs of both native and non-native origin, but it typically lacks diversity and conservative species. Common species include white snakeroot (*Ageratina altissima var. altissima*), jewelweed (*Impatiens capensis*), jumpseed (*Persicaria virginiana*), Jack-in-the-pulpit (*Arisaema triphyllum*). The invasive species garlic mustard (*Alliaria petiolate*) and Japanese stiltgrass (*Microstegium vimineum*) can be abundant. Vines can be absent or abundant. In stands with high vine cover, the vegetation structure can be altered by the weight of the vines pulling down trees and shrubs. Common vines include Virginia creeper (*Parthenocissus quinquefolia*), poison ivy (*Toxicodendron radicans*), wild grape (*Vitis labrusca*),

and the invasive vines oriental bittersweet (*Celastrus orbiculatus*) and Japanese honeysuckle (*Lonicera japonica*). It is unlikely that these stands will develop into a natural plant community dominated by native species, without restoration work.

Invasive Shrubland

These are areas dominated entirely by non-native invasive shrub species, forming a tall shrub canopy. Autumn olive, Amur honeysuckle, and privet are the most common species.

Honey Locust Savannah

One area had a scattered canopy of mature honey locust trees, with invasive shrub species and herbaceous growth between trees.

1.10 ECOLOGICAL INTEGRITY MAPPING

In Harrison Hills Park, the most ecologically intact communities are found in the stream valleys and adjacent steep slopes, as these areas were difficult to log or farm in the past and retained natural plant communities. Most of the more mature forested areas are oak-dominated communities on dry, acidic soils; these tend to be dramatically less invaded than the younger, post-agricultural forests. However, most of the mature forested areas have very low diversity in the herbaceous layer compared to what would be expected. This is likely due to long term overbrowsing by deer.

Compared to many other county parks, a large part of the park is forested. Slightly less than half of the forest is good quality, while the remainder is modified successional forest. No areas of "best quality" were found. However, stewardship efforts can restore "good" areas to "best" quality. Ways to improve ecological quality and restore ecosystem functions include:

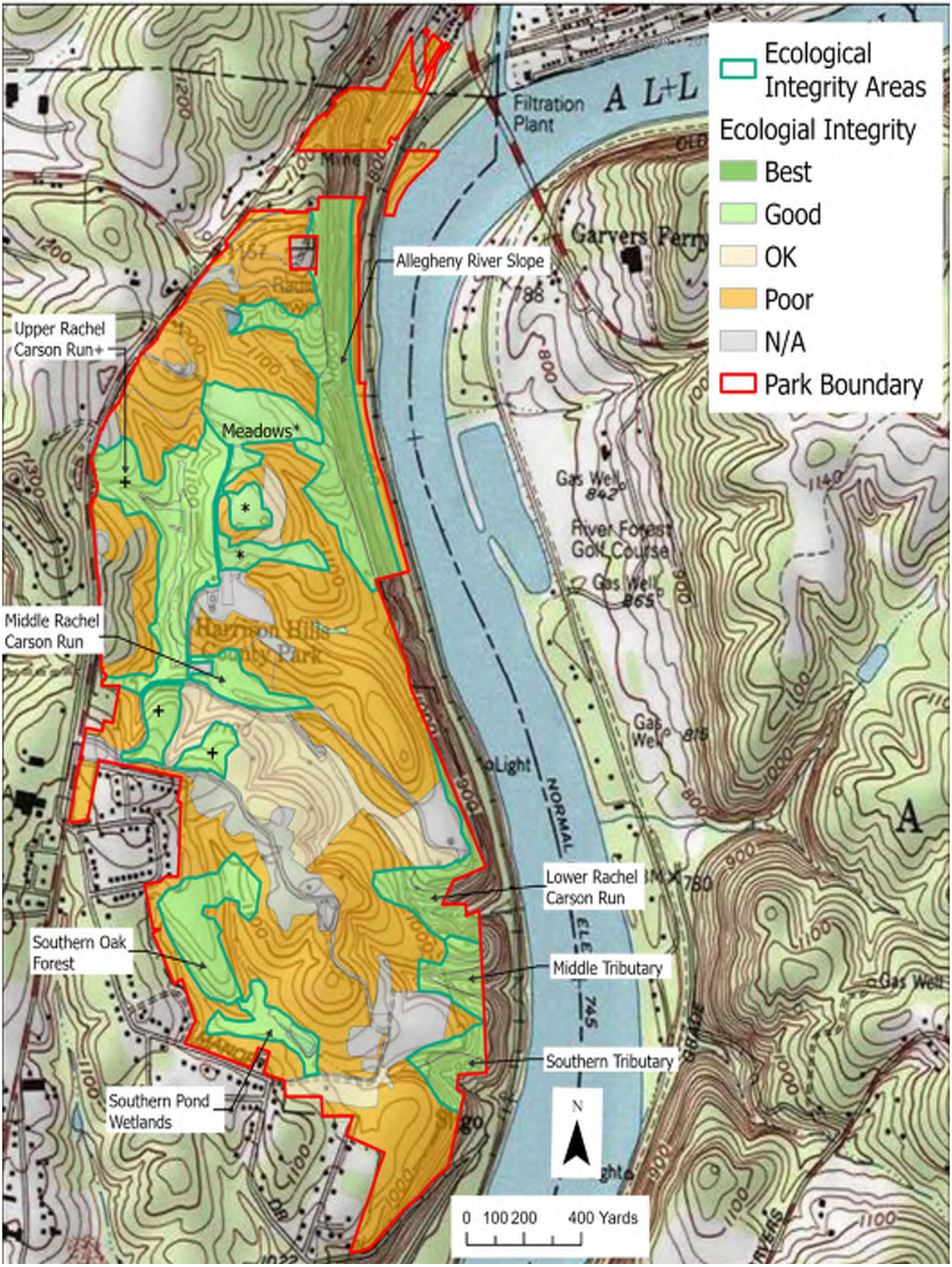
- Controlling invasive species
- Employing deer management strategies to preserve native plant populations and allow them to regenerate.
- Reintroducing ecologically appropriate native plant species that have been severely reduced or lost through restoration plantings.
- Monitoring and managing canopy gaps as needed.

All of these stewardship tasks are further detailed in the Project Recommendations section **(page 60).**

We have highlighted the areas with the greatest ecological integrity and diversity by mapping areas as "best", "good", "OK" and "poor" quality natural communities.

- **"Best Quality"** – These areas have mature plant communities with species diversity as good as or better than is typical for an intact example of the community type in our region, including more "conservative" species that require intact forest habitat and do not re-establish quickly after disturbance. These species have special conservation value, because they are difficult to re-establish once lost. They can also provide seed and propagule stock for restoration efforts elsewhere in the park, if they are managed to develop healthy populations and sustainably harvested. These areas also currently have low presence of invasive species, and should be monitored and managed to prevent the establishment and spread of invasive species.

Ecological Integrity Areas



- **"Good Quality" –** These are areas that have medium-aged to mature plant communities, with species diversity that is somewhat lower than expected for a reference example of the community type. "Conservative" species are less common or absent in these areas. Exotic species may be present but native species are dominant. Restoration of greater species diversity should be considered through movement of seed propagules from "best quality" examples of similar community types in the park. Invasive species management may also be needed in these areas.

- **"OK Quality"** – these are areas that have some elements of native natural communities, such as a native tree canopy that is fairly intact, or a meadow that includes a significant proportion of native species, but are also significantly disturbed and/or invaded.

- **"Poor Quality"** – these are areas that have early successional plant communities with low diversity of native plants; species tend to be non-conservative, i.e. those that can colonize disturbed habitats easily, and exotic invasive plants are common. These areas will require intensive management to restore ecological quality and allow them to proceed on a natural successional path to develop a mature native plant community. The primary difficulty is the need to manage invasive species so that natives can establish and mature; propagule introduction may also eventually be needed to restore more conservative species.

1.10.1 Best Quality Areas

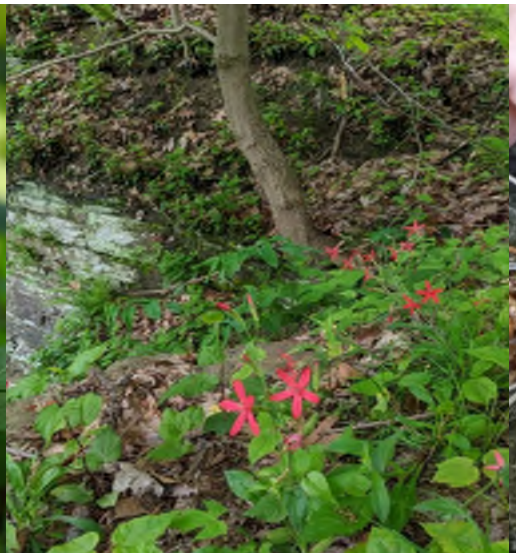
No areas meeting the definition of "best" quality ecological integrity were found within the park.

1.10.2 Good Quality Areas

Meadows:
Several meadow areas are mown infrequently and host a range of early successional native species and old field / hayfield non-native species. These provide habitat to bird species and other animals that require open, early successional conditions. The primary management issues are managing invasive species and improving the proportion of meadow species which are native. Native species provide greater habitat value. Invasive shrubs, including autumn olive (*Elaeagnus umbellata*) and privet (*Ligustrum sp.*) are scattered in the meadow matrix. Herbaceous invasive species are infrequently present; there is a substantial stand of the mugwort in one of the meadows.
Native species in the northern meadows include wrinkle-leaf goldenrod (*Solidago rugosa*), Canada goldenrod (*Solidago canadensis*), dogbane (*Apocynum sp.*), and deer-tongue grass (*Dichanthelium clandestinum*).

Allegheny River Slope:

Carolina Rose
(*Rosa caroliniana*)



Fire Pink (*Silene virginica*) & Maidenhair Spleenwort
(*Asplenium sp.)*

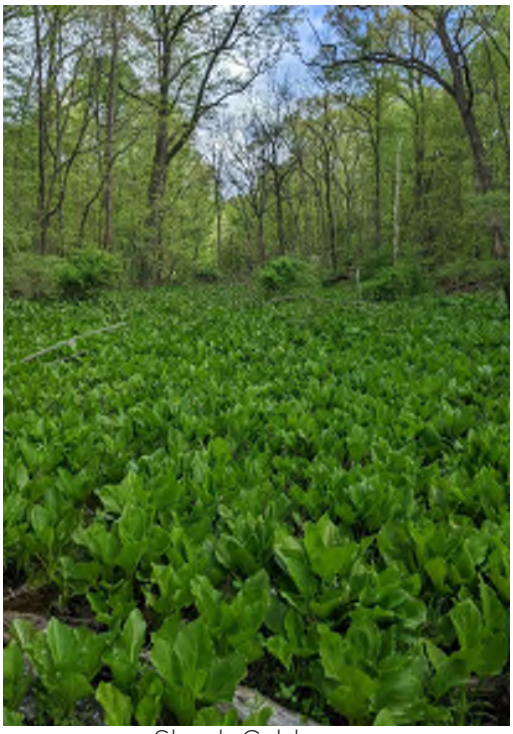
The steep slope above the Allegheny River has mature forest, due to the impracticality of logging in such a setting. The slope cuts through many geological layers; in some areas, the flora indicates calcareous influence, while in other areas it suggests acidic chemistry. The forest canopy varies correspondingly, with more sugar maple and basswood present in high pH areas, and more oak species, hickories, and black birch present in the acidic areas.

Rock outcroppings are present in the northern half of the slope; these host several unique plant species, in part due to the unusual substrate and in part because it is an area inaccessible to deer, which have browsed out plant diversity in most of the rest of the park. Calcareous outcroppings have indicator species including wild columbine (*Aquilegia canadensis*), wild hydrangea (*Hydrangea arborescens*), bluestem goldenrod (*Solidago caesia*), zigzag goldenrod (*Solidago flexicaulis*), Solomon's seal (*Polygonatum biflorum*), red elderberry (*Sambucus pubens*), bladdernut (*Staphylea trifolia*) and maidenhair spleenwort (*Asplenium trichomanes*). Acidic areas have indicators such as pinxter-flower (*Rhododendron periclymenoides*), marginal wood fern (*Dryopteris marginalis*), poverty grass (*Danthonia compressa*), lowbush blueberry (*Vaccinium pallidum*), fire pink (*Silene virginica*) and Carolina rose (*Rosa caroliniana*). The outcrops have some invasive species present, including garlic mustard (*Alliaria petiolata*) and narrowleaf bittercress (*Cardamine impatiens*).

Management Recommendations:

- This area requires very little management as it is inaccessible to foot traffic. Invasive control, to the extent possible, is always beneficial.

Upper Rachel Carson Run:
The upper portion of Rachel Carson Run has a fairly broad floodplain with wetland areas; the "wetland trail" runs along the stream here. The broad, seepage-fed wetlands are dominated by skunk cabbage in some places, but include a diverse assemblage of seep and floodplain wetland species. Many small seepage-fed tributaries emerge along the slope and feed into the main channel, each including a small, shaded seepage wetland area. The forests immediately surrounding the stream are mature and oak-dominated, often gaining a xeric character fairly quickly out of the banks of the stream. The more mesic areas are red oak mixed hardwood forest communities, and the drier areas on slopes are Allegheny oak forest. Beyond the zone of mature forest is younger, more invaded forest that is successional in character, dominated by black cherry and tuliptree (*Liriodendron tulipifera*).


Skunk Cabbage
(*Symplocarpus foetidus*)

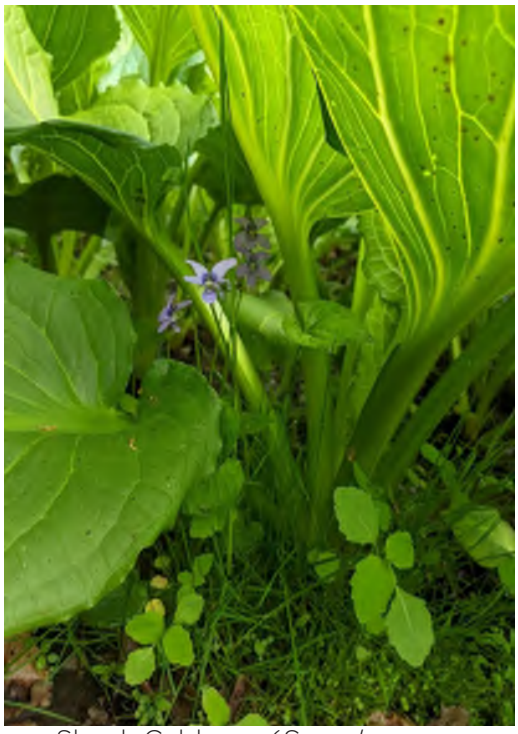
Oak Forest Species:
Black oak (*Quercus velutina*), white oak (*Quercus alba*), northern red oak (*Quercus rubra*), chestnut oak (*Quercus montana*), black birch (*Betula lenta*), sassafras (*Sassafras albidum*), shadbush (*Amelanchier arborea*), shagbark hickory (*Carya ovata*), black cherry (*Prunus serotina*), red maple (*Acer rubrum*), hawthorn (*Crataegus*), flowering dogwood (*Cornus florida*), witch-hazel (*Hamamelis virginiana*), maple-leaved viburnum (*Viburnum acerifolium*), lowbush blueberry (*Vaccinium pallidum*), pinxter-flower (*Rhododendron periclymenoides*), rue-anemone (*Thalictrum thalictroides*), bluets (*Houstonia caerulea*), sedge (*Carex pensylvanica*), mayapple (*Podophyllum peltatum*), Christmas fern (*Polystichum acrostichoides*), intermediate wood fern (*Dryopteris intermedia*), wild geranium (*Geranium maculatum*), smooth yellow violet (*Viola eriocarpa*), sedge (*Carex pensylvanica*), a dichanthelium (*Dichanthelium clandestinum or boscii*), Solomon's-seal (*Polygonatum pubescens)*, bluets (*Houstonia caerulea*), polytrichum moss (*Polytrichum*), hay-scented fern (Dennstaedtia punctilobula), starry campion (Silene stellata), red sedge (*Carex communis*), white wood aster (*Eurybia divaricata*), field woodrush (*Luzula multiflora)*, bluestem goldenrod (*Solidago caesia*), fire pink (*Silene virginica*), smooth rockcress (*Arabis laevigata*), marginal wood fern (*Dryopteris marginalis*), New York fern (*Thelypteris noveboracensis*), violet wood-sorrel (*Oxalis violacea*), Japanese stiltgrass (*Microstegium vimineum*), white wood aster (*Eurybia divaricata*), false Solomon's-seal (*Maianthemum racemosum*).

The invasive non-native species are present, at low to moderate levels: Morrow's honeysuckle (*Lonicera morrowii*), narrow-leaved bittercress *Cardamine impatiens*), Japanese barberry (*Berberis thunbergii*), and Japanese stiltgrass (*Microstegium vimineum*).

Oak Forest in Upper Rachel Carson Run

Wetland Species:
Skunk-cabbage (*Symplocarpus foetidus*), sedge (*Carex prasina*), Pennsylvania bittercress (*Cardamine pensylvanica*), a buttercup species (*Ranunculus*), turtlehead (*Chelone glabra*), jewelweed (*Impatiens*), soft rush (*Juncus effusus*), blue marsh violet (*Viola cucullata*), small-flowered crowfoot (*Ranunculus abortivus*), monkeyflower (*Mimulus*), sensitive fern (*Onoclea sensibilis*), spring cress (*Cardamine bulbosa*), field horsetail (*Equisetum arvense*), buttercup (*Ranunculus hispidus*), New York fern (*Thelypteris noveboracensis*), ragwort (*Packera obovata*), sedge (*Carex prasina*), lady fern (*Athyrium filix-femina*), lesser stitchwort (*Stellaria graminea*), blue marsh violet (*Viola cucullata*), cleavers (*Galium aparine*), wrinkle-leaf goldenrod (*Solidago rugosa*), a lily species (*Lilium*).

Some portions of the wetland are predominantly native species, while others have a moderately high fraction of non-native invasive cover; however, no areas are yet dominated by invasives.The following non-native invasive species are present in the wetland areas: Japanese stiltgrass (*Microstegium vimineum*), Iris (*Iris*), reed canary-grass (*Phalaris arundinacea*), autumn-olive (*Elaeagnus umbellata*), multiflora rose (*Rosa multiflora*), garlic-mustard (*Alliaria petiolata*), privet (*Ligustrum*), Japanese knotweed is also present in some seepage wetlands.



Skunk Cabbage (*Symplocarpus foetidus*), Jewelweed (*Impatiens*), & Blue Marsh Violet (*Viola Cucullata*)

Management Recommendations:

- Control the Japanese knotweed patches that have established in this area. This species will form a dense monoculture, displacing all other native species and greatly reducing the habitat value for native birds, amphibians, and even white-tailed deer. See project recommendations section for more detail on potential control methods.
- Control of other invasive species will also be beneficial to the long-term viability of the native ecosystem.
    - Remove invasive shrubs (Japanese barberry, introduced honeysuckles, privet, multiflora rose).
    - Monitor wetland herbaceous invasive species (reed canarygrass, Japanese stiltgrass, introduced Iris) and if they are expanding, pursue wetland-safe treatments.

Lower Rachel Carson Run

This area has the most mature and majestic forest community in the park. The forest is oak-dominated, but the center of the ravine also has small populations of mesic wildflower species. Canopy species include northern red oak (*Quercus rubra*), chestnut oak (*Quercus montana*), black birch (*Betula lenta*), sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), black cherry (*Prunus serotina*). Shrub species include American filbert (*Corylus americana*), lowbush blueberry (*Vaccinium pallidum*), black huckleberry (*Gaylussacia baccata*), witch-hazel (*Hamamelis virginiana*), choke cherry (*Prunus virginiana*), and spicebush (*Lindera benzoin*).


Lower Rachel Carson Run Forest

Herbaceous species include: Indian cucumber-root (*Medeola virginiana*), mayapple (*Podophyllum peltatum*), New York fern (*Thelypteris noveboracensis*), Solomon's-seal (*Polygonatum biflorum*), fire pink (*Silene virginica*), large-flowered trillium (*Trillium grandiflorum*), Solomon's-seal (*Polygonatum pubescens),* yellow fumewort (*Corydalis flavula*), Virginia spring-beauty (*Claytonia virginica*), small-flowered crowfoot (*Ranunculus abortivus*), cleavers (*Galium aparine*), false Solomon's-seal (*Maianthemum racemosum*), wakerobin (*Trillium erectum*), Carolina spring-beauty (*Claytonia caroliniana*), wild hydrangea (*Hydrangea arborescens*), jewelweed (*Impatiens*), intermediate wood fern (*Dryopteris intermedia*), and licorice root or sweet cicily (*Osmorhiza sp.*)

Management Recommendations:

- See "Project recommendations" section for recommendations for this area.

Middle Tributary

This ravine has sugar maple-basswood forest in the mesic central portion, and oak forests on the upper slopes. While some conservative wildflower species are present in the ravine, their populations are very small, likely due to deer browse. Invasive species are moderately prevalent. Restoration efforts will be needed to maintain the ecological integrity of this area.


Red Trillium (*Trillium erectum*) in middle ravine.

Canopy species include: basswood (*Tilia americana*), sugar maple (*Acer saccharum*), northern red oak (*Quercus rubra*), black birch (*Betula lenta*), and hop-hornbeam (*Ostrya virginiana*).

Herbaceous species include: mayapple (*Podophyllum peltatum*), Christmas fern (*Polystichum acrostichoides*), New York fern (*Thelypteris noveboracensis*), wakerobin (*Trillium erectum*), silvery glade fern (*Deparia acrostichoides*), bittercress (*Cardamine pensylvanica*), Jack-in-the-pulpit (*Arisaema triphyllum*), smooth yellow violet (*Viola eriocarpa*), Dutchman's breeches (*Dicentra*), cutleaf toothwort (*Cardamine concatenata*), two-leaved toothwort (*Cardamine diphylla*), garlic-mustard (*Alliaria petiolata*), large-flowered trillium (*Trillium grandiflorum*), waterleaf (*Hydrophyllum*), Solomon's-seal (*Polygonatum pubescens*), narrow-leaved bittercress (*Cardamine impatiens*).

Management Recommendations:

- Control invasive non-native species
- Control or exclude white-tailed deer. The conservative, long-lived native wildflowers in this species list have very small populations and are at the edge of viability. Without protection from deer browse, they will likely be lost.

Southern Pond Wetlands

The southernmost tributary in the park is dammed into a pond. The pond has a nice complex of zoned wetlands around it, including a diverse suite of native species. Alder shrubs grow around the edge, transitioning to emergent vegetation including arrowhead (*Saggitaria latifolia*) and cattails (*Typha latifolia*), with spatterdock (*Nuphar advena*) on the open water. The structural and floristic diversity creates habitat for a wide variety of amphibians, birds, small mammals, and invertebrates, including dragonflies, butterflies, and moths.

Meadow Area surrounding pond.

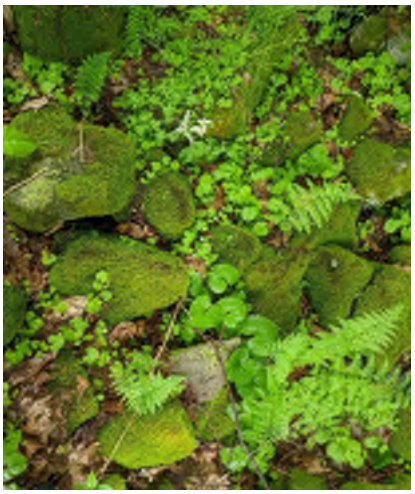
The meadow area surrounding the southern pond is the most diverse of the park's meadows, and with wetter soils the species mix includes some facultative wetland species. Species include: grass-leaved goldenrod (*Euthamia graminifolia*), deer-tongue grass (*Dichanthelium clandestinum*), autumn-olive (*Elaeagnus umbellata*), wrinkle-leaf goldenrod (*Solidago rugosa*), calico aster (*Symphyotrichum lateriflorum*), Queen Anne's-lace (*Daucus carota*), steeplebush (*Spiraea tomentosa*), purpletop (*Tridens flavus*), butterfly-weed (*Asclepias tuberosa*), southern agrimony (*Agrimonia parviflora*), Canada goldenrod (*Solidago canadensis*), Indian-hemp (*Apocynum cannabinum*), and Pennsylvania blackberry (*Rubus pensilvanicus*).

Management Recommendations:

- Monitor for invasive species and remove pioneer individuals promptly.
- Remove the scattered invasive shrubs in the meadow area.
- If spatterdock cover increases to a point of interfering with other uses, mechanical harvest can be used to reduce the cover somewhat. Total eradication is not ecologically desirable as the species provides habitat.

Southern Tributary Ravine

This ravine has sugar maple-basswood forest in the mesic central portion, and oak forests on the upper slopes. While some conservative wildflower species are present in the ravine, their populations are very small, likely due to deer browse. Invasive species are moderately prevalent. Restoration efforts will be needed to maintain the ecological integrity of this area.



Wild Ginger (Asarum canadense) & Wood Fern (*Dryopteris intermedia*)

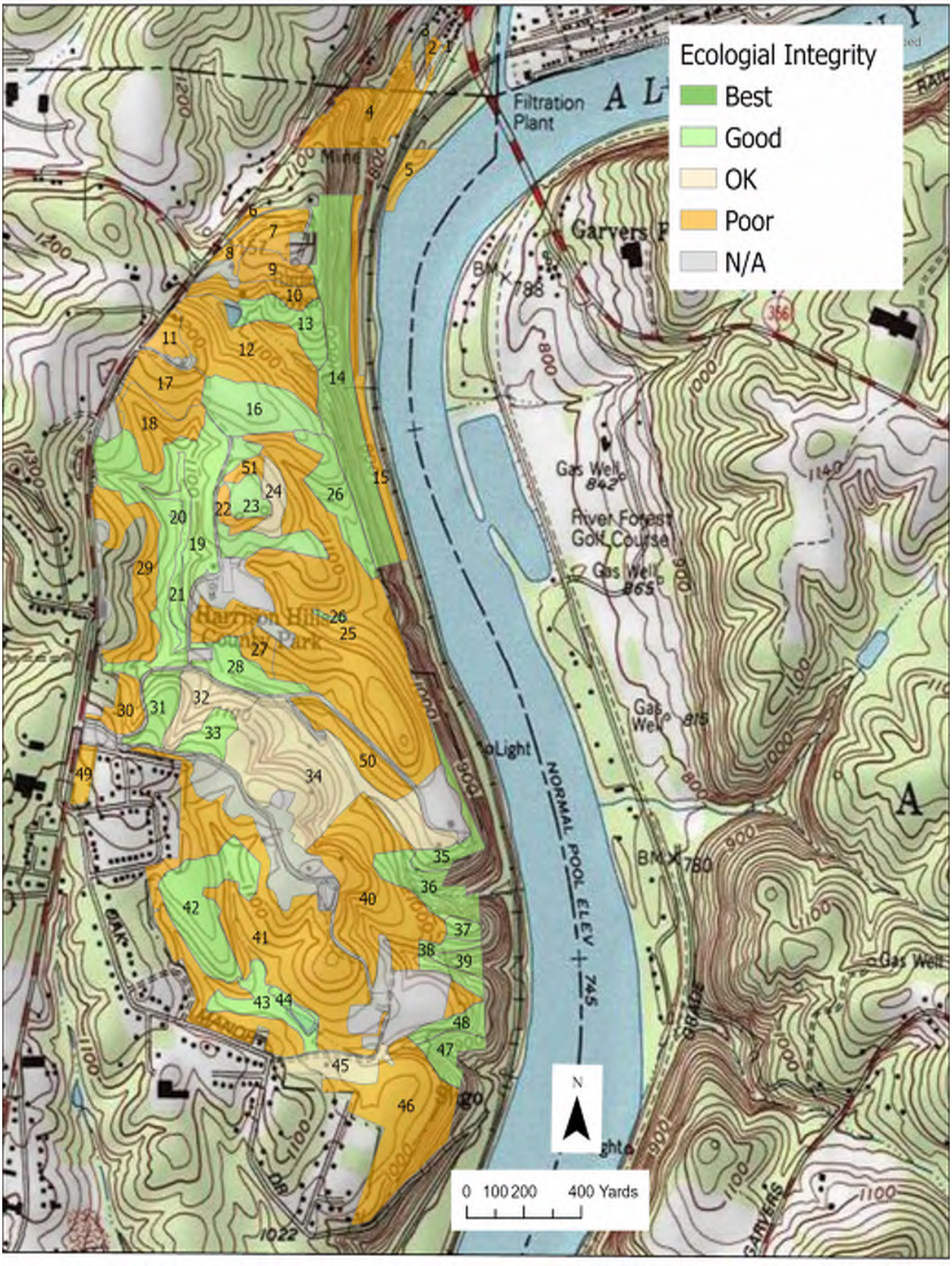
Canopy species include sugar maple (*Acer saccharum*), basswood (*Tilia americana*), and black birch (*Betula lenta*). The shrub layer is dominated by spicebush (*Lindera benzoin*). Herbaceous species include intermediate wood fern (*Dryopteris intermedia*), mayapple (*Podophyllum peltatum*), hay-scented fern (*Dennstaedtia punctilobula*), enchanter's nightshade (*Circaea canadensis*), Jack-in-the-pulpit (*Arisaema triphyllum*), Christmas fern (*Polystichum acrostichoides*), wakerobin (*Trillium erectum*), large-flowered trillium (*Trillium grandiflorum*), wood nettle (*Laportea canadensis*), skunk-cabbage (*Symplocarpus foetidus*), jewelweed (*Impatiens*), silvery glade fern (*Deparia acrostichoides*), wild stonecrop (*Sedum ternatum*), wild-ginger (*Asarum canadense*), sedge (*Carex albursina*), bristly greenbriar (*Smilax hispidus*), violet wood sorrel (*Oxalis violacea*), and red elder (*Sambucus pubens*). Two butternut (*Juglans cinerea*) trees were also observed in this ravine.

The non-native invasive species garlic-mustard (*Alliaria petiolata*) and narrowleaf bittercress were present.

Management Recommendations:

- Control invasive non-native species
- Control or exclude white-tailed deer. The conservative, long-lived native wildflowers in this species list have very small populations and are at the edge of viability. Without protection from deer browse, they will likely be lost.

Reference IDs for Poor and OK Ecological Integrity Areas



Southern Oak Forest

This slope is a forest community that is relatively uninvaded and dominated by native species. The canopy is almost entirely black oak in the southern end, with other oak species, red maple, black birch and sassafras in the northern end. Scattered shrubs include lowbush blueberry (*Vaccinium pallidum*) and huckleberry (*Gaylussacia baccata*).

Southern Oak Forest in Harrison Hills Park

1.10.3 “OK” & “Poor” Ecological Areas:

Descriptions are provided for these areas in the table below, per community type unit. IDs are shown on the map above, and the information in the table corresponds to the IDs.

ID	Composition	Plant Community	Integrity
24	Modified successional forest dominated by scarlet oak, red oak, and tuliptree; significant presence of invasie shrubs. Rated “OK” due to native canopy.	Western Allegheny Dry-mesic Oak - Hardwood Forest	OK
32	Typed as Allegheny oak hardwoods, but more mesic than area to west, dominated by black cherry and red oak, with occassional other species. A gradual transition between the more intact community to west and more successional community to east. Mature trees, some large. Some areas dominated by Japanese stiltgrass cover. Shrub cover is abundant spicebush in most areas.	Western Allegheny Dry-mesic Oak - Hardwood Forest	OK
34	Mature forest of Northern Hardwoods Ruderal Forest canopy composition. Black cherry is dominant. Red maple, red oak, red hickory (Carya ovalis) are occasional. Tall, dense shrub layer of spicebush. Japanese barberry common. Herb layer dominated by Japanese stiltgrass and New York fern. Rated “OK” quality because of mature forest canopy with slightly better diversity, mostly native shrub layer.	Northeastern Ruderal Hardwood Forest	OK
45	Meadow	Meadow	OK
1	Black cherry modified successional forest with tall shrub layer of Amur honeysuckle.	Northeastern Ruderal Hardwood Forest	Poor
2	Black cherry modified successional forest	Northeastern Ruderal Hardwood Forest	Poor
3	Shrubland on small area between streets.	Too small to type.	Poor
4	Mesic floodplain species on lower slope (sycamore, hackberry, silver maple, black walnut); also very disturbed, with Japanese knotweed common. Upper slope mainly black birch and somewhat less disturbed.	Northeastern Ruderal Hardwood Forest	Poor
5	Modified successional forest at edge of Allegheny River.	Northeastern Ruderal Hardwood Forest	Poor
6	Black cherry dominated Northern Hardwoods Ruderal Forest, with tall shrub layer of Amur honeysuckle. Some bigtooth aspen, dead ash. Invasive shrub dominant, also some hawthorn. Japanese stiltgrass in herb layer.	Northeastern Ruderal Hardwood Forest	Poor

ID	Composition	Plant Community	Integrity
7	Black cherry dominated Northern Hardwoods Ruderal Forest, with tall shrub layer of Amur honeysuckle. Some bigtooth aspen, dead ash. Invasive shrub dominant, also some hawthorn. Japanese stiltgrass in herb layer.	Northeastern Ruderal Hardwood Forest	Poor
8	Black cherry dominated Northern Hardwoods Ruderal Forest, with tall shrub layer of Amur honeysuckle. Some bigtooth aspen, dead ash. Invasive shrub dominant, also some hawthorn. Japanese stiltgrass in herb layer.	Northeastern Ruderal Hardwood Forest	Poor
9	Dense cover of invasive tall shrubs, mainly autumn olive and Amur honeysuckle. Japanese stiltgrass in herb layer, scattered mile-a-minute.	invasive shrubland	Poor
10	Black cherry modified successional forest with tall shrub layer of Amur honeysuckle.	Northeastern Ruderal Hardwood Forest	Poor
11	Honey locust savannah with invasive shrub.	honey locust savannah (local type)	Poor
12	Black cherry dominated Northern Hardwoods Ruderal successional forest with tall shrub layer of Amur honeysuckle. Some openings with Japanese stiltgrass, deer tongue grass (native), mile-a-minute.	Northeastern Ruderal Hardwood Forest	Poor
15	Lower slope above Allegheny River is forested, but more disturbed than upper slope. More invasive species. Bordered on east edge by railroad track.	Northeastern Ruderal Hardwood Forest	Poor
17	Young thin canopy in many areas, but with some larger tuliptree. Mainly invasive shrub and stiltgrass.	Northeastern Ruderal Hardwood Forest	Poor
18	Black cherry dominated Northeastern Ruderal Hardwood Forest with tall shrub layer of Amur honeysuckle. Also Japanese stiltgrass and some mile-a-minute.	Northeastern Ruderal Hardwood Forest	Poor
22	Modified successional forest, invaded.	Northeastern Ruderal Hardwood Forest	Poor
25	Successional forest, with black cherry and tuliptree variably dominant; Bitternut hickory, red oak, red maple, and sassafras are common to occasional. Tall shrub cover varies between Amur honeysuckle and native spicebush, with multiflora rose in some areas. Canopy cover ranges from 60% to closed canopy. Japanese stiltgrass is common to abundant. Other species include: garlic mustard, bedstraw (Galium aparine), enchanter's nightshade, Japanese stiltgrass, wild grape (Vitis sp), and poison ivy. A few American basswood and sugar maple are present at south end.	Northeastern Ruderal Hardwood Forest	Poor

ID	Composition	Plant Community	Integrity
27	black cherry modified successional forest	Northeastern Ruderal Hardwood Forest	Poor
29	Black cherry dominated successional forest with tall shrub layer of Amur honeysuckle and multiflora rose. Occasional red oak, tree-of-heaven.	Northeastern Ruderal Hardwood Forest	Poor
30	Black cherry dominated modified successional forest.	Northeastern Ruderal Hardwood Forest	Poor
40	Black cherry dominated mature modified successional forest. Open canopy 60%-70%. Bitternut hickory and sassafras are occassional. Abundant Japanese stiltgrass and mile-a-minute, lots of oriental bittersweet. Tall spice bush shrub canopy but lots of dieback. Includes old bottle dump area; dumping ~100 years old, forest vegetation, leaf litter, and soil are now thoroughly intermingled with old waste. Northern end densely shrubby with spicebush and Japanese barberry, Japanese stiltgrass.	Northeastern Ruderal Hardwood Forest	Poor
41	Successional forest. Canopy cover 60-80% with black cherry, sassafras, black oak, red oak, red maple. Trees range from young to mature. Shrub layer is dominated by invasive shrubs, in some areas and native spicebush in other areas. Japanese stiltgrass is abundant. Ravine is more open and invaded then adjacent slopes. Southeastern corner has Hhemlocks; some have been treated. Also planted spruces in decline.	Northeastern Ruderal Hardwood Forest	Poor
46	Black cherry dominated modified successional forest, with shrub cover of invasive species and native spicebush.	Northeastern Ruderal Hardwood Forest	Poor
49	Black cherry dominated modified successional forest.	Northeastern Ruderal Hardwood Forest	Poor
50	Black cherry dominated successional forest, with some red maple; trees range from small and young to moderate sized mature, some semi-open grown. 30-60% canopy. Open areas have spicebush, hawthorn, abundant Japanese stiltgrass, New York fern.	Northeastern Ruderal Hardwood Forest	Poor
51	Dominated by non-native invasive shrubs.	Northeastern Ruderal Hardwood Forest	Poor

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2.1 COMMUNITY FORESTRY PROJECT RECOMMENDATIONS

2.1.1 Sportsman Park Drive Shelters

The WPC Forester observed widespread tree decline within the maintained areas adjacent to Sportsman Park Drive. Many of the trees growing in close proximity to the Baneberry, Wake Robin, Walnut, Laurel and Rachel Carson shelters are presenting hazards due to dead branches, canopy decline and root decay. The primary tree species in these is locations is black cherry (*Prunus serotina*) with smaller populations of other species, including red maple (*Acer rubrum*), black locust (*Robinia pseudoacacia*), Ash (*Fraxinus sp.*) and Hickory (*Carya sp.*).

While disease and fungal decay are occurring within the trees currently, the initial cause of this tree decline is a prolonged history of mower damage to the lower trunk and root system. The repeated removal of outer tree tissue and the creation of exposed wounds result in consistent pathways for tree pests and diseases to infest the tree. Furthermore, the blades of the mowers can transport disease from one tree to another. The stress of from weakened root systems and disease can then compound with heat, drought, or storm damage to cause tree failure.

Trees presenting hazards along Sportsman Park Drive

The following photos highlight the described damage to tree roots from lawnmowers at the Sportsman Park Drive Shelters.

2.1.2 Recommended Species for Tree Planting:

Trees provide an incredible amount of benefits to park visitors and the surrounding community. Therefore it is highly recommended that new tree plantings should be planned for replacing any hazardous tree removals. The cooling shade cast by these trees allows playground equipment and benches to be usable during hot weather, lengthens the life of asphalt on roads and parking areas, and creates a more attractive setting for jogging and dog walking. A list of suggested tree species for replanting is provided below.

Common Name	***Scientific Name***
Redbud	*Cercis canadensis*
Hackberry	*Celtis occidentalis*
Ginkgo	*Ginkgo biloba*
Kentucky Coffeetree	*Gymnocladus dioicus*
Dawn Redwood	*Metasequoia glyptostroboides*
Black Tupelo	*Nyssa sylvatica*
Hophornbeam	*Ostrya virginiana*
Eastern White Pine	*Pinus strobus*
Swamp White Oak	*Quercus bicolor*
Chinkapin Oak	*Quercus muehlenbergii*

Depending on how many trees are designated to be removed by County Parks staff, it is estimated that as many as 60 trees could be replanted within these landscaped areas. The trees could be clustered in key locations that would maximize shade for playgrounds, benches and parking areas.

The estimated cost for a standard two-inch caliper balled and burlapped tree, along with expenses for delivery and supplementary planting materials such as bark guards, arbortie, stakes and mulch is $275/tree. Therefore the maximum recommendation of replacement tree plantings would cost up to $16,500.

Root and trunk damage can be easily avoided by maintaining a mulch ring around every landscaped tree within a mowed area. An excellent example of this practice is already being demonstrated within Harrison Hills Park near the Yakaon Shelter.

Many tree service companies have difficulty finding inexpensive local areas to dispose of wood chips. The County Parks staff could consider developing a relationship with nearby companies to acquire chippings. Tree mulching activities are appropriate for a wide range of ages and experience. The County Parks staff could then annually host volunteer community engagement events to spread mulch around landscaped trees. This methodology could be applied to any location within the County Parks system

2.1.3 Tree Species to Avoid Planting

All of the following tree species are not recommended for planting due to serious pest or disease issues:

Common Name	***Scientific Name***	**Disease**
Beech	*Fagus spp.*	Beech Leaf Disease
Spruce	*Picea spp.*	Needlecast / Canker
Ash	*Fraxinus spp.*	Emerald Ash Borer
Hemlock	*Tsuga spp.*	Hemlock Woolly Adelgid
Walnut	*Juglans spp.*	Thousand Canker Disease
Flowering Dogwood	*Cornus florida*	Anthracnose
Northern Red Oak	*Quercus rubra*	Oak Wilt Disease
Pin Oak	*Quercus palustris*	Oak Wilt Disease
Shingle Oak	Quercus imbricaria	Oak Wilt Disease

2.1.4 Canopy Gap Forest Restoration: Equestrian Showjumping Site

A large rectangular canopy gap that is approximately 0.75 acres in area exists just within the forested area to the southeast of the Yakoan park shelter and parking area. WPC staff noticed this unique site prior to fieldwork during their preliminary review of current and historical map images. They readily surmised that the site had been developed for some form of past human use due to its shape as a nearly symmetrical rectangle. Information regarding the history of this site was discussed during a meeting with staff from Harrison Hills Park and the Allegheny County Parks Foundation. The Harrison Hills Park Manager confirmed that this area was previously used as an outdoor event enclosure for equestrian showjumping.

Equestrian Canopy Gap at Harrison Hills Park

The highly compacted nature of the ground has significantly limited the growth of vegetation at this site. While it is surrounded by concentrated area of early to mid-successional forest, the majority of the site has persisted as predominately open space. A few clusters of young American sycamore (*Platanus occidentalis*) have colonized in this gap, along with a few species of small herbaceous plants. Thick swaths of American sweetgum (*Liquidambar styraciflua*) line the southern edge.

Much of the shrub and herbaceous layers surrounding this site contain high populations of invasive species. Privet (*Ligustrum sp.*) and honeysuckle (*Lonicera sp.*) are common throughout the forest to the north, while thick carpets of mile-a-minute (*Persicaria perfoliata*) are overspreading much of the forest to the south.

Due to the significant threat posed by the adjacent invasive species, this large human-caused canopy gap would benefit from tree plantings. If left to its own recourse, the area is likely to become overspread by primarily nonnative vegetation. It is attractive to begin supplemental tree plantings in this area immediately because it currently contains very few invasive plants and therefore requires little site preparation.

Tree species should be chosen that can withstand a more compacted growing space and/or a neutral to alkaline soil pH. Outdoor equine event enclosures are often installed with several inches of crushed gravel or limestone, topped with a thick layer of course sand. These construction materials can raise the local soil pH above what would be common in an undisturbed forested landscape.

Forest Restoration at Former Equestrian Showjumping Area

The WPC Forester recommends using two-gallon containerized plant material. Each tree could be individually tubed or caged, or the entire space could be fenced. Because the site is a neat rectangle, it could be less expensive to enclose this entire gap for deer protection versus a more rounded or irregularly shaped site. A suggested list of tree species is provided below.

Common Name	***Scientific Name***
Northern Catalpa	*Catalpa speciosa*
Eastern Redbud	*Cercis canadensis*
Hackberry	*Celtis occidentalis*
Hawthorn	*Crataegus sp*
Tuliptree	*Liriodendron tulipifera*
Crabapple	*Malus sp*
Aspen	*Populus tremuloides*
Bur Oak	*Quercus macrocarpa*
Chinkapin Oak	*Quercus muehlenbergii*

Equestrian Showjumping Site Canopy Gap Restoration Budget:

Material	**Quantity**	**Unit Cost**	**Total Cost**
Installation			
Trees (#2 Container)	300	$25.00	$7,500.00
Tree Tubes & Stakes (*not needed if using deer fence)	300	$7.50	$2,250.00*
Deer Fence: 8ft Woven Wir Fence w/ 12ft galvanized steel posts	1200	$6.00	$7,200.00
Deer Fence Gate	1	$500.00	$500
Signage	1	$500.00	$500
Screened Topsoil (cubic yards)	15	$40	$600
Total Installation Cost			$16,300-$18,500
Maintenance			
Annual Spot Maintenance of Invasive Plant regrowth	7	$1,500.00	$10,500.00
Total Cost			**$26,800 - $29,050**

2.2 NATURAL AREA RECOMMENDATIONS

Lower Rachel Carson Run Forest, a Good Ecological Integrity Area
within Harrison Hills Park

There is a great range of ecological stewardship needs within the park landscapes; however, we suggest two priorities.

- Steward "Best" and "Good" ecological integrity areas (**see pg. 30** for accounts of these areas in the park). Those areas that remain in good condition ecologically should be stewarded to remain in good condition.
- Protect populations of species that are regionally rare.

Both of these categories are prioritized because they are difficult to restore once lost, and because they are particularly significant to maintaining native biological diversity in our region. They serve as living repositories for native diversity.

Recommendations are provided below under headings for different categories of work. Within each category, general recommendations and specific project opportunities are listed. Opportunities to steward intact natural areas and rare species are emphasized.

2.2.1 Rare Species Management

For more background on individual species, see Rare Species of Harrison Hills Park, **pg. 22.**

Project Opportunities:

- Monitor ramps (*Allium tricoccum*) populations for signs of harvest. Ramps are a commercially valuable species vulnerable to overharvest because it reproduces relatively slowly.
- Post generic signs in the park to encourage users to take only photographs and leave only footprints and to convey the message that harvesting any plant materials is not sustainable in a park with a large number of public users. This can help protect a variety of long-lived, slow-to-regenerate native species that are attractive or commercially valuable.
- Observe paw paw (*Asimina triloba*) trees to determine if they are setting fruit. If they are not, introduction of another genetic individual may facilitate fruit set.
- Investigate the potential to use resistant butternut (cuttings or seeds from surviving trees) in canopy gap restoration. Habitat requirements are fairly similar to white ash, which has recently died en masse and left canopy gaps that need active attention to prevent further forest decline.
- Consider augmenting the ravine population of bladdernut (a single tree) with seed source from the river outcrop populations, as a single individual does not provide good genetic viability even if it were able to reproduce.

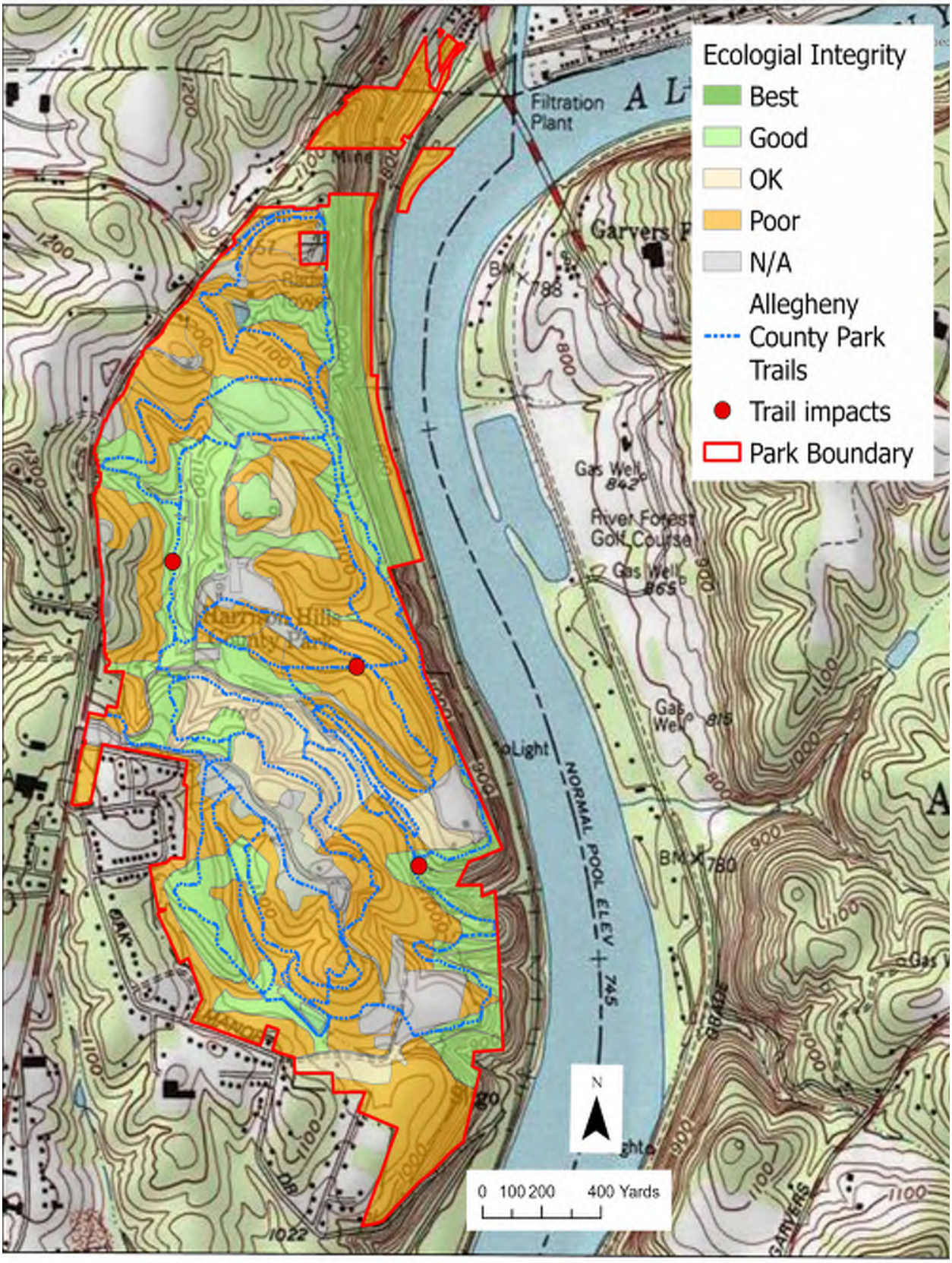
2.2.2 Trail Managament

Harrison Hills Park includes a segment of the Rachel Carson Trail, which sees very heavy use. Most other trails receive moderate use. Trail density is generally reasonable. In some areas, unauthorized trail proliferation should be limited. **Observed trail impacts are shown on page 54.**

General Recommendations:

- Follow best management practices to minimize trail impact on surrounding vegetation, topography, and erosion. We noted a few wet areas where trail damage was occurring.
- Professional assessment of the trail system can identify problem areas and recommend alternative solutions.
- Avoid routing trails near sensitive ecological features that would be vulnerable to poaching or damage from recreational exploration; this might include attractive rare flower species, delicate geological formations such as waterfalls, caves, or cliffs, etc. If trail routing cannot avoid such features, signage and physical barriers can help prevent damage to these features.

Trails and Trail Impacts



- From the perspective of ecological impact, the areas rated “OK” and “poor” ecological integrity are ideal for trail placement, and for more active uses. The majority of the informal forest trail network is currently in these areas.
- Minimize trail density in “best” and “good” ecological integrity areas; while some trail development is not incompatible with these areas and can create the benefit of developing public appreciation, dense networks of trails can erode the area available to native plants and wildlife.
    - Limit use to foot traffic in particularly sensitive areas, i.e those with steep slopes, abundant and diverse native vegetation, or wetland terrain.
    - In less-sensitive high ecological integrity areas, active use should be contingent on the user community’s ability to stay on existing trails and avoid unsanctioned trail proliferation.
    - Because horses can transport invasive species, horse use should be avoided in high ecological integrity areas.
    - At Harrison Hills, the heavily-used Rachel Carson trail and some other trails do pass through “good” ecological integrity areas. Trail damage is not ubiquitous, but a few damaged areas were observed.

Project Opportunities:

- Remediate trail damage at observed impact areas shown on the Map on **page 54.**
- The Lower Rachel Carson Run Ecological Integrity Area is a particularly important place to address trail issues, because off-trail traffic is impacting sensitive wildflower species (see southernmost trail impact point on **page 54**).

Trail Erosion on Green Trail

2.2.3 Canopy Gap Managament

General Recommendations:
Employ ecological forest restoration practices where canopy gaps develop within high quality forest. If left unmanaged, canopy gaps in high quality forest can become establishment sites for invasive non-native species that then expand outwards into adjacent forests, often causing further canopy loss and ecosystem destabilization. In most cases, even when canopy gaps occur from natural events such as treefall, native forest will not be able to re-establish without protection from deer browse and management of invasive species.

The goal of canopy gap restoration is to reforest relatively small areas where gaps have formed in native forest communities, to create a trajectory for re-establishment of native forest and improved forest integrity. A general project outline for canopy gap restoration is provide below; however, this should be adapted based on local site conditions. At some sites, deer fencing may be sufficient to encourage natural regrowth, while at others, invasive clearing, restoration planting, and deer protection may all be necessary.

The strategy is to first eradicate any existing invasive plant populations, then plant a suite of native trees, shrubs, and herbs that match the existing natural forest community, and will over time out-compete invasive plant species that could seed in, to restore a contiguous forest community.

Ongoing management will be needed at such sites to water new plantings, protect them from deer and small mammal herbivory, and to spot-treat any invasive plants that appear. Plantings may be designed in multiple phases. At first, establishing density and shade are most important; species that grow fast in gaps but do not persist long-term in shade may be used in this phase, possibly interspersed with slower-growing species. A second planting may be designed for a few years later once shade has been established, to introduce native forest species that are shade-tolerant, slower growing, and typical of the target forest community but unlikely to re-establish on their own.

In Harrison Hills Park, restoration planting species selection can be guided by the Natural Community map for the park (**page 27**) and the species composition in the associated plant community descriptions (**pages 28 - 29)**.

The New York City Park System's "Guidelines for Urban Forest Restoration" includes more detail about many aspects of restoration plantings, including how to control invasive plants, sizing and density of tree plantings, and examples of planting plans.

Project Phase	Cost Item	Timeframe
Site Preparation	Invasive species treatment	Year 1-2
First-stage Planting	Faster-growing trees & shrubs	Year 2 or 3 (if site requires invasive removal prior to planting)
	Herbivory protection	Planting years
Maintenance Costs	Watering	Years 1-? Following plantings
	Invasive monitoring and treatment	Years 2+
	Replanting any failures	Year following any plantings
Second stage Planting	Shade tolerant trees, shrubs, herbs	Years 7-10 depending on first stage growth
	(potential cost offset if local site materials are propagated in-house in time interval between stage 1 and 2)	
	Herbivory protection	Planting years

Project Opportunities:
The map on **page 59** shows canopy gaps noted during this study, overlaid on Ecological Integrity mapping (this should not be considered a comprehensive inventory of all gaps). Gap restoration in any of the good ecological integrity areas will help to preserve ecological quality and function in these areas.

Lower Rachel Carson Run Canopy Gap Restoration:
The Lower Rachel Carson Run "good" ecological integrity area contains some of the most mature forest in the park, with very large, magnificent trees. It also has small populations of conservative native wildflower species. It is a high priority area for canopy gap restoration to preserve the existing forest quality.

Several very large red oaks have recently died, creating canopy gaps. These gaps should be monitored for invasive species, to be removed if found, as the high-light conditions are very likely to attract invasive species. Restoration plantings may speed the recovery of a canopy and ensure that it is composed of native species. A small landslide area is noted on the map (**page 59**) and could also benefit from canopy-gap restoration techniques. Deer browse protection, either deployed locally around canopy gaps or in the form of a larger fence protecting the entire ravine, will greatly facilitate regeneration and protect restoration plantings.

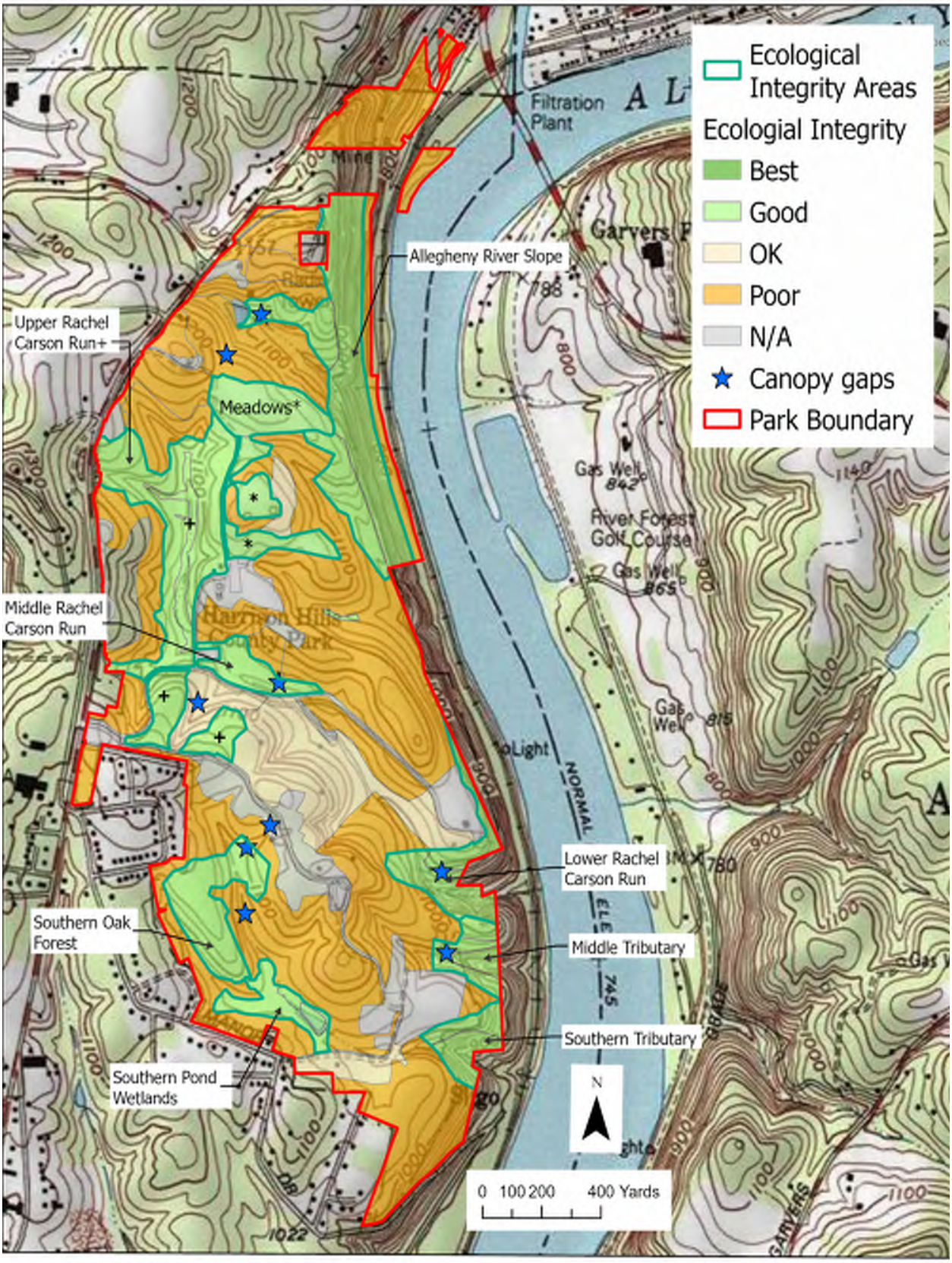
Lower Rachel Carson Ravine & Dead Red Oak creating a Light Gap.

Middle Rachel Carson Run Canopy Gap Restoration:
The canopy gap in this "good" ecological integrity area may be challenging to address because of the proximity of "poor" ecological integrity areas where the canopy is more open and invasive shrub and vine species are very common. Invasive species are fairly abundant in the gap, and the proximity of invasive seed source will make it challenging to keep invasives out of restoration efforts.

Middle Ravine Canopy Gap Restoration:
The canopy gap in this "good" ecological integrity area is on a lower slope within a mesic, higher pH community. It is near the transition zone between the Sugar Maple – Basswood Forest of the lower ravine and the Western Allegheny Dry-Mesic Oak Hardwood Forest of the mid- and upper slopes. Invasive species are currently present in the gap and would need to be removed as part of the restoration effort.

Allegheny River Slope and Southern Oak Forest
The canopy gaps mapped within these "good" integrity areas both fall within oak-dominated communities with very little herbaceous layer present. They are also in close proximity to "poor" ecological integrity areas with abundant invasive seed source present, but remediating the gaps will help stop the expansion of these areas into the "good" ecological integrity areas.

Canopy Gaps and Ecological Integrity Areas



2.2.4 Invasive Species Management

Because invasive species have established so extensively at this point that it is impossible to control or eradicate them in all areas, efforts must be strategically directed towards the areas where they will have the most impact. The highest management priorities are:

- Remove pioneer populations of invasive species
- Steward "Best" and "Good" Ecological Integrity Areas
- Manage invasive species in meadows & in areas recently removed from mowing or maintenance
- Manage Invasive species where they have particular impact on recreational or other park uses.

Each of these priorities is addressed under its own heading, below the General Recommendations.

General Recommendations for Invasive Control Efforts:

- Whenever control efforts are undertaken, plans should be included for subsequent revegetation, either through protection of natural seed source germination or through introduction of native plant materials consistent with the site and the surrounding natural communities.
- Restoration efforts will be most successful if time and resources are allocated for thorough invasive control before introduction of new plant materials. All restoration plans should also include long-term maintenance efforts to monitor and control invasive species while native vegetation is establishing.
- Many species commonly used in landscaping are highly invasive in natural settings, such as burning bush, privet, Japanese barberry, and Japanese silver-grass (*Miscanthus sinensis)*. All species introduced for horticultural purposes should be reviewed for invasiveness, and excluded if they are known to be invasive in similar climates or exhibit invasive tendencies.
- Take precautions to prevent accidental introduction of invasive species from equipment and the movement of materials. Earth moving equipment should always be cleaned between sites to prevent movement of seeds in dirt on tires or blades. Fill, compost, and soil moved from other areas can also be sources of invasive plant material; know the source, and vet it before use.
- Working with nearby landowners to remove invasive species reduces the flow of seed and propagules onto park land.
- Deer browse pressure makes natural areas more susceptible to the establishment of invasive species by creating bare soil areas and reducing competition from native species. Reducing deer browse pressure can strengthen the natural resilience of forest communities to invasion by non-native species.

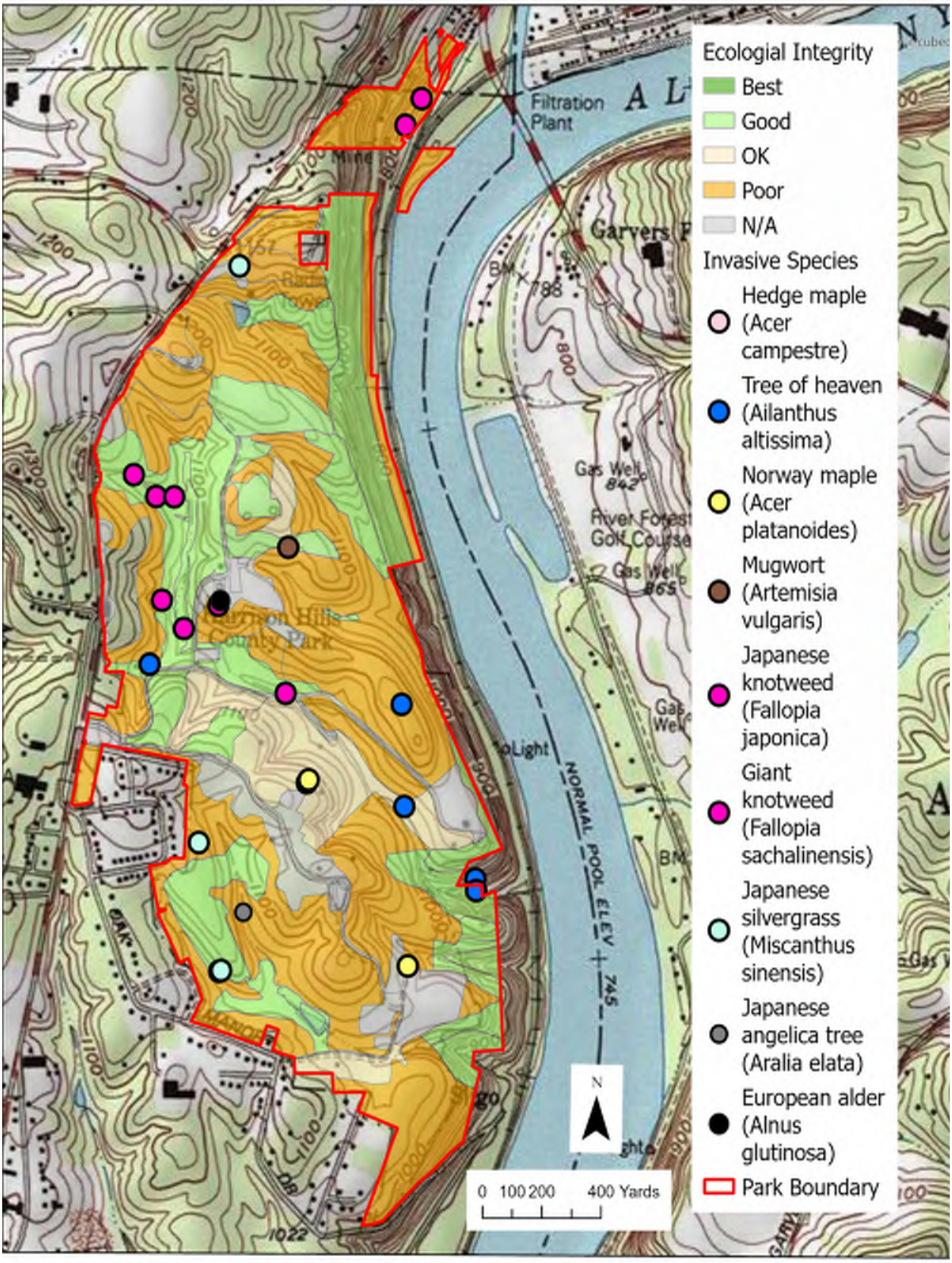
Pioneer Invasive Population Control
Most of the invasive species in Harrison Hills Park are widespread and well established. However, there are a few pioneer populations that can be controlled now to greatly save on future labor (**map - page 62**). For many of these species, there are only a few individuals present at this time. This list includes several species used in landscaping; if these species are in any landscape plantings in the park, they should be removed.

PROJECT OPPORTUNITIES:

Removal of Small Pioneer Populations:
Most of these removal projects are small, and can be undertaken by a staff member or trained volunteer. Knotweed removal will best be accomplished with a group of volunteers. Tree-of-heaven and mugwort may require herbicide use.

- **Hedge maple** (*Acer campestre)* is a species used in horticulture that can spread into natural settings.
- **Japanese silver-grass** (*Miscanthus sinensis*) – this species is commonly used in landscaping, and is now escaping into natural settings. It should not be used in landscaping within the park. Working with surrounding landowners to eliminate this species will reduce the seed source for new introductions into the park.
- **European alder** (*Alnus glutinosa)* – a single individual was observed. This species spreads rapidly in wetlands and is extremely difficult to eradicate once established.
- **Norway maple** (*Acer platanoides)* – this species forms dense stands that shade out all other growth on the forest floor. It can establish in shaded conditions. It is also allelopathic, chemically inhibiting the growth of other species of plant. At present, only a few individuals are in the park, and it is fairly easy to control through girdling or herbicide.
- **Mugwort** *(Artemesia vulgaris)* is a herbaceous species that forms dense stands, excluding other vegetation, in open field and meadow settings. This population is also mentioned in the recommendation for invasive control in meadows.
- **Japanese Angelica tree** (*Aralia elata)* is a tall, thorny plant that can form stands. Its fruit are spread by birds. It is very similar to a native species, devil's walking stick (Aralia spinosa); the ID has been confirmed in the mapped location, but any other potential locations should be confirmed by an expert before removal.
- **Tree of heaven** (*Ailanthus altissima*) has been included in the "very high priority" group of species because it is still uncommon in the park, and it is also the primary host of the spotted lanternfly, a new insect pest that has recently arrived in our area.

Pioneer Invasive Species Populations



Japanese Knotweed and Giant Knotweed removal in Upper Rachel Carson Run "Good" Ecological Integrity Area

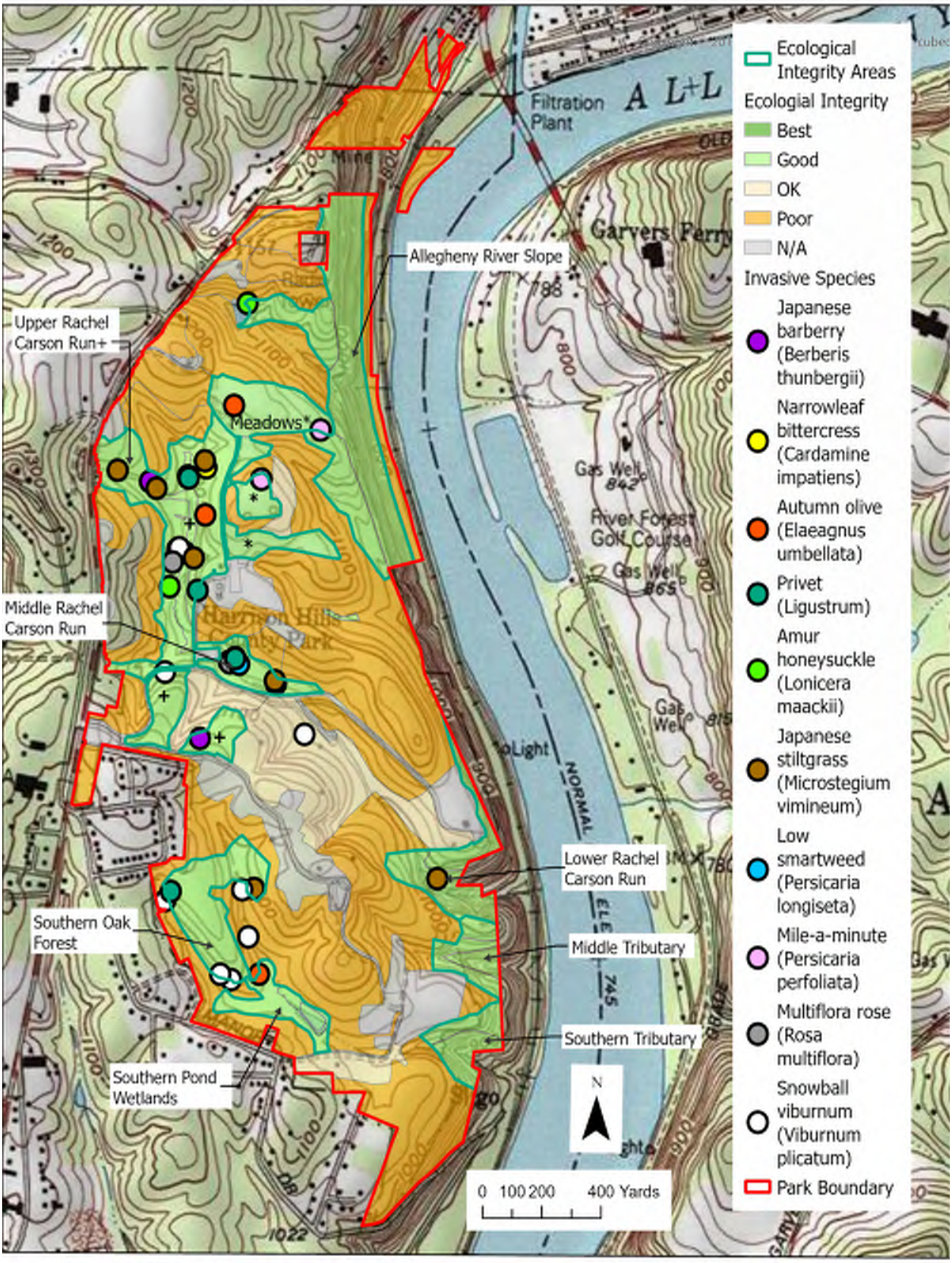
These two species are also included on the map of "pioneer" removal targets, although these species are more common than the other "pioneer" populations. They are still fairly uncommon in the park, and high priority due to the difficulty in removing them and the damage they cause. If left unchecked, will convert all floodplain and lower slope areas to a dense monoculture of knotweed, greatly reducing the natural biodiversity value of the park. Knotweed even reduces habitat for white-tailed deer, which do not eat it, by displacing other sources of food. Most of the areas Japanese knotweed was documented fall within the Upper Rachel Carson Run "Good" Ecological Area, along the Wetlands Trail. Removing the knotweed will protect the native diversity and ecological integrity of this area, while leaving it in place will guarantee the eventual degradation of the area.

- One treatment option that can be implemented by volunteers is a strategy of repeated cutting 3x per year for three years (with removal and safe disposal of all plant material), to starve the plants of nutrients. A group in New England using this strategy claims they can eliminate knotweed, and it will at a minimum keep it from spreading further. **Source:** https://www.oldlyme-ct.gov/sites/g/files/vyhlif3616/f/uploads/nip_the_knotweed_handout.pdf
- A biocontrol insect, Japanese psyllid, has been approved by the USDA and is currently being tested in field trials; this may be a future avenue of control to pursue.

Invasive Stewardship in "Good" Ecological Integrity Areas:

Wetlands in Upper Rachel Carson Run with Autumn Olive & Other Invasive Species

Invasive Species Populations in Good Ecological Integrity Areas



The map on **page 64** shows the invasive species documented within the "good" ecological integrity areas of the park. After the pioneer species, these areas are the highest priority for invasive control efforts, to protect the existing high-quality ecological communities in the park. Some of the removal work for these species can be accomplished by volunteers and staff members through hand-treatment. Patrol of these areas to detect and remove young plants would be particularly helpful. Other removal work requires a dedicated project effort.

- Most "best" and "good" ecological integrity areas have fairly low levels of invasive species infestation at present. The most effective strategy in maintaining the quality of these areas is to develop a program for volunteer or staff personnel to periodically monitor these areas for new invasive species and remove them while the plants are few in number.
- Where infestations exist that cannot be controlled through casual hand-picking efforts, a more detailed area-specific assessment and treatment plan will be needed.
- Canopy gaps are prime areas for establishment of invasive species, due to high light levels, disturbance, and lack of established native vegetation. Remediating canopy gaps can help to maintain ecological integrity over the long term.
    - When canopy gaps develop naturally, monitor and manage to prevent invasive species infestations from developing. Deer fencing can greatly facilitate regeneration.
- Japanese stiltgrass (*Microstegium vimineum*) is a species that is becoming ubiquitous in our forests. It spreads extremely rapidly, and there are no particularly effective ways of controlling it without also damaging native vegetation, especially at large scale. Penn State Extension's fact sheet offers further detail on control options. Source https://extension.psu.edu/japanese-stiltgrass.
- Many of the "best" and "good" ecological integrity areas currently have some degree of infestation, which will likely worsen over time. Disturbances that result in high-light areas and removal of vegetation greatly facilitate invasion. To slow down the progress of this invasive species:
    - Reduce deer browse pressure.
    - Avoid creating disturbances in intact forested areas
    - Follow above-listed recommendations on canopy gaps.
- Japanese barberry, autumn olive, privet, and Amur honeysuckle, multiflora rose, and burning bush are all non-native shrubs with similar control requirements.
    - Volunteers or patrolling staff can pull or weed-wrench younger individuals.
    - Larger shrubs will require cutting and herbicide use.

- Low smartweed and narrowleaf bittercress are herbaceous plants that grow abundantly from seed. These can be removed by hand by volunteers. It is difficult to fully eradicate them, but they can be reduced in numbers and their spread slowed.
- Mile-a-minute can be pulled with gloves in small infestations.

PROJECT OPPORTUNITIES LISTED PER ECOLOGICAL INTEGRITY AREA:

Upper Rachel Carson Run:
- Remove knotweed (see project in above section "pioneer invasive removal" - **page 63**)
- Remove invasive shrubs (Japanese barberry, introduced honeysuckles, privet, multiflora rose).
- Monitor wetland herbaceous invasive species (reed canarygrass, Japanese stiltgrass, introduced Iris) and if they are expanding, pursue wetland-safe treatments.

Middle Rachel Carson Run:
- Remove invasive shrub species, especially in the eastern end of the area.

Middle Tributary:
- Control invasive non-native species.

Southern Pond Wetlands:
- If spatterdock cover increases to a point of interfering with other uses, mechanical harvest can be used to reduce the cover somewhat. Total eradication is not ecologically desirable as the species provides habitat.
- Monitor for invasive species and remove pioneer individuals promptly.
- Remove the scattered invasive shrubs in the meadow area.

Southern Tributary Ravine:
- Control invasive non-native species
- Control or exclude white-tailed deer. The conservative, long-lived native wildflowers in this species list have very small populations and are at the edge of viability. Without protection from deer browse, they will likely be lost.

Manage Invasive Species in Meadows and Areas Removed from Mowing
Reduction of mowing in large park systems can have many benefits, including reduced fuel and labor costs, and increased ecological function of lands once native species re-establish. However, these areas are also vulnerable to the establishment of invasive species, especially where they occur adjacent to forests, woodlands, or shrublands where invasive species are already common. In Harrison Hills Park , several cleared areas now host meadows with predominantly native species. This is a prime example of areas removed from mowing that now provide enhanced value to wildlife and park users. These areas should be periodically monitored for early infestations of invasive species, and spot-treated before pioneer individuals spread extensively.

Invasive treatments can be combined with plans enhance native plant diversity through restoration planting. Ensure invasive control is successful before seeding or planting. Restoration plantings will also help to keep post-control areas that are newly open and disturbed from being recolonized by invasive species.

PROJECT OPPORTUNITIES:

Control Invasive Species in Meadows:
The meadows are generally in good condition, with a fair proportion of cover from native species. However, invasive shrubs have a scattered presence. Targeted removal of these individuals will maintain the herbaceous character of the landscape and its value as habitat for native species. If some level of shrub cover is desired for habitat reasons, there are many excellent native shrub choices that can be used instead.

One meadow area (see pioneer invasive species map, **page 62**) also has substantial patches of mugwort, a non-native invasive herbaceous species that spreads readily and is difficult to eradicate. Removing this species will enhance diversity long-term.

Invasive Species Conflicts with Recreational Uses: Spatterdock/Water Lily in Southern Pond:
The water lily in the southern pond is a native species, also known as spatterdock (*Nuphar sp.*). It naturally occupies shallow water habitats (1'-5' deep), and provides significant habitat benefits to a wide variety of species, including fish, amphibians, and insects. It is a vigorous grower. However, the water lily's dense growth and shade cover can be advantageous in protecting the pond against invasion by a number of other non-native, highly invasive and noxious weeds that cause more significant changes on the pond's ecology and diminish value for native animal species. These include hydrilla, Eurasian water milfoil (*Myriophyllum spicatum*), and more.

We recommend either leaving the water lily alone, or occasional light management of the water lily if needed for recreational purposes. Management could potentially aim to keep the center open and maybe a few spots on the banks to facilitate fishing. If management can be achieved with mechanical removal, with minimal disruption to other portions of the wetland, this is safest for the pond's other inhabitants. If herbicides are uses, follow all relevant guidelines for safety for aquatic use and minimizing harm to aquatic life.

2.2.5 Deer Browse Management

When deer population densities are too high, native plants and natural communities can be severely impacted. These species are their primary food. While plants can typically recover from some browse impact, when high levels of browse continue for many years, the recovery capacity is diminished, and populations begin to decline. Many native wildflowers do not disperse or re-establish quickly or easily, and if they are eradicated from an area due to overbrowsing, they may not replenish even if browsing is reduced (Goetsch et al. 2011; Pendergast IV et al. 2016). Studies have shown that long-term overbrowsing causing a permanent reduction in native species diversity, that can only be remediated through active re-introduction of lost species.

Mature Trillium persist only on steep slopes inaccessible to deer.

This effect is clearly visible in many of Allegheny County's forests, where the tree canopy composition and site conditions suggest a diverse array of native herbs should be present, but instead there is only bare soil with scatt ered herbs, or deer-resistant fern species. Deer overbrowsing also reduces other ecological functions: excessive bare soil reduces rain absorption capacity and increases soil erosion and flood vulnerability; long term overbrowse increases susceptibility to establishment and spread of invasive species (Averill et al. 2018; Knight et al. 2009); and overbrowsing also prevents forest regeneration

The ecological degradation caused by overbrowsing by white-tailed deer is not only harmful to the plant species which are eliminated, but degrades the habitat value for many other native animal species. If forests cannot regenerate, a wide range of birds and mammals lose their homes. Butterflies, moths, and other insects that rely on particular plant species for food or shelter are eliminated when the species they need are no longer present.

In Harrison Hills Park, current conditions show long-term overbrowsing impacts. Most forests show browse damage and diversity reduction in areas that are accessible to deer. Steep slopes and outcrops are naturally inaccessible to deer, and when these show a clear difference in species composition from flat areas, it is evidence that deer browse has altered the community. Many of the conservative, long-lived perennial wildflower species are barely hanging on the park, with very small populations.

General Recommendations:

- Continue efforts to encourage and facilitate deer hunting within the parks
- Support regional efforts to increase hunting and reduce deer populations.
- Put up deer fencing around any particularly valuable ecological areas that are showing browse impact, and around any restoration projects where new materials are vulnerable to deer browse.

PROJECT OPPORTUNITIES LISTED PER ECOLOGICAL INTEGRITY AREA:

Lower Rachel Carson Run:

- Deer fencing around the entire area will facilitate recovery of existing wildflower populations, regeneration of the forest canopy through seedling growth, and successful growth for any restoration plantings. This area is the highest priority because it is the most intact and least invaded of the areas recommended for deer fencing.

Middle Tributary:

- Control or exclude white-tailed deer. The conservative, long-lived native wildflowers in this species list have very small populations and are at the edge of viability. Without protection from deer browse, they will likely be lost. Deer fencing around a portion of this ravine could protect the remaining conservative species; it is a moderately high priority because the remaining diversity is of moderate level, and some invasive species are present.

Southern Tributary Ravine:

- Control or exclude white-tailed deer. The conservative, long-lived native wildflowers in this species list have very small populations and are at the edge of viability. Without protection from deer browse, they will likely be lost. This ravine is a lower priority because it already has moderate presence of non-native invasive species.

2.2.6 Native Species Restoration Plantings:

General Recommendations:
In some areas, native diversity has been reduced over time due to deer browse or other disturbances. Many "conservative" native plant species disperse and re-establish extremely slowly, such that on the timescale of human lives, very little regeneration occurs. Re-introducing these species, using appropriately sourced material, can rebuild the expected level of native diversity and restore expanded ecological function to these communities. When plant diversity is reduced, animal species suffer as well due to the lack of host plants, food, and shelter diverse species of plants provide.

Selecting Species:

- Light levels, soil moisture, and soil pH must be assessed at the site, and species should be chosen whose natural habitat matches these parameters.
- Consult the natural community type mapping for the park (**page 27**): determine the community type assigned at the site, and species found in other areas of the park that have the same community type mapping are likely to be appropriate.
- Consult the natural community type descriptions published by NatureServe or Pennsylvania Natural Heritage Program; these include listings of typical species, although they should not be considered to be comprehensive.
- The website http://bonap.net/tdc provides geographic distribution maps showing known native range for all North American plant species. These maps can be consulted to determine if a particular species is native to our region. Species should be native to Pennsylvania, but also native in areas geographically proximate to and ecologically similar to Harrison Hills Park. For example, coastal plain species native to extreme SE Pennsylvania, such as willow oak or dog hobble, are ecologically novel and highly geographically disjunct from their historical native range if introduced in our region.

Sourcing Material:

- Where possible, local provenance of material is desirable. Material derived from wild stock collected from far distant regions, even if advertised as "native", should be avoided.
- Using locally harvested plant propagules in a careful, sustainable manner is another way to restore the expected levels of native plant diversity to the park's ecosystems. Several efforts have developed in other regions of the country to train volunteers to carefully collect native seed and plant it in appropriate habitats it to restore native biodiversity in areas where it has declined.

Learn more at:
    - The Wild Seed Project: https://wildseedproject.net
    - Northeast Seed Collector: https://northeastwildseedcollectors.com
- Supporting local native plant growers who do use local-provenance materials through policy and contracts can help to maintain and expand sourcing options long-term.

PROJECT OPPORTUNITIES:
Many areas in the park could benefit from this work; a few high priority areas are selected below.

Rachel Carson Run:
Improve diversity of native forest community with ecologically-appropriate plantings. The current forest herb populations are small, scattered, and lack the full complement of diversity expected in a healthy example of the same forest type. This effort will only succeed if protection from deer browse is installed, or deer-resistant species are used.

Species Selection:
- Any native species found in any of the areas mapped as "Western Allegheny Dry-Mesic Oak Hardwood Forest" Community (**page 27**) within the park are appropriate.
- Species included in the following NatureServe and Pennsylvania Natural Heritage Program community type descriptions are also appropriate:
    - https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.687627/Quercus_alba_-_Quercus_rubra_-_Quercus_montana_-_Acer_saccharum_-_Lindera_benzoin_Forest
    - https://www.naturalheritage.state.pa.us/factsheets/16060.pdf

Improve Native Plant Diversity in Meadows
In some of the meadows, non-native grass species are prevalent. The value of these areas as habitat for native animal species can be improved through the introduction of additional native plant material, with the long-term goal of creating higher percent cover from native species. The meadow around the southern pond currently has the highest diversity of species, and could potentially be used for seed source for restoration elsewhere.


Southern Pond Meadow

2.2.7 Focal Project Areas:

Lower Rachel Carson Ravine & Dead Red Oak creating a Light Gap.

This area contains some of the most mature forest in the park, with very large, magnificent trees. It also has small populations of conservative native wildflower species. This area should be a focus of restoration, with the goal of remediating several current problems and restoring a healthy native forest community with the full complement of native species typical of similar settings. The following kinds of work are recommended, all described in more detail in the appropriate sections above.

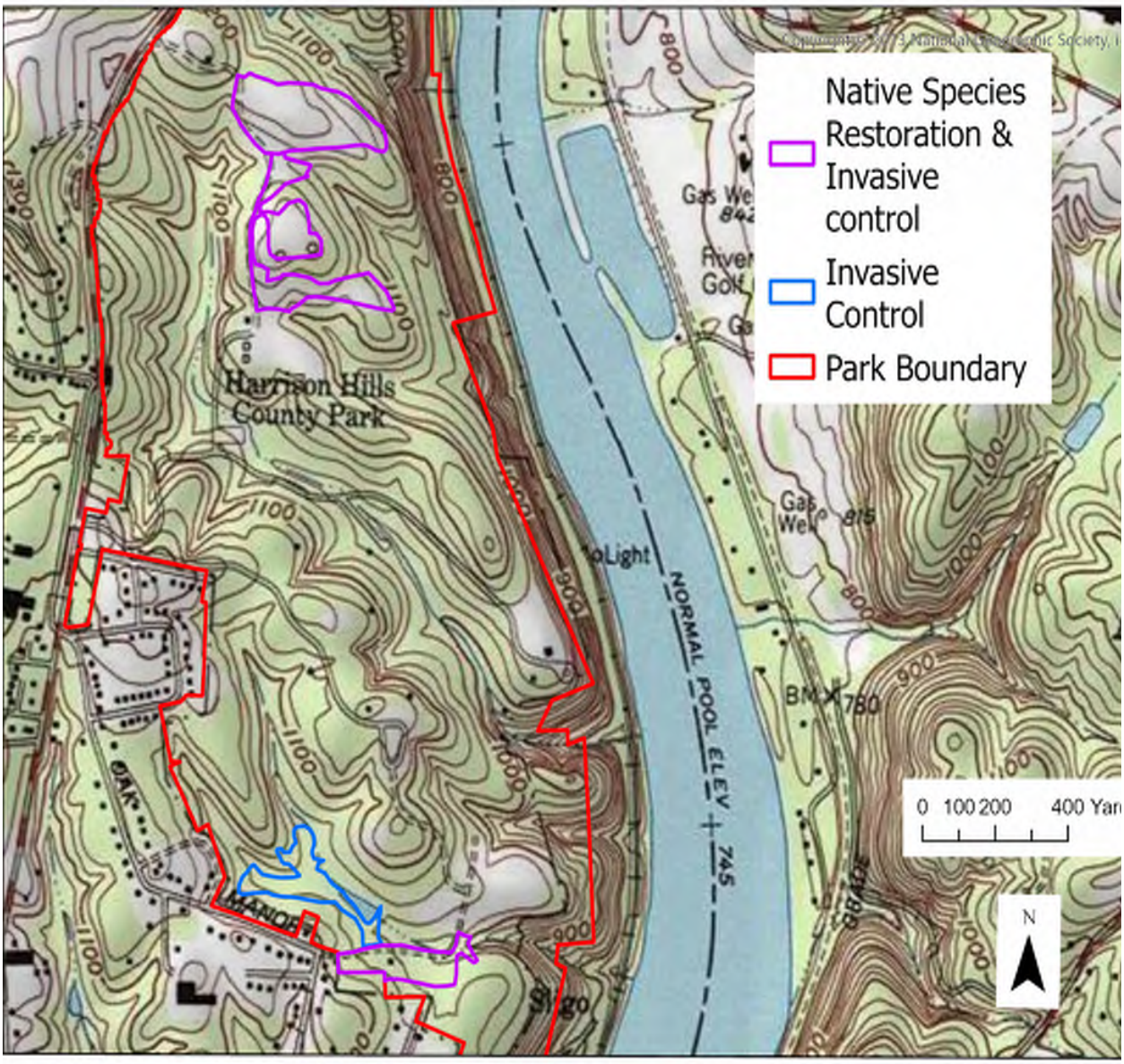
- Canopy gap restoration
- Trail management
- Invasive management – monitor and remove as needed to preserve current low density of invasives.
- Native species restoration

The map on **page 73** shows the locations of two canopy gaps and a trail management issue with the Lower Rachel Carson Run Ecological Integrity Area.

Meadows:
The meadows provide early successional habitat that benefits a variety of native animal species. If invasive species are controlled and native plant diversity is improved, even greater benefits can be realized. Approaching the areas holistically to coordinate invasive removal and native plant diversity improvement would be beneficial. Both projects are described in more detail in the appropriate sections above. The map on **page 74** shows recommended meadow areas for invasive management and native species restoration.

Lower Rachel Carson Run Forest Restoration

Meadow Project Recommendations



2.3 GREEN INFRASTRUCTURE RECOMMENDATIONS:

In collaboration with the Allegheny County Parks Department and the Allegheny County Parks Foundation, WPC has identified locations within Harrison Hills Park where green infrastructure facilities can help address stormwater runoff problems. The manager of the park guided WPC, ACPF, and Allegheny County Parks staff members to locations where stormwater runoff is creating issues including non-point source pollution, erosion, and sedimentation. The issues present within the park are consistent with stormwater management problems throughout the region, wherein wet weather runoff damages water quality, stream morphology, and habitat. Excessive runoff typically stems from large areas of impermeable surfaces such as parking lots, roads, buildings, and sidewalks. Throughout the Allegheny County Parks system, this runoff is typically discharged to open greenspaces such as fields, forests, and lawn areas where the flush of hot, dirty water from impermeable surfaces results in these negative impacts.

Properly designed green infrastructure facilities such as rain gardens, bioswales, green parking lots, permeable pavement, and green roofs are effective and affordable at controlling excess stormwater runoff through retention, slow release, and infiltration facilitated through natural features including plants and rocks. Design of these facilities should be based upon hydrologic analyses by qualified professionals (typically an engineer) to determine runoff rates and the capacity of the facilities. The design of the facilities should be completed by landscape architects that specialize in green infrastructure design and have the expertise to develop appropriate planting plans and design specifications for the various GI approaches. Designs can vary greatly based on the need, budget, location, and association with other features of the built environment. They can be very basic and low maintenance like a mowed swale or be elaborately landscaped or complex like large bioswales or green roofs. Regardless of the design, the engineer and landscape architect should develop short- and long-term operating and maintenance plans for the facilities to ensure optimal function and sustainability.

“Conventional” stormwater infrastructure focuses on capture and conveyance via catch basins and pipes and concentrates runoff for retention, release, and/or treatment. Conventional infrastructure approaches provide the single service of stormwater management and are typically and purposely not visible or accessible. Conversely, green infrastructure approaches to stormwater management provide a multitude of benefits. Green infrastructure is typically designed to intercept stormwater runoff before it enters the conventional sewer system. In general, the function is to mimic natural processes through the use of plants, rocks, pools, and/or weirs and to promote infiltration into the ground rather than conveyance into a storm sewer. The use of natural materials and the design approaches for green infrastructure make the facilities conducive to enhancing the appearance and function of a landscape, parking

lot, or building . Unlike conventional sewer infrastructure, people can enjoy and interact with green infrastructure facilities through plantings, maintenance, or simple observation. The plants and trees can provide habitat and food for wildlife, improve air quality, and provide seasonal interest through blossoms and foliage. Green infrastructure can also be an added-value investment in high profile or high-use areas such as community entry points, trail heads, playgrounds, picnic shelters, buildings, and more.

2.3.1 GREEN INFRASTRUCTURE APPROACHES

Green infrastructure approaches are widely recognized as effective, affordable, and attractive ways to address stormwater runoff, water quality, and other environmental issues. The U.S. Environmental Protection Agency (EPA) has developed definitions for the most common green infrastructure approaches as described below.

Rain Gardens
Rain gardens are small, shallow, sunken areas of plantings that collect stormwater runoff from roofs, streets, and sidewalks. Also known as bioretention cells, they are designed to mimic the natural ways water flows over and absorbs into land to reduce stormwater pollution.

Check Dams
Check dams are temporary or permanent structures used to control high velocity water flows by being constructed across drainage ditches or swales. In addition to addressing high velocity flows, check dams are primarily utilized to prevent erosion, settle sediments and pollutants, and to maintain soil moisture. Check dams can be constructed from a variety of materials including, rock, fiber logs, triangular sediment dikes, sand bags, cement blocks and poured concrete.

Bioswales
Bioswales, often found along curbs and in parking lots, use vegetation or mulch to slow and filter stormwater flows.

Green Parking Lots
Many green infrastructure elements can be seamlessly integrated into parking lot designs. Permeable pavements can be installed in sections of a lot and rain gardens and bioswales can be included in medians and along the parking lot perimeter. When built into a parking lot, these elements also reduce the heat island effect and improve walkability in the area.

Permeable Pavement
Permeable pavements infiltrate, treat, and/or store rainwater where it falls. They can be made of pervious concrete, porous asphalt, or permeable interlocking

pavers. This practice could be particularly cost effective where land values are high and flooding or icing is a problem.

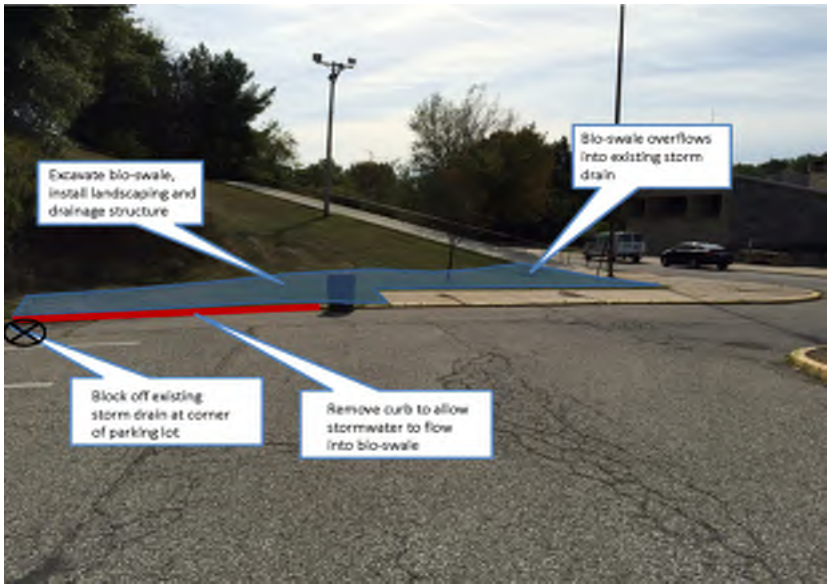
Green Roofs
Green roofs are covered with growing media and vegetation that enable rainfall infiltration and evapotranspiration of stored water. They are particularly cost-effective in dense urban areas where land values are high and on large industrial or office buildings where stormwater management costs are likely to be high.

2.3.2 EXAMPLES OF GREEN INFRASTRUCTURE IN THE ALLEGHENY COUNTY PARKS

The Allegheny County Parks Department and the Allegheny County Parks Foundation have implemented several substantial green infrastructure projects, guided by recommendations provided by WPC through previous ecological assessment projects in other county parks. As described above, these projects not only serve the function of stormwater management but provide an array of complementary benefits including beautification, habitat enhancement, and air quality improvement. Their presence in high profile locations has the added benefit of educating the public on the concept and benefits of green infrastructure.

Boyce Park Ski Lodge Bioswale

Original recommendation for a bioswale at the Boyce Park Ski Lodge from the 2015 Boyce Park Ecological Assessment Project:



Constructed Boyce Park Ski Lodge Bioswale (2022)

Located at the bottom of a large parking area at the Ski Lodge, this bioswale receives runoff via a section of removed curb (or “curb cut”). Rocks, plants, and mulch slow down the rush of runoff, promote infiltration of the runoff into the ground, and remove pollutants. Previously the runoff was conveyed via storm sewers directly into a tributary of the Pierson Run stream.

Constructed Boyce Park Ski Lodge Bioswale (2022)

Boyce Park Ski Lodge Bioswale from Upper Enterance to Ski Lodge (2022)

South Park Green "VIP" Parking Lot

Original concept for a green parking lot in South Park from the 2016 South Park Ecological Assessment Project:

Concept for Bioswale at South Park VIP lot

Permeable paving, bioswales and trees installed at the South Park green design parking solution (2021).

Mulch, plants and stone beautify the site and clean stormwater prior to entering Catfish Run stream.

Watershed Modeling Data

For project planning purposes, WPC utilizes the free online "Model My Watershed" tool to estimate the efficacy of green infrastructure modifications to the project recommendations in this report. As stated on the Wikiwatershed website, "Model My Watershed is part of Stroud Water Research Center's WikiWatershed initiative. WikiWatershed is a web toolkit designed to support citizens, conservation practitioners, municipal decision-makers, researchers, educators, and students to collaboratively advance knowledge and stewardship of fresh water."

This data is intended only for planning purposes. Hydrologic analyses and runoff models should be undertaken by qualified professionals prior to construction of any green infrastructure facility. Modelling data generated by the Wikiwatershed "Model My Watershed" web toolkit is required for several Pennsylvania state agency grant programs that fund watershed protection analysis and implementation projects.

2.3.3 POTENTIAL GI PROJECTS FOR HARRISON HILLS PARK

At 500 acres, Harrison Hills Park is the smallest of the nine Allegheny County Parks with a high percentage of forested land (76%) and a small amount of impermeable surface (16.5 acres). Other larger parks in the county system, such North, South, and Boyce Parks, are much more highly developed and in need of the benefits of green infrastructure for stormwater management and it's complementary benefits. Nevertheless, there are significant opportunities to implement green infrastructure facilities in the park for water quality improvements and the many ancillary benefits provided by these approaches. Below is a detailed approach for green infrastructure at the Harrison Hills Soccer Fields parking lot, followed by other opportunities noted within the park that could be further developed and pursued for implementation.

BIOSWALE APPROACH FOR THE HARRISON HILLS SOCCER FIELDS PARKING LOT

The soccer fields in the park are heavily used. The large parking area is predominantly gravel and receives large flushes of stormwater runoff from catch basins along Sportsmans Park Drive above the lot. This flush is released from an outfall near the entrance of the parking lot and creates significant erosion and ponding throughout the site.

Soccer Field Parking Lot
Culvert Outfall

Ponding & Erosion in the Soccer Fields parking lot.

A bioswale facility that includes rock for slowing the runoff and plants, trees, and mulch to promote infiltration would significantly reduce the erosion and ponding and beautify the site. The parking lot currently feels unwelcoming, isolated, and in need of maintenance. Piles of asphalt millings at the northern end of the lot are unsightly and contribute to stormwater management problems. Constructing a bioswale and adding other amenities such as trail wayfinding, informational signage, lighting, and paving improvements would significantly improve the function and appearance of this high-use area of the park.

Lower lot, with asphalt millings. Potential for landscaping & trailhead

The installation of a bioswale at the Soccer Fields parking lot would entail the following:

- Hydrologic analysis to determine runoff volume from nearby impermeable surfaces
- Infiltration testing
- Land Survey
- Design of the rain garden (contracted or in-house) to meet desired stormwater runoff capture goals. Controlling 100% of the first inch of runoff is a fairly standard approach in this region.
- Construction—excavation, grading, connection to existing sewer/catch basin, stone and plants installations.
- Maintenance & Monitoring
- Informational Signage.

The Soccer Field parking lot bioswale would intercept 94% of a 24 hour 1" storm (remaining 6% would evapotranspirate).

Proposed location of Harrison Hills Park Soccer Field Bioswale

Specifications for the Soccer Field Parking Lot Bioswale:

- The area of the parking lot is approximately 76,000 square feet.
- The addition of an 11,000 square foot bioswale along the west side of the lot would intercept and infiltrate 78% of a 1" 24-hour wet weather event and eliminate runoff altogether.
- Infiltration would increase from 58% to 77% (the other 23% is evapotranspiration)
- The bioswale would completely remediate suspended solids, Nitrogen, and Phosphorous during a 1" wet weather event
- Modeling data specific to the Harrison Hills Soccer Field parking lot bioswale can be accessed online at https://modelmywatershed.org/project/41650/

Budget Estimates for the Soccer Field Parking Lot Bioswale:

The table below represents outsourcing all of the project components. Any in-house or in-kind services would reduce the project implementation costs.

Trees, Supplies & Planting Site Prep.				
Category	**Description**	**Unit Cost**	**Each**	**Total**
Landscape Trees	2" Caliper Balled and Burlapped Landscape Trees	$230.00	20	$4,600.00
Restoration Trees	2-5 Gallon Native Trees	$40.00	50	$2,000.00
Shrubs	Native Shrubs for Bioswales	$40.00	300	$12,000.00
Perennials & Grasses	Native Grasses & Perennial Flowers	$25.00	1000	$37,000.00
Planting Supplies	Mulch, Soil, Stakes, Tubes, Fencing, Tie	$4,000.00	1	$4,000.00
20% Contingency				$12,020.00
Subtotal				**$72,120.00**

Administration & Facilitation				
Category	**Description**	**Unit Cost**	**Hours**	**Total**
Project Manager	Manage RFP Process & Contracts, Convene Partners, Financial Management, Staff and Contractor Oversight	$100.00	60	$6,000.00
Coordinator	Coordinate Partners & Volunteers for Planting	$50.00	80	$4,000.00
20% Contingency				**$2,000.00**
Subtotal				**$12,000.00**

Contracted Professional Services				
Category	**Description**	**Unit Cost**	**Hours**	**Total**
Landscape Architect	Design Services, Plant Selection and Sourcing Drawings, Planting Oversight	$150.00	100	$15,000.00
Civil Engineering	Hydrologic Analysis, Construction Drawings	$150.00	30	$4,500.00
Construction of GI	Demolition, Heavy Construction, Piping for GI facilities, Stone Installation, Excavation, Grading	$60,000.00	1	$60,000.00
Monitoring GI	Monitoring Protocol Developed for at least 1 Year. Monitoring Stream Channel Morphology	$2,500.00	1	$2,500.00
Signage	Durable Signage	$2,500.00	1	$2,500.00
Survey	Land Survey for Construction	$3,000.00	1	$3,000.00
Subtotal (with 20% Contingency)				**$104,400.00**
Soccer Field Parking Lot Bioswale				**$188,520.00**

2.3.4 Other Potential Opportunities for Green Infrastructure in Harrison Hills Park

Culvert Improvements

Ox Roast Culvert at Harrison Hills Park

Ox Roast Shelter at Harrison Hills Park

Culverts discharging runoff from parking lots and roads are an opportunity for small green infrastructure facilities. The culverts are common features throughout the Allegheny County Parks system and typically discharge into lawn areas around park shelters, playgrounds, and restrooms. This approach was described in detail in the Ecological Assessment and Action Plans for White Oak and Round Hill Parks. While individually small in scale, these culverts are widespread and present a cumulative issue on erosion and sedimentation in nearby streams. The culvert pictured above at the Ox Roast shelter in Harrison Hills Park presents these issues in addition to flooding the shelter itself during heavy precipitation. Park staff members have addressed the issue, but the site could be further improved with green infrastructure approaches.

Parks Lane

Near the intersection of Parks Lane and Cottontail Drive is an area that receives runoff from both Parks Lane and an abandoned access road to the park. This runoff creates significant erosion in the small unnamed stream and wetlands area below the road and the Wetlands Trail.

Abandoned access road at Harrison Hills Park

Parks Lane at Harrison Hills Park

A bioswale installed just to the North of Parks Lane could intercept, slow, and clean the runoff from Parks Lane and the abandoned Road.

Nature Center, Maintenance Buildings, and Yakaon Shelter Parking Areas

Green parking lot approaches and/or perimeter bioswales at parking lots within the park would help address erosion and water quality. The large lot for the Yakaon Shelter and Nature Center is gravel but is compacted enough to experience runoff issues as demonstrated by the erosion in the above photo. Trees and native plants would enhance habitat for wildlife, reduce summer temperatures, improve the appearance of the landscape, slow runoff, and improve air quality.

Parks Lane at Harrison Hills Park

Abandoned access road at Harrison Hills Park

SECTION III - GENERAL RECOMMENDATIONS:

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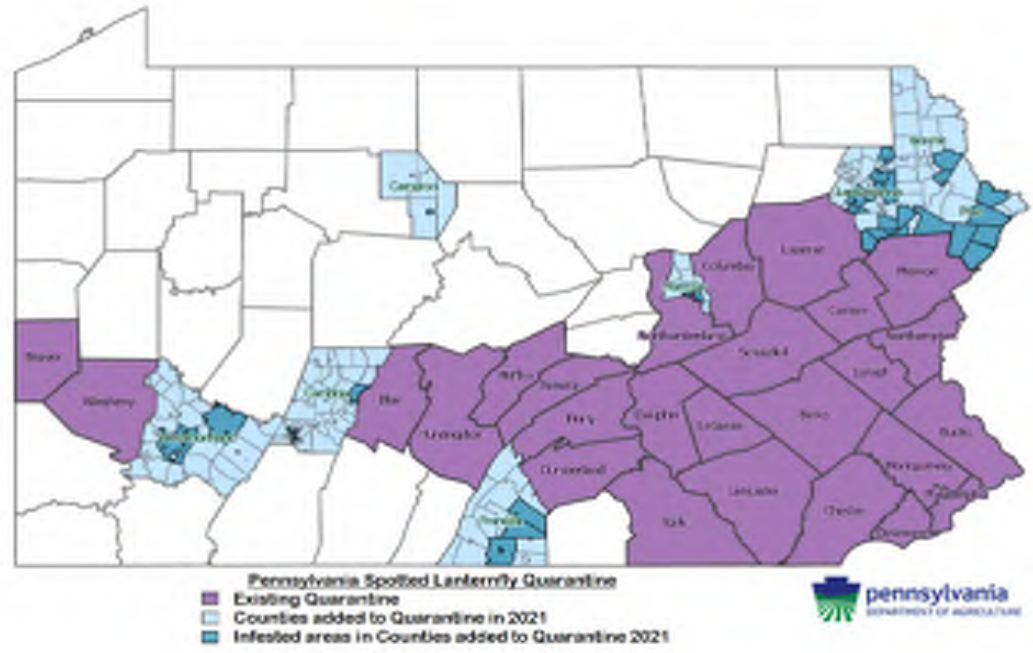
Adult spotted lanternfly. Credit: Jon-Marc Burdick, Cameron County Conservation District (Pennsylvania iMapInvasives Database - Presence record #1071021

3.1 SPOTTED LANTERNFLY IN PENNSYLVANIA

The spotted lanternfly (*Lycorma delicatula*) (SLF) is an invasive pest native to China, India and Vietnam. This insect is a type of planthopper with colorful markings on its wings and body. Though it may appear attractive on the surface, the spotted lanternfly continues to cause significant economic damage to the agricultural, forestry and tourism industries and poses a severe threat to our local and regional ecosystems. It's also a nuisance to business and homeowners due to the sticky "honey dew" it excretes that encourages the growth of a black, sooty mold. This mold is not harmful to humans, but can cause damage to plants and make outside recreational areas unusable.

Spotted lanternflies are often found on vegetation and are known to feed on the sap of over 70 different plant species. These include grapevines, maple trees, black walnut, birch, willow and other trees. It also has a strong preference for the invasive tree-of-heaven (Ailanthus altissima) which is (unfortunately) quite prevalent in much of Pennsylvania.

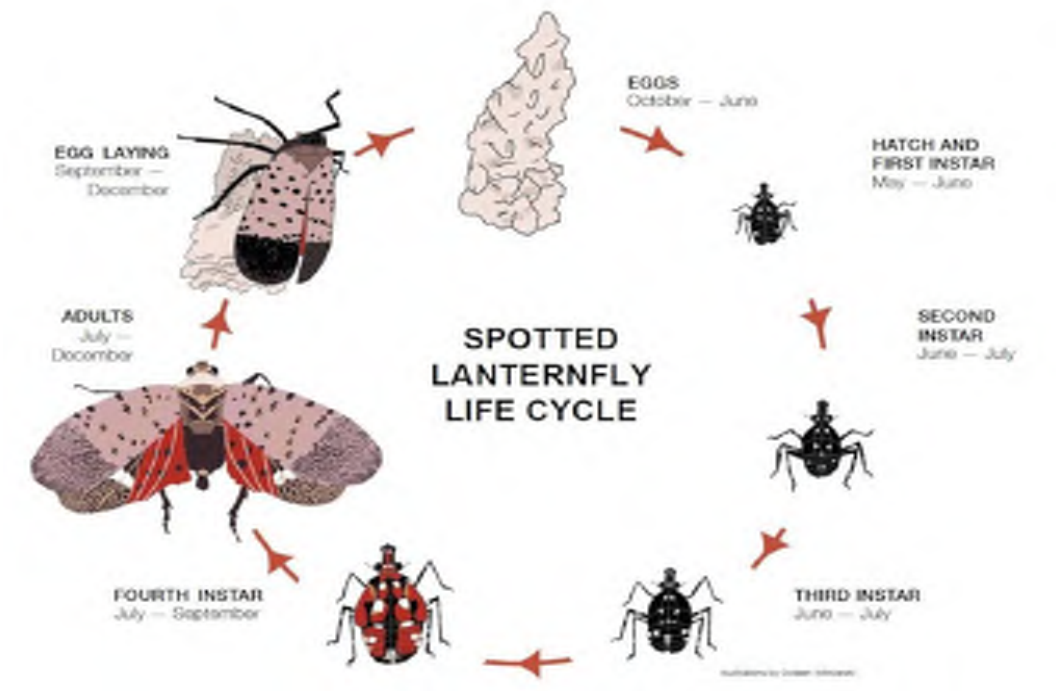
Spotted lanternfly was first found in the United States in September 2014 in Berks County, PA. It has since spread to 34 counties in Pennsylvania (or half of the state), as well as several other states.



This map shows the current extent of the spotted lanternfly quarantine zone in Pennsylvania as of November 9, 2021. Credit: Penn State Extension

The lifecycle of spotted lanternfly begins with a female laying her eggs (i.e., an egg mass) on any hard surface she can find such as a tree, picnic bench, car, truck, trailer, etc. Eggs are laid from September through December and will overwinter into spring. The first instars (or nymphs) of spotted lanternfly are black in color with white dots on their back. These nymphs emerge from an egg mass in May-June and molt into larger instars throughout the summer months. They eventually change their color from black to red and beginning in July, will transform into adults that resemble colorful moths. Adult spotted lanternflies are noticeable from July through December, and beginning in September, will begin the life cycle over again with the females laying their eggs.

If any life stage of a spotted lanternfly is observed (egg mass, instars, adults), it's important to report your finding to the Pennsylvania Department of Agriculture and Penn State Extension. An easy-to-use online tool has been developed for this specific purpose and is accessible at https://services.agriculture.pa.gov/SLFReport/.



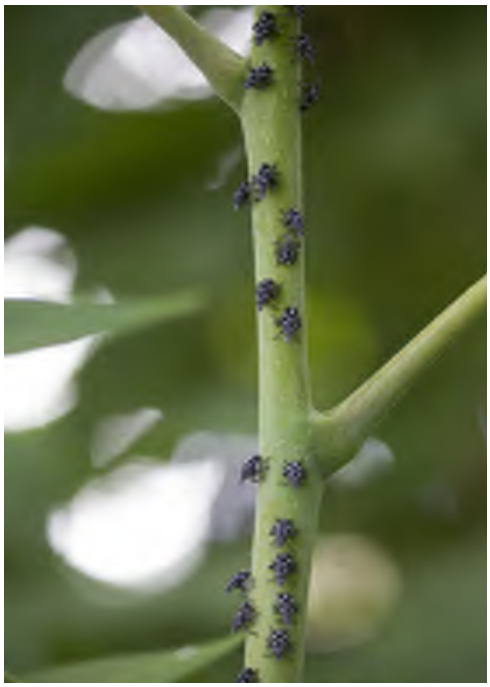
The lifecycle of a spotted lanternfly involves several different stages including an egg mass, various instars (nymphs), and finally an adult insect.

Spotted lanternfly is just one of several other tree pests to be on the lookout for in the Commonwealth. Other insects that can cause harm to our urban and natural forests include:

Common Name	***Scientific Name***	**Notes**
Asian Longhorned Beetle (ALB)	*Anoplophora glabripennis*	To date, ALB has not been found in PA.
Hemlock Woolly Adelgid	*Adelges tsugae*	-
Elongate Hemlock Scale	*Fiorinia externa Ferris*	-
-	*Lymantria Dispar*	Formerly known as Gypsy Moth
Oak Wilt	*Ceratocystis fagacearum*	Also known as *Bretziella fagacearum*
Root Rot	*Phytophthora spp.*	Also known as Sudden Oak Death

More information about the spotted lanternfly can be obtained from:

- Penn State Extension
- Pennsylvania Department of Agriculture
- Cornell College of Agriculture and Life Sciences



Spotted lanternfly nymphs. Credit: Nicholas Macelko (Pennsylvania

3.2 PARK STAFF TRAINING

Tree Planting and Care (Tree Tender Training)

WPC has been working with the non-profit Tree Pittsburgh since 2008 through the TreeVitalize Pittsburgh project. An important component of the success of that project has been the training of volunteers through Tree Pittsburgh's "Tree Tender" program. Tree Pittsburgh has trained over 1,600 Tree Tenders in Allegheny County through an eight hour workshop that covers everything from the benefits of trees to communities to the planting and care of trees over the long term. Based on past recommendations from earlier Ecological Assessments, the Allegheny Count Parks staff have undergone Tree Tender training to support the long term health of newly planted trees. WPC continues to recommend that new Allegheny County Parks Maintenance staff undergo Tree Tender Training to promote the sustainability of ongoing tree plantings in the parks.

Volunteers and staff plant and protect restoration trees during a planting along a river trail in Pittsburgh's South Side.

3.3 REDUCE MOWING, PRIORITIZE ECOLOGICAL MANAGEMENT AND MAINTENANCE OF CAPITAL PROJECTS

As staff time availability increases with reduced mowing obligations, staff capacity should be re-allocated more heavily toward ongoing maintenance and management of the capital projects mentioned above.

- Invasive Weed Management
  - As described in previous sections of this report, managing invasive weed infestations of Harrison Hills Park is a priority management concern, and will continue to be into the future. Investments in tools and staff training are priority recommendations also mentioned in this section.

- Trail System Maintenance

- Green Infrastructure Maintenance

- Meadows and Reforested Areas Maintenance

3.4 PROCURE TOOLS AND EQUIPMENT

For invasive weed management, trail maintenance, meadow management, tree planting, fence building and maintenance. Procuring an adequate supply of the tools listed below will cost approximately $20,000 total, although the tools could be acquired as needed over the course of several months/years.

Hand Tools:

Hedge shears:	$20-$75 each (depending on size)
Hand pruners:	$15-$45 each
Loppers:	$20-$80 each (depending on size)
Bow saws:	$15-$30 each
Long reach pruners:	$75-$150 each
Picks mattock:	$15-$40 each

Specialty Tools:

Tree and root puller (Pullerbear):	$200
Root Talon:	$70
Root Buster:	$45
Tree planting dibble bar:	$35-$45 each

Power Tools:

Professional-grade chain saws:	$350-$600 each (depending on size and brand)
Professional-grade Pole saws:	$400-$700 each (depending on size)
Walk-behind brush cutter:	$1,500 - $3,000
Brush hog tractor attachment:	$2,000 - $4,000
Tree hole auger:	
Attachment for tractor with 3-point hitch:	$450-$1,000
Hand-held:	$200-$400

Goat herd:

- Use of goat herds to graze on invasive weeds has emerged locally as a potentially high impact, low cost strategy to be used in combination with other treatment methods, either chemical or mechanical. For example, spraying a systemic herbicide (i.e. tryclopyr or glyphosate) immediately following grazing by goats can create good conditions for herbicide absorb into the plants' vascular system, increasing the chances of a total kill of the unwanted vegetation.

- There is one location non-profit organization that uses goats as a way to manage invasive and unwanted plant species - Alegheny GoatScape - that used to to business as Steel City Grazers. WPC engaged Steel City Grazers on one project to control a small patch of Japanese knotweed and other invasives in the City of Pittsburgh that proved to be highly effective. The fee for that project was based on a $500 base fee plus $100 per day for a 10-goat herd with an expectation that it could take two to three weeks per acre to be cleared. Those fees included transportation of the goats, temporary electric fencing to contain the goats to the area being managed, a donkey whose role was to protect the goats from predators such as coyotes and feral dogs and daily care of the animals.

- Interest was also raised by County Park staff and others during the meetings conducted in conjunction with this project about the possibility of acquiring a permanent goat herd (or herds) to manage invasive weeds across the County Parks system. Because of recent notoriety, demand is quite high for privately owned goat herds. Acquiring a goat herd would help to ensure goats are always available for weed management.

- Goats themselves are relatively inexpensive to buy (sometimes even free). However, they do require good fencing, food and shelter during winter and inclement weather, transportation to and from weed management projects, protection from predators, and a knowledgeable caretaker.

3.5 DEVELOP A SUSTAINABLE TRAIL MANAGEMENT PLAN

In conjunction with training Parks staff on trail management and maintenance, developing a sustainable trail management plan that provides a comprehensive vision and management framework for all trails in Harrison Hills Park is a top priority. Such a plan should include broad stakeholder and public input, as well as engagement of trail design, construction and maintenance professionals.

The scope of the plan should include the following:

- Survey and evaluation of current and future trail usage.
- A comprehensive assessment and evaluation of the existing trail system by trail consultants.
- Identifying most appropriate trails for each permitted use.
- Identifying locations for development of new trailheads.
- A plan for interpretive signage and other outreach and educational ssets.
- Prioritizing trails/trail sections will be the focus of future maintenance efforts and developing detailed work logs.
- Garner broad stakeholder and public input.
- Training and project oversight for County Parks staff on trail construction and maintenance BMPs.
- Identifying trails to close/eliminate due to redundancy, illegal vehicle use or other problems.
- Plan for accessibility in compliance with the ADA.

A more detailed budget estimate should be developed based on soliciting proposals from outside consultants, but the total cost to develop the plan is likely to cost fanywhere from $25,000 to $120,000 depending on the contractor. The planning process would likely take at least two years to complete. For fundraising purposes, developing the Sustainable Trail Management Plan could be packaged with other recommended initiatives to develop an interpretive plan for Harrison Hills Park and to train County Parks' staff on trail management and maintenance.

Based on discussions held in conjunction with this project, it was also mentioned that the plan could be done in conjunction with a broader County Parks system wide trail planning effort that leverages the skill and expertise of the Allegheny County Park Rangers and Trail Pittsburgh, an organization that conducts extensive volunteer activities to protect and enhance trails for all park user groups.

THE POWER OF GREEN

Harrison Hills Park is in a great position to use the power of green to enhance its immediate present and support its future. With the engagement and leadership of the Allegheny County Parks Foundation and the Allegheny County Parks, it has many of the elements that are necessary for successful greening projects. Strategic greening has the potential to be a rallying point for community improvement that can involve citizens from school children to seniors, from business owners to cultural institutions, from novices to skilled members of the community. The power of green is found in the multifaceted benefits and the profoundly satisfying experience of improving the living landscape of the community. Harrison Hills Park has the elements in place to harness this power for all its constituents, employees and its landscape.

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