June 2022

CLEVELAND METROPARKS NATURAL RESOURCES DIVISION

Natural Resource Management Approach & Plan

Table of Contents

List of Tables and Figures

1 Introduction

Cleveland Metroparks' conservation mission has evolved over time. Beginning as rural retreats from the core city, most reservations have been engulfed by the post-World War II suburban expansion of Greater Cleveland. For much of the Park District's history, acquiring and holding land in its natural state seemed adequate to satisfy the conservation mission. In 1936, the park's first naturalist A. B. Williams stated: "Civilization is destructive, but in the Metropolitan Park System, animal and plant life may be preserved for a long, long time" (Cleveland Plain Dealer, 1936).

While land acquisition continues to be a critical function and a lasting legacy for Cleveland Metroparks (MacKeigan, 2016), park leaders since realized that active management is necessary to mitigate the effects of regional land use changes, lost habitat, increased stormwater flows, expanded demand for outdoor recreation, decreased hunting pressure, fewer predators, and the invasion of exotic invasive species. In 1978, park leaders created a division specifically tasked with resource management, and to this day the Natural Resources Division (NR) serves as the programmatic lead for implementing the conservation mission. Natural resource management relies on the knowledge, enthusiasm, and collaboration of resource managers, scientists, planners, engineers, naturalists, reservation managers, volunteers, and administrative staff.

The natural resources within Cleveland Metroparks are an extraordinary treasure, set aside more than 100 years ago for the good of present and future generations. In 1929, park founder William Stinchcomb stated, "natural resources are the things which Nature gives us…forests, streams, lakes, fresh air-all of these are great resources and their recreational value to city dwellers far exceeds their commercial value…" (Cleveland Plain Dealer, 1929). Stinchcomb's statement forecasted today's efforts to quantify the value of ecosystem services that maintain the conditions for life on Earth (Millennium Ecosystem Assessment, 2005). They include provisioning services such as food, water, and wood products; regulating services such as flood, erosion, and disease control; cultural services such as recreational and spiritual benefits; and supporting services such as photosynthesis, pollination, and nutrient cycling. Park visitation sky-rocketed and hit record numbers during the COVID-19 pandemic (Cleveland Metroparks, 2022), demonstrating the increasing value of natural areas near urban centers. These tangible amenities and their associated ecosystem services provide benefits for all inhabitants of our region; not just our guests who recreate in the Park District or our neighbors who gain from increased property values or those who vote for our levies.

The Park District recently renewed its mission and vision through the Second Century of Stewardship System Plan. The following document begins with a brief overview of Cleveland Metroparks and the links between natural resource management and the System Plan (Cleveland Metroparks, 2021) (Section 1). Section 2 explains the guiding principles for natural resource management, followed by snapshots of current natural resource conditions and the stressors affecting them (Sections 3 and 4). The document concludes with a segment on the park's strategic stewardship goals and objectives (Section 5), and a discussion of the planning process and current project priorities (Section 6). This document was designed to be accessible to multiple audiences and to set the stage for management and project planning at reservation and smaller scales.

The Natural Resources Division enhances the integrity and resiliency of the land, water and living resources found in Cleveland Metroparks through adaptive ecosystem management based on sound, applied research. Our goal is to maintain and restore natural systems and services they provide to human society.

Cleveland Metroparks At-a-Glance

Mission
Protecting nature, connecting communities and inspiring conservation of our world.

Political Structure

Cleveland Metroparks is a separate political subdivision of the state of Ohio. The Cleveland Metroparks Board of Park Commissioners governs the Park District. The presiding Judge of the Probate Court of Cuyahoga County Board appoints its three members, who are citizens that serve three-year terms without compensation.

Description

Cleveland Metroparks consists of 18 reservations ranging in size from 59 acres to 4,290 acres (Figure 1). The reservations tend to follow rivers and streams, forming an "Emerald Necklace" around Cleveland. As of 2021, the reservation system encompassed 24,363 acres (9,859 hectares) in 49 municipalities and townships with over 19,000,000 visitors (Cleveland Metroparks 2021a; Cleveland Metroparks 2022). Land acquisition continues to protect habitats and provide additional recreational features. Recreational opportunities include hundreds of miles of hiking, running, bicycling, and horse trails, nature centers, golfing (8 courses), picnicking and fishing, among many others. Cleveland Metroparks Zoo is a world-class facility with modern collections and a staff dedicated to high-quality care and research focused on securing a future for wildlife.

Purpose and Relationship to Cleveland Metroparks 2022 System Plan

This Natural Resources Management Approach and Plan explains the rationale and priorities for management actions undertaken by Cleveland Metroparks Natural Resources Division (NR). It begins with NR's relationship to the six 2022 System Plan goals, followed by the principles that guide natural resource management decisions. The state of the Park District's natural resources is then presented as a snapshot in time of current conditions, followed by a summary of major threats to these resources. In the Strategic Stewardship section, we state NR's goals and objectives and describe the management activities and stewardship solutions carried out by NR, highlighting examples of ongoing and planned programs. Lastly, the final section describes our priorities for the future. Most priorities expressed in the final section were proposed as actions that could be implemented within a 5 to 20-year time frame, but because most would make enduring change to living systems, the management period is open-ended.

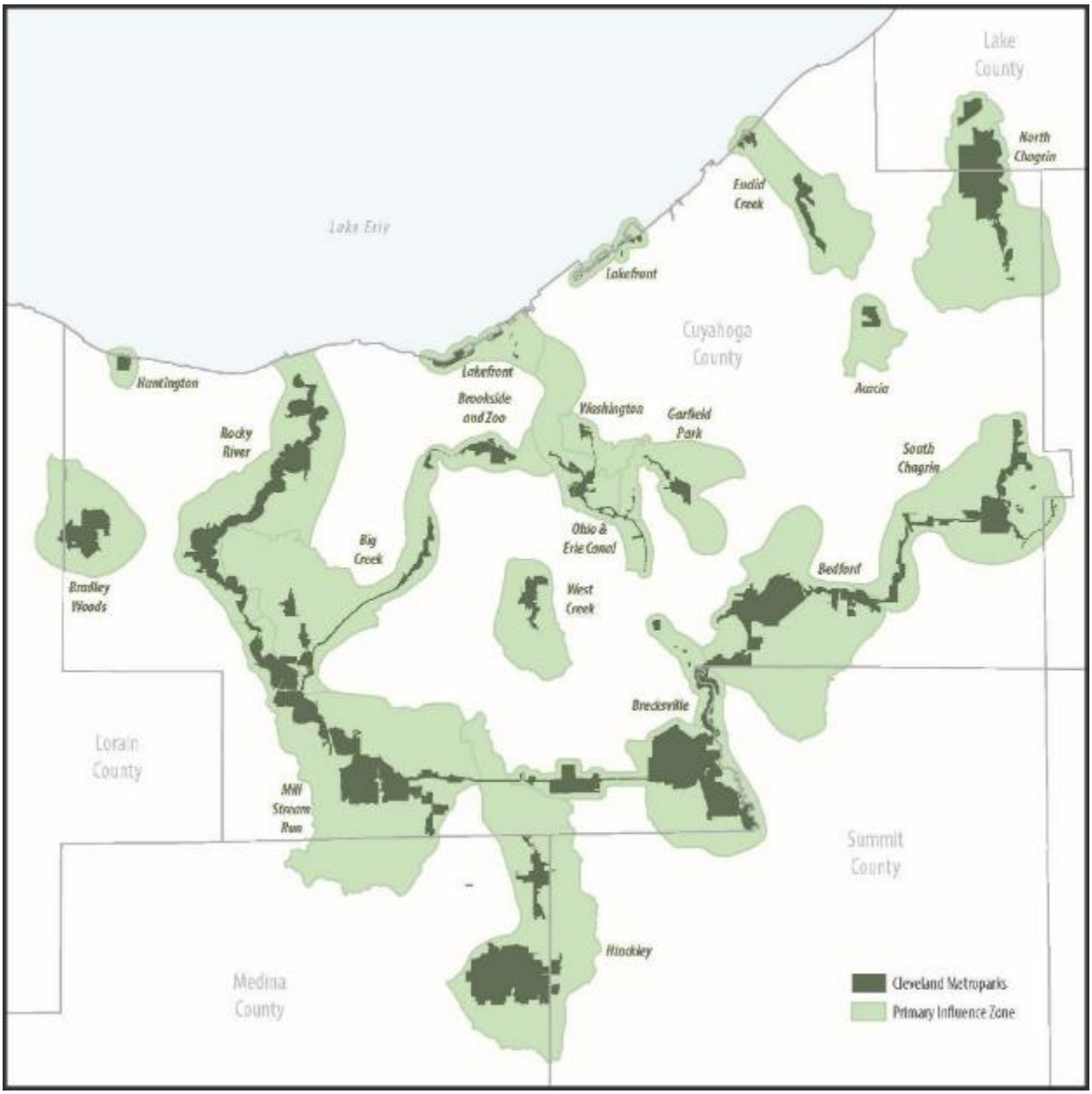


Figure 1. As of December 2021, Cleveland Metroparks encompasses 24,363 acres spread across at least three distinctive ecological regions (Lake Plains, Glaciated Allegheny Plateau, and the Till Plains; Ohio Division of Geological Survey. 1998), providing a diversity of habitats for a wide variety of species. Because political boundaries have little influence on the movement of flora, fauna, and water, NR also considers neighboring 'influence zones' when developing natural resource and other management programs (Section 4.2).

NATURAL RESOURCES IN CLEVELAND METROPARKS 2022 SYSTEM PLAN GOALS

Conserve *land, wildlife and water to protect the beauty and ecological function and resilience of our region and the world.*

Natural Resources Division (NR) is Cleveland Metroparks' scientific and management authority on the status, needs, and vulnerabilities of the Park District's green infrastructure. NR monitors and manages these resources, taking steps to increase the resilience and adaptive capacity of ecological communities. Resilience means limiting the impact of negative disturbances so that natural systems can adapt to changing conditions. Improved adaptive capacity can lead to increases in native species diversity and protection of genetic diversity of populations.

Connect *people to nature and each other to build community and inspire action.*

Ecological connectivity (Tabor et al, 2019) is a guiding principle for natural resource management. NR staff help prioritize land acquisitions to enhance ecological connectivity and provide information so that new trail or other recreational development minimize impacts to ecological connectivity for wildlife and plants. Furthermore, we try to minimize negative impacts on streams and wetlands that are an important avenue for ecological connectivity.

Welcome *all people to explore the parks and zoo and prioritize inclusion, diversity, equity and accessibility.*

NR welcomes a variety of audiences by hosting numerous volunteer activities throughout each year. Opportunities target registered volunteers as well as corporate, nonprofit, school and other special interest groups that represent a broad cross-section of our population. NR also reaches diverse audiences through an assortment of outreach mechanisms, including special events, media, public programs and conferences.

Engage *and serve people with high quality facilities, compelling zoological experiences, volunteer and recreational opportunities and captivating programs and events.*

Outdoor recreation and other experiences occur in our parks in large part because of the condition and abundance of natural resources. NR is responsible for managing these resources and to ensure stewardship and compliance with the regulations that protect surface waters, wetlands, and forests. Fishing, one of the Park District's most popular recreational activities, is closely related to NR programs.

Sustain *and uplift our region, our parks and our zoo, our people and our infrastructure for future generations.*

Walking/Hiking on paved and on natural trails are the top two uses of Cleveland Metroparks (Cleveland Metroparks, 2022a), indicating that intact nature is what attracts many guests to our reservations. Science-based management of natural resources is critical to maintaining attractive, functioning natural spaces and helps maintain support for the parks. NR staff positively impact our finite operational and capital dollars by obtaining significant grant funding. NR also partners with academic and private companies to amplify outcomes.

Innovate *by exploring new solutions to expand the health and well-being of our regional and the world.*

NR frequently trials new technologies and management techniques to explore more efficient and/or effective ways to complete a variety of tasks. Cleveland Metroparks also frequently engages in diverse partnerships to collaborate and solve common problems.

2 Guiding Principles

Three principles guide Cleveland Metroparks' management and protection of natural resources: provide lasting stewardship of the Park District's flora, fauna and geological resources; account for scale and connectivity when making resource decisions; and practice science-based adaptive management to address changing conditions through time.

2.1 Lasting Stewardship

In the earliest days of the national park system, and at the establishment of Cleveland Metroparks in 1917, managers thought that designating land as *protected* was adequate for long-term management. Today, land managers recognize that natural resources require management to mitigate outside forces that affect them.

Most local forests and other ecological communities are altered systems, modified from what they would have been absent extensive development in the region. For example, urban development leads to habitat fragmentation and widespread impervious surfaces that funnel tainted water into headwater streams and rivers. Top predators such as wolves, mountain lions, and bears, which keep other mammal populations in check, have been extirpated, leaving prey animals such as deer to expand greatly in population numbers and impact. Aggressive invasion by introduced plant and animal species change growth and reproduction dynamics of native species. Given these altered conditions, maintaining most basic ecological functions requires management.

Reading the Landscape

Effective stewardship requires reading today's landscape through observation and monitoring and using the information to plan for tomorrow:

- Knowing how development outside the Park District affects stormwater runoff informs management decisions to strengthen shorelines or slow flow through the installation of stormwater control measures. Without this knowledge, severe erosion and downstream flooding occurs, and restoration costs soar. Streams may no longer support juvenile fish or breeding amphibians, leading to declines in biodiversity.
- Monitoring native plant species such as Cutleaf Toothwort informs habitat restoration efforts. Without this knowledge, West Virginia white butterflies could disappear from the Park District entirely due to the loss of its primary host plant, furthering biodiversity declines.
- Forests with few seedlings and saplings of diverse species indicate excessive deer browse. NR monitors deer browse and uses the information to guide deer management. Forest regeneration is a critical need that is currently in jeopardy.

Resource managers consider the land use history as well as current conditions to set management goals and prioritize land acquisition to ensure long-term ecosystem function of Cleveland Metroparks. Understanding the landscape's history (see inset) along with its ecological function is the first step in managing for future conditions. Understanding stressors such as invasive species, climate change, and increasing development is necessary to build lasting stewardship plans.

Just as the management actions we take today have impacts far into the future, we are still discovering consequences of decisions made decades ago. An iconic example of Cleveland's environmental legacy is the foresight shown by William Stinchcomb and his supporters in protecting river corridors with forested buffers, which retain over 600% more stormwater than typical urban surfaces (Bonan, 2002). Even as other cities struggle today to create protective, vegetated buffers along their waterways (Pataki et al, 2011), Cleveland is enjoying the benefits provided by the early planning for reservation lands. Just as historic decisions to protect the waterways around Cleveland still deliver ecological and economic benefits today, today's land acquisition will provide similar benefits for future residents.

2.2 Scale and Connectivity

Cleveland's Emerald Necklace is a model of proactive urban park planning. From its earliest days, Park District planners anticipated one of the most important themes in urban conservation: connectivity. Given its orientation along major river corridors, the Park District serves to connect undeveloped land, allowing flora and fauna to disperse even as urbanization and development pressures increase and create physical and ecological barriers.

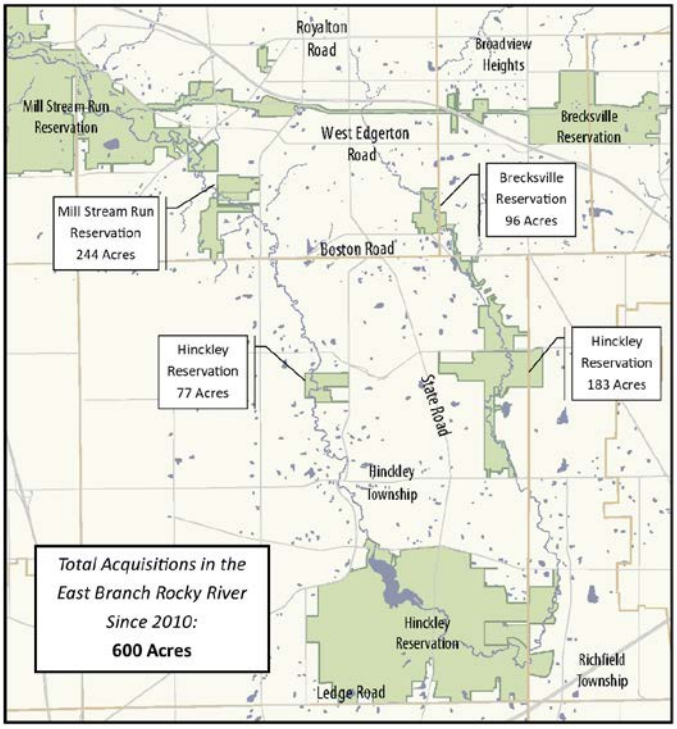
Land connectivity is important both in terms of natural resource function and public access. Both the parks and the communities around them benefit from initiatives that enhance connectivity.

Connectivity is an important consideration for a range of management decisions. At a small scale, trail placement may disrupt ecological processes such as by separating a pollinator species from its foraging habitat (Goverde et al, 2002). At the reservation scale, connectivity guides the prioritization of property acquisition. For example, Cleveland Metroparks makes concerted efforts to increase connectivity and protection of the East Branch of the Rocky River (see inset). Most recently, a Clean Ohio Conservation Fund grant in 2021 protected an additional 75-acres of forests, wetlands, meadows and headwater streams in this area.

Connectivity

For humans and nature

Connectivity and fragmentation are critically important concepts to natural resource management. A landscape with greater connectivity between habitat patches supports a greater number and diversity of plant and animal life. Moreover, park connectivity also works to link people to the parks and the places they are visiting, contributing to health and well-being. Within the reservation system, land is prioritized for acquisition in part according to how it improves connectivity.



At larger scales, connectivity also refers to linkages among reservations, neighboring properties, and broader watersheds. As stated in the System Plan, organizational thinking must extend beyond the reservation scale to more deliberately address the interaction of each reservation with the surrounding community (human and natural ecosystems). Because much of Cleveland Metroparks land is at the bottom of watersheds (Figure 2), actions taken outside the reservation boundaries greatly affect its conditions. At this scale, we also consider each reservation's relationship to its Primary Influence Zone and the variety of entities within that zone, a larger management unit that includes reservations plus the surrounding watershed.

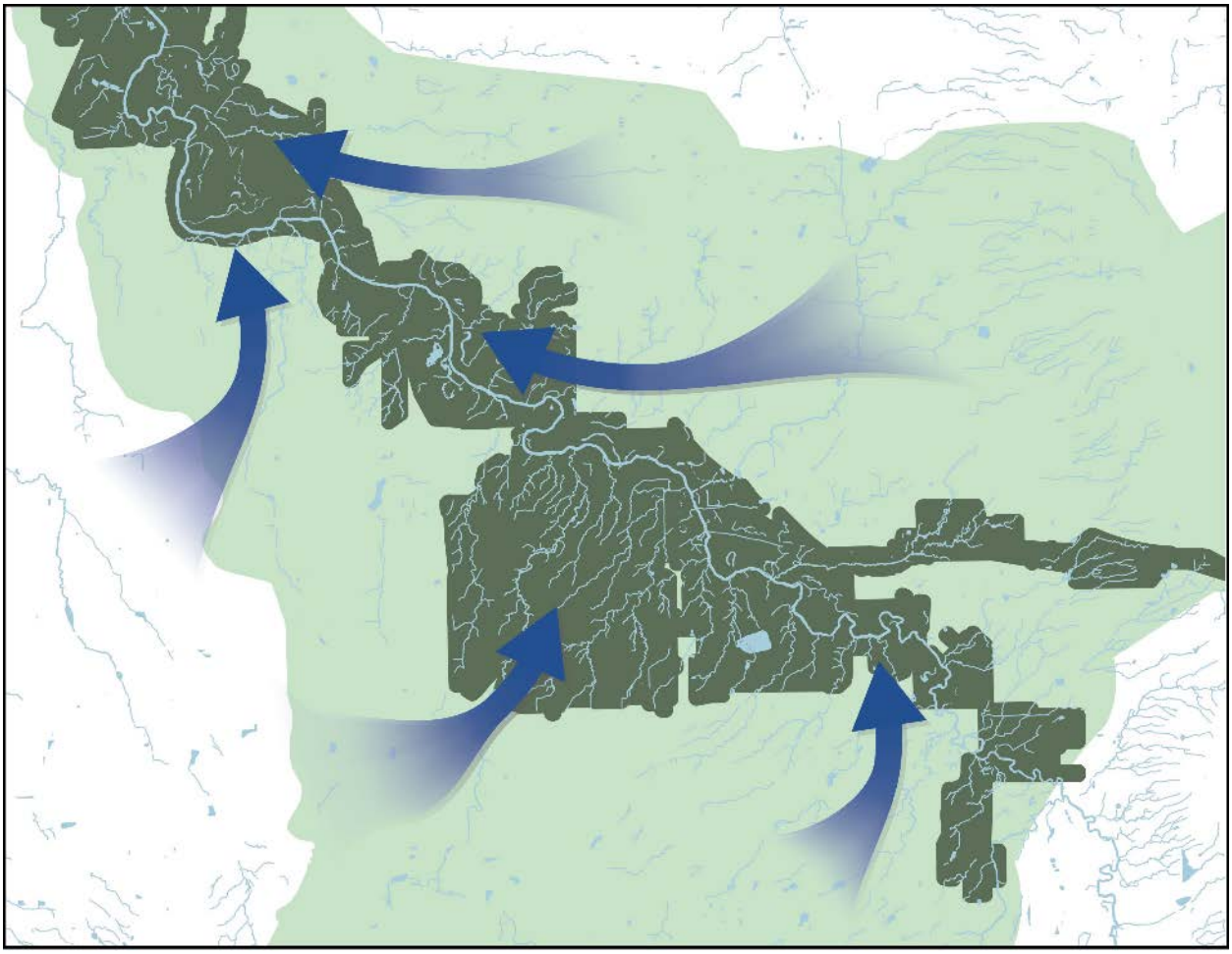


Figure 2. The Park District lands (dark green) often receive runoff from unprotected land in the watershed (light green), so neighboring land use strongly affects the waterways within the reservations.

2.3 Adaptive Management

The decisions we make about managing natural resources do not produce results quickly. Outcomes emerge over long time scales and result from complexities introduced by ecological interactions and human activities, which means that resource management decisions and their effects are burdened by uncertainty. Resource management plans state conservation goals and methods to achieve them, but once implemented, we have to document the actions and monitor results to determine if those goals are being met. Subsequently, managers adjust management activities to reach the goals or modify them to account for new information. This information may include changes in the status of resources, the initial goals, or social information gathered from park users. Social information about how humans interact with their environment is difficult to collect and quantify but is critically important in setting policy and management goals.

Such structured decision-making is termed adaptive management (see Case Study 1). Adaptive management requires that data be readily available to managers shortly after it is collected. NR is currently streamlining the data collection process, but there is further need for integrated database development and management. Verifiable results, which track the efficacy of management efforts, are an important part of these efforts. Increasingly, we are installing automated monitoring equipment for ongoing feedback on management effectiveness.

Taken together, these principles of lasting stewardship, scale and connectivity, and adaptive management guide NR's management of the Park District's rich natural resources.

Case Study 1: Adaptive Management in West Creek Reservation Bioretention

Project Quick Facts

Location: West Creek Reservation

Partners: West Creek Conservancy, Northeast Ohio Regional Sewer District

Timeline

- Early 2013: Initial bioretention installed
- Late 2013-early 2014: Observations & monitoring
- Mid-Late 2014: Redesign & reconstruction
- 2015-2016: Monitoring & maintenance
- 2017+: Design of new practices

Background

Cleveland Metroparks and the partnership that created and enhanced West Creek Reservation and the Watershed Stewardship Center (see section 4.4) identified a key opportunity to use the parking lots near the Stewardship Center as a demonstration site for good practices in managing stormwater in urban or developed land.

Adaptive Management in Action

The process that resulted in the current, high-functioning space was an example of adaptive management. Once the team had identified the goal of creating bioretention cells within the parking lot, engineers and designers worked together to design the model bioretention.

The initial design and construction was a solid starting point, but due to installation and maintenance challenges, the feature never achieved full functionality. Observations and scientific monitoring uncovered two major contributing factors: plant choice and outlet elevation. Originally, browse by white-tailed deer and lack of plant knowledge by maintenance staff meant that the project did not reach the designed aesthetic. Additionally, the outlet elevation did not result in full depth drainage, limiting the stormwater services provided by this feature.

Accordingly, the design was reexamined under an adaptive management framework that quantified the successes and potential improvements, and feedback from the designers and maintenance staff was used to inform a redesign of the bioretention cell. First, the existing subsoil was removed and replaced with material that was more absorptive, and alternative plant species were selected to reduce the threat of deer browse and promote better maintenance. Once the redesign was in place, NR installed new monitoring equipment to measure stormwater retention and ensure that the project goals were met.

This design and construction process has informed numerous subsequent designs at various locations throughout the Park District (e.g., Wildwood, Administration, Wolf Picnic Area, Chalet).

Reconstruction of a stormwater feature at the Watershed Stewardship Center

3 State of the Natural Resources

The Natural Resource Division is responsible for monitoring the state of the park's natural resources, which takes the form of a series of ongoing studies and research efforts. This section summarizes the natural resources in and around our parks and trends that are most pertinent to management actions.

3.1 Geology, Climate, and Regional Context

The geology of a site and its physical properties such as soil characteristics, slope, drainage, and sun exposure are the literal and figurative bedrock of its biological community. Therefore, natural resources can be best understood by considering the region's geology as well as its plant and wildlife communities. To a large degree, the geological and climatic characteristics of the Lake Plain, Till Plain, and Glaciated Allegheny Plateau physiographic regions (Ohio Division of Geological Survey. 1998), drive the ecological dynamics of Northeast Ohio. Geologically, these regions, which are shaped by repeated past glaciation, provide a wide palate of topography, soils, and drainage features, upon which the region's diverse fauna and flora have developed. Past land management by both Native Americans and early colonists further shaped the conditions we observe today, and current inhabitants continue to exhibit strong influence through their land-use decisions.

Climate change is expected to alter current conditions by increasing temperatures, resulting in more extreme rainfall events and drier summers, which will change the composition of the local ecosystem (Pryor et al., 2014). Precipitation will likely become more intense across the Midwest, leading to an increase in flood damage and lower water availability in the summer (USGCRP, 2009). Lake Erie itself is a significant driver of the regional climate. Because it warms and cools more slowly than the adjacent land, the lake delays the coming of spring and fall in coastal areas and increases annual snowfall, especially east of Cleveland.

Just as proximity and physical linkages among the reservations increase their value to plants and animals (connectivity), the overall extent of undeveloped natural space in the region bolsters the overall habitat quality and natural benefits of Cleveland Metroparks and Northeast Ohio (Figure 3). The regional context of these greenspaces is a consideration in natural resource planning to us and other land management agencies and communities in the region that have joined forces to form LEAP, the Lake Erie Allegheny Partnership for Biodiversity (http://www.leapbio.org).

Figure 3. Greenspace on the regional scale. Cuyahoga Valley National Park (including 20,500 acres of federal land, 3,600 acres that are privately held, and some overlap with Cleveland and Summit Metro Parks), Summit Metro Parks (15,000+ acres), and Holden Arboretum (3,600 acres) are major landholders in the region. Other entities contribute additional protected greenspace: the Cleveland Museum of Natural History, Lake Metroparks, Geauga Park District, Medina County Parks, Portage Park District, Lorain County Metro Parks, Western Reserve Land Conservancy, and West Creek Conservancy.

3.2 Water Resources

Northeast Ohio remains rich in water resources, even after decades of development that drained or filled many wetlands and buried or straightened miles of streams. Designed to follow greater Cleveland's river valleys, Cleveland Metroparks contains over 200 miles of river and stream, from small ephemeral streams that receive water from only a few acres, to the Cuyahoga River, which features an 809 mi^2 drainage area. Cleveland Metroparks spans multiple Lake Erie watersheds including those of the Black, Rocky, Cuyahoga, and Chagrin river watersheds, with other drainage basins such as Euclid Creek and Porter Creek, which flow directly to the lake. Within these watersheds are groundwater and surface water-dependent wetlands, headwaters, and ponds. Consequently, water quality and hydrologic function are two of the most important priorities for protection within the Park District.

NR documents and monitors the Park District's water resources in collaboration with the Northeast Ohio Regional Sewer District (NEORSD), Ohio EPA, and other local entities. Ohio EPA provides national leadership in techniques to assess stream and wetland health. Most of the assessments that we use for rivers, streams, seeps, and other wetland habitats rely on a weighted combination of biological community composition and physical variables such as erosion, channel structure, and water depth.

WETLANDS

Cleveland Metroparks contains a broad array of wetlands of various sizes, types and quality. Our inventory and evaluation of wetland resources has improved greatly over the last ten years. NR surveyed representative wetlands in 2005 (n=84) and 2006 (n=196) (Durkalec et al 2009), in an effort that confirmed urban development's effect on the reservations' wetlands, especially those surrounded by narrow or low-quality buffers.

In 2016, we completed the first comprehensive inventory of all wetlands in the Park District. This inventory mapped and described the physical and biological attributes of over 3,200 primarily naturally occurring wetlands. One of the most striking conclusions from this work is the preponderance of small wetlands (66% < 0.1 acres, 14% 0.1 to 0.3 acres, 16% 0.3 to 3 acres, 3% 3 to 10 acres, and 1% > 10 acres). Federal and state government agencies prohibit or control the destruction of most aquatic resources, but small wetlands that are isolated from other aquatic resources have minimal protection outside of parks. Throughout the region and especially outside of protected land, development or agriculture has destroyed many of these small wetlands. Cleveland Metroparks protects over 1,800 small wetlands and is a key player in maintaining their presence on a landscape scale. Wetlands located outside the floodplain, including many shrub swamps, forest seeps, sedge meadows, and vernal pools, are especially valuable because they provide a fish-free habitat for breeding amphibians and macroinvertebrates (i.e., larger arthropods, mollusks, and nematodes), support rare plant species, and maintain natural hydrology.

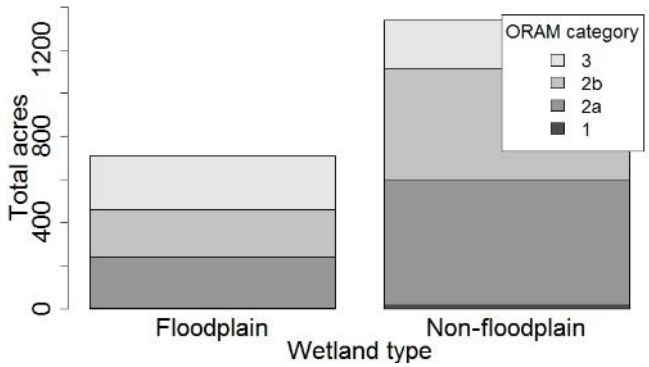


Figure 4. Wetlands regularly flooded by rivers and streams (Floodplain) have a larger proportion that are ranked as higher quality compared to wetlands influenced mostly by precipitation or groundwater (Non-floodplain). ORAM categories indicate 3 = High quality and/or superior function, supporting rare/threatened plants; 2b = Good quality and/or moderate function, no rare species; 2a = Good but degraded, restorable; 1 = Low quality, minimal function (few reservation wetlands fall in this category).

Grouping wetlands by quality (Figure 4), over 150 are ranked as having superior habitat and/or hydrologic function (i.e., Category 3 as defined by the Ohio Rapid Assessment

Method; Mack 2001), representing 23% of the total wetland area in the park. Floodplain wetlands, which are frequently flooded by streams and rivers, make up another 23% of the total wetland area in the Park District. Floodplain wetlands are generally of higher quality than wetlands isolated from floodplains, largely because they are well-buffered and more hydrologically complex.

STREAMS AND RIVERS

Cleveland Metroparks is the largest stream-side landowner in Ohio, with 31 miles bordering the Rocky River, 9.5 miles of the Chagrin River, and 5.3 miles of the Cuyahoga River. Outside of these larger river corridors, the Park District also protects over a dozen headwater streams draining watersheds smaller than 20 mi^2, and nearly 1000 primary headwater streams draining watersheds smaller than 1 mi^2. These small streams provide important ecosystem services including flood control, sediment reduction, and critical habitat for unique and sensitive aquatic species. Streams also serve as barometers for the health of the surrounding landscape, and they quickly reflect the impacts of development, agriculture, and other human activities.

From 2003 to 2012, staff assessed habitats and biological communities in primary headwater streams and smaller headwater streams that NEORSD and Ohio EPA do not monitor (Figure 5; Weldon 2012).

Although the rivers and streams in Cleveland Metroparks retain many of their natural channel characteristics and intact riparian areas typically surround them, large portions of their watersheds are sometimes located in highly developed urban or rapidly developing suburban/rural landscapes. Runoff and other consequences of nearby development generally affect the biological communities before causing noticeable physical changes in the streams. We see this when comparing a stream's physical quality to the numbers of insects it can support. If it is healthy, a stream with given physical characteristics should have certain biological characteristics and fall in the same class according to both measures. When the numbers of streams in each class don't correspond, it can indicate that inputs from upstream within the watershed are negatively affecting the stream. There are roughly the same number of streams in class III for both physical and biological characteristics, but fewer streams are class II than we would expect based on physical stream characteristics (Figure 5).

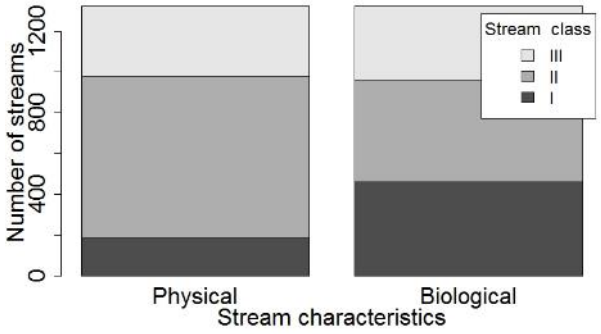


Figure 5. Roughly the same number of streams fall into class III for both physical and biological characteristics, but the counts are quite different for classes II or I. Classes for the physical (HHEI) index focus on substrate composition, maximum pool depth, and bankful width. Classes for the biological (HMFEI) index are based on macroinvertebrates and emphasizes the presence of three insect orders: Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies).

Our park-wide assessments indicate good overall condition of streams in the Park District, but assessments also help identify both exceptional and problematic areas. Primary headwaters in Hinckley and Bedford reservations stand out with their diverse and abundant assemblages of aquatic macroinvertebrates and stream-dependent salamanders. In contrast, Mill Stream Run and the urban reservations that make up the central core of the Park District have consistently poorer aquatic biota, likely because their watersheds are more urbanized and the natural systems are more fragmented.

LAKES AND PONDS

Cleveland Metroparks manages a total of 11 ponds, oxbow/canal segments, and inland lakes that offer both wildlife habitat and recreational opportunities such as wildlife watching, boating, fishing, and swimming.

The standard for managing these waterbodies is defined in federal law (Clean Water Act, 1972), often referred to as the "fishable/swimmable goal." We maintain, and improve where possible, the chemical, physical, and biological integrity of the waterbody. For lakes and ponds without swimming access, the foremost goal is to provide fishing areas. Electrofishing is used to estimate fish population structure, providing information to guide stocking regimes or to signal the need to remove exotic fish species such as carp. NR manages other waterbodies that are generally smaller and inappropriate for swimming or fishing as habitat for a wide range of animals and plants.

Overall, the public fishing ponds and lakes are fulfilling their role for fishing, and in some cases their additional roles for use of small watercraft and swimming. Based on a staggered (2 per year) five-year cycle of fish population sampling initiated in 2010, all 11 public fishing areas currently have self-sustaining (although sometimes supplemented with stocking) sunfish and largemouth bass populations. Two of those lakes did not contain largemouth bass, the top piscine predator in smaller Ohio water bodies, during the first round of monitoring. Subsequent stocking and follow-up surveys revealed they now contain reproducing populations. Others, such as Shadow Lake, have shown noticeable improvement of largemouth bass populations. Additionally, seven fishing areas are stocked with rainbow trout and ten are stocked with channel catfish to supplement fishing opportunities. Nusiance algae and aquatic macrophytes are annually treated at five fishing areas, although occasionally additional sites warrant treatment.

In coordination with the Cleveland Metroparks survey crew updated bathymetric maps have been produced since 2015 for 9 of the 11 public fishing areas (the exceptions being Oxbow Lagoon which is full of downed woody debris and the Ohio & Erie Canal which varies little in depth in its linear boundaries). These are of highest interest to the fishing community, as well as being of use for natural resources management purposes.

The Aquatic Invasive Plant Program began plant community assessment, with focus on Hydrilla surveillance, in 2016 and has monitored plant communities at all public lakes in Cleveland Metroparks on either an annual or biannual basis depending on level of risk involved. To date, Hydrilla has been found in only one public fishing area, Wallace Lake, and that was followed-up with aggressive multi-year treatments. It has not been observed in the lake since.

Popular swimming beaches are located at Wallace Lake and at the Hinckley Lake spillway. Wallace Lake is monitored by local health departments for bacteria 4 times/week during the swimming season and closures for exceedances are rare. The beach only had to close due to water quality 4 times since 2013 while lifeguards were on duty (once in July 2021 and 3 times in 2018). The area is closed if *E.coli* levels are above 900 mpn/100ml. Hinckley Lake swimming area is not tested for bacteria. Lake Erie fisheries and water quality near swimming beaches is closely monitored by a variety of local, regional and state agencies. Cleveland Metroparks provides assistance when needed, but generally does not lead Lake Erie monitoring or management efforts due to its scale and emphasis by others

3.3 Plant Communities

The forests that form the core of Cleveland Metroparks today helped earn Cleveland the nickname "the Forest City." In 2011, 77%, or 16,547 acres, of total reservation area was covered by trees and forest (Table 1; Hanou, 2010). Some especially valuable forested habitats include hemlock ravines and relatively undisturbed areas such as the beech-maple forests of A. B. Williams Woods. A county-wide urban tree canopy (UTC) assessment conducted in 2017 measured a decrease in UTC from

37.6% in 2011 to 34.7% in 2017, primary attributed to development, invasive pests, wind damage and neglect.

Table 1. Summarized results of the Urban Tree Cover (UTC) assessment, including the acres that could support trees if restored (2011, 2017) (Hanou 2010, Cuyahoga County 2019)

Area	Total Acres	Existing Urban Tree Canopy	UTC %	Impervious Acres	Impervious %	Possible UTC Acre
Reservations[a]	21,502	16,547	77.0	964	4.5	3,592
Primary Influence Zones[a]	150,514	61,597	40.9	39,479	26.2	48,802
Cuyahoga County 2011[a]	292,000	109,792	37.6	44,500	15.3	371,000
Cuyahoga County 2017[b]	292,000	101,324	34.7	45,200	15.5	371,000
[a] 2011 [b] 2017						

An important tool used to understand vegetation within the Park District is the Plant Community Assessment Program (PCAP; See Case Study 2). This rigorous monitoring effort has revealed that all major reservations have both high-quality plant communities that need protection and other lower quality communities that have been degraded by deer browsing, invasive species, land use change, and other factors (Eysenbach and Hausman, 2013).

PCAP measurements are implemented on a regular schedule across 16 of 18 reservations (we do not currently sample Acacia and Lakefront in this way), determining plant community types based on vegetation composition and assigning an integrated score of habitat quality to each site. We then use that score, the Floristic Quality Assessment Index (FQAI) to compare the condition of the community between sites and years (Mack and Gara 2015). Plant species that are widespread with broad habitat ranges are identified as "tolerant" to disturbances, versus those with high habitat fidelity and narrow ranges of ecological tolerances identified as "sensitive" (Andreas et al. 2004, Mack 2007, Mack and Gara 2015). Scores for select community types within reservations, are described in greater detail in Natural Resources Area Manager PCAP reports (Eysenbach and Hausman, 2017, 2017b, 2017c, 2018) and in the LEAP habitat descriptions (Stover and Curtis 2014) are summarized in Table 2.

Table 2. Summary of FQAI scores in major plant community types and coverage. Two contributing sub-metrics that are used to calculate the FQAI score (% Sensitive species, % Tolerant species) are also listed.

	Community type	Percent of plots	Plots sampled 2015-2018	Average FQAI score (min-max)	% Tolerant Species	% Sensitive Species
Terrestrial Communities	Beech-Mixed Hardwood (Hemlock) Forests	20.3	81	22 (7-35)	13.6%	30.3%
	Oak-Mixed Hardwood Forests	7.3	29	21.3 (13-28)	21.3%	14.3%
	Sugar Maple-Mixed Forest	23.8	95	21.2 (8-32)	28.7%	7.5%
	Bottomland Forests	9.8	39	17.2 (7-27)	42.2%	5.5%
	Mesic Meadow	5.8	23	8.4 (3-14.1)	77%	2.1%

	Ruderal Wet-Mesic Shrubland and Thicket	8.3	33	15.7 (5-30)	59.7%	5.3%
Wetland Communities	Wet Meadow and Marsh**	2.8	11	10.9 (2.5-18)	66.6%	4.4%
	Wet-Mesic Red Maple Forest	22.3	89	17.8 (9-32)	36.8%	11.5%
** Note small sample sizes: results are highly sensitive to the individual scores of particular plots						

Among these terrestrial communities, several are notable because they provide important ecological services that may not be common across the landscape. Floodplain forests provide key functions by protecting streams from erosion and other flooding effects and providing critical habitat and important travel corridors for wildlife. Beech-Mixed Hardwood (Hemlock) forests are characterized by dense tree canopies and thick layers of humus and leaf litter supporting seasonal vernal pools, which enhance the habitat value for amphibians and macroinvertebrates. Hemlocks are long-lived, and their communities provide shade for cooling streams and important habitat for species that live in tree cavities, such as woodpeckers, owls, and flying squirrels.

Finally, mesic meadow (Figure 6) habitat is common throughout Cleveland Metroparks, where old farm fields have reverted to open meadows. Without management intervention, these old fields would transition to early successional forest habitat. We maintain some of these fields as open meadows by brush-hogging and controlled burning. These community types host pollinators and sun-loving plants and provide habitat to birds such as the state endangered northern harrier, and state species of concern such as the bobolink. We maintain this habitat through irregular mowing and prescribed fire that avoids nesting times and sometimes remove trees. However, we balance efforts to create more of this habitat type against the need to reduce fragmentation and edge habitat associated with forests (see 3.1 below).

Figure 6. Old field community at Jackson Field, South Chagrin Reservation.

Case Study 2: Understanding Plant Communities—What is PCAP?

Project Quick Facts

Location: 16 of 18 reservations

Partners: Lake Erie Allegheny Partnership, National Science Foundation Urban Long Term Research Area Exploratory project

Timeline

- 2010 – 1st cycle of PCAP data collection begins
- 2014 – analysis of 1st cycle (405 plots over 4 yrs)
- 2015 – 2nd cycle of data collection initiated
- 2021 – 3rd cycle of data collection initiated & comparison of 1st & 2nd cycles

Background

Cleveland Metroparks, like natural resource management agencies across the country, needs a way to assess quality and document changes in plant communities through time to determine if management actions are working and to provide early problem detection. Prior to 2010, we tracked the state and quality of vegetation in each reservation separately, as well as in one park-wide project that tracked vegetation related to a single stress factor: deer browse. For various reasons, these efforts, while valuable, could not track conditions over time for many vegetation features. In 2010, we launched the Plant Community Assessment Program (PCAP) to document the physical and biological composition of plant communities and their changes through time for the entire Park District. In addition to recording vegetation community composition and structure, PCAP data also provides estimates of invasive plant species distributions, structural components of the site, the extent and species preference of deer browse, and potential threats by forest pests such as emerald ash borer (Hausman 2011; Hausman and Robison, 2010).

3.4 Animal Life

The Park District hosts a diversity of animal life, including a variety of insects and other arthropods, annelids, mollusks, fish, amphibians, reptiles, birds, and mammals. These animals play an integral role in the condition and character of Cleveland Metroparks. Serving as architects and inhabitants of dynamic ecosystems, they function as predators, prey, scavengers, decomposers, and pollinators. Wildlife provide cultural benefits and recreational opportunities, and their presence has implications for the quality of life of all residents of and visitors to the region. Birdwatching and fishing, especially along the lakefront and rivers, are multi-million dollar industries in Northeast Ohio (Xie 2012). To track changes in abundance, diversity, and health, park staff and volunteers actively monitor many animal species using field surveys and community science applications such as iNaturalist and eBird to document occurrences. Guest-submitted records of coyotes, birds, and a wide range of other animals are used to track species, too. Using wildlife cameras, we also look for secretive visitors that we have either not seen for many years or that may be immigrating from other areas. Examples of questions we hope to answer include: Do gray fox still exist in our parks? Have bobcats reached us yet as they expand their range from southern Ohio? Will cameras catch the occasional black bear that moves through our area? Do we have short-tailed weasels? Do we still have healthy populations of secretive or difficult-to-detect snake species, such as smooth green snakes, and do they show up using new camera trapping approaches? Can we capture seasonal migrations of amphibians to and from breeding wetlands?

BIRDS, MAMMALS, AMPHIBIANS, AND REPTILES

Wildlife include well-known animals such as bats, birds, turtles, amphibians, snakes, raccoons, deer, and coyotes, as well as animals such as river otters, mink, red fox, and smooth green snakes that are more secretive but nevertheless critical indicators of ecosystem function. For instance, the region hosts the eastern red-backed salamander. Through its foraging and territorial behavior, this salamander shapes the structure of forest floor invertebrate communities wherever it is found

(Walton 2013) serving as both predator and prey and contributing to the cycling of nutrients. Other rarely seen wildlife whose presence indicates stream and wetland health includes bald eagles, spotted salamanders, and mink. White-tailed deer are common and often overabundant, because of land use change, the lack of predators, and reduced hunting. This overabundance has resulted in heavy browsing on seedlings and understory forest plants changing the structure, temperature, and moisture found in the understory (McShea and Rappole 1992; Rooney 2001). Canada geese and raccoons are other native species that continue to increase in population numbers because of their adaptation to urban environment and shifting ecosystem and predation dynamics.

Some of the particularly sensitive and vulnerable species in this landscape are federally threatened or endangered, though most are migratory rather than permanent, year-round residents. These species include Indiana and northern long-eared bats, Kirtland's warbler, piping plover, and Rufa red knots. Sensitive species within the Park District also include smooth green snakes and Blanding's turtle, which are endangered and threatened respectively in Ohio. Blanding's turtles were the focus of a cooperative captive rearing project with Cleveland Metroparks Zoo (see section 4.2; Case Study 5). Other species on our watch list include cerulean warblers and bobolinks. These Neotropical migrants rely on local forests and meadows for nesting and rearing habitat and are excellent indicators of ecosystem health.

FISH

The high-quality drainage basins of Cleveland Metroparks host populations of southern redbelly dace and redside dace, both cold-water minnow species that are recognized by Ohio EPA to be in decline across the state. These species only live in clean, colder, fast-flowing streams. Ohio's threatened native brook trout are present in Hinckley Reservation, and the East Branch Rocky River and Cuyahoga watersheds support state-threatened central bigmouth shiner populations. The Park District's ponds and lakes support species such as white crappie, bluegill, and pumpkinseed sunfish, as well as largemouth bass, channel catfish and seasonal rainbow trout stocked in select areas. Lake Erie access from the lakefront parks offers a diversity of fish species such as yellow perch, walleye, and smallmouth bass. The rivers and streams offer diverse fisheries, with the main species including smallmouth bass, steelhead trout, channel catfish, common carp, suckers, and rock bass. We use the presence of defined fish species as indicators of stream quality based on standards developed through Ohio EPA research (Ohio EPA 2014, 2015).

INSECTS AND OTHER MACROINVERTEBRATES

In addition to fish and wildlife, Park District lands support a diversity of insects and macroinvertebrates in both terrestrial and aquatic environments. In a single one-day survey, Cleveland Metroparks and Cleveland Museum of Natural History staff tallied 137 species of insects and arthropods at the Roger's Road meadow (Figure 7) in North Chagrin Reservation. These organisms serve as the foundation of terrestrial and aquatic food webs and drive key ecological processes such as plant pollination and nutrient cycling through decomposition of organic material.

The wetlands, lakes, rivers, and streams of Cleveland Metroparks are home to a diverse community of aquatic macroinvertebrates, from ubiquitous crayfish and midges that can be found anywhere there is a trickle of water, to rare species of stoneflies and caddisflies that only inhabit the coldest and cleanest springs. Aquatic macroinvertebrates are excellent indicators of aquatic ecosystem health (Ohio EPA 2012). Species that are present (or absent) provide information on the condition of a waterbody and may indicate impairments such as chemical pollution or sedimentation. The Park District conducts regular monitoring of aquatic macroinvertebrate communities in headwater and primary headwater streams as part of its long-term ecosystem monitoring program.

In the terrestrial realm, insects are important as pollinators and for cycling the carbon sequestered by plants into other parts of the food chain. Flies, bees, and butterflies move from one plant to another, carrying the pollen necessary for fertilizing the next generation of plants. iNaturalist community scientists have reported over 100 species of butterflies and 17 species of bees in the Metroparks. Other insects and macroinvertebrates eat plant material, and then are eaten by birds and other wildlife, allowing the carbon that plants pull from the air during photosynthesis to support a diverse range of other animals. Forest trees support large diversities of insect and macroinvertebrate species. For example, one large oak tree can support 22 species of leaf-folding caterpillars (Tallamy 2007; Lill and Marquis 2003). As mentioned above, meadows are rich in insect diversity. Butterfly populations in the Park District have been monitored since 1996 as part of the Ohio Lepidoptera Long Term Butterfly Monitoring Program. Park wide, there have been 78 species of butterflies documented including the charismatic monarch butterfly down to the smallest of skippers.

Figure 7. Pollinators in Roger's Road meadow.

4 Natural Resource Threats and Stressors

4.1 Fragmentation and Land Use Change

Urbanization, open space development, and agriculture compromise or eliminate natural areas that previously supported native plants and animals, causing a net loss of habitat. As cities expand (Figure 8), urban sprawl tends to split the remaining tracts of natural communities. The resulting fragmented landscape offers less structural connectivity for movement of species among habitats.

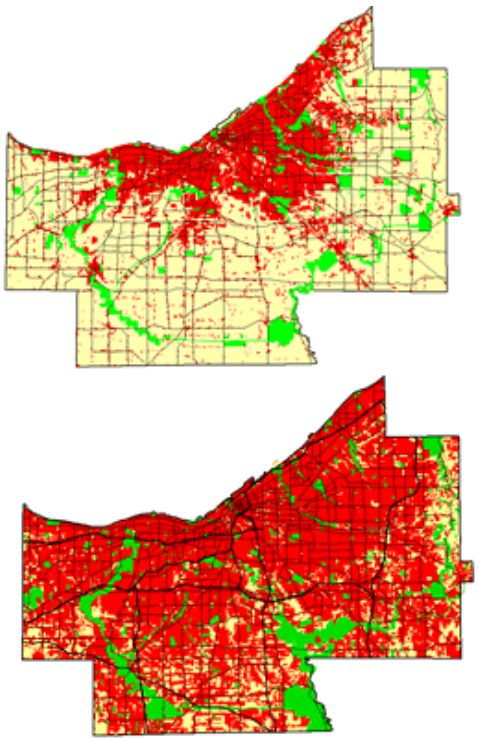


Figure 8. Urban areas in 1948 versus 2002 in the five county region. Red indicates urban expansion (**WR Land Conservancy**)

edge-to-forest-area ratios. Land use is also evolving on a scale smaller than the regional urbanization trends. Even at a small scale, disruptions in habitat continuity can lead to fragmentation effects such as species changes and brood parasitism (Rodewald et al 2013).

More urbanization also means greater demand for recreation and increasing pressures on the system from new trail development for mountain bikes, unauthorized on and off-trail use (Figure 9), and a suite of other interests such as drones, geocaching, and canopy ropes courses. It has never been more important to protect the few remaining blocks of intact habitat from these increasing pressures.

There is both less total forest cover and a higher ratio of forest edge to forest interior, which tends to reduce functional connectivity (i.e. gene flow, dispersal of species). Forest edges, where the forest

abuts open or developed space, are hotter, drier, and more prone to entry by invasive species (Cadenasso and Pickett 2001). Though some species, including white-tailed deer, thrive on forest edges, many native species, such as some neotropical migrant songbirds, suffer higher predation and parasitism near forest edges (Chalfoun et al 2002). These species require interior forest because it provides better shelter from nest parasites and predators and they have higher reproductive success there. For example, Brown-headed cowbirds, once a grassland species of the central US, have flourished and moved eastward as agriculture and urbanization have fragmented once expansive forests. Cowbirds are nest parasites: the females commit their energy to egg laying in other species' nests rather than building their own. When hatched, cowbird chicks dominate the nest, often displacing the native juveniles. Smaller, fragmented forests provide ideal conditions for this parasitic species to the detriment of host species.

Over the years, land acquisition has focused on tracts in key areas to improve connectivity throughout the Park District and enlarge existing tracts to reduce

Figure 9. Unauthorized ATV trails created in Bradley Woods reservation.

Case Study 3: Minimizing fragmentation along the A.B Williams Sylvan Loop Trail

Project Quick Facts

Location: North Chagrin Reservation

Result: Sustainable techniques integrated into trail design

Partners: Trails Division, Natural Resources Division, Outdoor Experiences Division, Park Operations Division

Timeline

- 2016 – Project identified
- 2011-2016 – Pre-opening ecological assessment
- 2017– Trail Construction

Background

Trails are the most important way for people to experience the wildest, most beautiful parts of a park. Trails provide the number one recreational use in Cleveland Metroparks, and walking, hiking, trail running, horse riding, bicycling, and mountain biking are popular activities that contribute to healthy lifestyles. Trails are an indispensable service to the public, but as trail miles increase, their impact on natural resources also increases. Some animals will change their behavior to avoid trails, while others use them to access areas they avoided previously. Trail-building creates new paths for water movement, leading to soil displacement and erosion. They provide pathways whereby unwanted pests such as invasive plant species are transported into new areas of forest. The challenge is to create trails by choosing sites and techniques that will provide the maximum benefit while protecting natural resources and the function of native ecosystems. Moreover, proper decommissioning of poorly constructed, eroding trails is at least if not more important than the construction of new trails. In response to off trail use, erosion issues, and historical renovations to the site of Cleveland Metroparks first trail side museum, staff from several divisions planned and implemented trail improvements including new trail segments and trail closures.

Management Actions

Creating a sustainable trail involved three phases: trail alignment, sensitivity analysis, and monitoring after construction (Protano ,2014). The A.B. Williams site offered several advantages. It provided the opportunity to decommission several sections of trail that were installed before modern guidelines for the protection of resources. It also provided significant improvements in grade, an important consideration for erosion control and accessibility to mobility challenged guests. Once the site was selected, NR biologists surveyed the area for rare or threatened species and determined the setbacks needed to protect these areas and sensitive stream banks from erosion. The trail design process was collaborative, with biologists' input on both route and construction. The discussions were tense at times because the area has little human impact, contains some of the largest and oldest trees in the Park District, and because of the presence of a new, unidentified pathogen termed beech leaf disease. In the end, we agreed that the improvements, if done correctly, would lead to a net gain in protection of the resource and public enjoyment. Trail construction took care to protect tree roots, utilize on-site materials as much as possible, and most importantly, rehabilitate closed sections of trail to prevent continued use of those sections. To monitor the long-term impacts of the completed trail on plant communities, NR established sample plots and measured a baseline of vegetation conditions prior to trail opening.

The Sylvan Loop Trail in North Chagrin Reservation is designed to minimize impact while providing access to a stunning yet fragile forest ecosystem.

Since explorers began sailing to new continents, human movement around the globe has come with the spread of species into areas where they did not previously occur. When these species spread rapidly into new areas and negatively affect existing native species, they are referred to as invasive species. Spread of exotic, invasive species has increased as travel has become more efficient and as people's appetite for "something different" in their garden has increased. As these invasive species spread, they alter the communities they invade, sometimes radically.

INVASIVE PLANTS

Invasive plants are major threats to native ecosystems, outcompeting native species and degrading the ecological services they provide. Staff in the plant community assessment and the invasive plant management programs collect detailed information about the distribution and abundance of non-native invasive plant species in the parks. Our knowledge and geospatial data guide management priorities and annual field work plans. We track over 100 species of terrestrial and aquatic plants, categorized into four survey tiers to classify their known population status (Table 3).

Each of these plants does not pose the same level of threat in every reservation; each reservation has its own mix of problem species with differing degrees of infestation. Many reservation wetlands are now dominated by narrow-leaved cattails, reed canarygrass, and common reed, leading to wetlands with very different appearances and ecological function.

The aquatic invasive species program (AIS) at Cleveland Metroparks surveys and manages aquatic plants in the park district. AIS staff are engaged in outreach and technical assistance within the Lake Erie basin in Ohio. Recently Cleveland Metroparks celebrated successful eradication of an aggressive aquatic invasive species - *Hydrilla verticillata*, that had been found in a handful of water bodies in several reservations. Staff will continue to monitor for its presence.

Table 3. Cleveland Metroparks classifies and manages invasive plant species using a tiered system. Species may change classification based on current data on distribution and abundance. (Hillmer and Eysenbach 2019)

PCAP / IPMP Survey Tier	Population status within Cleveland Metroparks (CM) or adjacent regions, known distribution	Comments
Tier 1	Early Detection – Rapid Response (EDRR) within CM; Reputed invasive in adjacent regions	Highest priority for management, known to be highly invasive elsewhere, limited distribution in CM
Tier 2	Localized populations in CM; Localized populations, disturbed sites; Localized populations in LEAP region	Known to be invasive elsewhere, has not fully occupied potential habitat at CM
Tier 3	Reputed invasive in adjacent regions; Reputed naturalized not invasive	
Tier 4	Widespread and abundant within Cleveland Metroparks	

INVASIVE ANIMALS

Invasive insects are addressed below, because they are commonly associated with diseases.

Though invasive plants are a more pervasive problem, invasive animals are present in the region. Several invasive earthworm species have widespread ramifications throughout local ecosystems

because they alter soil characteristics, reduce leaf litter, disrupt microbial communities, and destroy seed crops (Cassin and Kotanen 2016; Hale et al. 2006). The combined effects of worms and overpopulation of deer are responsible for altering understory plant communities, reducing tree recruitment, and allowing encroachment by grasses and non-native plant species (Fisichelli et al 2013). Mute swan invaded our waters and aggressively exclude native waterfowl. Non-native turtle species (e.g, red-eared and yellow-bellied sliders) compete for the same resources as our native turtle species, potentially limiting reproductive success. Others are mostly absent but require observation: feral swine are present in neighboring counties, requiring vigilant monitoring for them because of their extremely destructive habits especially to wetlands (Snow et al. 2017).

INVASIVE INSECTS AND PATHOGENS

Invasive insects and microbes can cause considerable damage to forests, woodlands, urban vegetation and wildlife (Table 4). Many of the most devastating are introduced species originating outside the U.S. Because our native species evolved without them, they have few mechanisms of resistance to introduced insects and disease-causing organisms. Some of these pests spread on their own, others are inadvertently introduced by people through activities such as moving infested firewood or bringing in infected hosts. Often the most devastating invasive insects and diseases kill trees (e.g., emerald ash borer, Asian long-horned beetles, hemlock woolly adelgid), leaving gaps in the forest, opening locations for invasive plants to grow. In other cases, invasive microbes can devastate host populations to the point of at least local extinction. Dutch elm disease and several emerging disease threats (e.g., beech bark disease) are caused by fungi transmitted by a beetle.

Table 3. Invasive insect and disease threats and their possible effects

	Invasive Insect or Disease	Host	Effect
Past	Chestnut blight fungus	American chestnut trees	Fungus damages bark and underlying tissues, causing death of trees over ~6 in diameter
	Dutch elm disease	American elm trees	Fungus carried by beetles damages tissues under bark, trees plug nutrient transmitting vessels and die
Current	Gypsy moth	Deciduous trees	Severe damage or death after second defoliation
	Emerald ash borer	Ash trees	Tree death within 3-5 years
	Chytrid fungus, Ranavirus	Amphibians	Salamander and frog mortality
	White nose syndrome	Bats	Local extinction of several bat species
	Beech leaf disease	Beech trees	Large scale leaf damage, canopy decline and young tree mortality.
	West Nile, Lyme disease, encephalitis	Mosquitos, ticks & vertebrates	Flu-like symptoms, encephalitis, death
	Hemlock woolly adelgid, Elongate hemlock scale	Eastern hemlocks	Tree death within 3-10 years
	Spotted Lanternfly	Cherry, Grapes, Maples, Oaks, Pine, Poplar, Sycamore, Walnut, Willow	Plant stressor; may not cause death on its own
	Coronavirus	Deer, unknown	Unknown
Future	Asian longhorn beetle	Deciduous trees	Tree death occurs 10-15 years after infestation

4.3 Stormwater

Cleveland Metroparks System Plan identifies stormwater runoff as a key stressor impacting natural resources and built infrastructure such as roads and bridges throughout the region. Natural surfaces, such as meadows and forests, allow water to soak into the ground closer to where it falls during a storm and then filter slowly into the groundwater. Typically, most water flows below the surface in groundwater and aquifers. Some of it empties into streams and rivers and other surface water bodies (Figure 10 below). Water flowing on natural surfaces or below ground is filtered and cooled along the way through natural processes.

With an increase in impervious cover (roads, sidewalks, and surfaces associated with buildings) in urbanized areas, stormwater rushes across pavement and into storm drains, which then release a torrent of warm, sometimes contaminated water directly into streams causing incised stream channels and downstream sedimentation through erosion. Such storm events and the ensuing runoff can create flood hazards, cost significant dollars to repair damage, and decrease biological quality. A single May 2014 storm event consumed 9,013 hours of Cleveland Metroparks staff time and $671,000 in clean-up costs (Cleveland Metroparks Project Completion and Certification Report, Disaster FEMA-4098-DR-OH, 2016). More impervious cover also causes streams to have larger average flood peaks and water levels to rise and fall quickly and sometimes violently.

Stormwater is a threat not only because of the physical impact of high water volume and flows, but also because of compromised water quality. In a natural system, water quality improves when it filters through vegetation and healthy soils. However, this cannot happen in a storm drain, a concrete channel, or a pipe where water is received directly from potentially contaminated surfaces. When stormwater runoff is not well-managed prior to discharge into natural water bodies, those contaminants can combine with increased scouring from high flow to cause a decline in the diversity of macroinvertebrates and other animals that depend on the stream habitat (Davidson-Bennett 2011).

Figure 10. Natural hydrological flows (Left) and altered flows after development (Right). © Biohabitats.

Across Cleveland Metroparks, there are a few areas where we have specific concerns about the stormwater that is entering the Park District. Where there is a juxtaposition of especially pristine, high-quality habitat with rapid or extensive development, the threat posed by stormwater is most intense. Suburban development near Brecksville's, North Chagrin's, and South Chagrin's high-quality

coldwater streams and a similar interface on several borders of Hinckley Reservation are monitored closely to ensure early detection of stream degradation or increased flooding.

Newer developments are required to have stormwater control measures, albeit not at a volume capture adequate for current observed rainfall let alone climate change forecasts. So the severity of runoff is somewhat correlated with the age of a development. Newer building and construction codes that specify methods of infiltration and onsite retention greatly reduce the volume, speed, and contamination of runoff, if these measures are implemented. Appropriate stormwater control measures can reduce the quantity and improve the quality of water flowing into streams during a large rain event. The Central Lake Erie Basin Collaborative, comprised of a variety of local water organizations, such as Chagrin River Watershed Partners, West Creek Conservancy (see Section 4.4), and the Cuyahoga County Soil and Water Conservation District, have coordinated at a regional-scale and proven to be key players in advocacy efforts, advancing sound development standards and practices and raising the standards of watershed stewardship in recent years.

Case Study 4: Addressing stormwater threats with the Fern Hill treatment wetland

Project Quick Facts

Location: Big Creek Reservation

Watershed: Rocky River Watershed

Result: 1 acre stormwater wetland

Partners: City of Parma and Big Creek Connects

Timeline

- 2010 – Balanced Growth Plan begins
- 2012 – Site ranking, OEPA grant received
- 2015 – Construction
- 2016+ - Ongoing maintenance

Background

The Big Creek watershed is one of the most urbanized and impervious tributaries to the Cuyahoga River. Big Creek's original drainage pattern, wetlands, floodplain, and riparian areas have been severely altered and replaced with concrete-lined channelized streams, spillway structures, urban development, and encroachment within the floodplain. Only 6% of the watershed is still in open space.

Big Creek Connects is an advocacy group with a mission to conserve, enhance, and bring recognition to the natural and historic resources of the Big Creek Watershed. In 2010, they created a Balanced Growth Plan (http://www.friendsofbigcreek.org/BalancedGrowthPlan/BigCreekBalGroPlan.pdf) that recognized the developed nature of the watershed and recommended stormwater retrofits as the best practice to pursue to gain environmental benefits. With consultant assistance, Big Creek Connects then pursued Stormwater Retrofit Ranking, which prioritized over 150 sites based on water quality treatment, community benefits, and feasibility. Fern Hill Picnic Area in Big Creek Reservation, just south of Brookpark Road in the City of Parma, was one of the top three ranked sites.

Management Actions

The project intercepts the first flush of run-off from a 36" stormwater outlet to Big Creek that drains over 50 acres of residential neighborhood west of Hauserman Road. The stormwater is diverted into a created wetland that captures, slows and infiltrates its flow, improving water quality.

Fern Hill Stormwater Treatment Wetland Project. Photos: Big Creek Connects

4.4 Wildlife Conflicts

One significant threat to the natural resources of northeast Ohio is the overabundance of white-tailed deer. Ohio's deer population was extirpated a century ago, returned in the 1950s, and then increased from about 17,000 deer in the 1970s to an estimated 700,000 deer today (Ohio DNR, 2016). Their natural predators no longer exist in Northeast Ohio, leaving the population largely unchecked (Cleveland Metroparks 2015b). As food sources have been depleted along the edges of the reservations, deer have shifted to interior forest areas for feeding and browsing. This impact affects not only other wildlife species that are dependent upon the structure that interior forest stands provide for food or shelter, but also the forests' ability to regenerate. Deer are also a significant problem for humans and have moved into yards, causing landscape and crop damage, automobile accidents, and the possibility of disease transmission (Ballash et al 2015).

Raccoons, geese, gulls, and beaver are sources of conflict as well. Wildlife have adapted comfortably to urban conditions that provide novel food sources and cover but lack top predators. Raccoon populations in developed areas now exceed those in rural areas because reproductive and survival rates are higher (Prange et al, 2003). Raccoons present nuisance problems because of their affinity for garbage at picnic areas, their impacts on threatened turtle populations, and their potential to carry disease including raccoon roundworm and raccoon rabies. Canada geese and a variety of gull species congregate in large numbers, and their feces foul beaches and swimming areas, increasing infectious disease risks. Beaver provide important water management functions but also damage new plantings at stream and river restoration sites and can cause flooding from their ponds.

Coyotes occasionally cause problems, chasing or infrequently attacking pets, or intimidating visitors who walk too close to their dens. Coyotes often cause problems when dogs are off-leash and off designated trails. Such encounters have led to demands for coyote removal, a measure that is considered if there is a confirmed pet attack. However, these animals provide important ecosystem services by preying on rodents, other small mammals, goose eggs, and fawns, thus helping to control their populations.

4.5 Climate Change

Climate change is a significant stressor and a growing problem for natural area managers. The national climate change assessment (Pryor et al. 2014) suggests that major impacts to this region will include extreme rainfall events, increased flooding, heat waves linked to more severe summer droughts, a longer frost-free season, and changing forest composition. Northeast Ohio's hardwood forests are diverse, and a recent climate change vulnerability assessment (Butler et al. 2015)

characterizes them as having neutral to negative potential impacts, moderate to high adaptive capacity and moderate vulnerability. Within them are scattered pockets of steep, hemlock-dominated ravines with cool microclimates that shelter coldwater streams. These will be more affected by climate change, with negative potential impacts, low-moderate adaptive capacity, and high vulnerability.

One change relevant to management will be in the ranges and distributions of plants and animals, which may need to migrate north as temperatures rise. Active management intervention will focus on planting climate-tolerant tree species capable of withstanding these changes over the next 100 years (Matthews et al. 2018). Invasive species are likely to become more of a problem, as well. Climate conditions may allow them to penetrate further into previously untouched areas and compromise existing communities as native species shift their distributions. Climate change may also require us to rethink what we consider native and invasive, as currently common species become scarcer and species with more southern distributions move north. And due to Lake Erie as northern boundary, one could also anticipate some level of adaptation, acclimatization or local extinction.

As indicated above, climate change will also place additional stress on water resources. In coming years, increased numbers of heavy precipitation events will increase flooding risk. Earlier spring snowmelt and peak runoff will also bring additional challenges.

The Natural Resources management team is focused on understanding the extent and impact of climate change by utilizing existing research and data to generate a carbon accounting report for the forested areas of the park system. Understanding how and where carbon is stored will allow management to better adapt vulnerable areas and facilitate resilient forests for the future. Anticipating and addressing these threats and understanding how they operate in concert drives not only research foci, but also many of the management actions of NR, as described in the next section.

5 Strategic Stewardship

Natural resource conservation in Cleveland Metroparks is guided by four Strategic Stewardship Goals, which are closely related to the goals of Cleveland Metroparks System Plan (Cleveland Metroparks 2022). **Conservation stewardship** ensures that natural resources are accounted for in decisions related to land acquisition, use, development, and in the policies that govern such decisions. To **promote ecosystem resilience** through habitat rehabilitation and restoration, resource managers must **understand natural systems** and their components. On-the-ground management and monitoring represent the bulk of the NR workload and include a wide range of activities such as removing invasive plants, managing wildlife, conducting prescribed burns, assessing aquatic resources, and tracking the plant communities found in Cleveland Metroparks reservations. Finally, it is through **partnerships** that we engage the right group of stakeholders around each issue, both within Cleveland Metroparks and from outside.

Table 4. Natural Resource Division Strategic Stewardship Goals & Objectives, related to the CM System Plan.

Strategic Stewardship Goals	Objectives
1: Support outdoor guest activities and advance connections through **conservation stewardship** that preserves natural resources and complies with environmental regulations including those that protect surface waters, forests, and their inhabitants. *System plan: Welcome and Engage*	1a. Provide guidance for Park District development and guest access
	1b. Ensure permitting compliance related to natural resource collections, research, and protection
	1c. Engage volunteers in beneficial projects
2. Promote ecosystem resilience through management activities that maintain healthy populations of wildlife, fish and plants, promoting native species diversity, increasing genetic diversity, and limiting the impact of negative disturbances. *System plan: Conserve and Connect*	2a. Maintain healthy wildlife & fish populations
	2b. Manage and restore aquatic resources
	2c. Manage and restore vegetation structure and composition
	2d. Quantify and support regional ecological connectivity
3. Enhance **understanding of the natural systems** of the Park District through research and monitoring that supports management decisions and furthers the educational and outreach goals of the Park District and Zoo. *System plan: Innovate*	3a. Collect, synthesize, and communicate critical information related to natural systems, their inhabitants, and their management
	3b. Detect current and emerging threats
	3c. Integrate density estimation/population viability analysis for key taxa
4. Cultivate strong and flexible **partnerships** among organizations that share our goals. *System plan: Sustain*	4a. Collaborate with the region's natural resource management community
	4b. Obtain grant funding for priority projects to extend internal operational and capital funds
	4c. Actively participate in regional committees and boards to facilitate conservation agenda.

5.1 Conservation Stewardship

Goal 1: Support outdoor guest activities and advance connections through conservation stewardship that preserves natural resources and complies with environmental regulations including those that protect surface waters, forests, and their inhabitants.

Objective 1a. Provide guidance for Park District development and guest access:

The stewardship of natural resources is one consideration in Cleveland Metroparks' planning decisions, from land acquisition and trail placement to new construction of recreational facilities such as the *Go Ape* high ropes course. Staff use a multifaceted approach to understand the potential effects of planning decisions in terms of impact to vulnerable resources and compliance with regulatory permits. The reservation planning process is an example of a formal activity to incorporate natural resource issues into decision making (Figure 11) (Cleveland Metroparks 2012). Management projects also have their own planning framework, as described in Section 5.3.

> "One of my favorite calls is when I pick up the phone and find a park manager on the line, wanting to know the natural resource implications of a proposed activity. Too often in the past, projects charged ahead without developing a nuanced understanding of the likely effects, but now we are frequently called in the early planning phases of a project."
>
> -Comment from NR Planning workshop

To initiate NR's contribution to reservation planning, staff compile site descriptions, including stream and vegetation surveys, landscape connectivity analysis, wetland delineations, invasive plant inventories, historic land use data, rare features, aerial photographs and satellite images, as available. Priority watersheds have been identified and ranked to focus planning and management efforts on our most sensitive and important waterways. To store this value data, Cleveland Metroparks has developed a robust Natural Features Database to compare between sites and years, detect issues as they arise, and guide management decisions. This database contains detailed information on biological and geological features within the Park District and will be linked with external taxonomic databases (e.g., ITIS, Catalogue of Life). Sources of data include ecological monitoring data collected by Cleveland Metroparks staff, observations from volunteers and park patrons, and historical observations/data from external sources like museums and universities. One particularly important use of the database will be the tracking of rare and sensitive taxa by park staff with expertise in specific taxonomic groups.

These natural resource inventories and assessments determine ecological baselines and contribute to an Index of Natural Resource Value that establishes catchment-based units categorized as high, moderate-high, moderate and limited natural resource value or essentially, site sensitivity. Once this mapping exercise is complete, staff analyze the data in light of other contributing factors, including access points and current land use, to evaluate the best opportunities for the public to enjoy the natural beauty of the landscape, and to identify areas where access should be restricted.

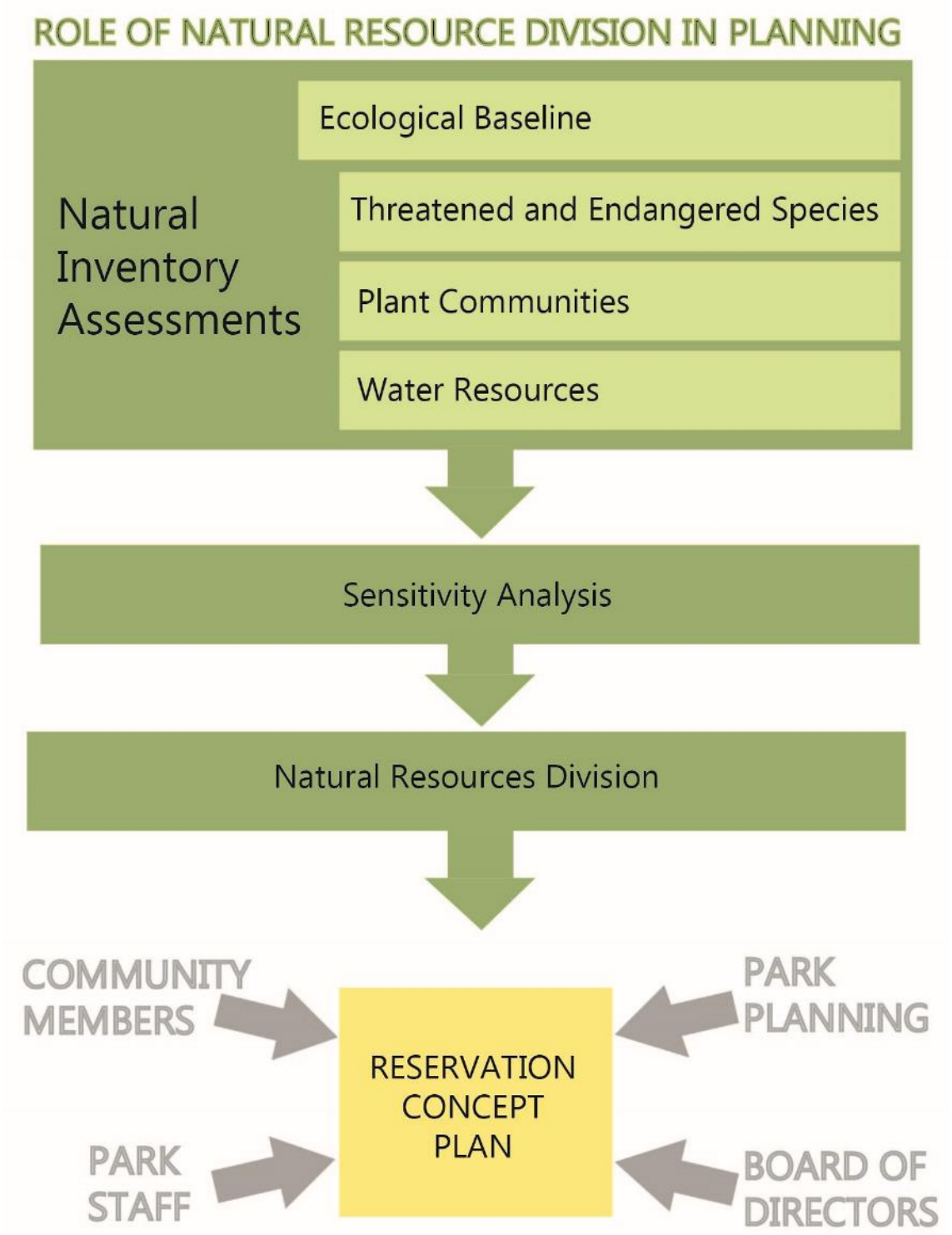


Figure 11. The Natural Resources Division is specifically responsible for framing how natural resources are represented in the reservation planning process, which is managed by the Department of Planning and Design.

Objective 1b. Ensure permitting compliance related to natural resource collections, research, and protection

Conservation stewardship also ensures that projects are appropriately permitted in accordance with local, state and federal regulations. We provide expertise concerning compliance, and when brought into the process early, can provide guidance to the permitting process. This aspect of conservation stewardship most often relates to wetlands and endangered species protection.

Objective 1c. Engage volunteers in beneficial projects

Integrating volunteers into monitoring and management activities expands the population base that is integrally aware of the work of natural resource management. These individuals also greatly enhance project outcomes due to the expanded capacity their assistance provides. Often volunteers energize regular staff and help to boost employee morale. Volunteer activities benefit the properties on which they are working, but the learned ethics and behaviors are often applied at home, in the workplace or school and in the broader community.

5.2 Resource Management

Goal 2: Promote ecosystem resilience through management activities that maintain healthy populations of wildlife, fish and plants, promoting native species diversity, increasing genetic diversity, and limiting the impact of negative disturbances.

Natural resource management activities ensure that ecosystems are resilient in the face of change and when appropriate, restore compromised systems that have been impacted by disturbances. The decision to undertake management activities or not implies an understanding of the ecological and social opportunities and consequences of such management.

Given the physical and biological stressors that threaten natural systems, human interventions and thoughtful management can mitigate these stressors, allowing natural systems to better resist and recover from disturbance events such as floods, insect pests, and past land use. The primary tools used to promote system-wide resilience are directed at the management of wildlife, water, and vegetation.

WILDLIFE & FISHERIES MANAGEMENT

Objective 2a. Maintain healthy wildlife & fish populations

Wildlife management manipulates wildlife populations and habitat to achieve goals of establishing, protecting or expanding populations of species of concern or reducing the numbers or effects of nuisance, invasive, or damaging species. In general, lands are managed to promote vegetation structure and diversity. These provide habitat for species native to Northeast Ohio. We also strive to provide quality stopover habitat for the millions of migratory birds and insects that reside or pass through our region.

In some instances, we have initiated programs to support healthy local populations of individual species including wood ducks, Blanding's turtles (Case Study 5), and bats. Bat houses and wood duck boxes, built in several reservations, provide roosting and nesting sites. Nest boxes also provide suitable habitat for other cavity-nesting species such as eastern bluebirds and tree swallows.

In some cases, wildlife species are over-abundant and cause damage to natural systems or impact critical human activities. Activities to manage these populations include trapping and removal of beaver or raccoons where they have the potential to damage structures or spread disease, respectively. To discourage dense populations of geese and reduce concomitant *E. coli* contamination and browsing on newly planted restoration sites, staff contract with a local company specialized in harassment using trained dogs and remote-control boats.

Our largest wildlife management effort is centered on deer population control. Deer overpopulation in urban areas like Cleveland is caused by the absence of natural predators, greatly reduced hunting, and increased food and habitat (e.g., lawns and yard plants). As a result, the park needs to reduce

and then maintain deer populations at levels at or below and optimal threshold that minimizes deer impacts on the landscape and is deemed “sustainable” (Cleveland Metroparks, 2015). Cleveland Metroparks began deer culling in 1998. The park uses information on density and health metrics collected from managed deer to understand the population biology and behavioral patterns of deer (Dubey et al, 2014). These data are used to make informed decisions on appropriate density levels and management techniques.

The fisheries program, which is devoted to maintaining adequate populations of sport fish for public recreation and ecosystem health, includes detailed plans for each managed lake (Durkalec, 2012). “Recreational fishers can be instrumental in successful fisheries conservation,” (Granek et al, 2008) and fishing is an important introduction to environmental stewardship. Cleveland Metroparks controls nuisance levels of emergent plants and algae, removes non-native fish, and NR conducts regular monitoring and fish surveys. If we see fish populations declining, this may lead to an analysis of angler harvest, evaluation of emergent plant coverage, water chemistry parameters (such as dissolved oxygen in water), or analysis of fish habitat. These analyses might lead to dredging, aquatic vegetation management, or addition of fish habitat structures. Active fisheries management includes surveys and stocking. A current goal of the program is to increase fishing access in the central and eastern parts of the Park District.

Support for the fisheries program is extensive, and the Park’s Fishing Blog is a top-5 visited site on Cleveland Metroparks website. An example of support comes from the Ohio Central Basin Steelheaders (OCBS) fishing club, an association of fishermen dedicated to the protection and promotion of steelhead sport fishing. In 1996, Cleveland Metroparks chose this non-profit group for the inaugural Conservation Partner Award and the partnership has only grown in the two decades since that time. OCBS now supports the Cleveland Metroparks three largest children’s fishing events of the year as well as events such as the annual Rocky River Volunteer Clean-up and the Steelhead Expo event at the Rocky River Nature Center. OCBS is a great example of a long-lived and flourishing collaboration between Cleveland Metroparks and a recreational user group that helps support all three facets of our mission.

Case Study 5: Cooperative Management for a Threatened Species - Blanding's Turtles

Project Quick Facts	Timeline
Location: Ohio & Erie Canal Reservation *Watershed:* Cuyahoga River Watershed *Result:* population expansion and tool development through agency collaboration *Partners:* Cleveland Metroparks Zoo, Ohio Division of Wildlilfe, U.S. Fish & Wildlife Service	• 1999 – OEC becomes part of Cleveland Metroparks • 2000 – Female Blanding's turtle discovered in 1999 tracked to nest site using telemetry • 2000-2005 – Eggs from OEC and other Ohio sites reared at Zoo for headstarting and release • 2011-present – Mesopredator control • 2012-2019 – Turtle monitoring

Background

Ohio & Erie Canal Reservation (OEC) became part of Cleveland Metroparks in 1999. The reservation, located along the Cuyahoga River and the historic Ohio & Erie Canal, is nestled in a valley surrounded by industry. Created wetlands abound, and habitat varies from protected forests on old beach ridges to novel ecosystems sprouting from industrial fill. That same year, three male and one female adult Blanding's Turtles (*Emydoidea blandingii*) were discovered by Hugh Quinn, former General Curator at Cleveland Metroparks Zoo (CMZ) at OEC during a reptile and amphibian survey. The female and one male were fitted with radio transmitters to track the animals' movements using radio telemetry. As a result, the adult female was observed nesting in a landscaping bed behind the Leonard Krieger Canalway Visitor Center in June 2000. Twelve eggs were laid, and Park District staff subsequently screened the nest to protect it from potential predators. On 23 August 2000, 10 neonate turtles emerged from this nest and were collected by staff. Four of the hatchlings were released directly to the restored wetland west of the Canalway Center. With permission from the Ohio Division of Wildlife, the other six hatchlings were brought to the CMZ to be raised in captivity until such time that they were deemed large enough to be safely released back to the wetlands. Thus began Cleveland Metroparks Blanding's Turtle head-start and restoration effort at OEC (Spetz and Robison 2011).

Management Actions

Following the discovery of the first turtle nest in June 2000, an additional 12 hatchlings were produced from eggs collected from a second nest at OEC in 2001. This time the eggs were artificially incubated, and the hatchlings were raised in captivity at the CMZ. In 2003, 2004, and 2005, the Ohio Division of Wildlife granted permission to collect additional eggs from adults captured at the Sheldon Marsh State Nature Preserve in Erie County. Young hatchlings were reared at the Zoo as part of a "head-starting" program to provide larger individuals for reintroduction. To date, 84 turtles have been released into the wild, many with transmitters to monitor their movements and survival. The lessons we have learned about rearing practices and release protocol are guiding a similar endeavor with other partners to enhance populations of spotted turtles, another turtle listed as threatened in Ohio.

Left to Right: Hugh Quinn with female Blanding's turtle and eggs; turtle neonates with transmitters; release of turtle to OEC.

Objective 2b. Manage and restore aquatic resources

Aquatic resources include rivers and streams, lakes and ponds, wetlands and their associated biota. Monitoring using established protocols allows us to evaluate fish and macroinvertebrate communities, stream habitat, wetland quality, and plant populations. We manage aquatic resources to improve habitat by controlling invasive and nuisance wildlife and plants and enhancing habitat structure. We manipulate wetland water levels to encourage or discourage certain plant populations, and we restore streams to allow incised streams to reconnect to their floodplains.

Efforts to restore aquatic systems range from large wetland and stream restoration projects such as Fowles Marsh, Fern Hill wetlands (Case Study 4), and Euclid Creek at Acacia (Case Study 10) to smaller stream segments protecting upstream habitat at Hinckley Stables (Case Study 6). In stream restorations, eroded streams with deep channels can be lifted so that the water in the channel overflows the stream banks onto the floodplain during storm events. This allows the floodplain to trap sediment, store and filter water, and provide breeding habitat for amphibians. Stream restoration can also add meanders or bends to artificially straightened streams, stabilize eroding banks, and add pools, rocks and large woody debris to increase habitat diversity within the channel. Biological integrity generally builds from a baseline of channel stability and appropriate hydrological flows (Figure 12).

The potential to rehabilitate streams and wetlands depends on dynamics upstream within the watershed, where stormwater flows originate. Therefore, an increasingly important aspect of restoration is working with neighboring communities to reduce the input of stormwater from impervious surfaces throughout the Primary Influence Zones (reservation plus the surrounding watershed). Cleveland Metroparks has participated in city and regional efforts to increase tree canopy cover as a tool to intercept and infiltrate stormwater. The Park District has been successful in obtaining grants to retrofit parking lots based on stormwater best management practices (BMPs). Cleveland Metroparks has started working with upstream homeowners to follow best practices including rain barrels and rain gardens that absorb and retain rainwater on private property. One showcase of these techniques in Cleveland Metroparks is the Watershed Stewardship Center at West Creek (see 4.4), which includes over 30 demonstration stormwater control measures as well as programming opportunities for schools, professionals, and the public.

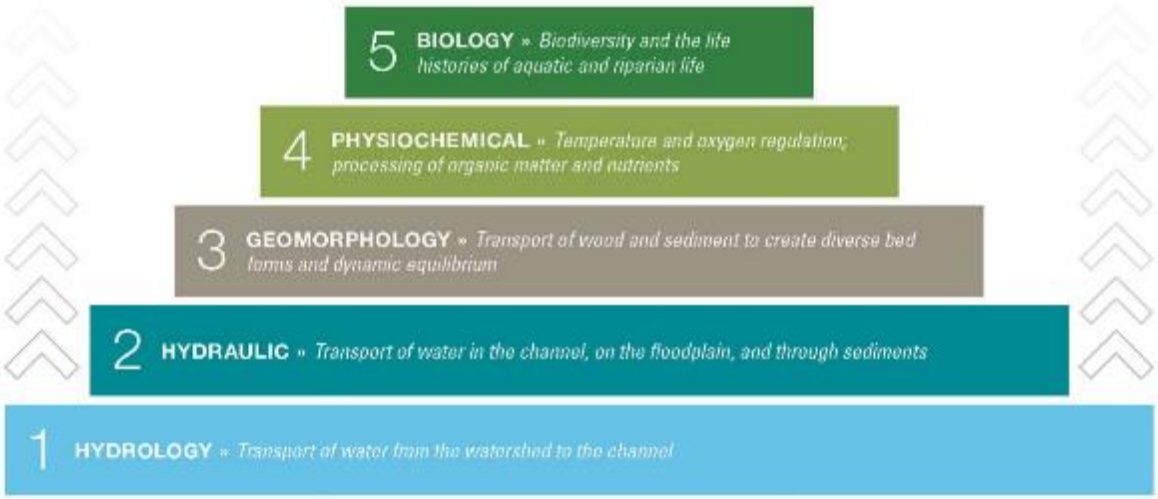


Figure 12. The functional pyramid sets a hierarchy of values to ensure that key processes are not overlooked during the design process for stream restorations. It is structured according to the modifications that are necessary to ensure functionality. For example, physicochemical traits such as temperature (4) cannot be restored without the appropriate geomorphology (3) (source: StreamMechanics, Harman et. al., 2012).

Case Study 6: Aquatic Restoration at Hinckley Stables

Project Quick Facts

Location: Former Ranger Stables, Hinckley Reservation

Watershed: East branch of Rocky River

Result: Headwater stream restoration, sedimentation reduction & pasture reforestation

Partners: U.S. Fish and Wildlife Service, Cuyahoga Soil and Water Conservation District

Timeline

- 2012 – Project identified
- 2013 –USFS Partnership grant
- 2014 – SWIF grant
- 2014-15 Implementation
- 2016 – Maintenance & Visual monitoring

Background

Mirror Valley is home to a number of rare species, including northern red salamanders and a population of state threatened brook trout. NR has designated it as Priority 1 watershed within the park system. Efforts to restore the headwaters of Mirror Valley include a small ephemeral stream flowing through a horse pasture of the former CM Ranger Mounted Unit Stables. Because of erosion largely driven by upstream agriculture and roadside ditches, this stream segment developed a severe headcut, an abrupt vertical drop that, left unmanaged, would eventually form a deep gully. When the headcut began migrating upstream and contributing sediment to a tributary that supports the Mirror Valley cold water stream system, Cleveland Metroparks developed a plan to restore the stream channel to address the erosion. We have also planted trees in the pasture and rehabilitated the surrounding site through invasive species control.

Management Actions

In 2013 and 2014, we began removing woody invasive species from the 5-acre project site, focusing primarily on the forested edges. With funding from the U.S. Fish and Wildlife Service and Ohio EPA's Surface Water Improvement Fund (SWIF), we worked with consultants to create a restoration design to stabilize the headcut and restore the pasture to forest. Spring of 2015 included site prep, stream channel work and installation of plant material. Rather than relying on costly off-site materials, the stream design adaptively re-used ash trees previously decimated by emerald ash borer, in addition to boulders from an old farm road. These materials were repurposed to create a step-like structure to address the headcut, prevent further erosion, and also provide instream and terrestrial habitat.

The restoration was completed with assistance from Cleveland Metroparks' Watershed Volunteer Program, whose trained volunteers harvested and later installed native willow and dogwood live stakes along the stream bank to add stability and habitat. They, along with other volunteer groups, also planted native trees and shrubs to reforest the pasture and replace the woody invasives plants that were removed. The completed project enhances both aquatic and terrestrial habitat.

The original headcut (L) was repaired, and restored to a stable configuration (R).

VEGETATION MANAGEMENT

Objective 2c. Manage and restore vegetation structure and composition

For many years, each reservation was managed independently for diversity of habitat types within its own borders. Today, we look at the Park District as a whole and its place within the region to determine appropriate management goals. For example, on a regional scale, there is a critical absence of both contiguous forest blocks and early successional forest habitats (i.e., dense sapling stands). Both are important habitats for different animals and plants and having the right balance of the two can affect biodiversity positively. To enlarge our blocks of contiguous forest, meadow parcels located within large, otherwise intact sections of forest are being reforested or allowed to succeed to forest to provide larger blocks of contiguous forest. In other, more suitable sites, managers might cut small (2-5 acres) blocks of forest to simulate natural disturbances and promote forest regeneration, habitat conditions that are valuable for migratory birds and mammals. Such gap disturbances also provide enough light to help regenerate oak-hickory forests that used to dominate this region.

Old fields and meadows are also important, limiting habitats for plants, birds, reptiles and mammals. To ensure adequate attention to these habitats, we will concentrate management outside our contiguous forests where the Park District borders other landowners' open habitat. In addition, we work closely with utility companies and the US Fish & Wildlife Service to expand habitat management in right-of-way sections that pass through the Park District. These areas are not only expansive but provide long connected corridors aiding movement and migration.

Prescribed Fire

Prescribed fire is another valuable tool that has been utilized for more than 30 years in Cleveland Metroparks to manage vegetation and control invasive species. Fire, including wild and prescribed fire, lessens fuel loads, sets back fire sensitive tree species and invasive species, and stimulates new growth (Figure 13). The most common use for prescribed fires is to maintain the open character of meadows and fields, habitats where invasive species may flourish and there is constant pressure from successional processes for woody plants to overtake the meadow vegetation. Native warm-season grasses and some forbs are fire-adapted, whereas many invasive plants die after the burns. We also use prescribed fire in forested settings to encourage slower-growing, fire tolerant and desirable tree species such as oaks and hickories that can otherwise be outcompeted by faster growing maples or beeches (See Case Study 7). Prescribed burns do not totally exclude maples and beeches, but they reduce competition from these common species and allow the oaks to reach a point of dominance.

Figure 13. Prescribed burning of a fairway at Acacia Reservation. Prescribed fire is used to reduce the dominance of unwanted species.

In both cases, fire offers important advantages over other control and clearing methods. Foremost among these is the maintenance of habitat structure. Fires sweep through an area leaving an open mix of ash, stubble, and unburned patches where the fire has skipped over small areas. This diverse matrix allows a variety of habitats to develop. Conversely, areas cleared by brush hog are more uniform and retain a dense layer of grass at the soil surface. Ground-nesting birds such as bobolinks, savannah sparrows and meadowlarks are unable to rear their young in such habitats because the chicks cannot penetrate the choking mat of grasses that remains after mowing.

NR cannot perform prescribed burning unless the plans meet stringent weather requirements and generally only burn small areas, from 1 to 30 acres. Burn plans also must meet requirements of local fire departments, and these departments are invited to participate in this management for training purposes. Our burns avoid the avian nesting season, and we leave natural cover nearby to allow escape routes for wildlife. Also, the typical annual effort is modest, with three burn days treating a total of 23.5 acres across four properties in 2014. Only two acres were burned in 2015 because of wet weather, but 2016 was more typical, with 21.5 acres burned in four locations. NR is planning larger-scale burns, although the opportunities to burn these within prescribed weather conditions are limited.

Removal of invasive species

As mentioned above, reducing or managing the threat of invasive species is a significant focus of our management efforts. Since 2008, Cleveland Metroparks' Invasive Plant Management Program has implemented an early detection-early control approach, to stop new infestations quickly before they expand. However, in reservations with existing large-scale infestations, we must implement multi-year programs to attain these lowered threshold levels. We augment our internal support with grants to tackle larger infestations using commercial contractors (e.g., hydrilla eradication efforts) and fund cooperative efforts such as the Crooked River Cooperative Weed Management Area.

Detecting and responding to invasive forest pests and pathogens is another management focus. Emerald ash borer (EAB) offers a sobering case study of the damage inflicted by exotic pests. Our reaction to EAB had to be swift because of the Park District's proximity to the initial invasion front. In the future, our efforts to plan and manage the EAB outbreak will help in preparing for the next invasion from Asian long horned beetle, hemlock wooly adelgid, or other as yet unknown pests or pathogens.

Crooked River Cooperative Weed Management Area
(Hillmer 2015)

In this special collaboration, seven of Cleveland Metroparks' Divisions (Natural Resources, Park Maintenance, Outdoor Experiences, Visual Communications, Volunteer Services, Golf Services, and the Zoo) actively collaborating to control invasive plants and restore habitat alongside

- Summit Metro Parks
- National Park Service
- Tinker's Creek Watershed Partners
- Geauga Park District
- Ohio Department of Natural Resources
- Portage Park District
- The Nature Conservancy
- Cuyahoga River Restoration

Native plant installation

Planting trees, shrubs and forbs is another major tool for terrestrial rehabilitation and restoration. We use planting to reforest open sites, protect stream channels, enhance wetland and stream restoration projects, and replace trees lost to insects and disease. Planting helps increase species variability after removing invasive plants, when canopy trees die from disease, and when understory saplings are decimated by deer browse.

Planting efforts range widely in size. Typical small opportunities might include supplemental plantings around forest edges where invasive species tend to thrive or where we have recently removed structures or parking lots. Larger-scale habitat restoration efforts change the face of the

landscape over many acres. Some planting locations (e.g. old parking lots, retired football fields/tracks) require intensive preparation of soils to decompact them and allow tree roots to extend further into the ground. Recent decompaction reforestation projects include Dunham Park at Bedford Reservation (Figure 14) and Trolley Turn at Garfield Park Reservation. From 2012 to 2019, Cleveland Metroparks planted more than 32,284 trees. In 2021 alone, NR installed 4,836 trees of a variety of sizes.

Figure 14. Garfield Heights high school students and Cleveland Metroparks staff plant native trees into decompacted area at Dunham Park where a parking lot used to be.

In any planting project, simply planting young trees and shrubs is not enough. Early in the establishment process, crews may need to water recently planted seedlings if rainfall is insufficient. Deer, beaver, voles, moles and other herbivores can destroy acres of newly planted material within months if plants are not protected. We employ both individual tree protection and larger areas of fencing to protect saplings until they are old enough to resist the effects of animal browse and deer rubbing. These protect the resources invested in each planting project, but also mean that maintenance costs must be considered during project planning. NR seasonal staff are a key resource in our reforestation efforts.

Initial efforts to replace aging conifer stands that are reaching the end of their life expectancy are currently underway. Norway spruce, red pine, Scots pine, and white pine stands were planted in the 1930s mainly by WPA work crews but also by private landowners on deserted farms through Ohio Division of Forestry programs. The first three species are not native to this region. None of these conifers are adapted to the sites on which they were planted and are dying early as a result. As part of Cleveland Metroparks 100th anniversary, the Centennial Forests Fund was created to help pay for sustainable forest management including the conversion of these plantations to native habitat. Plantation conversion has shown to increase plant diversity and cover benefitting conservation of important native plants and invertebrates (Abella et al. 2017). Efforts are being made to salvage wood products from these stands where possible.

Right-of-Way Management

Extensive acreage of utility rights of way (ROW) exist throughout Cleveland Metroparks (Figure 15). These areas have easements owned by the utility companies allowing them to do vegetation management to maintain access and operability of the utility lines. Regulations vary and management in some cases is linked to Homeland Security, but all require vegetation to be controlled, sometimes with zero tolerance for woody plants. Over time, Cleveland Metroparks has worked with these companies to plan management activities that maximize habitat value while keeping within regulatory restrictions. Research done by Cleveland Metroparks and sponsored by First Energy verified the high value of shrub-scrub habitat in ROW for Neotropical migrant birds. ROWs within the Park District also contain high quality wetlands and associated habitat. Vegetation management agreements encourage native species of grasses, forbs, sedges, and short stature

woody vegetation and limited, targeted use of herbicides in as many locations as possible. Discussions are underway to work collaboratively with First Energy and the U.S. Fish & Wildlife Service on establishing pollinator habitat along additional acreages of ROW. Our hope is that this cooperative management can be transferred to ROW throughout Northeast Ohio to create long corridors of uninterrupted habitat providing connectivity for migration routes.

Figure 15. Power line right-of-way showing old and new management. Before the 2003 east coast power outage attributed to inadequate right-of-way maintenance, rights-of-way were managed for shrubs (L). Since that outage, they are maintained as meadows or old fields (R) (Cieslewicz and Novembri 2004; photo Kuilder).

Case Study 7: Resource Management to Regenerate Oak at Brecksville

Project Quick Facts

Location: Oak Grove in Brecksville Reservation
Watershed: Cuyahoga River
Action: prescribed fire on 27 acres
Result: successful oak regeneration

Timeline

- 1989 – Lack of recruitment documented
- 1991 – 2002 Continuous monitoring of plots
- 1991-1995 - Fire and forest management
- 1999-2015 – Deer control
- 2014 – Resurvey of monitoring plots
- 2016 – Fire management reintroduced

Background

Vast hardwood forests once covered most of the area around Cleveland, and today oak trees are a critical component of the remaining forest, dominating the composition of some stands. However, there are few young oaks in the understory, which means that the future will see a decrease in oak dominance without management intervention. Through much of the Park District, young trees are rare, and where present, they tend to be dense growths of beech, yellow poplar and maple. These fast-growing species have value to wildlife, but pale in comparison to the rich acorn crops and habitat offered by mature oaks. Oak trees can host at least 534 species of butterfly and moth caterpillars (Tallamy 2007).

Management History

The Oak Grove Picnic Shelter is named for the beautiful mature oaks that spread over the nearby forest, but the oaks were poised to lose their dominance because young trees were unable to grow. About 20 years ago, NR staff began to document the high mortality and stunted development of oak saplings. The first problem recorded was lack of light and choking competition from other species*. Because of the history of timber harvest and agriculture, many areas have grown up in dense stands of trees that were the same age and size and competed fiercely for light. Slow-growing oaks were at a disadvantage. Based on the documented success of thinning efforts elsewhere, managers thinned the forest considerably to create a diverse crop of desirable species. However, it rapidly became apparent that lack of light was not the only problem.

Even with adequate light and space, the young oaks grew only to be browsed by deer*. By the late 1990s, the deer overpopulation problem was so severe that the growth of young oak trees almost ground to a halt. Because of their rich underground stores of resources, oaks are able to persist for years in the face of consistent browse pressure. However, the intense browse meant that they could not gain height, and biologists began to recognize saplings that were decades old but only a few inches to a few feet tall. On top of the forest thinning, deer management was clearly required.

Thanks to public support and ongoing wildlife management, local deer populations are low enough that they no longer inhibit all seedling growth. With that threat coming under control, managers are again working to control competition among tree species by using fire to favor oaks over more common maple and beech seedlings that cannot withstand fire.

** Indicates examples where the highlighted observations led to **Adaptive Management** — manager's observations, based on data collected over several years, led to changes in management techniques.*

Case Study 8: Forest Restoration through Reforestation at Redwing Picnic Area

Project Quick Facts

Location: Redwing Picnic Area, Hinckley Reservation

Watershed: Rocky River

Result: 9000 trees planted

Timeline

- 2012 – Project identified
- 2014-2015 – Field and buffer prep; woody invasive plant control
- 2015 - planting
- 2015-2022 - Monitoring and sapling protection

Background

Throughout the Park District, there are persistent patches of old fields within larger blocks of forest that host invasive species, require regular mowing and maintenance, and offer little in terms of habitat diversity. High deer browse often prevents tree growth in these old fields. The fields are partly a vestige of agriculture and were managed as open lands to fulfill the goal of having a diverse suite of habitat types within every reservation. Recent management goals propose that each reservation needs to be managed in a more holistic manner at a regional scale rather than fitting all habitats into all areas of the Park District. Hinckley Reservation contains some of Cleveland Metroparks largest, contiguous stands of mature forest, but these internal gaps lessen the habitat value that more contiguous forests offer. We are now managing to enlarge these forests at Hinckley by closing gaps in the interior of the reservation. These young forest stands will contribute to acres of early forest successional habitat which is lacking throughout the Park District.

Left alone, species such as Black Locust, Buckthorn, and American Sweetgum may overtake a site, while other sites will be frozen in a stage of open meadow because of the current suite of species and pressure from deer. To allow species that are dominant in the forest surrounding these sites to recolonize the fields, we have chosen to intervene and assist forest regeneration. To that end, reforestation of a 19-acre field surrounded by forest within Hinckley Reservation near Redwing Picnic Area has become a project site for large-scale reforestation efforts.

Management Actions

Much of the reforestation taking place throughout the Park District is on a small scale of 1 to 2 acres. Redwing is a departure from those efforts: at 9,000 young trees and 19 acres, it is the largest reforestation undertaken to date by NR. Trees were planted in April 2015, using both a tractor-drawn tree planter and by hand. We also conducted an experiment to compare different methods of excluding deer that showed that electric fencing is an effective deer deterrent at this site.

Planted and sheltered seedling (L), the extent of the reforestation project (C), and deer exclosure (R). Photo: Krynak

Objective 2d. Quantify and support regional ecological connectivity

Following Baudry and Merriam (1988) and LaPoint et al. (2015), ecological connectivity can be divided into two components: structural and functional connectivity. Structural connectivity refers to the configuration of the landscape itself, such as the size and shape of patches of forest, the shape of a stream reach, and even - in the case of the Cleveland Metroparks system - the size, shape, and configuration of protected and managed areas across the landscape. The other component of ecological connectivity is functional connectivity, which is the actual movement of organisms, nutrients, and matter through ecological systems (Baudry and Merriam 1988, Mushet et al. 2019). While structural connectivity can be studied using remote sensing datasets and physical measurements of landscape or stream characteristics, studying functional connectivity often involves estimating rates of flow or movement within ecological systems - involving techniques ranging from flow measurement in streams to estimation of animal movement using radio telemetry. Our division tackles these aspects of connectivity using a three-pronged approach: 1) characterizing the structural connectivity of our reservations and natural areas using both remotely sensed and field classification of our changing landscapes, 2) understanding functional connectivity by integrating automated technological solutions (i.e., stream monitoring stations, acoustic wildlife recorders, and wildlife cameras) with detailed field studies, and 3) characterizing how structural connectivity either impedes or facilitates functional connectivity.

5.3 Understanding System and Process

Goal 3: Enhance understanding of the natural systems of the Park District through research and monitoring that supports management decisions and furthers the educational and outreach goals of the Park District and Zoo.

Objective 3a. Collect, synthesize, and communicate critical information related to natural systems, their inhabitants, and their management

Objective 3b. Detect current and emerging threats

Information gathered through monitoring and research activities is used to develop a broad-based understanding of current condition and trends of park and regional natural resources. We report on resource condition to aid decision making, understand and adjust management actions, support other agencies conservation efforts, and promote public understanding of natural resource issues and solutions. We use scientifically sound monitoring criteria such as those developed by Ohio EPA for wetland, stream and amphibian indices of biotic integrity to track conditions of the park's natural resources over time. Where indices do not exist, we work with collaborators to develop appropriate statistics for monitoring. If the expected trajectory of a project is not meeting expectations, we adapt our strategies and make management adjustments or refine objectives to achieve overarching project goals. In addition, monitoring serves to detect emerging threats and anticipate future management needs.

ONGOING DATA COLLECTION

We use nine continuing, baseline monitoring programs to document the state of various systems within the Park District, quantify changes in quality and variability, and detect emerging trends and threats (Table 6). These programs cover terrestrial plant communities, wetlands, streams and rivers, impoundments, and wildlife. Several programs repeat observations on regular schedules, but some are undertaken irregularly or in response to specific needs and grant opportunities. Most of the information summarized above in State of the Natural Resources (Section 2) resulted from data collected during these programs.

PROJECT AND SITE DATA COLLECTION

In addition to ongoing monitoring and evaluation programs that have developed over time, we also collect data to better understand specific management opportunities and needs. These drivers might

include the information needed to underpin forest or meadow management interventions and development such as trail construction or new property acquisitions (Case Study 9).

DATA COLLECTION TECHNOLOGY

An ongoing challenge is to make monitoring data more available and useful for management decision making. Nationwide interest in natural resource focused databases is growing, and we are tracking these developments to improve our data management capabilities. We have begun using tablet and smartphone-based data collection to increase time in the field, decrease data entry errors, and reduce time between data gathering and decision making. Natural resource monitoring data is now being entered into a central database to improve reporting and allow more timely assessment of the effects of management actions.

Objective 3c. Integrate density estimation/population viability analysis for key taxa

The previously-outlined data collection efforts provide a strong foundation for quantitatively tracking the dynamics of our natural resources in space and time. One particularly important component of this includes estimating population historical, current, and future status for high priority species within our park systems, when possible. For species with robust data availability, such as white-tailed deer, this may involve estimating densities and population status across parks, reconciling these estimates across different datasets, and projecting these densities forward in time under varying environmental change scenarios. For more data-deficient species, such as mink, this may involve using quantitative predictive tools, such as species distribution modelling approaches, to: predict potential high quality habitat, target further surveying efforts, and project changes in habitat suitability into the future.

Table 5. Natural Resource Division monitoring programs

System-wide Monitoring	Schedule	Indices (see Glossary)	Description
Wetland Delineation and Assessment	Variable	Wetland VIBI	Baseline census completed in 2016 to map and classify wetlands of Cleveland Metroparks
Headwater streams, Ponds and Lakes	Variable	IBI, QHEI	Rapid assessment of fish, macroinvertebrates, vegetation, and habitat quality; fish surveys (electrofishing)
Primary Headwater Streams	Watershed based schedule	HHEI, HMFEI	Rapid assessment of stream habitat, macroinvertebrates, amphibians, and fish to determine stream class for physical and biotic characteristics.
Streambank Erosion Monitoring	Irregular but annual assessment effort	BEHI, cross-sections	Bank Erosion Hazard Index is used to classify both discrete cases of bank erosion suggesting localized problems, and consistent, widespread erosion suggesting systemic stormwater problems that likely originates offsite.
Plant Community Assessment Program	Every 5 years; seasonally	Upland VIBI; photo monitoring	400 sites are monitored once every five years to document changes in plant communities throughout reservations.
Invasive Plant Assessments	Annual		Constant vigilance is required to track populations and local densities of species such as lesser celandine, phragmites, buckthorn, narrow leaf cattail, reed canary grass, and hydrilla
Deer Impact	Annual	Browse indices, density estimates	To set targets for the deer management program, we estimate numbers of deer annually with evolving methodologies (see case study 9)
Bird Diversity Assessments	Weekly to annual	Point and breeding counts	At several locations, including Lakefront, Rocky River, and Acacia reservations, volunteers and staff conduct surveys of bird diversity.
Wildlife Camera Traps	Continuous	Diversity, Presence/Absence	Network of 200+ camera traps to assess wildlife diversity and activity

Case Study 9: Estimating Deer Browsing Impact – an Evolving Technology

Project Quick Facts

Location: System-wide

Timeline

- 1980s - visual and telemetry density- estimates began
- 1989 - Aerial deer density estimation
- 2002 - Initiated browse focused plant community survey
- 2010 - PCAP program initiated with browse monitoring
- 2016 - Deer browse evaluation plots tested; extensive camera network deployed

Background

Since the late 1980s, expanding deer populations have created management concerns. Management decisions depend on knowing how deer affect their environment. Deer population estimates are a key factor because we assume that density is highly correlated to browsing damage. However, the true measure is the actual effect of deer on important plant species and habitat conditions. This takes a keen understanding of deer biology and the effect of deer browsing. NR's evolving efforts to quantify the impact is an example of both our technological advances and adaptive management.

Management Actions

The Park District relies on several lines of evidence to determine deer management objectives. These data describe long term trends in browse levels and the ecological condition of our plant communities.

- We measure deer browse on vegetation using multiple designs since 2003. In 2016, we intensified efforts to quantify browse impacts using our Plant Community Assessment Program (PCAP) plots established from 2010-2014.
- Static "photo" plots (where photographs are taken at the same position and time of year to track changes in vegetation) located in key forest areas in 1997 and are updated annually.
- Aerial infrared surveys that count individual deer within and around reservations
- Field methods including spotlight counts, deer pellet (scat) counts, mapping home ranges of deer social groups, tracking deer, and counting deer that use bait stations.
- Deer exclosures have been erected to determine forest vegetation recovery rates.
- Demographic data are collected from harvested deer.

We continue to explore other technologies for reducing costs and enhancing our population estimates including forward looking infrared (FLIR) cameras, remote tracking, genetic tracking, and trail cameras. With the advent of our Focus on Wildlife camera project in cooperation with Michigan State University, we have been able to place more than 200 cameras throughout the Park District at PCAP plots. Current research is developing methods for estimating population size from camera images using unmarked animals; a method that has escaped other researchers because of low camera density. Working through this project has led to advances in automated photo analysis and other cutting-edge techniques to evaluate wildlife habits.

Aerial infrared survey at Bradley Woods reservation (L). FLIR imagery (C), and deer rub on sapling (R).

Case Study 10: Understanding Data for Site Planning at Acacia Reservation

Project Quick Facts

Location: Acacia Reservation

Watershed: Euclid Creek

Partners: Ohio EPA, USFWS, Euclid Creek Watershed Program, NEORSD

Features: 4,000 linear feet of headwaters, 1,000 linear feet of Euclid Creek

Goals: 20 acres of habitat enhancement & restoration

Timeline

- 2013 – Project identified, invasive plant management began
- 2014 – Ecological Restoration Master Plan developed
- 2015 – Tree planting began
- 2016– Implementation plan designed, refined, and permitted
- 2016 (Fall) – Grant obtained/Construction
- 2017+ - Ongoing monitoring

Background

In 2012, Cleveland Metroparks acquired Acacia Reservation, a 155-acre, 100-year-old golf course. Euclid Creek, a tributary to Lake Erie, flows through the site. The watershed is home to over 60,000 people and has been greatly impacted by development, and urban runoff, impairing the health and function of the watershed.

Cleveland Metroparks is restoring this suburban golf course into a natural and cultural resource with a natural configuration of habitats including wetlands, woodlands, streams, and meadows. The restoration is also intended to encourage public access and stewardship, protect the Euclid Creek watershed through stormwater management, and create a landscape consistent with nearby reservations. The site required master planning that was driven by a quantitative understanding of its resources and potential based on comprehensive data collection.

Data Collection & Management Actions

The master planning began with an assessment of site conditions, including soils, hydrology, ecology, and landform patterns (Cleveland Metroparks 2014). The data collection phase included soil conditions, to determine the suitability of various sections of the property for restoration activity, a detailed analysis of the site hydrology and drainages, and a habitat assessment that examined the physical and biological conditions of streams and wetlands. Minor modifications to the habitat in response to the data collected includes tilling some fairways and breaking drainage tile in many locations. Major stream and wetland restoration are now complete at this location including major efforts to reattach Euclid Creek to its floodplain and disrupt underground drainage tile that permeated the golf course. We have also planted over 6,000 trees and established over 20 acres of pollinator-friendly meadow since 2014.

Hydrology and habitat restoration at Acacia Reservation

5.4 Partnerships for Nature

Goal 4: Cultivate strong and flexible partnerships among organizations that share our goals.

Partnerships with private and public entities are critically important to achieving natural resource management goals. Partners vary through time and according to project scope and location; however, what remains constant is that the nature of our work requires strong and flexible partnerships among disparate groups. These include other Divisions within Cleveland Metroparks, city, county, state and federal agencies, conservation non-profits, local businesses, volunteers, schools, universities, and others.

Collaboration among divisions and departments within Cleveland Metroparks is of extreme importance. One characteristic of Park District employees is that they do not always concur on how to approach a project or challenge. They bring diverse perspectives and expertise that allow for critical analysis and creative problem solving to agree effective compromise towards beneficial outcomes (e.g. Case Study 3).

Rather than attempt to list all of the generous and hard-working organizations that help our projects succeed, we have chosen to highlight three projects that engage various types of partners: West Creek Reservation Partnership, Lake Erie Allegheny Partnership for Biodiversity (LEAP) and the Acacia Reservation Restoration Partnership.

WEST CREEK RESERVATION PARTNERSHIP

Objective 4a. Collaborate with the region's natural resource management community.

The collaboration at West Creek Reservation between Cleveland Metroparks, West Creek Conservancy (WCC), the City of Parma, and Northeast Ohio Regional Sewer District (NEORSD) is an example of an enduring, productive, and positive relationship borne out of concerned citizens creating an alternative vision of growth and development (Figure 16).

In 1997, only one large undeveloped area in Parma remained, which was slated to become another shopping center and Parma's second golf course. A group of citizens founded WCC, then the West Creek Preservation Committee, and created a vision to preserve public greenspace and protect this area and others from development. They joined forces with the City of Parma and Cuyahoga Soil & Water Conservation District to protect the land through land purchase and conservation easements. In 2006, WCC transferred management duties to Cleveland Metroparks, and West Creek Reservation entered the Park District. NEORSD entered the partnership by committing monetary and staff contributions to the development of West Creek Reservation and its Watershed Stewardship Center. As of 2021, the reservation totals 468 contiguous acres of the West Creek watershed, and it continues to grow as the WCC acquires adjacent land. With a mission to restore urban watersheds, the Watershed Stewardship Center is now the hub of a host of novel watershed focused research, stewardship, and environmental education

Figure 16. The Watershed Stewardship Center in West Creek Reservation was the product of partnership.

initiatives. This collaborative success has led to residential stormwater retrofits, professional trainings, educational programs, an award-winning Watershed Volunteer Program, community science activities, university research projects and special events, which have engaged a wealth of stakeholders in achieving this mission.

ACACIA RESERVATION

Objective 4b. Obtain grant funding for priority projects to extend internal operational and capital funds

The partnership that resulted in Acacia Reservation coming under Cleveland Metroparks' management is a good example of how quickly a concerned group of citizens can bring about important change in their community.

Cleveland Metroparks acquired the 155-acre Acacia Country Club property, located in the city of Lyndhurst, as a donation from The Conservation Fund, a national non-profit conservation organization, after the shareholders of the club agreed to sell their property for preservation of open space rather than commercial development. Conditions in the deed restrictions set the stage for Natural Resources Division staff to take the lead in guiding the management of this property.

> *"Furthermore…, the following Deed Restrictions shall be placed on the Property… for the overall purpose of restoring the Property to a predominantly natural and native state…"*

Early efforts focused on understanding the current condition of the property. Staff hosted two bioblitzes to document then current conditions with assistance from Cleveland Museum of Natural History and local universities including Notre Dame College, Cleveland State University, University of Akron, and Case Western Reserve University. Additional data collection was completed during the development of an Ecological Restoration Master Plan (Cleveland Metroparks 2014). In keeping with the recent focus on restoration at the watershed scale, this plan fits into a broader Euclid Creek Watershed Action Plan (http://water.ohiodnr.gov/portals/soilwater/downloads/wap/EuclidCr.pdf). Assistance from the Euclid Creek Watershed Program and Friends of Euclid Creek has been extremely beneficial to the development of plan and restoration concepts and in implementing outreach to educate the public on the restoration process. The Plan has not only helped to define where development can happen, but also to recruit additional partners and funders. To date, we are managing five different grants from entities including US EPA Great Lakes Restoration Initiative, Ohio EPA, US Fish and Wildlife Service and Charles Pack Trust to accomplish stream and wetland restoration, tree establishment studies, and pond enhancement.

Once a private country club, Acacia Reservation now directly benefits park users by providing hiking trails and wildlife observation opportunities, and it benefits others in the region by providing improved stormwater management through the implementation of the restoration plan and increased property values. This acquisition tripled the amount of public open space within the Euclid Creek watershed for residents in Lyndhurst, Beachwood, Pepper Pike and adjacent communities to enjoy. As habitat structure and diversity continues to improve, the experiences of reservation guests will be enhanced.

LAKE ERIE ALLEGHENY PARTNERSHIP FOR BIODIVERSITY (LEAP)

Objective 4c. Actively participate in regional committees and boards to facilitate conservation agenda.

LEAP is a consortium of over 50 entities that includes conservation organizations, park districts, universities, and municipalities, as well as local, state, and federal government agencies, who share a common goal: to enhance the biodiversity of our habitats and ecosystems (http://www.leapbio.org). First convened in March 2004, LEAP's geographic boundary encompasses the glaciated region south of Canada from Sandusky Bay to the Allegheny Mountains. This region contains diverse habitats and rare ecosystems that harbor many unique and uncommon species. LEAP's work involves identifying, protecting and restoring ecosystems and habitats in our region. As a

member, Cleveland Metroparks assists with activities including native plant promotion and wildlife committees, conservation fund, and regional biodiversity plan. Our staff have been instrumental in obtaining grants to further LEAP's mission.

LEAP addresses issues on a regional scale by unifying efforts of local partners in a larger proactive alliance that can address broad issues together. For example, Environmental Protection Agency, Region 5 grant funding was obtained to refine land cover maps for the LEAP region to aid planning efforts. LEAP members participated by ground truthing predicted habitat types developed through the project. This project complemented the development of a biodiversity heat map showing predicted areas in the region that have high potential for harboring important species diversity.

Another example of this regional impact is LEAP's position statement on White-tailed Deer management, endorsed by 19 entities including the Park District. The concise summary statement supports local municipalities that are making decisions for their communities about White-tailed Deer management (https://www.leapbio.org/resources/white-tailed-deer-management). In 2016, several municipalities in Cuyahoga County successfully introduced some form of active deer management program using this position statement as part of their justification evidence.

6 Natural Resource Project Planning

6.1 Ongoing Projects

Natural resource planning is a continual process, as the data collected each year feed into the ongoing maintenance and management operations. Project plans are guided by Cleveland Metroparks system plan and the reservation planning process. Natural resource information including priority watersheds and rare features are included in the reservation planning documents. The strategic and reservation level planning processes are directed by expert planners within the Planning and Design Department to ensure input from all departments and the public.

Ongoing projects such as wildlife management, habitat restoration, and resource monitoring consume most of NR's temporal and financial resources, and each project's value is regularly reassessed to maximize the benefits to the Park District. Project evaluations also attempt to refine data collection and data processing. Data management has been identified as an area in need of refinement with database development and project linkages as future areas of improvement.

6.2 Project Planning Framework

In addition to assessing ongoing projects, thoughtful natural resource planning must take place on a scale of decades or longer. This Natural Resource Management Approach and Plan establishes a planning framework and identifies important future efforts that can be initiated on a 5 - 10 year horizon.

In employing the framework, we examine priorities over the breadth of the reservation system rather than at any specific reservation. The planning process is generally as follows:

1. Review Objectives for each Strategic Stewardship Goal (Section 4)
2. Compile a list of proposed project activities to fulfill each Objective – a mix of scales, implementation time frames, and levels of commitment.
3. Prioritize project activities for each Goal and Objective by examining their Ecological Sensitivity, Urgency, Cost, Partnerships, Feasibility, and Alignment with Cleveland Metroparks' strategic goals.

In creating a list of proposed activities, we solicited project concepts and ideas from reservation managers, NR staff, and others. We then calculated a Priority Index by scoring each project in six categories (Table 7).

Ecological Sensitivity, Urgency, Cost, and Partnerships are scored on a scale of 0-4 in order of increasing priority, wherein Ecological Sensitivity and Urgency are given extra weight by multiplying their score by an "emphasis factor" of 2X before adding the scores for the four categories together. The final categories, Feasibility and Alignment with Strategic Goals, are both grounds for a go/no-go decision, such that if a project does not meet these criteria, it will not go forward.

New mechanisms are being developed to track plan development, project implementation, and on-the-ground management results over time. Previously, many projects emerged out of brief discussions with little vetting and minimal documentation. Today, concise project plans, electronic data collection, robust monitoring programs, and new database development provide tools to better understand specific project objectives and verify that goals are being met through implementation, effectiveness, and validation monitoring.

Also known as compliance monitoring, implementation monitoring verifies that a plan's conservation actions are fulfilled as written. Effectiveness monitoring documents short-term (1-3 years after treatment) and long-term changes in habitat conditions to determine whether habitat objectives were met. Validation monitoring is defined as monitoring "to evaluate cause-and-effect relationships between habitat conditions resulting from implementation of management activities and the animal or plant populations these actions are intended to benefit

6.3 2016-17 Project Planning

Twenty-eight projects identified during 2016 NR Project Planning, subsequent discussions, and administrative directives are listed according to how they fit into NR's Strategic Stewardship Goals (Table 8) and according to their Priority Index (Table 9). Two technically similar projects such as large-scale deer enclosures at Main Street Wetlands and Gannett Woods can be ranked very differently – with the former in the top five priority projects and the latter ranked last. On the other hand, some trends are clear. Four of the top five projects are directed at hydrilla removal and control, (Sunset Pond and Sanctuary Marsh Wallace Lake, Blue Heron Marsh, and Greathouse Wetlands), which reflects the combination of urgency and dedicated funding for addressing the threat posed by this invasive species. Several ranked projects involve the management of off-site stormwater to improve the health of streams in the reservations, which has emerged as a growing concern since we first focused attention on it in 2004. Highly ranked projects are operationally and economically feasible and meet one or more 2020 Strategic Goals, while ranking highly for Sensitivity, Urgency, Funding, and Partnerships.

Table 6. Scoring categories and criteria for project planning and prioritization.

Scoring Category	Included Criteria
Ecological Sensitivity Guided by the quantitative metrics that apply to the project.	▪ Index of NR Value ▪ LEAP model score ▪ HHEI, HMFEI, BEHI, QHEI, IBI ▪ FQAI, VIBI ▪ ORAM ▪ 0 to 4 scale (weighted 2x)
Urgency Urgency may vary according to project type and must be evaluated regularly.	▪ Time pressure ▪ Critical path (i.e., other projects delayed) ▪ Risk of inaction (e.g., urban development, lost resources) ▪ Regulatory requirements ▪ 0 to 4 scale (weighted 2x)
Funding opportunities Indicates whether funding already exists or is potentially available.	▪ 0 = no funding exists or is likely ▪ 1 = opportunity exists for part of project or identified funding sources are improbable ▪ 2 = opportunity exists, may cover all or part of project, and competitiveness is uncertain ▪ 3 = funds cover full project costs, and the project should be competitive for grant ▪ 4 = CM invited to submit proposal for noncompetitive funding or covered by Operating Budget or NEORSD Annual District Contribution, USFWS funds, etc.
Partnerships Captures the importance of partnership(s) in terms of whether partners are involved who can contribute funds or technical support.	▪ 0 = no partnership exists ▪ 1 = basic partnership (no ties) ▪ 2 = partnership w/ money or in-kind or multiple partners ▪ 3 = multiple partners providing money or in-kind ▪ 4 = partner driving project and/or minimal funding needed from CM, and large expected benefit
Feasibility in Cost or Staff Availability If the project score makes it a candidate for implementation, budget and staff availability are evaluated according to the proposed project schedule. (Yes or No)	
Alignment with Strategic Goals Each proposed project must meet one or more of the Strategic Goals expressed in the Cleveland Metroparks System Plan, or the project cannot proceed. (Yes or No)	

Table 7. Natural Resource Division's 2016-17 Project Planning by Goal

Strategic Stewardship Goals & Objectives		Activity	Project Locations
Conservation Stewardship	Provide guidance for Park District development and guest access	Trail planning and construction	Johnson's Picnic Area , HINCKLEY Worden's Ledges, HINCKLEY Fort Hill, ROCKY RIVER
			Mountain bike use assessment, WEST CREEK, BRECKSVILLE, NORTH CHAGRIN
		Waterfront and fishing access	Ranger Lake, MILL STREAM RUN
		Beach Access Planning	Recreational Beach, EUCLID AND LAKEFRONT
Ecosystem Resilience	Maintain healthy fish & wildlife populations	Large-scale deer exclosures	Main Street Wetlands, MILL STREAM RUN Abram Terrace, ROCKY RIVER Gannett Woods, WEST CREEK Lake Plain forest, BRADLEY WOODS
		Hydrological restoration to improve water quality and fish habitat	Strawberry Pond, NORTH CHAGRIN
		Pollinator habitat enhancement and connectivity	Utility ROWs, BEDFORD, ROCKY RIVER
	Manage and restore aquatic resources	Wetland Restoration	Fowles Marsh & Lake Abram, BIG CREEK Snowville Wetlands, BRECKSVILLE Tinker's Creek Floodplain, BEDFORD
		Stream Restoration	Euclid Creek headwaters, ACACIA Snowville Streams, BRECKSVILLE Bonnie Park dam remove/modification, MILL STREAM RUN Sulphur Springs, SOUTH CHAGRIN
		Reduce stormwater inflow by working with engaged communities and watershed partners	East Branch Rocky River, Johnson Creek, Ledge Creek, Rising Valley, Mirror Valley, HINCKLEY Sulphur Springs, SOUTH CHAGRIN
	Manage and restore vegetation structure and composition	Invasive Species Control: *Hydrilla*	Wallace Lake, MILL STREAM RUN Sunset and Sanctuary, NORTH CHAGRIN Blue Heron Marsh, OHIO & ERIE CANAL Greathouse & Washout Wetlands, WEST CREEK
		Invasive Species Early Detection: Hemlock Wooly Adelgid	Abram Terrace, ROCKY RIVER Hemlock ravines, N & S CHAGRIN, BEDFORD
		Reforestation: Planting and maintenance	Ranger stables, Mirror Valley, HINCKLEY Former greens, tees and fairways, ACACIA
		Reforestation: Hardwood Regeneration	I-480 Bridge, ROCKY RIVER Oak Grove and Rice Ridge, BRECKSVILLE Pine Plantations Sites, ALL
		Reforestation: Close gaps	Redwing Field, Bellus Field, HINCKLEY
Understanding	Detect current and emerging threats to natural resources and park's built infrastructure	Create a spatial overlay of built infrastructure (e.g., roads, trails, pipelines) threatened by erosion.	ALL PARK DISTRICT *(Not included in priority ranking)*
		Create web-based geo-database and smart phone based apps for tracking management plans and activities.	
	Collect and synthesize critical information related to natural systems and their management	Improve data management for monitoring data collected in support of projects in this table and others.	
Partner	Collaborate with the region's natural resource management community	Broaden membership for and support additional staff in the Lake Eerie Allegheny Partnership for Biodiversity	

[?] *Feasibility relies on some outside factors such as priorities from other Departments, availability of grant funding, or collaborators, and therefore has not been evaluated for all priority projects*

Table 8. Results of Natural Resource Division's 2016 Project Planning by Score with status as of 2022 (C=Complete, O=Ongoing, P=Partial, None=No Action, ?=unknown) 13 projects are complete, 7 projects are ongoing, 7 projects are partially complete, 1 project has no action and 2 projects have an unknown status.

Project Locations/Activity	Ecological Sensitivity	Urgency	Funding	Partnerships	*Feasibility*	*Strategic Goals*	Project Score	Status
Sunset Pond and Sanctuary Marsh Hydrilla control NORTH CHAGRIN	3	4	4	2	Y	Y	20	C
Pollinator habitat enhancement and connectivity, utility ROWs BEDFORD, ROCKY RIVER	4	3	2	3	Y	Y	19	O
Wallace Lake Hydrilla control MILL STREAM RUN	2	4	4	2	Y	Y	18	C
Blue Heron Marsh Hydrilla control OHIO & ERIE CANAL	2	4	4	2	Y	Y	18	C
Main Street Wetlands; IPMP, protection, deer MILL STREAM RUN	4	3	2	1	?	Y	17	P
Bonnie Park dam remove/modification MILL STREAM RUN	3	3	3	2	Y	Y	17	C
Greathouse & Washout Wetlands Hydrilla control WEST CREEK	1	4	4	2	Y	Y	16	C
Former greens, tees and fairways; reforestation ACACIA	1	4	3	3	Y	Y	16	O
Euclid Creek headwaters; stream restoration ACACIA	1	4	3	3	Y	Y	16	C
East Branch Rocky River, Johnson Creek, Ledge Creek, Rising Valley, Mirror Valley; stormwater mitigation HINCKLEY	3	3	2	2	?	Y	16	O
Mountain bike use assessment WEST CREEK	1	4	4	1	Y	Y	15	C
Sulphur Springs; stream restoration SOUTH CHAGRIN	3	3	2	1	Y	Y	15	C
Hemlock Ravines; protection, exotic insect NORTH CHAGRIN	3	3	2	1	Y	Y	15	O
Snowville Wetlands; wetland , IPMP BRECKSVILLE	3	2	2	2	?	Y	14	P
Snowville Streams; stream restoration BRECKSVILLE	3	2	2	2	?	Y	14	P
I-480 Bridge area; forest regeneration ROCKY RIVER	2	3	2	2	?	Y	14	C
Tinker's Creek Floodplain; wetland restoration BEDFORD	3	2	2	1	?	Y	13	P

Strawberry Pond; hydrology/fishing restoration NORTH CHAGRIN	3	2	2	1	Y	Y	13	C
Fort Hill; trail planning ROCKY RIVER	3	2	2	1	Y	Y	13	C
Lake plain forest; protection, deer BRADLEY WOODS	3	2	2	1	?	Y	13	P
Pine Plantations Sites; hardwood regeneration PARK-WIDE	2	3	3	1	?	Y	13	P
Redwing Field, Ranger stables, Mirror Valley, Bellus Field; reforestation HINCKLEY	3	1	2	2	Y	Y	12	O
Worden's Ledges; trail planning HINCKLEY	3	1	2	1	?	Y	11	O
Oak Grove and Rice Ridge; oak regeneration BRECKSVILLE	2	2	2	1	Y	Y	11	O
Fowles Marsh & Lake Abram; wetland restoration/maintenance BIG CREEK	2	2	2	1	Y	Y	11	P
Abram Terrace; protection, deer and oak regeneration ROCKY RIVER	2	2	1	1	?	Y	10	?
Recreational Beach EUCLID AND LAKEFRONT	1	2	2	2	?	Y	10	?
Ranger Lake; fishing access planning MILL STREAM RUN	2	1	2	1	?	Y	9	None
Johnson's Picnic Area; trail planning HINCKLEY	2	1	2	1	Y	Y	9	C
Gannett Woods; protection, deer WEST CREEK	1	1	3	1	Y	Y	8	C

6.4 A Living Document

This Natural Resource Management Approach & Plan is intended to be a living document that summarizes the status and threats for Cleveland Metroparks natural resources and provides a planning framework for their thoughtful inclusion in management decisions across the Park District. One of the central goals of this document, in addition to communicating the current assessment of the system's natural resources and threats, is to document the process by which natural resource projects are selected and prioritized in the short, mid, and long-term. It is therefore essential to revisit this document and the list of future projects on a regular schedule.

Future efforts rely on implementing actions to meet the Strategic Stewardship Goals and Objectives, continually assessing natural resource conditions, drafting strategies for restoration and management, and testing their effectiveness through adaptive management. The future project list should be revisited biannually to account for changing social and ecological environments. The planning framework described above will form the basis for discussions to set future priorities.

7 Acknowledgements

Our current Natural Resources Division structure and management approach is based on the hard work and significant contributions of several key past division employees, including former Natural

Resource Division Chiefs/Directors Tom Stanley, Dan Petit, John Mack and Terry Robison; John Kason (Wildlife Biologist), John Gerlach (Forester), and Rick Tyler (Senior Natural Resources Area Manager).

8 Acronyms & Glossary

BEHI—Bank Erosion Hazard Index (Rosgen, 2001)

BMP—Best Management Practice, usually in reference to stormwater techniques

FQAI—Floristic Quality Assessment Index (Andreas et al, 2004)

HHEI—Headwater Habitat Evaluation Index (Ohio EPA, 2012)

HMFEI—Headwater Macroinvertebrate Field Evaluation Index (Ohio EPA, 2012)

LEAP—Lake Eerie Allegheny Partnership for Biodiversity

ORAM—Ohio Rapid Assessment Method for Wetlands (Mack, 2001)

PCAP—Plant Community Assessment Program

QHEI-- Qualitative Habitat Evaluation Index (Mack, 2001)

VIBI—Vegetation Index of Biotic Integrity, the index that is calculated from PCAP and wetland plot data to assess ecological health (Mack, 2007)

Bioretention - a stormwater management facility that removes contaminants and sedimentation from stormwater runoff by filtering the runoff through soil and vegetation. A bioretention treatment area includes a buffer strip, sand bed, ponding area, organic/mulch layer, planting soil, and plants.

Buffer - a vegetated area near a water body that filters stormwater runoff and helps shade and partially protect the water body from the impacts of adjacent land uses.

Ecological Connectivity – degree to which landscapes and seascapes allow species to move freely and ecological processes to function unimpeded.

Exclosure - an area from which unwanted animals are physically excluded.

Floodplain - an area of low-lying ground adjacent to a river, formed mainly of river sediments and subject to flooding.

Forage - food or provisions, especially for wildlife

Hydrological flow - water moving down a stream or channel.

Mesic - Refers to environmental conditions that have medium moisture supplies as compared to wet conditions (Hydric) or dry conditions (Xeric). Mesic forests are sometimes called upland forests.

Macroinvertebrate – invertebrate fauna that can be caught in a 500 µm net

Primary Influence Zones – land neighboring reservations but in the same watershed or drainage, where water flows to the reservations originate.

Riparian - of or relating to land adjacent to rivers and streams.

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