Restoration of a Multi-Functional Landscape: Mill Creek after Dam Removal

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Abstract

Mill Creek has been dammed at the Village of Dexter, Michigan, since the 1820s. The Village's relationship with Mill Creek has changed from one based primarily on power for saw and grist mills (economic growth) in the 1800s to one based on a free-flowing stream after the dam's removal in 2008. Our recommendations can help the Village of Dexter achieve its ecological goals for Mill Creek Park, improve the watershed's health and integrity, improve interpretive and educational experiences, and develop a richer, more diverse relationship between the Village and Mill Creek.

Key watershed recommendations are: 1) conduct local restoration/enhancement projects such that they contribute to the watershed's ecological functions and processes, 2) reduce the height and angle of artificially high streambanks, 3) reduce erosion around stormwater outfalls, 4) move stormwater from pipes to bioswales, 5) adopt or revise ordinances to protect riparian and wetland areas, to encourage low impact development, and to prevent use of invasive plants in landscaping, 6) remove invasive plant species, 7) move proposed paved trail more than 25 feet from streambanks, 8) reestablish natural disturbances (fire and flooding), and 9) improve safety in the Outdoor Education Area (OEA) by repairing erosion that threatens walkways, removing poison ivy, dead-standing trees and dangerous debris near the trails, and repairing boardwalks and walkways.

Key recommendations to facilitate effective relationships between people and Mill Creek are: 1) use this report's OEA plant identification guide, 2) establish either a point person or a core group of teachers to manage and effectively use the OEA for education, 3) pursue professional development opportunities for schoolteachers, 4) adopt, pilot test, and measure the effectiveness of the interpretive signs produced by this report, 5) recruit a volunteer program coordinator to plan volunteer activities and schedules, outreach, and supervise workdays, 6) use this report's suggested tools and strategies for volunteers, and 7) recruit volunteers from a variety of businesses, civic groups, and organizations.

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Acronyms

ADA: Americans with Disabilities Act

ARA: Active River Area

BMP: Best Management Practices

CoC: Certificate of Coverage

DEM: digital elevation model

DNRE: Michigan Department of Natural Resources and Environment (the new state department formed from the combined Department of Environmental Quality and the Department of Natural Resources)

ECT: Environmental Consulting & Technology, Inc. is an employee owned consulting firm specializing in the resolution of complex environmental issues through cost-effective project planning, management, and applied engineering and scientific expertise. Contributed to the creation of the Mill Creek Park Recreation Master Plan

GIS: geographic information system

GLSI: Great Lakes Stewardship Initiative

GPS: global positioning system

HRWC: Huron River Watershed Council

IDEP: Illicit Discharge Elimination Program

JJR: Johnson, Johnson, and Roy, Inc. A consulting firm focused on providing services in landscape architecture, planning, urban design, civil engineering, and environmental science. Contributed to the creation of the Mill Creek Park Recreation Master Plan

LID: low impact development

LLC: Legacy Land Conservation, formerly the Washtenaw Land Trust

MAEOE: Michigan Association of Environmental and Outdoor Education

Master Plan: Mill Creek Park Recreation Master Plan, JJR & EC, January 26, 2009

MBGNA: Matthaei Botanical Gardens and Nichols Arboretum

MDEQ: Michigan Department of Environmental Quality (now known as the Department of Natural Resources and Environment (DNRE))

MEERA: My Environmental Education Evaluation Resource Assistant – meera.snre.umich.edu

MNFI: Michigan Natural Features Inventory

NAP: Ann Arbor Natural Area Preservation

NOAA: National Oceanic and Atmospheric Administration

NPDES: National Pollutant Discharge Elimination System

NRC: National Research Council

OEA: Outdoor Education Area at Creekside Intermediate School

PaRC: Village of Dexter Parks and Recreation Commission

PEP: Public Education Program

SAG: Stakeholder Advisory Group that helped produce the Mill Creek Subwatershed Management Plan (SWMP)

SER: Society for Ecological Restoration International

S.M.A.R.T.: Specific, Measureable, Attainable, Relevant, and Time-bound

SMP: Shoreline Management Programs or Stormwater Management Program

SN: Stewardship Network

SWMP: Mill Creek Subwatershed Management Plan

SWPPI: Stormwater Pollution Prevention Initiative

TNC: The Nature Conservancy

USEPA: United States Environmental Protection Agency

Executive Summary

Restoration of a Multi-Functional Landscape: Mill Creek after Dam Removal

Mill Creek, a tributary of the Huron River, had been dammed since 1824 in Dexter, Michigan. The Village of Dexter removed Mill Creek Dam in 2008 and the stream now flows free as it passes the downtown portion of the Village. Removal of the dam created about 22 acres of newly exposed land in the formerly impounded area. This produced certain challenges for meeting diverse ecological, recreational, and educational needs as the Village pursued plans to construct a new park in the former impoundment area. The Mill Creek Park Recreation Master Plan was created for the Village in 2009 to stimulate economic activity in the downtown business district and to aid in addressing these challenges. Our report builds on the Master Plan, and details recommendations for the Village, its schools, and area residents with the goal of reconnecting the community with Mill Creek through the proposed park and surrounding natural areas, all while improving the health and integrity of the Mill Creek watershed. Our recommended options for enhancing this dynamic, multi-functional landscape stem from research on ecological restoration and management as well as human interaction with the environment. This report is divided into six chapters, each of which details a **need** or challenge facing the area, the **research methods** our team used in studying this need, the **results** of our research, and finally a set of **recommendations** for best addressing the need.

Restoration, Enhancement, and Management

Mill Creek Dam and its subsequent removal altered the landscape in the Village's current Mill Creek Park project area. The Village of Dexter can restore this landscape and promote healthy watersheds and ecosystems by using the best science in developing the park and restoring local ecosystems. Restoring and enhancing areas within the proposed park area can improve fish and wildlife habitat, streambank and riparian habitats, and filtration of sediments and stormwater. Restoration activities performed in and around Mill Creek Park in can in turn contribute to the health of the Huron River, as Mill Creek is its largest tributary.

Our research revealed that restoration of creek and river systems is challenging—each system is complex, with a mixture of ecological and physical characteristics that cannot be

fully addressed with universal solutions. Many aquatic restoration projects fail because they are too limited in their geographical focus, they address only one aspect of stream recovery (e.g. bank stabilization) without taking a broader ecological perspective, or they are based on inadequate data.

Our recommendations expand and improve upon the foundation provided by the Master Plan and methodology in a Village grant application for restoration and enhancement. First, the Village should take a watershed-wide perspective when conducting restoration projects. It is important to design restoration and enhancement projects within Mill Creek Park to benefit not only the Park, but also benefit the ecological processes and functions of the riparian corridor and Mill Creek watershed. Secondly, the Village should reconsider the placement of trails to provide better protection of riparian areas close to the stream. Currently, the Master Plan calls for placing multiple-use trails too close to creek banks. We recommend moving the trail at least 25 feet from the creek edge. Third, the Village should align its restoration goals more closely with those of the Mill Creek Sub-Watershed Management Plan to address the most important ecological problems of Mill Creek: altered flow regimes, loss of connections between the creek and its floodplain and riparian habitats, stormwater flows, streambank erosion, sediment deposition, and various pollutants. Finally, the Village could fit its local plans into a broader plan for the watershed by considering the Nature Conservancy's Active River Areas framework for watershed restoration and management, consulting with a "community of experts" with diverse backgrounds, and formally and cooperatively coordinating land-use and planning decisions with the other communities in the watershed.

Stormwater Management

The Village, though a small municipality, is considered an urban landscape with many hard, non-porous surfaces, such as pavement and rooftops. These surfaces allow pollution- and sediment-filled runoff to flow into Mill Creek and the Huron River. The Village of Dexter has the responsibility to reduce the negative impacts of such runoff. By examining locally pertinent documents and National Pollutant Discharge Elimination System requirements, as well as conducting outfall and wetland evaluations and examining the

practice of Low-Impact Design, we formulated recommendations to address runoff to Mill Creek from residences and other upland areas.

We recommend that several aging outfalls in the proposed park area be repaired according to a prioritized checklist. Each outfall will require a specific approach, which we outlined in our report. Outside of the park, we recommend residences and businesses adopt Low-Impact Design practices. In order to facilitate this action, we also recommend that the Village implement a Low-Impact Design Stormwater Ordinance.

The Outdoor Education Area: Management

To examine the health of one of the riparian habitats in the Mill Creek area, we made several visits to the Outdoor Education Area (OEA), a five-acre parcel of woods, wetlands, and trails behind Creekside Intermediate School, just south of the former impoundment. We discovered a number of ecological concerns in the area, such as the presence of invasive species and the apparent lack of natural disturbances. To enhance our understanding of the composition of the OEA and its natural processes, we identified the natural communities present in the OEA and examined the occurrence of natural disturbances and the extent of invasive species. Our results revealed that the OEA is composed of several ecosystem types in which natural flooding and fire, which have been suppressed in recent years, play a key role in maintaining healthy ecosystem functioning. Partially as a consequence of this disruption of the disturbance cycle, several invasive species have taken a foothold in the area and native plant regeneration has been slowed. We observed many issues related to comfort and safety, which likely have an impact as to how teachers and students use the OEA. These issues include the presence of poison ivy, standing dead trees, litter, and poorly maintained walkways.

Our recommendations for dealing with the challenges of maintaining safety and ecological integrity are outlined in a comprehensive management plan. The ecological portion of this plan includes suggested practices for removing invasive species and re-establishing the cycle of natural disturbance. Because the school might not have the funding or manpower necessary to carry out these tasks, we have designed these activities in a way that school groups, volunteers, or contractors can carry them out. In addition, we recommend preventative measures that the Village can take to inhibit the spread of invasive species, such

as removing them from the lists of recommended plants in the Village landscaping ordinance and working with residents, the nearby Forest Lawn Cemetery, and commercial properties to remove them. The safety portion of the plan describes actions that must be taken to assure teacher comfort in teaching outside. These include repairing trails, removing dead trees and debris, and removing poison ivy only in areas where people will gather most often.

The Outdoor Education Area: Environmental Education at Creekside Intermediate School

Making the OEA a safer place to visit will help to improve teacher use of this wonderful resource. Outdoor environmental education can engage students, assist teachers in meeting learning standards, and make ecological stewards out of all involved, benefiting the environment and the community. Unfortunately, the OEA has been neglected since the '90s. Although a trail guide was developed to coordinate ecological information to numbered posts along the trails, the information and the posts are now out-of-date and teachers no longer have a resource to aid them in conducting outdoor educational activities. To allow teachers to take advantage of this space, the school needs an updated guide, trails that are safe and dry, and a way to keep teachers skilled and excited about teaching outdoors. The OEA also presents an opportunity for connecting the students with work in the adjacent Mill Creek Park by carrying out some of the ecological restoration described previously.

In order to assess the teacher's needs regarding the OEA, we held several meetings with the teachers and school administrators. We also developed a survey for Creekside's teachers in order to gauge interest in current and future use of the OEA. The results of our communication with the teachers indicated that their main concerns are comfort (trail locations, wet and dry spots), safety (avoiding poison ivy), and lack of knowledge of ecological features in the OEA. Therefore, we created a new, identification-based OEA Guide by modeling field guides, curriculum guides and educational coloring books. In addition, we included lists of important plants in the OEA, describing their growth form, conservation importance, and habitat characteristics. The guide is designed to be flexible, so teachers can use it to meet their specific needs. To complement the guide, our report also provides recommendations for teaching outdoors and maintaining a long-term commitment

to using the OEA through the establishment of an overseer and a system of evaluation. The teachers' concerns regarding comfort are addressed in our OEA management plan.

Interpretation

Interpretive programming, such as signs or guided tours, can enhance park visitors' experiences by making the surrounding environment more understandable. In addition, interpretation can aid in increasing visitor knowledge, garnering support for restoration projects, and directing visitors to recreation opportunities. For the Village of Dexter, this programming can foster greater connections between the community and the creek, and contribute to the health of the creek by encouraging ecologically responsible actions.

Our team initiated the establishment of an interpretive program for Mill Creek Park by following an established series of steps interpreters use to create programming. Our team successfully navigated the first phase of the interpretive programming process by working with community members and the Parks and Recreation Commission to identify objectives and a scope for the initial program and then creating six draft signs for the Village that make the desired information accessible and interesting to a wide audience. We now recommend that the Village continue the process of developing their interpretive program by completing the draft materials, finalizing locations for the signs, and establishing an evaluation and maintenance plan. The Village should then pilot test the program and implement it according to their plans. If the Village wishes to expand their interpretive programming for Mill Creek Park in the future, we included a discussion of additional opportunities, and recommendations for moving forward.

Volunteer Program

Although many of the recommendations in our report involve work by Village employees and hired contractors, some activities, such as those outlined in the OEA management section are suitable to be performed by volunteers if funding and staff time are not available. Volunteer work is an excellent way to accomplish restoration tasks at a reduced cost, with positive side benefits for the environment, the community, and the volunteers themselves. By examining models of existing stewardship programs, performing a

literature review, and interviewing several volunteer managers at local organizations, we identified the key duties a volunteer coordinator needs to perform. These include planning, outreach, and workday leadership.

We developed a list of priorities and a timeline for the Village to create its own volunteer program. Our recommendations include groups to target for recruitment, techniques for recruiting them, and ways to foster long-term volunteers. The actions the Village must take include deciding whether the program will be a part of its bureaucratic structure, or whether it will be a non-profit organization and determining the mission of the program. A volunteer coordinator must be appointed to run the first small workdays and delegate tasks to volunteers. These volunteers may be recruited from scout groups, church groups, school groups, or from the community in general. The coordinator must also work to keep the volunteer pool engaged and interested. He or she may do this by giving thanks through letters or by providing fun, relevant trainings, for example. Using our recommended methods, the Village may be able to foster a group of committed volunteers who can carry out, restoration, enhancement, and management work in the park in a responsible and sustainable way.

From creating a volunteer stewardship program to lowering artificially high streambanks, our recommendations take into consideration the needs of the watershed, the community, and the Village. They can help the Village of Dexter capitalize on the opportunity they have to forge a new connection with Mill Creek and its watershed in a way that supports it as a multifunction landscape. As the Village moves forward with their plans for Mill Creek Park, these recommendations will help them to promote ecological functioning and natural systems as well as human interaction, recreation, and understanding.

Introduction

The time for planning the future of Mill Creek is now. This is an opportunity for careful consideration of alternate strategies for protection, rehabilitation, and enhancement of recreational and aesthetic aspects of Mill Creek. Though watershed planning is necessarily a political process, it must be based on sound technical science. Stream systems are constrained by a series of hydrologic, geomorphic, and biologic realities. What Mill Creek becomes in the future will depend not only on our actions and desires, but also on the basic nature of its catchment and its connections to larger, regional ecosystems.

~ P. Seelbach and M. Wiley, 1996

I. Background: Mill Creek and Dexter, Michigan

This Master's Project focuses on the Village of Dexter's effort to restore the local environment of Mill Creek, in Washtenaw County, Michigan. Mill Creek is the largest contributing tributary to the Huron River, which has a drainage area of 144 square miles. It runs through Dexter, a small municipality with a population of 2,338 in 2000. The creek has been a central part of Dexter's history since its founding. In fact, Dexter was called "Mill Creek Settlement" until 1830 when it was named after its most prominent resident, Judge Samuel Dexter (regent of the University of Michigan and supporter of the Underground Railroad). As its name implies, Mill Creek has been the site of woolen, grist, and cider mills. In the 1820s, a dam was constructed for one of these mills, at the site of the current Main Street Bridge, creating a 22-acre impoundment area named Mill Pond. The dam lost its original purpose of powering the mill (Riggs, 2008), while Mill Pond remained a favorite fishing and hunting spot. In May 2008, the dam was removed as part of the

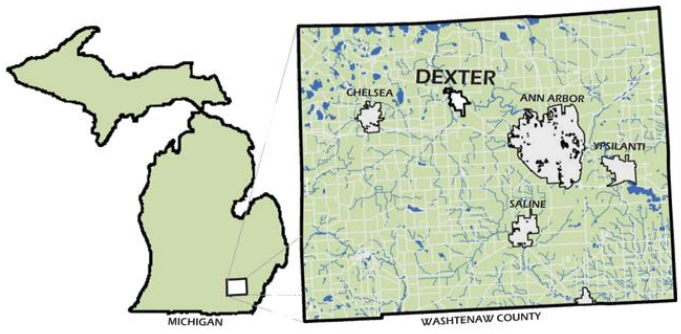


Figure I: Dexter, Michigan

reconstruction of Dexter's Main Street Bridge. As a result, Mill Pond has dissipated and Mill Creek is now free flowing.

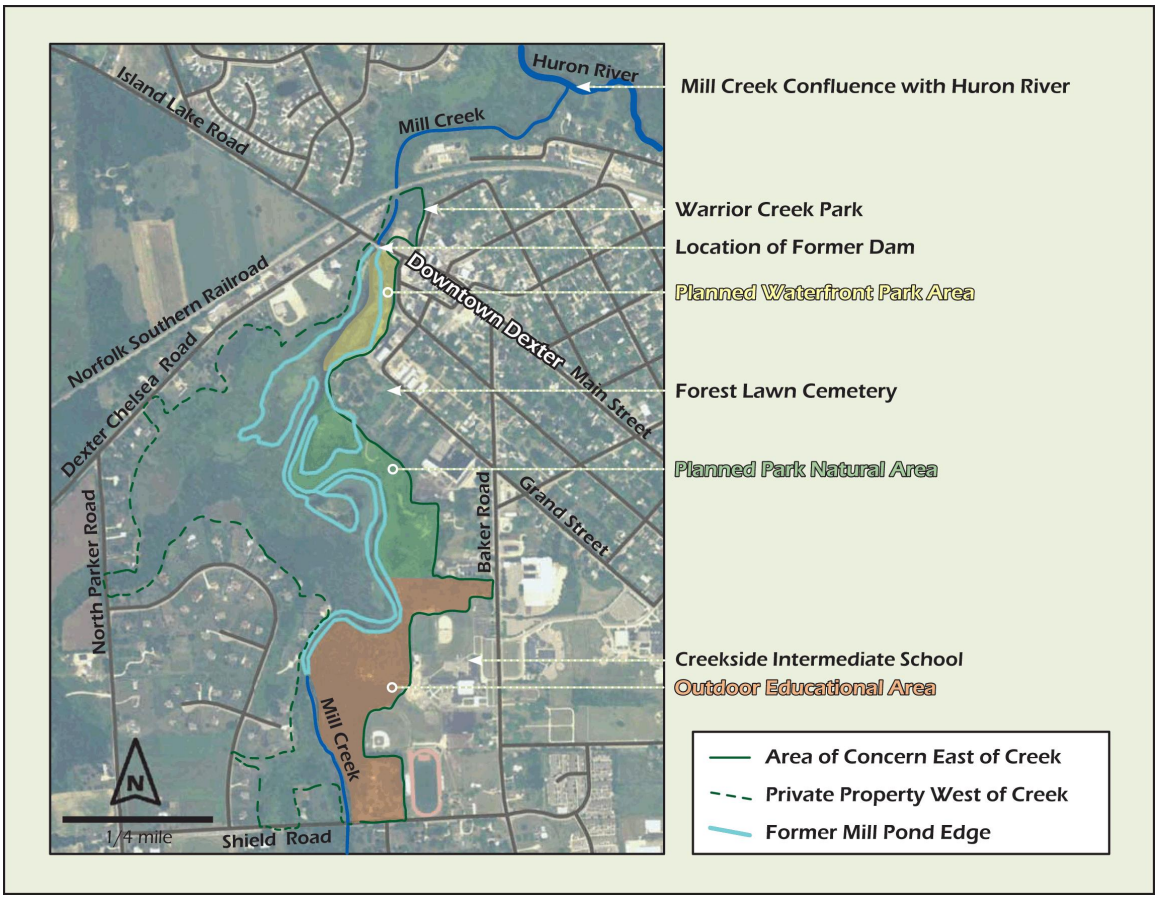


Figure II: Area of Interest and Context Map

Ia. Mill Creek Dam Removal in a Larger Context

Dams of various sizes were built in the United States, and in Michigan, for a variety of reasons: to provide power to sawmills and gristmills, to help control flooding, to provide reservoirs for water supply to local community, to provide different types of recreation, and to supply hydroelectric power. Although these represent diverse reasons for building dams, they all represent how communities connected to and had relationships with their local streams and rivers. These connections and relationships exhibit how a community viewed a stream or river as a particular resource – primarily, as one to be harnessed and/or controlled.

As dams aged, they required repairs. Often, an aging dam would become a safety liability and a significant economic cost to a community. As the needs and viewpoints of communities changed over the past 200 years or so, the relationship between a community and the local dam often changed, too. The Village of Dexter is a prime example. The dam on Mill Creek was first built to provide power needed to run a saw mill and a grist mill. The Village grew around the location of the dam because of the resource that the dam and stream provided to the new community. When the dam no longer served the purpose of providing power to the mills, the relationship of the Village to the stream was shaped largely by the recreational opportunities provided by the pond that existed behind the dam.

Two key factors altered the Village's relationship over the past decade or so with the pond and Mill Creek itself: 1) the eventual filling of the pond with sediments such that the pond became very shallow, and 2) the decay of the dam and the need to repair the bridge to which the dam was attached. As a result, the Mill Creek Dam joined the growing list of small dams being removed across the United States (American Rivers, 1999). The decision to remove the dam wrote a new chapter in the relationship and connection between the Village and Mill Creek.

As in many other cases, dam removal in Dexter has created unique opportunities for ecological restoration and integration with the human community. Restoration may improve biodiversity, water quality, habitat, and flood control. Additional strategies can make the area more accessible to the community through stewardship, recreation, and educational opportunities.

To put this change in broader perspective, Dexter lies at the confluence of Mill Creek and the Huron River, and thus at the nexus of a greenway involving the Huron-Clinton Metroparks and Washtenaw County's Border to Border Trail. Restoration of Mill Creek will help connect the Village to this broader network of natural and recreational spaces, uniting fragmented natural areas and bringing additional visitors to the downtown area. In order to achieve the best ecological and social outcomes, it may be useful to cooperate with non-Village residents on the west side of the Creek. Restoring both sides of the river will safeguard the area's ecological integrity and will also benefit property owners.

Ib. The Mill Creek Park Master Plan

In January 2009, the Village completed the Mill Creek Park Master Plan in conjunction with a community planning team and a pair of contractors, Johnson, Johnson, and Roy (JJR) and Environmental Consulting Technology (ECT). The Master Plan outlines the development of Mill Creek Park and establishes the Village's vision and goals for its reconnection to a free-flowing Mill Creek – a stream that had been dammed at the Village for over 180 years. The Village now views the free-flowing Mill Creek as a resource in more diverse ways than ever before – economic, ecological, social, educational, and aesthetic ways. A key goal of this Master's Project is to assist the Village of Dexter with its efforts to redefine its connections to and relationships with Mill Creek now that the dam has been removed.

The Master Plan lays out options for restoring and developing the areas just north (Warrior Creek Park area) and south (Mill Creek Park area) of the Main Street Bridge, with tentative plans for the Outdoor Education Area (OEA) at Creekside Intermediate School. Our project focuses on this area, from Warrior Creek Park to the southern edge of the OEA (Shield Road), but we went beyond the existing Master Plan in a few key respects. The Master Plan primarily focuses on the park area south of the bridge. By contrast, our project looked at the park as a small but important piece of a bigger picture—as a part of the Mill Creek watershed and a vital place for the people of Dexter and local communities. Mill Creek's health and integrity are important for the new connections and relationships between the Village and the stream. Our project focuses on different areas of the Village that are along Mill Creek. These different locations have different needs and issues, such as stormwater management, invasive species management, and educational and interpretive functions. Therefore, our project uses different approaches and methods to develop options for the Village to consider when it conducts projects to meet the goals of its Master Plan for Mill Creek Park. Although the various parts of our project occurred in different locations and used different methods, the overall unifying goals of our project are to:

1. assist the Village and the Dexter Community Schools in attaining their goals, and
2. help the Village develop ways to improve the health and integrity of Mill Creek.

Our project contributes to what is a continuing public conversation about how to implement the Master Plan for Mill Creek Park (Dalton 2010).

II. How to Use this Guide

IIa. A Multidisciplinary Approach

This Masters Project developed strategies for the restoration and management of the area in and around Mill Creek Park. The land, the flora, and fauna have been undergoing major changes since the dam was removed, and recreational and educational opportunities have changed along with them. In light of the changes, our project sought to find ways for the Village and others to restore the ecological health of the creek while also restoring residents' connection with it. We drew on various disciplines to create well-rounded, complementary recommendations for achieving these goals.

Our recommendations are designed for use by the Village of Dexter's parks and planning staff, Dexter Community Schools, and local residents. Specifically, we recommend options for professional and volunteer ecological restoration efforts, stormwater solutions, and outdoor education and interpretation opportunities, while putting these recommendations in a broader context. Our recommendations range from philosophical to technical in nature and from social to biological in focus. All have the ultimate goal of improving the well-being of both human and nonhuman life in this area. By its nature, this goal suggests two lenses through which to view our recommendations: ecological restoration and management and human interactions with the environment.

Improving the health and integrity of Mill Creek is the central theme of this project. Using current ecological knowledge and research, we provide recommendations for addressing concerns such as streambank erosion, sediment deposition, and invasive species. Drawing on a social-scientific perspective, we also recommend ways to give people new opportunities to interact with the Mill Creek ecosystem, which will subsequently improve the health of the creek. Environmental education and interpretation are important for building ecological awareness. People who learn about the creek may feel a greater connection to the local environment and become more likely to care for the area, support restoration efforts, or

even volunteer. Volunteer work helps reach ecological goals through restoration, monitoring, and fostering an environmental ethic. These two types of recommendations help foster a holistic approach to improving the health and integrity of Mill Creek

IIb. Chapter Organization

The chapters in this guide are organized into four sections: needs, methods, results, and recommendations (some chapters also have chapter appendices with maps, charts, and images that relate to that chapter). This organization is meant to satisfy both the academic reader interested in the research herein and the practitioner that is most interested in the actions they can take. Each chapter begins with a description of a Mill Creek need—the problem that will be addressed in that chapter. The chapters then explain the research methods we used, including our approach and specific actions, in order to understand the problem and determine recommendations. Next, each chapter describes the findings of the research, and what it means for the Village of Dexter and its section of Mill Creek Park. The chapters end with recommendations for acting on the research and meeting the needs of the ecosystem and its people.

This report is organized into six chapters. The remaining chapters reflect the different locations and the location-specific needs and concerns within the proposed park. Chapter 1 discusses the ecological restoration, enhancement, and management primarily within the Transition and Habitat Enhancement Zone of the park. This zone includes the area formerly impounded by the dam and some areas immediately upstream from the impoundment. Chapter 2 covers the stormwater management outfalls within the park and the Outdoor Recreation Area (OEA), as well as certain stormwater issues within the Village. Chapter 3 discusses the management of OEA, mainly with a focus on removal of invasive plant species, ecological enhancement, and certain safety and comfort concerns. Chapter 4 covers environmental education within the OEA, primarily with a focus on the use of the OEA by students and teachers of Creekside Elementary School. Chapter 5 provides information about interpretation – the opportunities for park visitors to learn and appreciate the environmental efforts being made by the Village within the park. Such interpretation opportunities will occur along the trails in the park. Chapter 6 covers opportunities to recruit volunteers and to

build a volunteer program. Volunteers will be an important part of the maintenance and ongoing ecological restoration and enhancement of the park. Each chapter provides options and suggested recommendations to address the major issues and concerns of the different locations and stakeholders in the project area.

Chapter 1: Enhancement, Restoration, and Management

A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.

~ Aldo Leopold, A Sand County Almanac

The terms "restoration" and "enhancement" are sometimes used in similar or even synonymous ways, yet they are different ecological concepts. Using the Society for Ecological Restoration's framework (Society for Ecological Restoration International, 2004), Clewell and Aronson define *ecological restoration* in a holistic manner, as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (2007: 7). Restoration helps return the ecosystem to "a state of wholeness" with the following characteristics:

- *integrity*: the system exhibits its typical biodiversity, composition of species, community structure, and ecosystem functioning (Society for Ecological Restoration International, 2004);
- *health*: the dynamic characteristics or processes of an ecosystem occur "within 'normal' ranges of activity relative to its ecological stage of development" (Society for Ecological Restoration International, 2004);
- *self-organization*: the functions of the ecosystem are generated by internal processes (Clewell & Aronson, 2007); and
- *self-sustainability*: the ecosystem can persist over long time periods even though some internal changes may occur in response to changes in the environment (Clewell & Aronson, 2007).

Thus, ecological restoration addresses the wholeness, not simply the partial repair, of an ecosystem.

Ecological enhancement is any partial measure or action to an area to repair an ecosystem, such as reintroducing a locally extinct or missing species, except in cases where that partial action is the only thing needed to complete the repair (Clewell & Aronson, 2007: 12). Clewell and Aronson clearly distinguish enhancement from restoration: "We do not recognize as ecological restoration any partial measures that do not lead to ecosystem wholeness" (2007: 12).

Both Palmer et al. (2005, 2006) and the NRC (1992) provide definitions and frameworks for ecological restoration of fluvial (that is, river and stream) ecosystems in particular. The NRC (1992: 17-18) defines restoration in terms of a wholeness much like that described by SER (2004) and Clewell and Aronson, (2007). The NRC focuses on the goal of reestablishing self-regulation, structure and functions of the ecosystem, emphasizing that a holistic approach is "not achieved through the isolated manipulation of individual elements" (1992: 17). For fluvial ecosystems, restoration entails "… the reestablishment of predisturbance aquatic functions and related physical, chemical, and biological characteristics" in order "to emulate a natural, functioning self-regulating system that is integrated with the ecological landscape in which it occurs" (National Research Council 1992: 17-18). According to Palmer, et al., "ecological restoration is an attempt to return a system to some historical state." (2006: 1). At the same time, "a more realistic goal may be to move a damaged ecosystem to an ecological state that is within some acceptable limits relative to a less disturbed system… In this sense of the term, ecological restoration can be viewed as an attempt to recover a natural range of ecosystem composition, structure, and dynamics" (Palmer et al., 2006: 1).

Within these frameworks, it is recognized that fluvial systems cannot always be restored to the exact state prior to human disturbance. First, it may not be easy to identify an ecosystem's previous state with precision; second, dynamic forces may have changed the systems to some extent, as a result of changes in climatic and environmental conditions since the time of disturbance. Clewell and Aronson (2007, Ch. 1 and 2) make this point with regard to terrestrial ecosystems, yet it applies to fluvial ecosystems as well. The dynamic nature of

such ecosystems and the environmental factors that affect them makes it impractical to set a single historical target or endpoint for restoration. Instead, the goal should be to restore enough self-organization and ecological complexity to help reestablish the ecosystem's functions and processes, as well as self-sustainability (Clewell & Aronson, 2007: Ch. 4 and Ch. 12, respectively).

1.1. Need (Defining the Problem)

Freshwater ecosystems, including streams and rivers, provide a wide range of valuable services: recreation, habitat for animals and plants, flood control, drinking water, transportation, the production of food and market goods, and the treatment and purification of human and industrial waste (Postel & Carpenter, 1997; Wilson & Carpenter, 1999; Baron et al., 2003). Degradation of rivers and streams, as well as other freshwater systems, can lead to a decline or even a loss of many of these services. In the United States, human actions have controlled 85 percent of the inland water surface area, in contrast to only 60 percent of the land surface area (National Research Council, 1992: 22). Humans have altered rivers and streams by physically changing either the channels themselves or the surrounding landscape—primarily by damming, dredging, channelizing, building levees, draining adjacent wetlands, and altering land uses (Naiman & Decamps, 1997, Allan, 2004). A key benefit of restoring and sustaining fluvial ecosystems is to maintain the services that they provide to human beings (Baron et al., 2002, 2003). The NRC (1992: 15) stated: "Restoration is essential if per capita ecosystem service levels are to remain constant while the global human population increases."

Mill Creek is an important natural resource: an ecologically important part of the Huron River watershed and a provider of many ecosystem services and potential recreational opportunities to local communities. Like so many fluvial systems, however, Mill Creek and its watershed have been modified by past human activities, such as draining wetlands and damming, dredging, and channelizing the stream. Urban, suburban, and agricultural activities continue to have a negative impact on the Mill Creek ecosystem (see Seelbach & Wiley, 1996; Huron River Watershed Council, 2006). Without more strategic planning, these human

activities will continue to affect the health and integrity of the Mill Creek ecosystem, as well as the quality of life for residents of the watershed. Such planning must incorporate key ecological principles and processes:

> The time for planning the future of Mill Creek (and the rest of the Huron River system) is now. This is an opportunity for careful consideration of alternate strategies for protection, rehabilitation, and enhancement of recreational and aesthetic aspects of Mill Creek. Though watershed planning is necessarily a political process it must be based on sound technical science. (Seelbach & Wiley, 1996)

Any restoration and enhancement projects undertaken by the Village of Dexter are also opportunities to improve and sustain the Mill Creek ecosystem's services for residents of the area. The Village's decision to remove the dam and enable the stream to flow more naturally (Figure 1.1) was a crucial step in this direction. Thoughtful, science-based decisions now need to be made in order to further restore, enhance, and protect Mill Creek and its benefits to human residents. Such actions could continue to increase the quality of life in Dexter and neighboring communities, especially those downstream along the Huron River.

Figure 1.1: Mill Creek as it flows past the site of the former dam in Dexter, Michigan. (Photo by James Minesky)

Unfortunately, most fluvial restoration and enhancement efforts have quite limited success, and in some cases meet with complete failure. Researchers have developed a fairly solid understanding of why these projects have such a poor track record.

To enhance the Village's efforts to secure grant money to fund the proposed restoration and enhancement work and to increase the likelihood of the success of that work, several factors must be considered. First, the reasons for the poor success of many past fluvial restoration projects must be understood. Second, various options that will improve the chances of securing funding and of implementing successful restoration and enhancement work on Mill Creek must be explored. Lastly, the goals and objectives for restoration and enhancement in the Village's 2009 "Mill Creek Park Recreation Master Plan", as well as the Village's policies and ordinances related to the natural environment, should align with the scientific understanding of functional stream ecosystems and the goals and objectives outlined by the Mill Creek Subwatershed SAG (Huron River Watershed Council, 2006) in the Mill Creek Subwatershed Management Plan (SWMP).

This section of this report, then, outlines: 1) the options for restoring and enhancing Mill Creek within the proposed project area, in ways that also contribute to the ecological processes and wholeness of the watershed; and 2) the need to use current scientific knowledge about fluvial systems and their restoration to aid the Village's chances of securing funds to fulfill the vision and goals of the Master Plan and to enhance and restore Mill Creek and its watershed. Mill Creek Park will occupy a small part of the lower reach of Mill Creek before the creek flows into the Huron River. This report provides recommendations that can help the Village connect their projects to the larger ecological functions and processes of the Mill Creek watershed and the Huron River watershed. The Village's Master Plan and Mill Creek Park fit within the larger context of the Mill Creek watershed and the larger Huron River watershed, as conceptually shown in Figure 1.2.

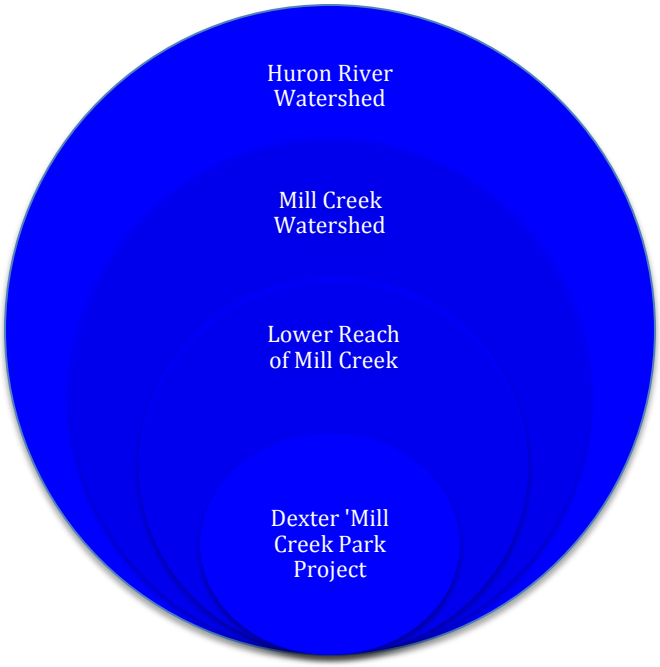


Figure 1.2: Illustration that shows the ecological context within which the Village of Dexter's project proposed in the "Mill Creek Park Recreation Master Plan" resides in Mill Creek and the Huron River watershed.

1.2. Research Methods

In evaluating the restoration and enhancement proposals in the Village's Master Plan, our team was able to draw on various sources of information. The Master Plan summarized the Village's vision, goals, and objectives. The Village's 2009 NOAA (National Oceanic and Atmospheric Administration) grant application, prepared with the help of JJR and ECT, described the methods that the Village would likely use to carry out both enhancement and restoration. The application outlined key methods to be used for to enhance fish habitat and stabilize the streambanks if NOAA funding were secured. In addition, descriptions and data from previously published reports were used to understand some of the fundamental characteristics of the stream and watershed. We gathered watershed recommendations for Mill Creek and the Huron River system from management reports such as the SWMP, comparing its goals and objectives with the Village's approaches restoration and enhancement. Finally, scientific, peer-reviewed papers and government reports on stream restoration, particularly those that described past outcomes and recommendations for action proved were valuable resources.

1.3. Results

1.3.1. Scientific Framework for Successful Ecological Restoration and Enhancement

Today, there is a wealth of scientific research on the fundamental ecology and geomorphology of fluvial systems and recent research examining actual fluvial restoration projects. This research should inform all restoration, enhancement, and management projects. (See Appendix A for a summary of key findings.) Such work treats each river or stream as a fairly complex system that varies in structure and function over both space and time. In addition, each river or stream is an open system connected to the surrounding land and the neighboring surface water and groundwater, which exchanges nutrients, organic matter and sediments with its surroundings. A systematic use of this knowledge will increase the likelihood of ecological success. Unfortunately, the practice of stream and river restoration does not appear to be keeping up with the available scientific knowledge, and most ecological restoration projects on streams and rivers have not been very successful. The reasons for this will be explained below.

In its 1992 report on restoration of aquatic ecosystems, the NRC (National Research Council) provides a range of guidelines for such efforts. It identifies the major known stressors for streams and rivers, emphasizes the need to work with fluvial systems rather than against them, recommends reestablishing flow regimes and flooding while reducing sediments and chemical contaminants, and recognizes the importance of interactions between the channel and surrounding land by calling for restoring riparian areas and wetlands (see National Research Council, 1992:166, 227, 350). The NRC also recommends using a landscape perspective in policies and programs aimed at restoring aquatic systems (National Research Council, 1992: 356-357).

Since the early 1990s, research has not only confirmed most of these conclusions, but has also further expanded our scientific understanding of how to enhance, restore, and repair fluvial systems. For example, Naiman et al. (1993) argue that better protection of riparian corridors, better maintenance of hydrologic connections between rivers and riparian corridors, and better maintenance of hydrologic variability of riparian corridors can help maintain the ecology and health of river systems. Overall, the scientific research has shown

clearly that a river or stream is a complex, dynamic system that exists as a mosaic of different floodplain, riparian, channel, surface, and subsurface features, any of which can shift or change over time in response to a hierarchy of controlling environmental factors (see Allan & Castillo, 2008, Ch. 14). A river is a system, best viewed and studied from the perspectives of ecosystem ecology, landscape ecology, and geomorphology.

These fundamental findings from ecosystem ecology and landscape ecology have an important place in the enhancement, management, and restoration of rivers and streams. The more holistic management approaches now being adopted take into account how those ecosystems function and how a river's health changes over time (Allan & Castillo, 2008: 348). Such approaches make use of well-tested management practices and benefit from the will and organizational structure to implement useful ideas (Allan & Castillo, 2008: 348).

Unfortunately, the practice of stream and river restoration does not appear to be keeping up with the available scientific knowledge, and most ecological restoration projects on streams and rivers have not been very successful (see evaluations by National Research Council, 1992 and Palmer et al., 2003). Many projects have been too limited in focus, have had teams of experts with a limited range of expertise, and have used less comprehensive methods to understand flow regimes and sediment transport. They have also tended to lack pre-restoration or post-restoration data to assess the effects of the restoration, as well as useful assessment data to evaluate the project's true level of success, especially in the case of urban streams. Finally, too many projects have failed to incorporate and integrate economic, social, and political factors in a meaningful way. (More details and examples can be found in Appendix B.)

In addition, certain "myths" of restoration ecology have the potential to undermine a project's prospects of success. Hilderbrand et al. (2005) explain three myths that are particularly relevant to the Village of Dexter's Mill Creek restoration plans: 1) the myth of the carbon copy, 2) the myth of the field of dreams, and 3) the myth of the cookbook. The myth of the carbon copy is rooted in the belief that an ecosystem can be restored to a pristine, ideal state, as it existed before its disturbance by human beings. The myth of the field of dreams is the idea that if physical features and structural habitat are built, species will be attracted to the area and biotic composition (e.g., community structure) and ecological function will assemble on their own. This idea is common in attempts to restore both streams

and wetlands, because such projects often focus on recreating physical characteristics of the site and give little or no focus to biotic responses. Lastly, the myth of the cookbook is the belief in a single, uniform approach to restoration and enhancement. For example, a published methodology may be used over and over among systems that appear to be similar physically and ecologically, with little or no consideration of idiosyncrasies and uncertainty within a given system. Stream restoration projects tend to use cookbook methods, such as the Rosgen approach (Hilderbrand et al., 2005). Appendix C explains these myths in further detail.

The Master Plan and 2009 NOAA grant application (see Appendices D-G for more details) take some approaches that could be successful, but others that could lead to low success. First, they envision attracting fish into the previously impounded area and enhancing fish populations within stream reaches in the proposed park area primarily by creating or enhancing structural habitat. This strategy relies too heavily on a bioengineering approach and does not give enough consideration to other key factors that affect the presence of species and the formation of communities in river systems. Fish reproduction, recruitment, survivorship, and population growth over the long-term depend on flow regime, water quality, sediment flux (both inputs and outputs), chemical and nutrient flux, and thermal and light inputs (see Figure 1.3). These factors are not only vital to sustaining fish populations, but for maintaining invertebrate diversity and community assemblages (Allan & Flecker, 1993; Baron et al., 2003; Allan & Castillo, 2008, Ch. 10).

In building ecological communities or ecosystems, it is risky to assume that assembly processes of a community or ecosystem simply follow a predictable, repeatable trajectory (see Hilderbrand et al., 2005 and references therein). Dexter's current plans primarily use a bioengineering approach to improve fish habitat, without considering the flow regime and stream alterations occurring in upstream parts of the watershed. The Village thus runs the risk of not seeing a significant return on its investment. Recall the myth of the field of dreams: "the notion that all one needs is the physical structure for a particular ecosystem, and biotic composition and function will self-assemble – if you build it, they will come" (Hilderbrand et al., 2005).

Second, the Village (as seen in its NOAA grant application) may rely too heavily on the Rosgen method in its efforts to restore the stream channel and enhance fish habitat. A

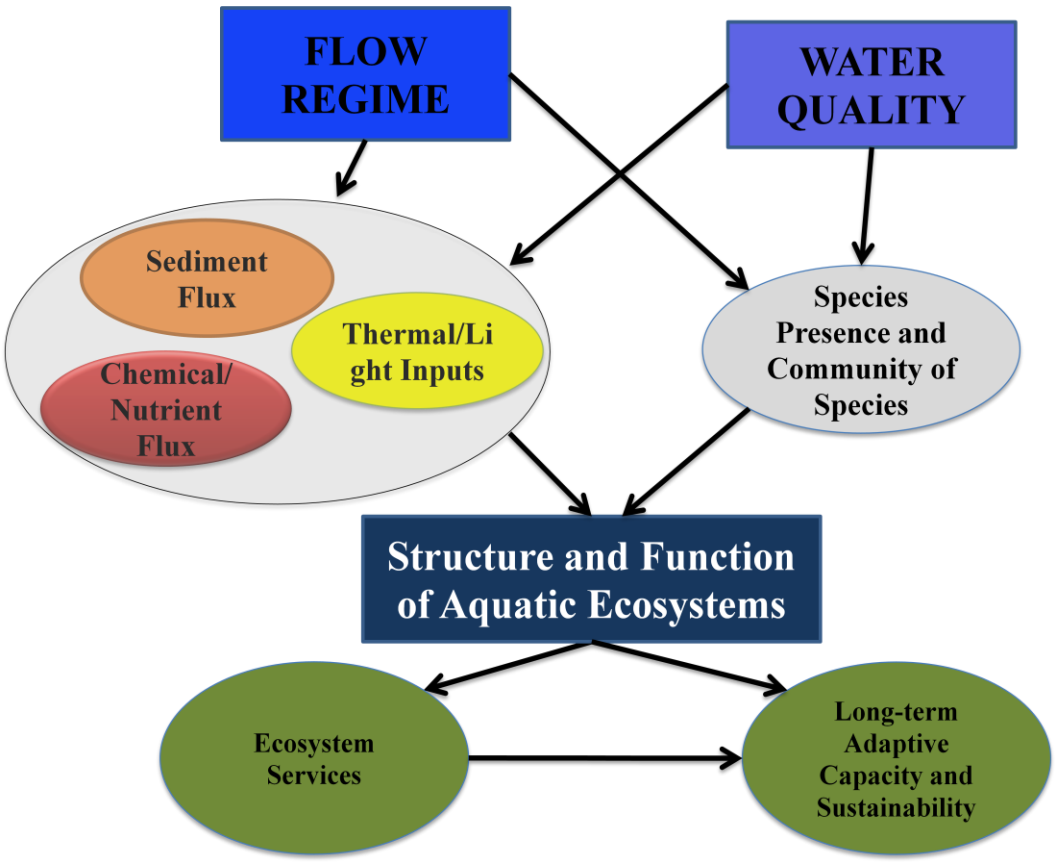


Figure 1.3: The occurrence of a species and the community of species (aka 'biotic or community assemblage') in a river ecosystem is greatly influenced by flow regime and water quality, not simply structural habitat. Adapted from Baron et al., 2003 (Figure 2, p. 4).

popular assessment tool, the Rosgen method is useful for classifying streams and applying aspects of fluvial geomorphology to stream enhancement and restoration projects. The method uses aerial photographs, topographic maps, computer software, and principles of fluvial geomorphology to understand a stream's channel and bank morphology and stability (Smith et al., 2008). Yet this approach, although it can be potentially adapted to local conditions, may lead to limited success unless the Village draws on additional methods and the expertise of fluvial ecologists and geomorphologists. Reliance on just one methodology to enhance and restore the stream's channel within a specific stream reach has several serious drawbacks (Hilderbrand et al., 2005; see also Appendix B):

- It is too limited in focus, given the importance of the larger environmental and ecological context, not just the narrow goals of restoring and stabilizing the stream channel as in the Rosgen approach.
- It may draw on too narrow a range of expertise; the Village's current plans, for instance, do not include fluvial ecologists or fluvial geomorphologists in its team of experts.
- It uses limited, less comprehensive methods to understand flow regimes and sediment transport.
- It can lead to falling into the "myth of the field of dreams" and the "myth of the carbon copy" if relied upon too heavily (see Hilderbrand et al., 2005 and references therein).

All in all, the Rosgen method only provides limited information about floodplain functions and sediment processes, and does not have the ability to estimate the effects of future conditions in the watershed. Therefore, instead of relying on one assessment or design method, such as Rosgen, it is useful to confirm its findings through multiple methods (Smith et al., 2008: 35).

Third, the Village's restoration plans will keep the artificially high stream banks intact, and will probably place a paved trail on or near those banks. In two locations, the banks appear to be especially high, with nearly vertical sides facing the stream (Figure 1.4). In the first location, the area of the former impoundment, the elevated banks have resulted from many decades of sediment accumulation when that area was part of the dam's impoundment. In the second location, upstream between the former impoundment and the Outdoor Education Area (OEA), the problem is most likely due to the placement of dredge spoil piles along the streambanks (as suggested in the Village's 2009 NOAA grant application and in Seelbach & Wiley, 1996).

Artificially high banks prevent Mill Creek from extending into riparian and floodplain areas during moderate to high-flow events, and thus keep it from experiencing all of the ecological benefits of being connected to those areas. This is an example of altered hydrology, addressed in what the Mill Creek SWMP identifies as the first "priority

Figure 1.4: Artificially high streambanks along Mill Creek between the former impoundment at the Village of Dexter and the Outdoor Education Area. Note the vertical face of the banks. The right side of the photo is in the proposed Mill Creek Park. (Photo by James Minesky)

challenge" for Mill Creek. Likewise, the SAG recommends addressing the loss of the connection between stream and floodplain owing to channelization. The Village's current restoration plans do not address the issue of reconnecting the stream with its riparian and floodplain areas, which could be one way to help improve fish habitat and restore healthy riparian woodlands and wetlands. This would give the Village's plans a broader ecological focus.

Fourth, the Village's 2009 NOAA grant application discusses the monitoring of various ecological parameters as a measurement of success, yet its criteria remain vague. The application mentions some specific methods for monitoring fish and stream invertebrates, such as species abundance, species composition, and overall diversity. However, it defines no specific ecological criteria for using the data obtained from monitoring work to demonstrate "successful" restoration. The Village's plans do not mention whether restoration and enhancement of fish populations would be deemed a success, for example, if diversity

increased by a specific numeric factor or by a statistically significant difference from baseline, pre-restoration levels. Such a clarification would be very useful.

Fortunately, the use of careful, scientifically knowledgeable design and planning can overcome the problems and avoid the missteps that cause so many restoration and enhancement projects to fail. According to Palmer et al. (2005), the most effective restoration projects involve three primary components or axes of success: stakeholder success, learning success, and ecological success. We illustrate the criteria for success within each of these three axes in Figure 1.5, reproduced directly from Palmer et al. (2005: 209).

Figure 1.5: The three primary axes of success for restoration projects. Reproduced directly and quoted from Palmer et al., 2005 (p. 209, Fig. 1).

"Fig. 1. The most effective river restoration projects lie at the intersection of the three primary axes of success. This study focuses on the five attributes of ecological success, but recognizes that overall restoration success has these additional axes. Stakeholder success reflects human satisfaction with restoration outcome, whereas learning success reflects advances in scientific knowledge and management practices that will benefit future restoration action."

Appendix H provides details of the guidelines proposed by Palmer et al. (2005) for evaluating whether or not fluvial restoration is an ecological success. These criteria developed can be applied to projects of any scale, from large to small. Any restoration project, regardless of size, should consider a "guiding image of a dynamic state" as a criterion. This criterion emphasizes the importance of understanding: 1) the range of key system variables such as hydrology, geomorphology, biology, rather than just the mean values; 2) human-caused changes to the range of the key variables; 3) stressors both on a

local scale and on the scale of the watershed; and 4) the extent to which local restoration projects can contribute to restoration of the larger watershed (Palmer et al., 2005).

As stream restoration practitioners, Gillilan et al., (2005) support the same ecologically based standards for river restoration. Restoration practitioners sometimes choose methods for stabilizing banks and channels, such as root wads or boulders, before completely formulating the guiding image for a dynamic ecological end state. Gillilan et al. (2005) point out that the latter initial step, although often challenging, is typically the most critical part of a fluvial restoration project. For example, if it is discovered that habitat cover was the factor limiting a fish population at a project site, the best approach is to use the guiding image to discern *why* the cover is missing and *how* to restore natural processes to create and maintain necessary habitat features such as pool depth, overhanging vegetation, and undercut banks (Gillilan et al., 2005).

Gillilan et al. (2005) also agree with Palmer et al. (2005) that the term "ecological restoration" is often misapplied to projects. For example, many projects trying to restore river channels, such as geomorphic restoration efforts, call themselves "restoration" projects when they do little more than artificially create certain channel characteristics and habitats that are often not sustainable. Figure 1.6 illustrates the continuum of project types that exist in channel alteration projects, but this continuum can be applied to all projects (Gillilan et al., 2005: 224). In setting a guiding image for the project, scientists and practitioners may find it useful to view projects along this continuum. "By objectively placing their projects along this continuum as part of the guiding image process, restoration practitioners and sponsors can identify the relative ecological benefits of their project and act accordingly" (Gillier, 2005:205, referring to Gillilan et al., 2005).

From the Village's Master Plan, it is unclear whether a guiding image of a dynamic state has been developed for the project. The process of producing this plan involved the expertise of two private consulting firms as well as some stakeholder and citizen engagement. Yet many of the techniques and methods proposed do not clearly state how they will contribute to reestablishing or revitalizing natural processes that will create and maintain habitats over the long-term as the stream system undergoes natural (dynamic) changes. For example, the use of bioengineering approaches to create stable banks and construct in- stream fish habitat does not address the ecological reasons for the lack of those features; nor is it

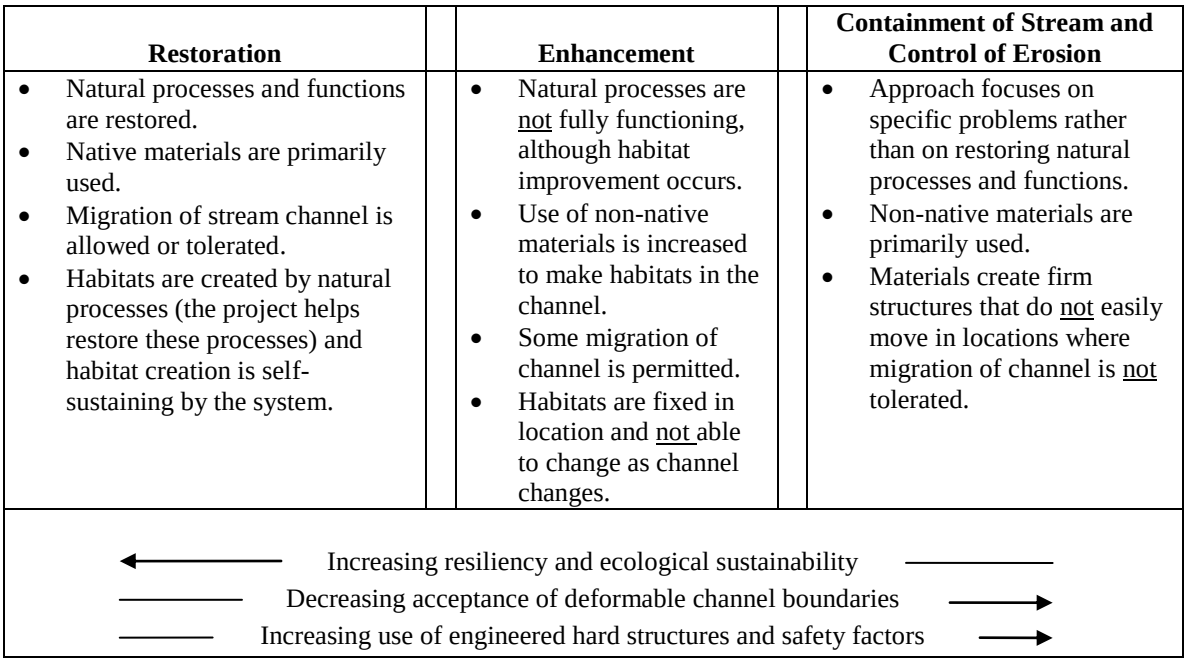


Figure 1.6: An example using channel alteration projects to illustrate the differences between true ecological restoration projects, enhancement projects, and control and containment projects. Modified from Gillilan et al., 2005 (p. 224, Fig. 1).

clear how the proposed methods would restore natural processes to help stabilize banks and maintain in-stream fish habitat. According to the standards of Gillilan et al. (2005), the measures the Village is proposing are best classified as "enhancement," or even lower on the continuum, rather than as "ecological restoration." If the Village truly wants to achieve ecological restoration of the area, it needs to pay closer attention to developing a guiding image of a dynamic state. To complicate matters, the Master Plan sometimes uses the terms "restoration" and "enhancement" interchangeably. This could send the wrong signals to reviewers of future grant applications, especially if the latter are scientists or restoration practitioners.

1.3.2. Alignment of Village Goals and Mill Creek SWMP Goals

The Mill Creek SWMP suggested several priority challenges for the watershed. By combining these priority challenges with the criteria and guidelines set up by Palmer et al. (2005)—especially the "guiding image" of a dynamic stream—restoration and enhancement

projects can achieve a better fit between local goals and goals for restoration of the larger watershed. Table 1.1 summarizes SAG's priority challenges for the Mill Creek system.

In general, the objectives of the Village's Master Plan (see Appendix D) align with the top three priority challenges defined by SAG in the Mill Creek SWMP. The removal of the dam in 2008 was a notable step towards restoring Mill Creek's altered hydrology. Dexter's Master Plan describes its vision for addressing sedimentation and soil erosion by proposing to stabilize streambanks and reducing sediment deposition

Table 1.1: Listing of priority challenges for the Mill Creek watershed, by ranking (top priority = 1, second priority = 2, and so on) according to the Mill Creek Subwatershed Management Plan (Huron River Watershed Council, 2006). All are known challenges, except for those designated 'S' for 'Suspected'.

Priority Ranking	Priority Challenge for Mill Creek
1	high stormwater peak flows/altered hydrology
2	sedimentation, soil erosion
3	high nutrient load
4	oil, grease, metals, brine/salt
5	high water temperature [S]
6	pathogens [S]
7	pesticides [S]

coming from a culvert pipe at Baker Road (JJR & ECT, 2009: 27). This chapter focuses on those efforts. Chapter 2 will more thoroughly discuss specific details about stormwater flows and approaches to managing them.

Table 1.2 describes the known sources and causes of the priority challenges as described by the Mill Creek Subwatershed SAG (Huron River Watershed Council, 2006). Appendix E summarizes key design opportunities and plans of the Village's Master Plan.

We believe the Master Plan will have mixed success in controlling high stormwater peak flows and correcting the altered hydrology for two primary reasons. First, the Master Plan proposes to stabilize the banks while keeping the high banks intact. Meanwhile, it appears the main shared-use path, a paved trail, will be placed very near the stream's edge. The Master Plan (JJR & ECT, 2009: 22-23) states: "Most of the shared-use path will parallel the creek bank taking advantage of existing higher ground" in the Transition and Habitat Enhancement Zone. That suggests the trail will run either on top of or right next to the banks (see Figure 1.7). If the high banks within the proposed project area are indeed the result of

Table 1.2: Priority challenges 1 and 2 for the Mill Creek watershed and the known causes of the problem for each priority challenge, quoted directly from the Mill Creek Subwatershed Management Plan (Huron River Watershed Council, 2006).

Priority Challenge for Mill Creek	Known Sources and Causes (Sources are numbered; causes shown by bullet points)
High Stormwater Flows/Altered Hydrology	1. Drains: • loss of connection between stream and floodplain from channelization. 2. Loss of wetlands and natural features • wetlands drained and converted for crops. 3. Developed and developing areas: • directly connected impervious areas. • insufficient stormwater management practices. 4. In-stream structures: • dams, in-line detention, and lake control structure.
Sedimentation, Soil Erosion	1. Stream banks: • erratic flow fluctuations. • insufficient riparian vegetation on banks. 2. Agricultural land: • insufficient upland conservation practices. • insufficient vegetated riparian buffers. • wind erosion on unprotected erosion-prone soils. 3. Developed areas/construction sites: • insufficient upland conservation practices. • insufficient vegetated riparian buffers. • inadequate soil erosion practices. • inadequate inspection and compliance with regulations. 4. Road-stream crossings: • undersized culverts • poorly stabilized head walls • erosive road or bridge surface

human activity, then those high banks are acting as mini-levees that unnaturally prevent the stream from reconnecting with the riparian areas and floodplain during moderate or high flows. The Village's plans will not fully align with the Mill Creek SWMP as long as they continue to focus on maintaining and stabilizing these artificially high banks.

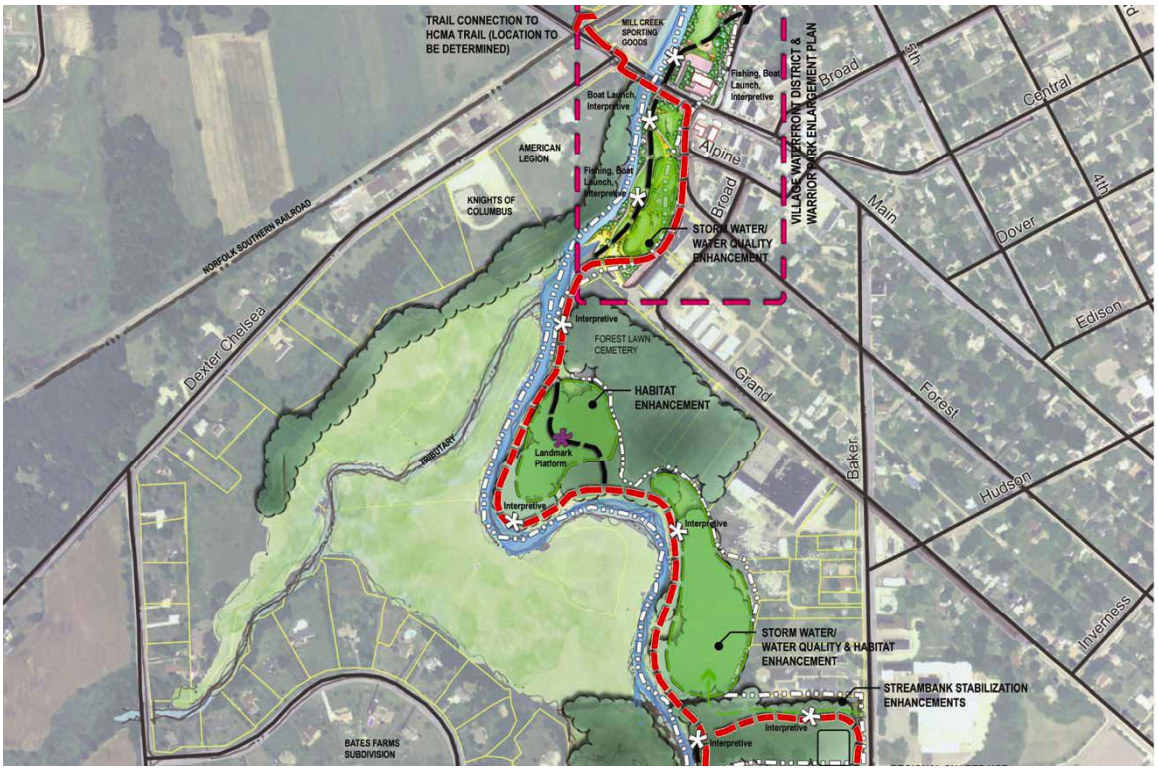


Figure 1.7: Map of the location of the main shared use path (thick dashed red line) running along the stream edge through the proposed Mill Creek Park. Note how close this shared-use path is to the stream, running well within the part of the riparian zone closest to the stream. Map from Mill Creek Park Recreation Master Plan (JJR & ECT, 2009).

The second problem with the Master Plan, as currently configured, is that high levels of stormwater might put more water into the wetlands than they can handle. It seems the wetlands will easily handle many stormwater flow events. But with a lack sufficient modeling at this time, some uncertainty remains about the capacity of the wetlands to handle peak flows of stormwater. If the stream is allowed to reconnect with its floodplain, especially if the high banks are lowered, it may be necessary to increase the capacity of the wetlands to handle high stormwater runoff events in order to prevent stormwater from mixing with stream water before the wetlands can treat it.

Regarding sedimentation and soil erosion, the Village's Master Plan aligns fairly well with the Mill Creek SWMP. (See Appendices D and E) The Master Plan is very attentive to the present and common streambank erosion problem (see Figure 1.8) and the need to establish native vegetation along the banks. Furthermore, the Master Plan seeks to remove the extensive growth of reed canary grass and to reestablish native plants, especially shrubs

and trees, in the Transition and Habitat Enhancement Zone (see JJR & ECT, 2009: 11, Figure 4).

However, the Master Plan's proposed location for the shared-use trail very close to the streambanks could be problematic and may not entirely align with the SWMP's priority challenge of addressing sedimentation and soil erosion. One of the major causes of soil erosion may be a lack of sufficient vegetation in riparian and streambank locations. If so, a shared-use path so close to the stream will reduce the ground area available for riparian vegetation to grow and thus stabilize banks and the riparian corridor. The Huron River Watershed Council's (2008) three-zone approach to riparian buffer systems recommends, first, that the streamside zone (Zone 1) be *at least* 25 feet wide and have very restricted uses such as footpaths. It also recommends that the middle zone (Zone 2), which may include some restricted uses such as bicycle paths, extend at least 25 to 80 feet from the stream's edge (Huron River Watershed Council, 2008: 28, Table 5, and 2008: 29, Figure 4). These recommendations argue against placing a shared-use path, essentially a bicycle path, located closer than 55 to 80 feet from the stream edge. Even in Zone 2, only bicycle and hiking trails constructed with pervious materials should be permitted (Huron River Watershed Council, 2007: 12).

Figure 1.8: Streambank erosion on Mill Creek within the Village's proposed Mill Creek Park that is causing sections of the bank to begin slumping into the stream. (Photo by James Minesky)

In addition, the Master Plan states: "The success of habitat restoration along the creek edge in Mill Creek and Warrior Creek Park is related to the extent that the creek banks are stabilized…" This statement appears to overestimate the need for stabilization—which we infer from the 2009 NOAA grant application to mean the use of both natural and non-native engineered

structures—without considering alternatives to the stabilization of what appear to be artificially high streambanks.

1.3.3. Policy and Planning Support

Appropriate policies and planning can aid in the long-term success of ecological restoration, protection, and management. Michigan does not have a statewide regulatory program for riparian corridors. Instead, it relies on local units of government to decide which regulatory measures and tools will be used to protect such areas (Huron River Watershed Council, 2008: 3). Unfortunately, the Village of Dexter's policies and ordinances are unclear in this respect.

Some current ordinances and overlays, such as the Dexter-Ann Arbor Road Overlay District, do support the environmental protection of Mill Creek, but to only a limited degree. This situation is typical for the region. "Few communities in the Huron River watershed, primarily those with Natural Rivers Zone designation, have policies or programs to protect riparian corridors. Even communities that boast a fairly comprehensive policy to protect natural features fail to include protections for riparian corridors specifically" (Huron River Watershed Council, 2007: 2).

In fact, some communities within the Huron River watershed, such as the City of Ann Arbor and Ann Arbor Township, have adopted open space or setback ordinances for natural features (Huron River Watershed Council, 2008: 26). The HRWC has drafted a "model ordinance" for riparian corridor protection that communities can use for formal riparian protection (Huron River Watershed Council, 2007, 2008). The Village, by contrast, does not have many such long-term policies in place to protect and improve wetland and riparian areas, to keep nutrients (primarily phosphorus) from running off from Dexter into Mill Creek, and to enhance and restore the stream in general.

Regionally coordinated planning among local governments in the watershed could help ensure the long-term health and integrity of the Mill Creek ecosystem. Such collective planning can achieve certain environmental goals more effectively than each municipality can achieve by planning independently. In the state of Washington, the State Shoreline and Management Act requires cities and counties to update their shoreline management programs

(SMPs) to regulate activity and development along and near streams, rivers, and lakes. Jurisdictions around the city of Vancouver, Washington, similarly try to use a coordinated planning approach, sharing data and developing policies and regulations that are consistent across all jurisdictions (City of Vancouver).

1.4. Recommendations

1.4.1. Framework for Successful Ecological Restoration and Enhancement

The Village of Dexter has a very good plan for establishing Mill Creek Park and conducting ecological projects to enhance Mill Creek. Nonetheless, our team recommends the Village reexamine some aspects of the methods it has proposed for ecological restoration and enhancement, especially in light of current science on fluvial systems and our current understanding of the reasons why so many stream and river restoration projects fail. One important consideration is to re-examine the Village's definition of the terms "ecological restoration" and "ecological enhancement," as well as control measures such as bank stabilization, making sure to distinguish these processes adequately from one another. This may seem like a minor point. But in reality, the distinction between restoration and enhancement reflects a deeper difference in the actual methods and actions used to improve and revitalize a habitat, an ecosystem, or an ecological landscape. A failure to distinguish between these terms can lead to a mismatch between methods and ecological goals. It can also inadvertently mislead government agencies, funding sources, and the public about what is truly being achieved.

Another important question is how well the Village's current approaches fit in with the overall ecology of the Mill Creek watershed. It appears that some of what the Village is doing, such as focusing on structural enhancement of fish habitat and the maintenance of artificially high stream banks, does not take into account the broader context of the watershed. Some of the Village's proposed approaches are also not entirely consistent with the goals and objectives of the Mill Creek SWMP.

In sum, the Village's restoration and enhancement efforts are most likely to succeed if it formulates its methods both 1) in light of a current scientific understanding of fluvial

systems and the reasons why so many restoration projects fail; and 2) in the context of the overall watershed and its ecological and geomorphic structure and processes. The following pages outline our specific recommendations for successful ecological restoration and enhancement.

As Table 1.3, there are four basic options for improving fish populations and assemblages. The Master Plan mainly focuses on option 1, which considers structural habitat improvement in the stream and along streambanks, as well some channel characteristics, as the primary means of increasing the number of fish species in the stream and the size of their populations. This strategy does not fully consider other factors, such as water quality, the need to reconnect the stream with its floodplain, the flow regime, and the natural and anthropogenic disturbances that affect fish species in a stream system. Options 2 through 4 consider those other factors, but differ on how efforts to address them should be timed with habitat improvements.

Table 1.3: Possible options for either restoration or enhancement of fish habitat and fish populations in the proposed Mill Creek project area, Village of Dexter.

Fish Habitat Improvements	
Option	**Description**
1	Implement all structural improvements of fish habitats without regard to other key ecological factors (e.g., water quality, reconnection of stream with its floodplain, and the flow regime) that affect fish populations and communities now and in the future.
2	Implement all structural improvements of fish habitats first, and then later work on other key ecological factors (e.g., water quality, reconnection of stream with its floodplain, and the flow regime) that affect fish populations and communities now and in the future.
3	Use a 'phased approach' to implementing structural improvements of fish habitats in light of the other key ecological factors that affect fish populations and communities now and in the future.
4	Work on the key ecological factors (e.g., water quality, reconnection of stream with its floodplain, and the flow regime) that affect fish populations and communities prior to implementing structural improvements of fish habitats.

In the long term, option 4 is the most likely to succeed in reestablishing populations of some fish species and for enhancing the populations of others. Water quality is one key factor to address early on. The federal Clean Water Act and amendments and state laws and regulations safeguard water quality somewhat, but not entirely. Urban and suburban development as well as improper agricultural practices could negatively affect Mill Creek's water quality, especially sediment and nutrient loads and possibly temperature. The good news is that more comprehensive watershed approaches can succeed in protecting water quality.

Mill Creek has experienced increases in base flows because of changes in the watershed due to human activity (Seelbach & Wiley, 1996). Further development and population growth, leading to changes in land use, could continue to alter hydrology, stormwater flow, peak flows, and base flows of Mill Creek—all of which are likely to affect many aspects of the aquatic environment for both macroinvertebrates and fish. Unless the Village considers such future changes in the overall stream environment, such changes over the next 10 to 50 years could negate any efforts to improve and enhance fish habitats. The Village needs to weigh its priorities for possible short-term success versus long-term success in this regard.

Given these issues, it may be useful for future grant applications to separate the riparian, wetland, and stream-bank work from the in-stream work, as combining all of these together in one grant application is a tall order. Funding agencies and foundations might see problems with doing in-stream restoration work before riparian, wetland, and streambank restoration has a chance to work its beneficial effects on the stream. Likewise, a grant proposal for riparian, wetland, and streambank restoration that addresses the many factors involved in enhancing fish populations, including upstream land use and activities, might increase the chances of securing funding for restoration work outside of the in-stream restoration. In short, the Village should consider applying for grants to improve the overall health and integrity of Mill Creek and the watershed *before* seeking funding to improve fish habitat.

There are several options for riparian and streambank restoration and enhancement (see Table 1.4). Overall, the Village's plans are very good for removing invasive plants,

notably reed canary grass and purple loosestrife, and reestablishing native plants in riparian habitats. The options presented in Table 1.4 focus instead on streambank stabilization and the goal of reconnecting riparian areas with the stream channel. Option 1, using the Village's Master Plan and approaches proposed in its 2009 grant application, maintains the presumed artificially high streambanks and places a paved shared-use path on or right next to the banks in the Transition and Habitat Enhancement Zone. We believe this option provides only limited improvement in streambanks and riparian areas. This is because it uses the former dredge spoil piles as mini-levees, does not allow for reconnecting the stream channel with its riparian and floodplain areas, puts a high-use path too close to the stream's edge, and assumes there is an ecological value to maintaining those high banks.

Option 2 keeps the banks of the stream at their present height above the stream in the Transition and Habitat Enhancement Zone, but suggests moving the shared-use trail further away from the stream's edge and using constructed notches in the streambank to create

Table 1.4: Possible options for riparian restoration and/or enhancement in the proposed Mill Creek project area, Village of Dexter.

Riparian Restoration/Enhancement and Streambank Stabilization	
Option	**Description**
1	Implement all actions for streambank stabilization and riparian improvement as outlined in Master Plan and 2009 NOAA grant application, including keeping the high dredge spoil streambanks and placing the shared-use trail along the stream's edge.
2	Implement all actions for streambank stabilization and riparian improvement as outlined in Master Plan and 2009 NOAA grant application and keep the high dredge spoil streambanks. However, place the shared-use trail at least 25 feet away from the stream's edge and construct some backwater areas that are directly connected to the stream via notches in the high streambanks.
3	Implement all actions for bank stabilization and riparian improvement as outlined in Master Plan and 2009 NOAA grant application, but with three key exceptions: a) cut down the height of the dredge spoil along the streambank to make lower banks, b) Place the shared-use trail at least 25 feet away from the stream's edge, and c) consider providing legal protection to all riparian areas, wetlands, and floodplains in Dexter.

backwater connections or bayous. First, such a move would provide more area for native riparian vegetation to establish and more effectively protect streambank and riparian areas. Second, constructing notches in the bank and backwater areas will help to reconnect the stream with riparian, floodplain, and wetland areas; it will also reduce stream power in the channel during moderate to high flows, and could provide additional habitat improvement for certain fish, amphibians, reptiles, birds, and mammals. Seelbach and Wiley (1996) suggest using constructed backwater connections along the main branch of Mill Creek. This may be a viable option for certain locations in the park. A key challenge in option 2 is either to place the shared-use path so it does not cross over the backwater areas or to have it cross the backwater areas by using small bridges or boardwalks.

Overall, option 3 most accurately reflects the current scientific understanding of riparian areas, and is the recommended option. We view the riparian areas in the framework of "riparian corridors" as defined by Naiman et al.: the corridor consisting of the stream channel as well as the land and living organisms that occur from the high water mark to upland areas "where vegetation may be influenced by elevated water tables or flooding, and by the ability of soils to hold water" (1993: 209). Besides the benefits to fish and wildlife, Seelbach and Wiley (1996) argue that the presence of riparian wetlands and floodplains on the lower main stem of Mill Creek will 1) dissipate energy from storm flows; 2) storing some off-channel sediments in the floodplain; and 3) provide a physical buffer between stream and land development in and around Dexter. Such a buffer can help maintain water quality despite further population growth and development in the area.

In order to sustain riparian corridors and experience all of their benefits in the long term, it is also vital to maintain the factors that shape and influence these corridors. Such factors include the upland areas, geomorphic channel processes, disturbance regime of channel flows and floods, the variability of flows and floods, and the hydrologic connectivity between the stream and its corridors (Naiman et al., 1993). Scientific knowledge of riparian corridors reminds us of the importance of reconnecting the stream to its riparian corridors wherever those connections have been altered. In the proposed Mill Creek Park, the artificially high streambanks caused by human actions appear to have diminished this connectivity. Note that for riparian and streambank efforts to be deemed "ecological restoration," ecological processes should be reestablished. Maintaining artificially high

streambanks with legacy sediments and dredge spoils is neither ecological restoration nor enhancement.

Option 3 would entail lowering the height of the stream banks in the Transition and Habitat Enhancement Zone and sloping them gradually back away from the stream channel, so that moderate to high flows of Mill Creek could spread into riparian and floodplain areas and reduce the stream power in the channel itself. Stream restoration work elsewhere provides many examples of this kind of action. One project in Vermont, as shown in Figure 1.9, has succeeded in lowering some artificially high banks and thereby reducing bank erosion and deposition of both sediments and phosphorus into the stream. This situation is similar to that of Mill Creek, where bank erosion is leading to the release of sediment and phosphorus. Option 3 is the option most likely to help reconnect the stream to its riparian

Figure 1.9: Example of river corridor restoration involving reducing the height and forming more gradually sloping streambanks. These actions, taken by Vermont's Agency of Natural Resources (ANR) and River Management Program, helped to stabilize this stream's banks and reduce deposition of sediments and phosphorus into the stream. (Photos by Vermont Clean & Clear Plan: Agency of Natural Resources: http://www.anr.state.vt.us/cleanandclear/rivstrm.htm)

wetlands and floodplain, reduce erosion of streambanks, and help reestablish ecological processes and improve the health and integrity of the riparian corridor—which, in turn, will contribute to the overall health of the Mill Creek ecosystem.

Option 3 requires the use of some construction equipment and therefore would likely need to be performed in the project's early phase, before native vegetation is planted. The Village could also consider whether or not to construct some backwater areas that directly connect to the stream via notches in the high streambanks. This may be an additional way to connect the stream to riparian and wetland areas even if the bank height is lowered. A renewed connection between the stream and its riparian corridor and wetlands could improve the quality of fish habitats as well. In particular, a reconnection with marshy wetlands would create high-quality spawning habitats for pickerel and pike (Seelbach & Wiley, 1996).

The HRWC guidelines (2008), which recommend the three-zone approach to riparian buffer systems, inform options 2 and for the relocation of the shared-use path. This approach includes very restricted uses within at least 25 feet of the stream's edge, and the placement of bicycle paths at least 25 to 80 feet away. Such recommendations are consistent with our scientific understanding of the ecology and restoration of riparian corridors.

Unlike the other options in Table 1.4, option 3 proposes legal protection, such as new ordinances, for wetlands, riparian corridors, and floodplain areas. Such legal protection is outlined further later in this chapter, under "Policy Support".

1.4.2. Alignment of Village Goals and Mill Creek SWMP Goals

In general, the Village's Master Plan goals for controlling high stormwater peak flows, altered hydrology, and sedimentation and soil erosion match those of the Mill Creek SWMP (2003) (refer to Table 1 and 2 in SWMP). However, some of the Master Plan's goals and methods do not fully address the goals in the SWMP. We therefore provide an additional option.

The Village's Master Plan currently follows option 1 in Table 1.5, as well as some of the fish habitat and riparian improvement methods outlined in the 2009 NOAA grant application. This option would help to reduce streambank erosion and revegetate the streambanks and riparian areas. However, option 1 does not fully address the extent to which

the high banks and legacy dredge spoils on the banks themselves prevent the stream from reconnecting with the riparian corridors and floodplain during moderate to high flows, and thus contribute to erosion and sedimentation. The high banks also confine the stream channel, possibly causing the banks to erode even further. In addition, option 1 fails to put the Mill Creek Master Plan into the ecological context of the watershed and how factors upstream from the Village interact with the proposed actions in Mill Creek Park.

Option 2 (in Table 1.5) is based on calls in the scientific literature for restoration and enhancement projects to align themselves more closely with the goal of improving the health and integrity of the whole watershed. (Refer back to Figure 1.2 for a basic representation).

Table 1.5: Possible options for aligning the goals of the Master Plan by JJR and ECT with the goals of the Mill Creek Subwatershed Management Plan.

Watershed Context and Alignment of Goals With Mill Creek SWMP	
Option	**Description**
1	Implement all actions for streambank stabilization, revegetation, and riparian improvement as outlined in Master Plan and 2009 NOAA grant application.
2	Design and implement actions for ecological restoration and enhancement by putting those actions in the context of the Mill Creek watershed, thereby ensuring that those actions contribute to restoring and enhancing both local and watershed ecological processes and functions.

Such a watershed context recognizes the importance of physical, ecological, and anthropogenic processes to the success of ecological restoration within the area covered in the Master Plan.

Option 2 could be implemented in a couple of different ways. One promising approach for watershed management, protection, and restoration involves use of the active river area (ARA) framework proposed by Smith et al. (2008). "Active" means that the processes that create and maintain the riparian and fluvial systems, as well as their habitats, are dynamic—that is, prone to change—and driven by disturbances. "River Area" refers to more than just the floodplain and channel. It refers to two primary areas: 1) land that contains

terrestrial habitats and aquatic habitats, and 2) land that participates in processes that both interact with and contribute to the channel (Smith et al., 2008). The Nature Conservancy supports and uses this approach.

The ARA framework is built upon a scientific understanding of fluvial ecosystem structure and function and the importance of using ecological processes to conserve, manage, and restore fluvial ecosystems. It establishes a methodology to help reestablish and revitalize key fluvial processes that can help a stream and watershed become more resilient to future environmental stresses and more self-sustaining over the long term. Otherwise, Mill Creek and its watershed will require constant direct management efforts and funding to maintain the ecological, economic, and recreational qualities desired by the region's residents.

The ARA framework is both a place-based and a process-based approach that helps to conserve, manage, and restore a fluvial ecosystem's health and integrity by protecting, enhancing, or restoring both physical and ecological processes that are key to the system (Smith et al., 2008: Ch. 1). It uses "a spatially-explicit framework based on watershed position and key geomorphic components" to assist with conservation, management, and restoration (Smith et al., 2008: 1). ARA considers the importance of ecosystem ecology and landscape ecology, as well as geomorphology, for the conservation, management, and restoration of rivers and streams.

Thus, the ARA framework is a holistic approach based on the evidence that the conservation, management, and restoration of the health, integrity, and biodiversity of a river must be achieved through the protection and re-establishment of key physical and ecological processes. Such processes are determined primarily by inputs of organic matter and other energy flows that influence ecological productivity and food webs, water movement across land, through groundwater, and in channels, sediment movement, and the movement of organisms (Smith et al., 2008: 1). "By understanding how and where the river interacts (or would interact if restored) with areas outside of its banks, project managers can better recognize the processes involved with restoration efforts and how to design these efforts to more effectively restore these natural processes." (Smith et al., 2008: 42). The ARA framework also helps avoid some of the myths of ecological restoration (Hilderbrand et al., 2005)—especially the "myth of the cookbook," since ARA employs a variety of methods and techniques.

Appendix I provides some details about the ARA framework. Use of this framework will help the HRWC and communities within the Mill Creek watershed to develop an effective plan for improving the health and integrity of the watershed, in conjunction with the Mill Creek SWMP. At the same time, the ARA approach could enable the Village of Dexter to place its efforts more in alignment with the SWMP and ensure that projects in Mill Creek Park not only benefit the local steam ecology, but play a larger role in improving and sustaining the health and integrity of the watershed. Our team recommends that the Village discuss the potential use of the ARA framework with other Mill Creek communities, the HRWC, the DNRE, and possibly staff at the Nature Conservancy who are using this framework. In addition to the ecological benefits, the use of the ARA framework may make it easier to secure grant funding for projects as part of Mill Creek Park.

1.4.3. Community of Experts

Another question is how many and what kind of experts the Village of Dexter should use in implementing the Master Plan. This is a key issue if the Village is to restore and enhance Mill Creek, secure funding to carry out the project, and align the Village's goals with those of the Mill Creek SWMP. The Village of Dexter has at least three options for the use of experts (Table 1.6). In its Master Plan and grant applications, the Village currently follows option 1. In option 2, experts in different disciplines and knowledge are either hired or obtained as volunteers to work on different aspects of projects related to Mill Creek Park and implementing the Master Plan. In this option, the experts are obtained independently, but could work on different parts of the project in small teams, as needed. Finally, option 3 uses a "community of experts" approach. Here, a team of experts from a diversity of knowledge domains can provide the Village with a greater variety of experiences and insight than separate, independently working individuals or teams of just two consultants. A community of experts, working in concert together, provides greater knowledge, understanding, and contacts with government, academic, business, and philanthropic resources and communities.

Using a community of experts (option 3), in our opinion, is the best way for the village to achieve all of its goals. If the Village chooses to take a more comprehensive approach to its Master Plan and put that work in the context of the Mill Creek watershed, perhaps using the ARA framework, that approach is also likely to yield the highest success.

Table 1.6: Options to consider regarding the use of experts to help the Village of Dexter successfully achieve its ecological and environmental goals and objectives.

Use of Experts	
Option	**Description**
1	In all planning, grant writing, and implementation of restoration and enhancement work, continue to use the Village's current approach to obtaining and implementing input from individual, independent experts on an 'as needed' basis.
2	Hire or recruit different experts individually and independently, as needed on specific but separate projects for planning, grant writing, and implementation of restoration and enhancement work related to the health and integrity of Mill Creek and the proposed park.
3	Use a "community of experts" approach in all planning, grant writing, and implementation of restoration and enhancement work related to the health and integrity of Mill Creek and the proposed park.

Some experts in the natural and social sciences, as well as in policy and planning, might find working with local government officials and municipalities as clients to be challenging for a variety of reasons: 1) lack of clearly stated expectations by the client, 2) lack of incentives such as financial compensation or awards, 3) competing demands from work, family and other commitments, and 4) lack of recognition from their employer or supervisors for their outside work with government and municipal clients. The Village of Dexter might overcome some of these challenges in the following ways:

- clearly state the Village's expectations.
- cultivate friendships with the experts.
- provide incentives or compensation, even if small, to the volunteer experts.
- understand what motivates experts, especially volunteer experts, to work on such projects with municipal and other public-sector clients.

1.4.4. Policy Support

As outlined in Table 1.7, we recommend that the Village of Dexter consider several policy and planning options for land use and Mill Creek's health and integrity.

Table 1.7: Policy/planning options about land use and the long-term health and integrity of Mill Creek.

Land-Use Planning and Mill Creek Health and Integrity	
Option	**Description**
1	Make planning decisions that affect land use and the health and integrity of Mill Creek independently of other communities in the Mill Creek watershed. Also, either maintain current ordinances and overlay districts or evaluate the effectiveness of model ordinances for protection of riparian corridors and wetlands independent of other communities.
2	Use an approach whereby each Mill Creek community makes planning decisions independently of each other, but by which each community informally consults with other communities about planning decisions being evaluated that could affect the health and integrity of Mill Creek. Include the use of ordinances for the protection of riparian corridors and wetlands.
3	Use an approach whereby each Mill Creek community adopts the same or very similar zoning ordinances about planning decisions being evaluated that could affect the health and integrity of Mill Creek, including the use of ordinances for the protection of riparian corridors and wetlands.
4	Develop and implement, in conjunction with other Mill Creek communities, a coordinated planning approach—one in which ordinances and both land-use planning and decisions are made by communities together in the context of the ecological, economic, and social well-being within the overall watershed. This approach would also use ordinances to specifically protect riparian corridors and wetlands.

The success of Mill Creek Park, as envisioned in the Master Plan, is highly dependent on the long-term health and integrity of the Mill Creek ecosystem—not just the stream in the jurisdictional boundaries of the Village. Accordingly, the primary aim of policy and planning

should not be to produce a greater regulatory environment in the Village, but to bolster existing ordinances and protect the health and integrity of Mill Creek in more comprehensive way. Given the rate of development and population growth in watershed communities, a less independent, comprehensive approach—especially option 1—is likely to fail in this goal, at a high cost to the town and community.

Of the various options available, option 4 is the most likely to strengthen the Mill Creek ecosystem in the long term. Hay-Chmielewski et al. (1995), in an assessment of the Huron River and its tributaries, similarly proposed that a more integrated and coordinated regional planning approach be used to help maintain the health of the river system. It is crucial to note that many funding agencies and philanthropic organizations tend to have a favorable view of both coordinated efforts among communities and comprehensive approaches to environmental and economic projects. Thus, option 4 will provide the greatest support for grant applications to secure funding for the Mill Creek Master Plan and Mill Creek Park.

In the context of such a comprehensive effort, ordinances can be effective policy and planning tools. In their assessment of Mill Creek, Seelbach and Wiley (1996) recognize the importance of such protections: "The lower mainstem of Mill Creek has the potential to be a major natural asset to the Dexter-Chelsea area. … We suggest protection of wetlands in this portion of the river be given very high priority. … Legal protection of the floodplain, and its natural vegetation, and possible public purchase where possible should be aggressively pursued."

The Huron River Watershed Council (HRWC) has drafted a model ordinance for riparian corridor protection, but has balanced it with the multiple uses and citizen needs of the stream and surrounding areas (Huron River Watershed Council 2007, 2008). This model ordinance "is based on scientific underpinnings in order to make the policy useful in fulfilling its intent and defensible as communities seek to implement it" (Huron River Watershed Council, 2008: 17). The model ordinance has the following aims: "Protect and improve water quality, Attenuate flows, Stabilize streambanks, Remove sediment, Moderate stream temperature, Protect and improve the abundance and diversity of indigenous fish and wildlife" (Huron River Watershed Council, 2008: 18).

Our team recommends that the Village of Dexter, along with Chelsea and

surrounding townships, adopt similar ordinances for the protection of riparian, wetland, and floodplain areas (1996). The Village should carefully consider the benefits of such an ordinance, not just for the stream itself, but in order to increase the chances of obtaining grant funding and the long-term economic, educational, and recreational benefits of a healthy stream ecosystem and park.

1.5. Securing Short- And Long-Term Project Funding Summary

One of the most important challenges the Village faces is that of obtaining funding, most likely via grants, to support the work proposed in the Master Plan. The Village will have a better chance of obtaining funding if it addresses the key issues associated with the success of fluvial restorations and the ecosystem's long-term sustainability. Funding sources and grant application reviewers are more likely to approve funding for projects with clear agreement on project goals and the methods to meet them. For example, grant applications with ecological restoration goals and appropriate methodology will be funded more frequently and more extensively than projects that strive for restoration but only use methods of ecological enhancement or system control. The Village's applications are likewise more likely to succeed if it places its project in the larger context of the Mill Creek watershed and the broader challenge of sustaining the watershed's ecosystem.

With these points in mind, the following options have the potential to enhance funding applications: 1) continue to submit proposals based on the current Master Plan and on the approach taken in the application submitted to NOAA in 2009; 2) submit proposals based on one clear goal, either ecological restoration or ecological enhancement, taking care to correctly match the goal with the relevant methodology or approach; or 3) take a truly comprehensive watershed approach, developing partnerships with other Mill Creek communities and combining aspects of both ecological restoration and ecological enhancement. Such a comprehensive approach entails:

- Developing a coalition with all local communities that seek to improve the health and integrity of the Mill Creek watershed.
- Forming a team or community of experts from the fields of environmental planning,

fluvial ecology, fluvial geomorphology, wetland ecology, landscape architecture, and restoration design and construction, who are willing to work on both comprehensive and small-scale projects. This community of experts will help provide the scientific content and context for projects and grant applications.

- Developing one common, comprehensive plan for improving the health and integrity of the stream and its watershed among Mill Creek communities, in consultation with the community of experts. The Mill Creek Subwatershed Management Plan is a good starting point, but it could be enhanced with the vision and methodology of the ARA framework to form a comprehensive Mill Creek plan.
- Including a mix of ecological restoration projects and ecological enhancement projects in this comprehensive plan. The community of experts could help to identify and define potential projects by how likely they are to achieve restoration as defined in the scientific literature (e.g., Society for Ecological Restoration International, 2004; Clewell & Aronson, 2007), as described earlier in this report. If a project cannot be defined as ecological restoration, then it could be considered as a candidate for "ecological enhancement." The goal is to use scientific data in order to decide which potential projects can be termed ecological restoration and which ones fall under the category of ecological enhancement, and then to build a plan that includes both types of approaches.
- Drafting grant applications in each community for projects within their jurisdictions, clearly showing how each project is part of the formal Mill Creek comprehensive plan. We believe individual restoration and enhancement projects are more likely to be funded if the project goals, objectives, and methodologies are formally part of such a comprehensive plan that demonstrates a high level of integration and coordination between communities, rather than the loose and less formal relationships that currently exist.

1.6. Summary of Recommended Options

Priority	Recommendations	Description
High	Riparian Restoration/ Enhancement and Streambank Stabilization	Implement all actions for streambank stabilization and riparian improvement as outlined in Master Plan and 2009 NOAA grant application, with three exceptions: A) Cut down the height of the dredge spoil along the streambank to make lower banks, B) Place the shared-use trail at least 25 feet away from the stream's edge, and C) Consider providing legal protection to all riparian areas, wetlands, and floodplains in Dexter.
High	Watershed Context and Alignment of Goals With Mill Creek SWMP	Design and implement actions for ecological restoration and enhancement by putting them in the Mill Creek watershed context to ensure those actions contribute to restoring and enhancing both local and watershed ecological processes and functions.
High	Use of Experts	Use a "community of experts" approach in all planning, grant writing, and implementation of restoration and enhancement work related to the health and integrity of Mill Creek and Mill Creek watershed.
High	Land-Use Planning and Mill Creek Health and Integrity	In conjunction with other Mill Creek communities, develop and implement a coordinated planning approach in which ordinances and land-use planning and decisions are made in the context of the ecological, economic, and social well-being of the watershed. This would also use ordinances to specifically protect riparian corridors and wetlands.
High	Enhancing Grant Applications to Increase Likelihood of Securing Project Funding	Take a comprehensive watershed approach that develops partnerships with other Mill Creek communities and combines aspects of ecological restoration and enhancement by adopting the options above. Draft grant applications in each community for projects that clearly reference how they are part of a formal comprehensive plan produced by the coalition of Mill Creek communities .
Medium	Fish Habitat Improvements	Work on the ecological factors (e.g., water quality, reconnection of stream with its floodplain, and the flow regime) that affect fish populations and communities prior to implementing structural improvements of fish habitats.

Chapter 2:
Stormwater Solutions

Who will love the imperfect lands, the fragments of backyard…paradise, the creek that runs between farms?

~ Barbara Kingsolver

Stormwater management is a key aspect of sustaining the health of the Mill Creek watershed, as ineffective management practices can contribute to mixed success in controlling the high stormwater peak flows and correcting altered hydrology. This chapter describes multiple approaches for improving stormwater management practices both in Mill Creek and in contributing watershed drainage areas. To formulate these approaches, our team conducted research into various stormwater issues: natural versus urban landscape stormwater runoff; the impact of urban stormwater runoff; stormwater regulations and corresponding issues; and low-impact development, a new strategy for addressing stormwater management.

2.1. Stormwater Concerns and Needs

2.1.1. Natural versus Urban Landscape Stormwater Runoff Quantity

When precipitation falls on a natural landscape in Washtenaw County, most of the filters into the ground. Evaporation, along with uptake and transpiration by plants, returns some of this water to the atmosphere. A heavy rainfall or snowmelt may saturate the soil, causing any additional water to flow over the ground surface. This flow over land is called stormwater runoff. In Washtenaw County, only a small amount of the total precipitation that falls on a natural landscape actually results in stormwater runoff.

In contrast, an urban landscape usually contains less vegetation and more roads, sidewalks, and rooftops. These impermeable surfaces prevent precipitation from soaking into the ground, so that most of it ends up as runoff.

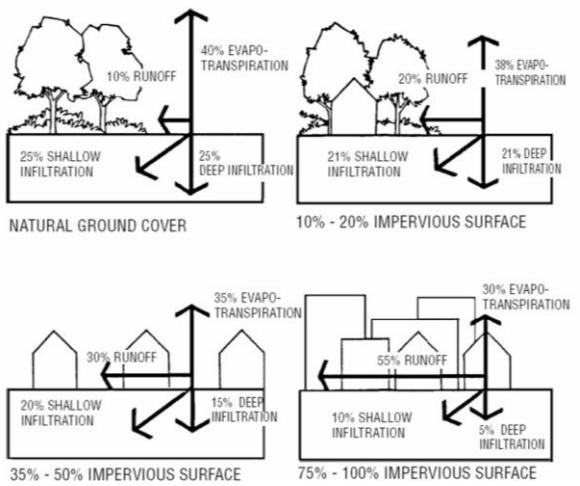


Figure 2.1: This diagram displays typical hydrological differences between natural landscapes and urban landscapes with varying amounts of impermeable land cover (Tourbier & Westmacott, 1981).

2.1.2 Impacts of Urban Stormwater Runoff

Stormwater shed from urban landscapes leads to reduced water quality. In a natural landscape, stormwater runoff is usually filtered through vegetation before entering a body of surface water and is not problematic. However, in the urban landscape, runoff collects and is piped, sometimes directly to the nearest body of surface water. As runoff flows over roads, parking lots, sidewalks, and rooftops, it picks up and carries various pollutants such as trash, particulate matter, nitrogen, phosphorus, heavy metals, salts, oils, and heat—the result of human activities such as driving automobiles, fertilizing lawns, and de-icing roads.

Pollutants in stormwater runoff represent "a significant source of environmental impacts to the quality" of bodies of surface water in Washtenaw County (U.S. Environmental Protection Agency Office of Water, 1996). Streams and rivers flowing away from urban landscapes usually have "a flashier hydrograph, elevated concentrations of [pollutants], altered channel morphology and stability, and reduced biotic richness, with increased dominance of tolerant species" (Walsh, Cottingham, Feminella, Roy, Groffman, & Morgan

II, 2005). A flashier hydrograph indicates that the water flow rate varies between lower to higher levels more quickly than occurs naturally.

The Village of Dexter lies partially within the Mill Creek watershed and, as Mill Creek is a tributary to the Huron River, is also entirely within the Huron River watershed (Figure 2.1). All stormwater runoff from the Village contributes to these bodies of water.

Table 2.1 provides information on Village areas which drain to the Mill Creek and the Huron River and shows how much of that area is considered urbanized. As this data is more than six years old, however, the area of urbanization has likely increased with continued development.

Table 2.1: Village and urbanized area contributing to subwatersheds (Eureste, 2004).

Subwatershed	Area of Village in each Subwatershed (acres)	Urbanized Area in each Subwatershed (acres)
Mill Creek	694	593
Huron River (mainstem)	419	327

2.1.3. Stormwater Regulations

Recognizing the potentially negative impacts of urban stormwater runoff, the U.S. Congress amended the Clean Water Act in 1987, directing the Environmental Protection Agency (USEPA) to develop regulations requiring municipalities to take measures to lessen the impacts of stormwater runoff. The regulations were issued in two phases. Phase I, promulgated in 1990, was directed at municipalities with a population of 100,000 or more. Phase II, starting in 1999, applied to smaller municipalities, including the Village of Dexter (U.S. Environmental Protection Agency Office of Water, 1996).

The Village responded by applying for and receiving a National Pollutant Discharge Elimination System (NPDES) Phase II Stormwater Permit. Specifically, the Michigan Department of Environmental Quality (MDEQ) issued General Permit No. MIS040000 (Certificate of Coverage (CoC) No. MIS040022) to the Village on February 25, 2003. Before that permit expired on April 1, 2008, the Village applied for a renewal. The new permit was

issued on May 22, 2008, expiring April 1, 2013. The Michigan Department of Natural Resources and Environment (DNRE, formerly known as the MDEQ and the MDNR) did not issue a new CoC on February 9, 2010. The delay in issuing the CoC was due to the Village's transition from a jurisdictional-based permit to a watershed-based permit. At present the Huron River Watershed Council (HRWC) is helping several municipalities in the Huron River watershed, including the Village of Dexter, to develop permit application documents.

2.1.3. The Stormwater Runoff Problem

These regulations will only partially address stormwater runoff impacts on bodies of surface water, and the USEPA does not currently have the authority to place additional requirements on municipalities. Thus, the USEPA encourages municipalities to commit to further efforts beyond the requirements to more fully address stormwater runoff impacts. This chapter provides information and suggestions for how the Village of Dexter can not only comply with their NPDES stormwater permit but also more fully address the impacts of stormwater runoff.

2.1.4. Low Impact Development

Low Impact Development (LID), a term first coined in Prince George County, Maryland, describes a fundamental shift from conventional stormwater management to on-site stormwater management. The objectives of conventional stormwater management are to move water away from built structures as quickly as possible and prevent off-site downstream flooding. A conveyance system often rapidly transports stormwater from the site to a collection pond, which detains and releases the stormwater slowly through an outlet (Department of Environmental Resource Programs and Planning Division, 1999). Conversely, LID techniques seek to mimic a site's natural, predevelopment hydrology by capturing rainwater, detaining stormwater where it falls, allowing infiltration to occur, and filtering stormwater pollutants. All of these processes normally occur in a natural landscape. A key difference is the focus on managing runoff in place as it falls, rather than waiting until

a large volume of water accumulates (Department of Environmental Resource Programs and Planning Division, 1999).

LID techniques have been slow to become widespread. The reasons include: "(1) uncertainties in performance and cost, (2) insufficient engineering standards and guidelines, (3) fragmented responsibilities, (4) lack of institutional capacity, (5) lack of legislative mandate, (6) lack of funding and market incentives, and (7) resistance to change" (Roy, et al., 2008). The Village could address reasons 3, 5, and 7 on a local level, which will be discussed later in this chapter.

2.2. Research Methods

Our team used the following methods to identify best practices and provide stormwater solutions for the Village of Dexter. First, we reviewed existing Village documents and other relevant local documentation pertaining to stormwater. These information sources included the following:

- Storm Water Management Study, Orchard, Hiltz & McCliment, Inc. 2004
- NPDES Phase II Stormwater General Permit MIS0400000 (Certificate of Coverage No. MIS040022)
- Storm Water Management Program, Village of Dexter, October 1, 2004
- NPDES Phase II Stormwater Permit application documents, July 31, 2008
- Mill Creek Park Recreation Master Plan, JJR & ECT, January 26, 2009
- HRWC Storm Water Pollution Prevention Initiative (Draft Template) and associated documents, January 8, 2010
- NPDES Phase II Stormwater General Permit MIG610000 (Certificate of Coverage No. MIG610380)
- Mill Creek Subwatershed Management Plan, HRWC, revised February 2006

In addition, our team conducted a review of available and applicable low impact development (LID) manuals. These included the Low Impact Development Manual for Michigan, the Stormwater Management Guidance Manual, Version 2.0 (Philadelphia Water

Department, Office of Watersheds); and the Rhode Island Stormwater Design and Installation Standards Manual (Rhode Island Department of Environmental Management, 2009). Additionally, several site visits helped in identifying and observing stormwater outfalls in the Village of Dexter.

2.3. Results

2.3.1. Summary of Documentation Review

Storm Water Management Study. The Village contracted with the firm Orchard Hiltz & McCliment to conduct a study of how stormwater was conveyed through the historic downtown district. The report focuses on traditional storm water management techniques and provides recommendations for improving stormwater management.

First NPDES Stormwater Permit. The State issued this permit authorizing the Village to discharge stormwater and placed several requirements on the Village. Those requirements include annual stormwater reporting and developing a Stormwater Management Plan (SMP).

Storm Water Management Program. This legal document was written in response to a requirement of the Village's NPDES permit and approved by the State authority. The document details the Village's planned activities to reduce the impact of stormwater runoff on bodies of surface water as much as possible. As required by law, six categories of activities are detailed in the SMP: a Public Education Plan (PEP), Public Participation and Involvement, Illicit Discharge Elimination Program (IDEP), Post Construction Storm Water Management Program for New Development and Redevelopment Projects, Construction Storm Water Runoff Control, and Pollution Prevention/Good Housekeeping for Municipal Operations. This is an excellent document. The program, if followed, should significantly reduce the impact of stormwater runoff from the Village.

NPDES Stormwater Permit application. The Village submitted NPDES Stormwater Permit application documents to renew their existing NPDES stormwater permit before the previous permit's expiration on April 1, 2008. The documents contain information requested by the state authority to renew the permit.

Mill Creek Park Recreation Master Plan. The Master Plan discusses the "installation of swirl concentrators designed to remove sediments, grease, and oils from the stormwater before it enters the creek" for the three outfalls discharging stormwater from downtown Dexter. It also cites opportunities to create decorative stormwater features at these outfall locations, which would treat the stormwater prior to discharge into Mill Creek. The master plan also discusses a "Habitat Enhancement Zone" including a possible constructed treatment wetland. Additionally, the plan mentions a potential pervious parking lot at the Warrior Creek Park (The document is briefly mentioned in Appendix E).

HRWC Draft Template: Storm Water Pollution Prevention Initiative and associated documents. The HRWC is assisting several communities as part of a watershed planning effort, and thus provided draft template documents to assist the Village in complying with its NPDES stormwater permit. According to the 2010 watershed-based permit issued to the Village, a draft Storm Water Pollution Prevention Initiative (SWPPI) is to be submitted to the DNRE by October 1, 2010. The SWPPI document appears to have many of the same requirements as in the SMP, and is possibly simply a change in terminology. A complete comparison with the 2004 SMP was not possible because the main components (as described in the previous SMP section of this chapter), listed as appendices to the SWPPI, were not immediately available.

HRWC Mill Creek Subwatershed Management Plan. This document was originally published in September 2003 and revised in February 2006. Chapter 8 discusses several best management practices (BMPs) for stormwater management. The report provides a large matrix of recommended strategies, many of which are recommended for the Village. One potential action, listed as a priority restoration opportunity specifically for the Village, is a stormwater BMP retrofit at Dexter Business Park. According to the document, "incremental degradation via nonpoint source runoff" and "improper detention basin controls" are identified as causing hydrologic flow issues and sediment source.

2.3.2. Site Visits

Our team made several visits to the Mill Creek area to identify, observe, and photograph Village of Dexter stormwater outfalls. A few Village documents identify the

outfalls, but these documents lack consistency. The figure and matrix clarify the outfalls and their locations, and it describes the probable drainage area.

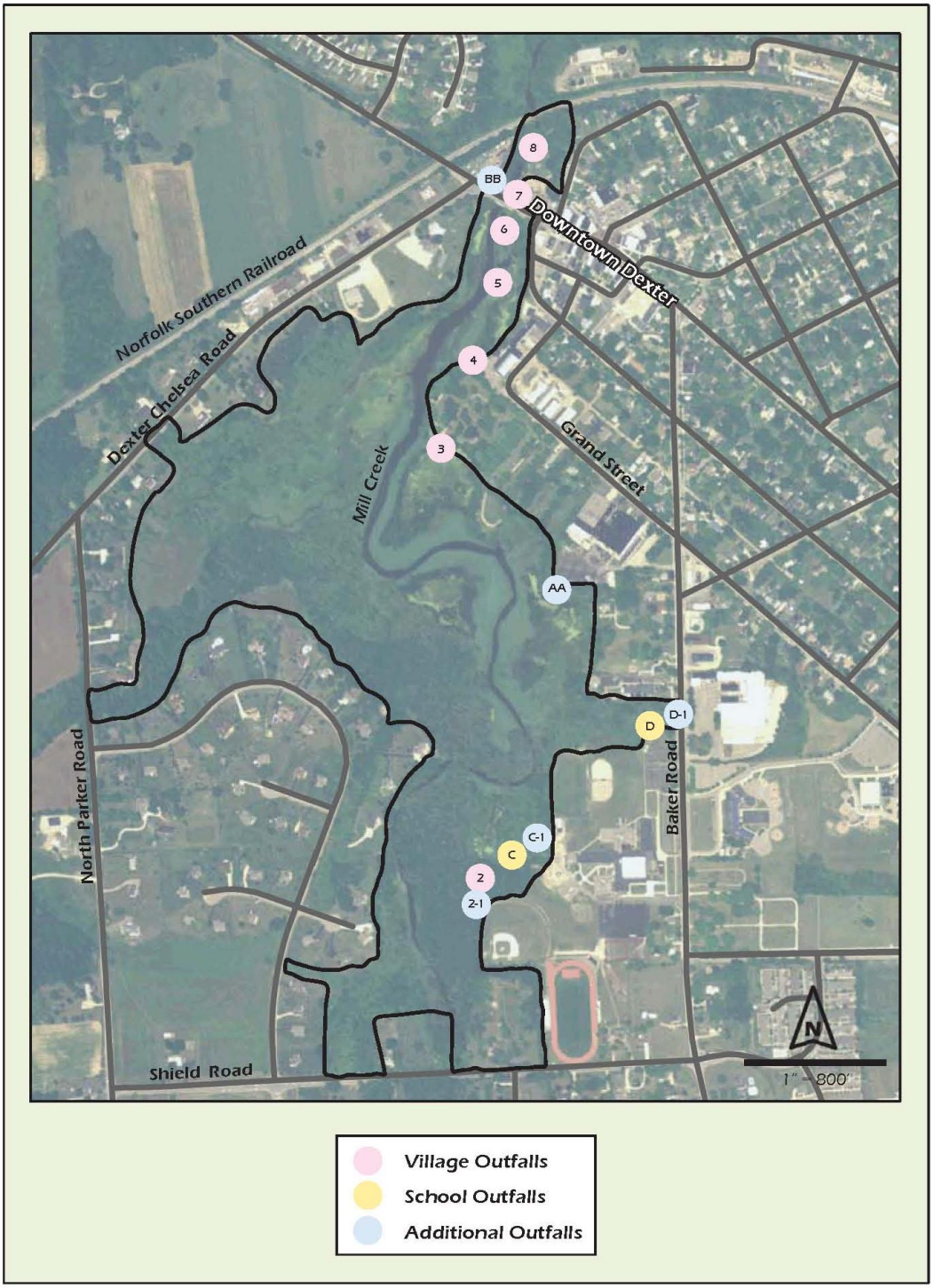


Figure 2.2: Urbanized areas in the Mill Creek and Huron River Watersheds

Table 2.2: Matrix of area of interest outfalls (Photos by Thomas O'Dowd and Patrick Reed)

Photograph of Outfall	Outfall and/or Drainage Area Identification				Estimated Area (acres)	Approximate Outfall Size (inches)	Important Site Visit Observations
	Dexter Masters Project Report Figure	2008 Carlisle/Wortman Associates, Inc. Watersheds and Outfall Locations figure	2004 OHM Stormwater Management Report	Drainage Area Description			
	School Outfall C	School Outfall C	--	school ground	--	16"	○ Serious erosion has occurred since construction. ○ A piece of concrete embedded with football sized rocks, which appeared to be designed for dispersing the water power of the Outfall, was only partially functioning and undercut. ○ Nearby trees were being undercut along the channel.
	Outfall C-1	--	--	unknown	--	12"	○ (near School Outfall C). ○ severe erosion has occurred since construction. ○ the outfall points directly at a critical support post for an overhead bridge. It is likely only a matter of time before erosion causes the bridge to collapse.

Photograph of Outfall	Outfall and/or Drainage Area Identification				Estimated Area (acres)	Approximate Outfall Size (inches)	Important Site Visit Observations
	Dexter Masters Project Report Figure	2008 Carlisle/Wortman Associates, Inc. Watersheds and Outfall Locations figure	2004 OHM Stormwater Management Report	Drainage Area Description			
	Village Outfall #2	Village Outfall #2	--	probably area south of Dan Hoey Road	--	24”	○ The retaining wall was no longer functioning and was displaced and a channel had formed due to erosion. ○ Debris had been dumped into the channel from the school field above, including a piece of broken playground equipment. ○ Two Black Cherry trees and a Northern Red Oak , which are native species, were being undercut due to the erosion. ○ Also, minnows were observed in puddles less than fifty feet downstream of this Outfall.
	Outfall #2-1	--	--	unknown	--	12”	○ (near Village Outfall #2). ○ severe erosion has occurred since construction.

Photograph of Outfall	Outfall and/or Drainage Area Identification				Estimated Area (acres)	Approximate Outfall Size (inches)	Important Site Visit Observations
	Dexter Masters Project Report Figure	2008 Carlisle/Wortman Associates, Inc. Watersheds and Outfall Locations figure	2004 OHM Stormwater Management Report	Drainage Area Description			
	School Outfall D	School Outfall D	--	school ground	--	24”	○ Some erosion downstream has occurred since construction. ○ The discharge intersects with the channelized stream bed that runs along the north border of the Creekside Intermediate School sports fields. This channel, which was constructed to be straight, suffers from erosion and is overgrown with invasive plants.
	Outfall D-1	--	DA15 Kensington	area east of Baker Road	~90	30”	○ Severe erosion above the outfall has occurred since construction. Erosion has carried away the dirt held by the retaining wall (in photograph). Erosion has caused a hole, which is nearing the sidewalk on the east side of Baker Street. ○ The outfall discharges into the channelized stream bed that runs along the north border of the Creekside Intermediate School sports fields. This channel, which was constructed to be straight, suffers from erosion and is overgrown with invasive plants.

Photograph of Outfall	Outfall and/or Drainage Area Identification				Estimated Area (acres)	Approximate Outfall Size (inches)	Important Site Visit Observations
	Dexter Masters Project Report Figure	2008 Carlisle/Wortman Associates, Inc. Watersheds and Outfall Locations figure	2004 OHM Stormwater Management Report	Drainage Area Description			
	Outfall AA	--	DA14 Grand South	western portions of Grand Street and Forest Street	~50	30”	○ Some erosion downstream of the outfall has occurred since construction. A streambed has been created which wonders approximately 300’ across the riparian area before entering Mill Creek.
was not able to find this outfall with a reasonable search	--	Village Outfall #3	DA13 Grand North	portion of Forest Lawn cemetery	<0.25	probably very small	--
	Village Outfall #4	Village Outfall #4	DA13 Grand North	Forest Lawn Cemetery and Grand Street area	15.84	8”	○ A small streambed was formed downstream of the outfall, wondering through the riparian area to Mill Creek. ○ Currently a large pile of soil material is located in close proximity to this outfall (i.e. silt fence in photograph). That pile of soil may be resulting in some of the sedimentation downstream of the outfall in the small stream bed.

Photograph of Outfall	Outfall and/or Drainage Area Identification				Estimated Area (acres)	Approximate Outfall Size (inches)	Important Site Visit Observations
	Dexter Masters Project Report Figure	2008 Carlisle/Wortman Associates, Inc. Watersheds and Outfall Locations figure	2004 OHM Stormwater Management Report	Drainage Area Description			
	Village Outfall #5	Village Outfall #5	DA12 Forest	western Forest Street near Downtown Dexter	10.16	30”	○ The outfall is in the newly constructed Mill Creek recreation area. ○ A straight bioswale runs directly from the outfall to Mill Creek.
	Village Outfall #6	Village Outfall #6	DA11 Ann Arbor	Downtown Dexter area	25.61	30”	○ The outfall is in the newly constructed Mill Creek recreation area. ○ A curvy bioswale with a gravel based bed runs from the outfall to Mill Creek.
no photograph available	Village Outfall #7	Village Outfall #7	DA11 Ann Arbor	Dexter-Ann Arbor Road bridge area over Mill Creek	<0.25	6”	○ The outfall is in the newly constructed Mill Creek recreation area. ○ It discharges onto gravel on the bank of Mill Creek.

Photograph of Outfall	Outfall and/or Drainage Area Identification				Estimated Area (acres)	Approximate Outfall Size (inches)	Important Site Visit Observations
	Dexter Masters Project Report Figure	2008 Carlisle/Wortman Associates, Inc. Watersheds and Outfall Locations figure	2004 OHM Stormwater Management Report	Drainage Area Description			
	Village Outfall #8	Village Outfall #8	--	unknown, portion of Warrior Park	--	12”	○ The outfall discharges directly into Mill Creek in Warrior Park.
	Outfall BB	--	--	west side of Dexter Chelsea Road			○ The outfall is in the newly constructed Mill Creek recreation area. ○ The outfall discharges onto gravel and boulders on the bank of Mill Creek.

Figure 2.3: Wetland in the outdoor education area. (Photo by Patrick Reed)

Several outfalls do not discharge directly to Mill Creek. There is a wetland between Mill Creek and Outfalls C, C-1, #2, and #2-1, as shown above.

Bioswales or small stream channels are located between Mill Creek and Outfalls D, D-1, AA, #4, #5, and #6. Wetlands, bioswales, and small stream channels likely provide some water quality treatment to the stormwater prior to entering Mill Creek.

2.3.3. Low Impact Development Techniques

The Dexter Masters Project team reviewed the following three LID-focused documents.

- Low Impact Development Manual for Michigan
- Stormwater Management Guidance Manual, Version 2.0 (City of Philadelphia)
- Rhode Island Stormwater Design and Installation Standards Manual (Public Review Draft, May 2009)

These documents, especially the Manual for Michigan, provide a broad, useful array of ideas and LID techniques for the Village to implement.

2.4. Recommendations

Drawing on our research, we developed several key recommendations to improve stormwater management in and around the Village.

Recommendation 1: Identify and resolve cause of erosion above Outfall D-1 and replace eroded soil near the sidewalk on Baker Road.

Figure 2.4: Erosion around the Baker Road outfall moving toward the sidewalk. (Photo by Patrick Reed)

Erosion above Outfall D-1 is encroaching on the sidewalk on the east side of Baker Road. The eroded hole poses a safety hazard. Overland flow above Outfall D-1 does not appear to be causing the hole. The flow of water in Outfall D-1, underneath the sidewalk level, appears to be carrying soil away, causing it to cave in. If that is the case, simply replacing the soil will not resolve the issue, and the caving is likely to continue. If not corrected, the erosion will continue and will further encroach on the sidewalk, which is a well-traveled route to Dexter schools. This problem should therefore be fixed before the 2010 academic year.

Recommendation 2: Rebuild Outfall C-1 and re-establish and confirm stability of wooden bridge structure.

Outfall C-1 discharges directly onto the rocks and a critical support post below a wooden bridge structure that is part of the OEA trail system. Water from the outfall will erode soil underneath the post and rot the post, eventually causing the collapse of the

structure. The outfall and bridge structure should be renovated as soon as possible in order to head off this risk.

Figure 2.5: Outfall C-1 and critical support beam for above wooden bridge. (Photo by Patrick Reed)

Recommendation 3: Rebuild School Outfall C, Village Outfall #2, and Outfall #2-1 in the Outdoor Education Area.

Unfortunately, erosion near School Outfall C, Village Outfall #2, and Outfall #2-1 has destabilized these areas so much that erosion will continue unless reconstructive actions are taken. Although planting or seeding can help stabilize a sloped surface, the project team believes that revegetating these areas will not significantly slow the erosion rate, as many of the surfaces near these outfalls are completely vertical or undercut. Meanwhile, erosion from these outfalls has also undercut a number of small to large trees. These trees, with much of their roots bare and unsupported, represent a safety hazard in the OEA. For outfall design guidelines, please see Herrera Environmental Consultants, Inc. document (2007) in Works Cited.

Figure 2.6: Village Outfall #8 drains directly into Mill Creek. (Photo by Thomas O'Dowd)

Recommendation 4. In Warrior Park, construct a naturally curved bioswale from the hillside to Mill Creek, daylighting the stormwater pipe to Village Outfall #8.

Such a bioswale and the bioswales downstream of Village Outfalls #5 and #6 are wonderful opportunities for displaying and treating stormwater from downtown Dexter before it is discharged. Stormwater should be treated as an amenity, not just disposed of.

For Village Outfall #8, the project team could not identify the corresponding drainage area. The stormwater pipe appears to be buried at a shallow depth crossing Warrior Park from the hillside, discharging directly into Mill Creek. The team recommends that a bioswale be constructed similar to those downstream of Village Outfall #5 and 6. Daylighting the stormwater pipe across Warrior Creek Park would increase infiltration and also provide for filtration via the bioswale's vegetation. Design guidance for bioswales can be found in the Herrera Environmental Consultants, Inc. document (2007) in Works Cited.

Recommendation 5. Reform the unnaturally straight bioswale between Village Outfall #5 and Mill Creek with a natural curve and oscillation of width.

Village Outfall #5 discharges stormwater onto an unnaturally straight bioswale, which could be improved. Before further park construction and landscaping, the Village should thus consider reshaping this bioswale to give it natural curves and oscillation of widths. The Village should also consider

Figure 2.7: Village Outfall #5 bioswale to Mill Creek. (Photo by Thomas O'Dowd).

placing rock check dams to detain stormwater, providing more opportunity for it to infiltrate. Information on how to construct rock check dams is included in the Herrera Environmental Consultants, Inc. document (2007) in Works Cited.

In addition, the bioswale is set at a perpendicular angle to Mill Creek. The bioswale "should be oriented at no less than a 30 degree angle from a perpendicular alignment with [Mill Creek] with the confluence of flow oriented in the downstream direction" (Herrera Environmental Consultants, Inc., 2007). Orienting the discharge in this way may reduce turbulence and erosion and lessen the outlet's effect on downstream geomorphology. The flow from Village Outfall #5 may be insignificant, however, without any effect at the confluence with Mill Creek. The Village may want to consult with a geomorphologist before reforming this bioswale.

Recommendation 6: Restabilize the earth around Outfall AA and Village Outfall #4.

Outfall AA and Village Outfall #4 appeared significantly more stable than the Outfalls in Recommendation 3. Nonetheless, erosion is occurring here, albeit to a much lesser degree. The team recommends that gravel and rock check dams be placed in the channel downstream of these outfalls. The gravel should reduce further erosion of the channel, and the check dams should temporarily detain stormwater.

Recommendation 7: Apply the recommendations on stream restoration from Chapter III to the small stream from Outfall D-1.

Outfall D-1 probably discharges a stream year round, not simply after storms. Because the drainage channel is actually a stream, the Village should follow the recommendations in Chapter 1 regarding stream restoration. Following those recommendations for this stretch of drainage channel should increase the area's biodiversity and protect water quality downstream.

Recommendation 8: Adopt the model LID Stormwater Ordinance.

The Mill Creek Subwatershed Report recommends that the Village of Dexter adopt a stormwater management ordinance. Such an ordinance should promote the installation of LIDs in future construction projects in the Village's urban areas and will help improve

protection of downstream water quality. This recommendation addresses one of the reasons LID techniques have been implemented slowly. The Low Impact Development Manual for Michigan contains a model LID stormwater ordinance that can be revised to suit the Village's needs. The manual should be available for download from the Southeast Michigan Council of Governments online at semcog.org.

Recommendation 9. Encourage all Village personnel to become familiar with LID and at least one Village employee to become an LID expert.

LID-focused stormwater management is a significant advance on conventional stormwater management. Village personnel are encouraged to read Chapter 2 of the LID Manual for Michigan and Chapters 2, 3, and 4 of the Rhode Island Stormwater Design and Installation Standards Manual. Furthermore, we encourage at least one Village employee to develop an expertise in LID-focused stormwater management. This person can champion Recommendation 8 and assist developers with understanding the Village ordinances. Familiarizing Village personnel with the fundamentals of LID would address a couple of the reasons why LID techniques have been implemented slowly.

Recommendation 10. Compare the requirements of the new Stormwater Pollution Prevention Initiative (SWPPI) to the current Stormwater Management Plan (SMP).

The Village of Dexter is required to submit a new SWPPI to the DNRE on October 1, 2010. Before doing so, the Village should compare the requirements set forth in the current SMP and in the draft SWPPI document. Almost all of the requirements in the SMP should also be in the SWPPI, and the Village should have a reasonable explanation for why any requirement is left out. The DNRE will likely perform such a comparison, and will probably note any requirements that are included in the SMP but not the SWPPI. The DNRE may request that any missing requirements be added into the SWPPI before it is approved. The state authority is not likely to relax requirements without due cause.

Recommendation 11: Require the use of native plants in a natural stormwater infrastructure.

Using native plants rather than non-native plants is highly recommended, because native plants are adapted to local conditions and better support the local ecology. These plants are typically available either from large nurseries or member nurseries of the Michigan Native Plant Producers Association (MNPPA). A list of member nurseries is available online at mnppa.org. The Low Impact Development Manual for Michigan also contains a model native plant ordinance. The manual is available for download from the Southeast Michigan Council of Governments at semcog.org. Adding native plant ordinance to local law would help promote usage of native plants and protect surrounding native plant resources. A matrix of recommended plants is provided in Appendix J.

Recommendation 12. Consider constructing a stormwater treatment wetland in the natural area downstream of School Outfall D, Outfall D-1, and Outfall AA.

The Master Plan indicates an opportunity to construct a wetland for stormwater treatment downstream of School Outfall D, Outfall D-1, and Outfall AA, before they converge with Mill Creek. The Village should consider assembling a small group of local experts in order to build this wetland. This group of experts should first decide whether constructing a treatment wetland on this site is a reasonable course of action: in other words, do the benefits of constructing a wetland in this space outweigh the costs? If the experts approve the construction of a wetland, they should also oversee its design, construction, and maintenance.

Mary Beth O'Doyle Park in Ann Arbor, Michigan is a beautiful local example of a recently constructed wetland. The Ann Arbor wetland, which treats a much higher flow, is significantly larger than the proposed wetland in Mill Creek Park. It should be noted that a continuous flow source is a typical requirement for siting a constructed wetland; fortunately, the small stream meets this requirement.

2.5. Summary and Prioritization of Stormwater Management Recommendations

Priority	Outfall Recommendations	Deadline
High	1. Identify and resolve cause of erosion above Outfall D-1. Replace eroded soil near eastside Baker Road sidewalk.	Prior to start of 2010 school year as this sidewalk seems to be a well-traveled route to and from Dexter schools.
High	2. Rebuild Outfall C-1 and re-establish/confirm stability of wooden bridge structure.	Prior to collapse (and loss) of structure.
Medium	3. Rebuild School Outfall C, Village Outfall #2, and Outfall #2-1 in the OEA.	Prior to ramping up school usage of OEA.
Medium	4. In Warrior Park, construct a naturally curved bioswale from the hillside to Mill Creek, daylighting the stormwater pipe to Village Outfall #8.	Prior to other area construction projects (such as for trails or playgrounds).
Low	5. Reform the unnaturally straight bioswale between Village Outfall #5 and Mill Creek with a natural curve and oscillation of width.	Prior to other area construction projects (such as for trails or boardwalks) and prior to instigating an increase of visitor usage.
Low	6. Re-establish earth stability around Outfall AA and Village Outfall #4.	Prior to other area construction projects (such as for trails or boardwalks) and prior to instigating an increase of visitor usage.
Low	7. Follow the recommendations from Chapter III. Stream Restoration for the small stream from Outfall D-1.	Prior to ramping up school usage of OEA.
	LID Recommendations	
Medium	8. Adopt the model LID Stormwater Ordinance.	The sooner the better.

Priority	Outfall Recommendations	Deadline
Low	9. Encourage all Village personnel to become familiar with LID and at least one Village employee to become an LID expert.	This should be an ongoing process.
	Misc. Recommendations	
High	10. Compare requirements of the new Stormwater Pollution Prevention Initiative (SWPPI) to the current Stormwater Management Plan (SMP). Make sure all current requirements are included in the SWPPI or reasonably addressed if missing.	The SWPPI is due to be submitted to the DNRE on October 1, 2010.
Medium	11. Require the use of native plants in natural stormwater infrastructure.	Prior to all future landscaping and vegetation projects.
Low	12. Consider constructing a stormwater treatment wetland in the natural area downstream of School Outfall D, Outfall D-1, and Outfall AA.	Take time to find funding and plan this construction project well.

Chapter 3: The Outdoor Education Area: A Management Plan

Big things of the world can only be achieved by attending to their small beginnings.

~ Tao Te Ching, Number 63

The Outdoor Education Area (OEA) is a wonderful resource for the students of Dexter's schools. The Outdoor Education Area is a five-acre natural area right on the grounds of Creekside Intermediate School, between its athletic fields and the meandering Mill Creek. A rough path winds through a forested area, along Mill Creek, and past a wetland (JJR & ECT, 2009). The OEA is easily accessible and would be an excellent place for classes to study ecology, learning about the interactions of its biotic elements (such as deer, wildflowers, and aquatic life) and abiotic elements such as water and soil.

In the 1980s and 1990s, the OEA was a popular spot for students to experience science firsthand. Unfortunately, over the years it has been less frequently used, and has fallen into disrepair. Classes have not been taught in the OEA in over 15 years. This chapter addresses the ways in which the OEA can be returned to a functioning outdoor classroom that teachers and students can safely use to enhance their understanding of nature. The activities presented in this chapter are designed to enlist the participation of students and volunteers from the community, providing an additional opportunity for them to learn about ecology while helping to protect and enhance the ecological quality of the OEA. The restoration work suggested here will not only help to return the ecological integrity of the OEA; it will also enhance the health of the broader watershed.

As a result of neglect, ecological degradation and safety hazards are on the rise in the Outdoor Education Area. Fortunately, it is not too late to reverse this trend. In order to restore the OEA as a place of ecological integrity where students can safely study the environment, several actions must be taken. If the recommendations put forward by this chapter are implemented, it will ensure that the OEA remains a treasure for generations of students to come.

3.1. Management Needs

In order to assess which restoration methods should be used in the OEA, it is important to identify the natural communities in the area. By identifying these communities, we can better understand how they function and recommend restoration methods that maximize benefits and minimize harm to the system. In addition, identifying these communities will help teachers familiarize themselves with the composition of the OEA. They may integrate this ecological knowledge into class lessons.

The various problems facing the OEA fall into two broad categories: ecological concerns and safety. From an ecological point of view, the main goal is to restore proper ecosystem functioning to the area, thus improving the overall quality of the OEA and the larger watershed. Meanwhile, there are several factors that must be addressed in order to make the OEA safe for students to visit and explore.

3.1.1. Ecological Needs

The main ecological need is to address the threat of invasive plant species. Invasive species are organisms that are accidentally or intentionally introduced to an area where they do not naturally occur. In these areas, invasives are able to thrive due to a lack of natural factors, such as disease or predators that would normally keep them under control. As their populations grow unchecked, these invaders aggressively compete with native species for resources such as light, nutrients, and water. Some invasive species, such as garlic mustard, even alter soil chemistry or produce toxins in their roots that kill nearby plants, eliminating potential native competitors. If allowed to spread, invasives can completely displace native

vegetation and form a monoculture in which only the invader is present (Figure 3.1). This destroys habitat for native animals, possibly displacing them at the local level or causing them to become extinct (U.S. Fish and Wildlife Service, 2009). In the OEA, it is especially important to control invasives to prevent their spread in the future Mill Creek Park and its neighboring restored natural areas.

Figure 3.1: Garlic mustard monoculture. (Photo by Daniel Herms, The Ohio State University, Bugwood.org)

Natural disturbances, such as flooding and fire, must also be considered in improving biodiversity and proper ecosystem functioning in the OEA. These disturbances play a key role in revitalizing and regenerating native species. Although flooding is difficult to control, owing to the large geographic extent of stream networks, efforts to prevent alteration of the area's hydrology can allow natural flooding to continue unhindered. In the case of fire, controlled burning performed by trained professionals serves as a good substitute for natural fires. In addition to stimulating regrowth and renewal, these natural disturbances help control the spread of invasive species.

3.1.2. Safety Needs

To make the OEA a suitable place for children to visit, several safety issues must be addressed. These include the presence of poison ivy, dead trees, and man-made debris, the overgrowth of trails, and the neglected state of boardwalks and bridges.

3.2. Research Methods

One of our initial goals upon visiting the OEA was to determine the natural communities found in the area. To delineate the boundaries of these communities, our team used a combination of field observations and interpretation of aerial photographs. During our site visits, we noted the general shape and extent of the different communities identified. We then acquired aerial imagery of the OEA from the U.S. Geological Survey's National Map Seamless Server and imported it into GIS mapping software. By combining our notes with our on-screen interpretation of community boundaries, we were able to create a map of the OEA's natural communities (Figure 3.2).

To assess the ecological quality and safety of the OEA, our team conducted several additional visits to study the vegetation and wildlife in the area, and to collect information about the seasonal changes in the area and the overall health of the ecosystems identified. To do this, we identified the observed plant and animal species, and gathered soil samples for chemical analysis. We compared the identified plant species with the Michigan Department of Natural Resources and Environment Floristic Quality Assessment to determine invasive species that are in need of management.

Richard Wolinski, a local resident and wildlife ecologist for the Michigan Department of Transportation, and Justin Heslinga, a natural resources technician from the Huron-Clinton Metroparks also participated in some of the site visits. They provided specific insight into wildlife, vegetation, natural communities, and hydrologic events in the area, and made recommendations for potential restoration activities.

During these ecological field surveys, our team also sought to determine the extent of invasive species in the area, by photographing invasive individuals and noting the extent of their spread. To assist any future removal efforts that may occur, we marked the locations of

many of the invasive individuals using a GPS unit (See Figure 3.3). Where invaders had formed dense colonies, field notes, combined with aerial photo interpretation, allowed us to include these invaders in our map. To reach our recommendations for action, we reviewed information provided by several state and federal agencies concerned with the management of natural areas.

To assess the safety of the OEA for students, our team walked along the established trails, noting and photographing any potential safety hazards. We also questioned some of the teachers from the nearby schools regarding their safety concerns. Richard Wolinski also provided insight on additional potential hazards. We assessed the condition of the boardwalks and trails to determine the accessibility and usability of the OEA in its current state and the measures necessary to create a safe and usable space for both teachers and students. One site visit included assessing the stormwater outlets and the effects of run-off and erosion in the OEA.

3.3. Results

3.3.1. Ecosystems of the OEA

The OEA is unusual, insofar as it combines several distinct ecosystem types in a relatively small space. These ecosystems are classified by the Michigan Natural Features Inventory (MNFI) as dry-mesic southern forest, floodplain forest, southern shrub-carr, and emergent marsh (See Figure 3.2). The presence of these ecosystems makes the OEA a great place for students to learn about various aspects of ecology and environmental science.

The dry-mesic southern forest occurs along the side of the hill that slopes down toward Mill Creek. Relatively dry soils and the dominance of oak and hickory trees characterize this ecosystem (Lee, 2007). Its designation as a "southern" forest distinguishes it from the dry-mesic forests dominated by pines in northern Michigan. Dry-mesic forests are fire-dependent, meaning they require occasional burning to suppress invasive and shade-tolerant species, promote regeneration, and suppress pathogens and predators (Lee, 2007). Historically, lightning strikes and Native Americans caused fires in these ecosystems, but with the suppression of fires by municipal governments, many dry-mesic forests are now

Figure 3.2: Locations of natural communities found in the OEA. (Map by Rebecca Gajewski)

choked with invasive plants and are susceptible to the oak wilt fungus. The OEA's dry-mesic forest has clearly suffered from the absence of fire, as several invasive species have established themselves in the area (see below).

The OEA's floodplain forest lies in the flat area between Mill Creek and the foot of the hill that slopes up to the Creekside property. Floodplain forests occur in low-lying areas adjacent to streams and rivers, and are characterized by periodic flooding. This flooding is

evidenced in the OEA by large, broken logs and branches that have been deposited by receding floodwaters. A fine coat of clay or sand on these limbs and on ground cover is further evidence of past floods. The vegetation found in this area, such as wild ginger, musclewood, ash, and silver maple, is typical of a floodplain forest (Kost et al., 2007b). In managing a floodplain forest to preserve biodiversity, the most important requirement is to preserve the natural flooding regime. This is very difficult to manage on such a small scale because river networks encompass such a vast area (Kost et al., 2007b). However, some conservation practices, such as lowering artificially high stream banks, can be used on a local scale to ensure floodwaters still reach the forest.

The southern shrub-carr ecosystem is found in the northern section of the OEA at the foot of the slope down from Creekside. Again, the "southern" designation differentiates it from its northern Michigan counterpart. Shrub-carr is a wetland ecosystem characterized by the dominance of woody shrubs such as dogwoods, willows, and winterberry (Kost et al., 2007c). Shrub-carr ecosystems occur in bands along rivers and streams, with saturated and seasonally flooded soils. This kind of ecosystem arises in wetland areas that have experienced fire suppression, allowing shrubs to colonize the area. Unlike areas that experience fire suppression and subsequent colonization by invasive species, shrub-carr communities perform some important functions in the ecosystem, such as providing habitat to many rare plant and animal species (Kost et al., 2007c).

Emergent marsh (or wetland) is located in the middle of the shrub-carr community. This community is a shallow-water wetland commonly found along streams. The vegetation here consists of broad-leaved and grass-like plants that emerge from the waters' surface. These plants include sedges, cat-tails, and bulrushes. Floating vegetation, such as the water-lily, is also common. Emergent marshes are subject to frequent periods of flooding. In times of low water, seeds are able to germinate and establish seedlings. In times of high water, peat moss and oxygen-poor sediments accumulate. Both phases are necessary for proper ecosystem functioning. Historically, in areas where emergent marshes occurred next to fire-dependent uplands (such as the dry-mesic southern forest of the OEA hillside), fire may have occasionally swept through the community, promoting the establishment of seedlings (Kost et al., 2007a). To manage this ecosystem and preserve biodiversity, activities such as dredging and ditching should be avoided. At the same time, the high nutrient input from

overland runoff and the arrival of invasive species also threaten the integrity of the community. The natural flooding regime should be kept as unaltered as possible, and prescribed fires for the dry-mesic uplands should include the emergent marsh (Kost et al., 2007a).

3.3.2. Invasive Species

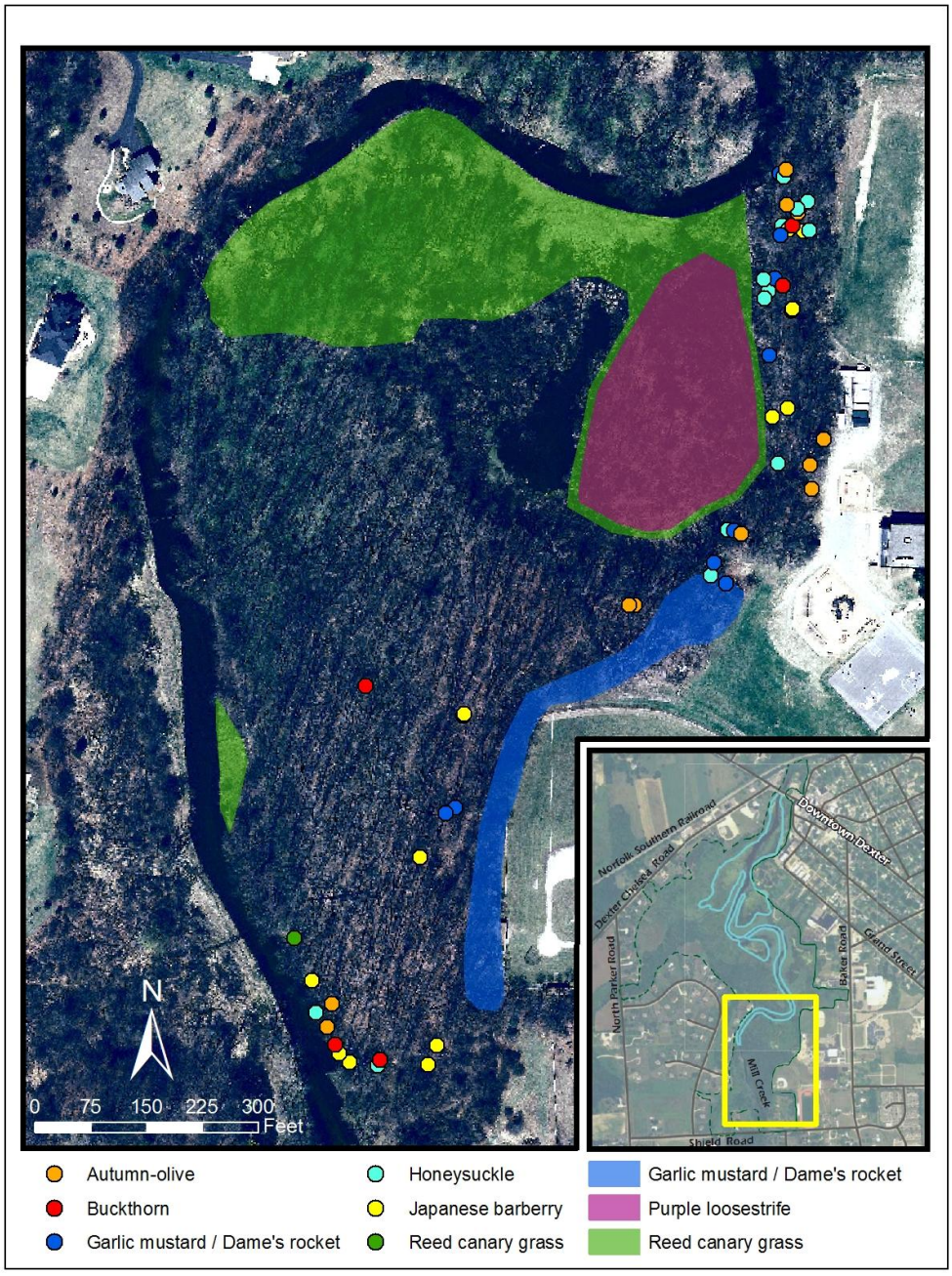


Figure 3.3: Locations of invasive species in the OEA. (Map by Rebecca Gajewski)

The results of our invasive species survey may be seen in Figure 3.3. We identified garlic mustard, dame's rocket, reed canary grass, purple loosestrife, autumn-olive, honeysuckle, buckthorn, and Japanese barberry (see Appendix K for identification guide). In general, the invasives were found along the eastern edge of the OEA, especially on the hillside surrounding the wetland and next to the OEA entrance. Furthermore, a fair number of invaders were found along the southern margin of the OEA, and a few were found along the creek. Purple loosestrife and reed canary grass were common in the shrub-carr ecosystem, though the extent of the reed canary grass also stretched into the entire northern portion of the floodplain forest. (See Table 3.1 for detailed locations and Appendix L for specific coordinate locations.)

Table 3.1: Locations of invasive species in the OEA

Species	Location within OEA
Garlic mustard/Dame's rocket	Dense patches immediately surrounding entrance, extending southward along the top of the hill on the eastern margin *Note: At the time of the survey, garlic mustard and dame's rocket had entered their dormant phase, in which they look extremely similar. Thus, they were lumped into the same category.
Purple loosestrife	Scattered throughout the shrub-carr ecosystem
Reed canary grass	Dense invasion throughout the shrub-carr ecosystem, extending into the northern part of the floodplain forest. One isolated patch (approx. 350 yd^2) next to the creek in the middle region of the floodplain forest
Autumn-olive	Isolated individuals along eastern edge of the OEA and in the southern region along the creek
Honeysuckle	Prevalent along the eastern margin of the shrub-carr ecosystem; a few individuals on the southern margin near the creek
Buckthorn	Scattered individuals in north eastern and south western corners; one individual in the middle of the floodplain forest
Japanese barberry	Scattered along the eastern edge *Note: Only the largest individuals were marked with the GPS. Several very small individuals were not marked.

3.3.3. Mechanisms of Invasion

While all the invasives identified have the potential to become serious problems in the OEA, some species are more aggressive than others. Reed canary grass is especially harmful because it spreads through a variety of mechanisms. First, it produces a large amount of seeds per area, facilitating its spread via birds and other animals. It also spreads through dense underground stems, called rhizomes, which can sprout multiple new plants. In late summer, the shoots of the plant collapse, forming a thick thatch of stems and leaves over the soil surface and smothering other plants that may be growing nearby (Wisconsin Department of Natural Resources, 2009). Thus, reed canary grass forms a monoculture, greatly decreasing biodiversity. The effects of a reed canary grass monoculture may be observed in the former Mill Pond area, where reed canary grass is the dominant vegetation.

Purple loosestrife is a similarly aggressive invader. Its success in wetland habitats results from its ability to grow in a range of soils, from moist to flooded. According to the Michigan Sea Grant, a mature plant can produce up to 2.7 million seeds per year. These seeds can be transported by water, or by birds and animals that get seeds stuck in their feathers and fur. Though the plant prefers full sun, it can also grow in the shade of other plants. Dense invasions of purple loosestrife pose serious consequences for wildlife. Its thick, dense stems repel waterfowl, and the plant provides very low nutritional value for animals. Moreover, the plant's dense stems and roots trap sediments, causing wetlands to fill in (Michigan Sea Grant, n.d.).

Garlic mustard and dame's rocket are deceptive invaders. They may appear to be wildflowers at first glance; in fact, seeds of the dame's rocket are often included in commercial wildflower mixes. Both plants, however, compete with native plants for resources, forcing them out of their habitats. Garlic mustard is more aggressive than dame's rocket, since it is allelopathic, releasing chemicals from its roots that poison nearby plants (Landis & Evans, 2009a). Both plants can grow in a variety of habitats and spread quickly as they produce huge quantities of seeds per plant.

The remaining invaders are woody species: autumn-olive, honeysuckle, Japanese barberry, and buckthorn. Though they grow more slowly than the herbaceous invaders, and they have much longer life cycles. Like the other invaders, they harm ecosystems by shading

out native plants, and they also form dense thickets that are inhospitable to wildlife. Barberry and autumn-olive branches are covered in thorns, causing a nuisance to visitors who stumble across them. Similarly, buckthorn twigs sprout thorns from their tips. These plants are successful invaders because they produce massive quantities of berries, which are widely dispersed by the birds that feed on them.

3.3.4. Natural Disturbances

Both fire and flooding are essential to the proper functioning of the ecosystems in the OEA. Based on the OEA's proximity to the school and other developed areas, one can assume that fire has been suppressed in this ecosystem for a long time. The presence of invasive species is another indicator of fire suppression, as many invasives are resistant to fire. Flooding appears to continue unhindered, however, according to our conversations with Richard Wolinski and our observations in the field. During one of our visits to the site, a fine film of sediment was visible over some of the debris on the forest floor, suggesting the area had recently been underwater. The debris itself, consisting of many small branches and some large logs and branch fragments, is scattered randomly throughout the forest in a density and pattern suggesting it was deposited by water.

3.3.5. Safety of Visitors

The teachers' most common safety concern was the presence of poison ivy near the trails. During our visits, we did observe some poison ivy growth, but also observed some plants that are commonly mistaken for poison ivy, such as wild raspberry species, Virginia creeper, and box-elder seedlings. (See Figure 3.5 for comparisons.)

Figure 3.4: Barbed wire fence at the southern end of the OEA. (Photo by Rebecca Gajewski)

Figure 3.5: Poison ivy and plant species with which it is commonly confused.

Guide to Poison Ivy Identification

(1) Poison ivy: Leaves are composed of three leaflets, with the middle leaflet on a longer stalk than the other two. The leaflets usually have a few large teeth, but they may also have smooth margins. The margins of the side leaflets which face toward the middle leaflet are usually smoother than the margins facing the stem. Leaves are alternately arranged on the stem. May grow as a shrub or as a climbing vine covered with hairy roots. (Photo by Joseph LaForest, University of Georgia, Bugwood.org).

(2) Raspberry species: Leaves are composed of three leaflets with finely serrated margins. May have the texture of sandpaper. Underside of the leaf is white in color. Stems are pinkish to purple-red in color and are covered with prickles. (Photo by Steven J. Baskauf).

(3) Box-elder: Leaves are divided into three to seven leaflets edged with coarse teeth. Leaves are arranged opposite each other on the stem. Grows as an erect tree with dark purple-red twigs. (Photo by Robert Vidéki, Doronicum Kft., Bugwood.org).

(4) Virginia creeper: Leaves are composed of five leaflets that radiate out from a central point. Grows as a trailing or climbing vine that attaches itself to surfaces using small tendrils tipped with suction cups. (Photo by Ted Bodner, Southern Weed Science Society, Bugwood.org).

Our site visits also revealed several manmade hazards. There is some evidence of dumping and littering in the area between the school yard and the slope down to the shrub-carr wetland. Moreover, an old, rusty barbed-wire fence is still in place along the southern boundary, posing a significant threat to anyone who goes exploring off the trail (See Figure 3.4). One of the boards is missing on the bridge across the small stream that flows into the wetland just south of the OEA entrance. This is a significant tripping hazard. In addition, a step is missing from the northern end of the boardwalk overlooking the wetland.

For the safety of visitors using the trails, it is vital to address the problem of overgrowth. The trails along the eastern and southern edges of the OEA are well established, but the trail along the creek becomes more overgrown as it moves north, and the trail along the southern edge of the wetland has almost completely disappeared. In addition, the trail that cuts through the middle of the floodplain forest is difficult to find. It was previously lined with cut logs, but more logs washed up by floods have confused the true trail route. Another safety concern is the presence of dead trees. Several ash trees killed by the emerald ash borer are still standing in the floodplain forest and some of these trees are directly adjacent to the trails. Several other dead ash trees that were presumably killed around the same time have already fallen down, suggesting that other trees may fall in the near future.

3.4. Recommendations

3.4.1. Invasive Species

Invasive species in the OEA should be removed as soon as possible. Addressing this problem now will prevent the invasives from becoming dominant in the OEA, and it will prevent their spread into Mill Creek Park and its associated habitat enhancement areas. The following are the most effective methods for removing each type of invader found in the OEA. Students or volunteers can perform many of these activities. In addition, several steps can be taken to ensure that the invasives do not return once they are removed.

- ***Reed canary grass***. Reed canary grass is very well established in the wetland and along the creek. Because the invasion is so dense, a combination of strategies may be

required to bring the species under control. A controlled burn performed in spring, before native plants emerge from dormancy, can reduce reed canary grass growth and burn off dead thatch from the previous year. The thatch reduction will allow more light to reach native species, stimulating their growth. Timing is critical, however: a burn performed too early in the spring can cause a rapid increase in the growth of reed canary grass (Wisconsin Reed Canary Grass Management Working Group, 2009). The fire itself may damage native shrubs if it is too intense, but the reed canary grass infestation is so extensive that little can be done to remove it without also harming desirable vegetation. After a burn, reed canary grass will resprout using reserve energy stored in its roots. When the grass has reached a height of 6-12 inches, an herbicide approved for use in aquatic areas, such as glyphosate (sold under trade names such as Aqua Star, Glypro, and Aquamaster; see Michigan DEQ document in Works Cited for a complete list of approved aquatic herbicides) should be sprayed on the plant to kill its underground root system (Wisconsin Reed Canary Grass Management Working Group, 2009). Glyphosate is relatively non-toxic to humans and not at all toxic to fish. In the environment, it adheres tightly to soil particles where it does not leach away and can be quickly broken down by microbes (Extension Toxicology Network, 1994). It is a non-selective herbicide, meaning it will kill or injure any vegetation it comes into contact with (Invasive Plants Association of Wisconsin, n.d.). Because the invasion is so widespread, and because desirable native plants in the area should remain uninjured, only a licensed professional should apply glyphosate. Several years of follow-up treatment with herbicide or removal by hand may be needed to completely eradicate the grass (Wisconsin Reed Canary Grass Management Working Group, 2009). Studies have suggested that the planting of native shrubs, such as red-osier dogwood, highbush-cranberry, and nannyberry, also helps decrease reed canary grass survival, as the planted shrubs help shade out the grass (Hovick & Reinartz, 2007).

- ***Purple loosestrife***. Several effective strategies exist for dealing with purple loosestrife. Hand-pulling the plant may be an effective strategy for eliminating isolated clumps of young plants, but care must be taken to avoid spreading seeds that

might get stuck to clothing (Michigan Sea Grant, n.d.). Purple loosestrife begins setting seed in mid- to late July, so plants can be pulled before then (Missouri Department of Conservation, n.d.). Volunteers or students of any age could participate in this activity. Another strategy is to release *Hylobius transversovittatus*, a root-boring weevil that attacks the roots of purple loosestrife. Other biological control agents are *Galerusella pusilla* and *G. calmariensis*, leaf-eating beetles that again only attack purple loosestrife (Michigan Sea Grant, n.d.). School children can raise and release these agents as part of their science education. The Michigan Sea Grant's online purple loosestrife education project, The Purple Pages (www.miseagrant.umich.edu/ais/pp/index.html), provides instructions for starting new biological control projects. It even includes lesson plans to help teachers educate their students about the dangers of purple loosestrife.

- ***Garlic mustard and dame's rocket***. Because the garlic mustard and dame's rocket infestation is relatively small and contained, pulling them out by hand is the most effective method for elimination (Landis & Evans, 2009b). Again, this project is suitable for volunteers of a variety of ages. Pulling should be performed when the plants are in flower and before their seeds have ripened—from late April through June for garlic mustard (Landis & Evans, 2009a), and before June for dame's rocket (Young, 2001). If the plants are pulled up after the seed pods have ripened, there is a high risk of accidentally breaking the pods open and spreading the seeds. Because seeds continue ripening even after the plants are pulled, the plants should be bundled in trash bags and sent to the landfill to prevent any viable seeds from escaping (Landis and Evans, 2009b). It is also important to remove the entire plant, along with its roots, in order to prevent it from resprouting. Volunteers should begin removal on the edges of the invasion and work toward the core (Landis & Evans, 2009b). Because garlic mustard is biennial, meaning it flowers every two years, it is important to establish a removal regime that spans a number of years.

- ***Autumn-olive, honeysuckle, Japanese barberry, and buckthorn***. For invasive shrubs and trees, hand-pulling or digging may be effective if the plants are small. However,

most of the invasive shrubs observed in the OEA are too large to pull up or dig out. In this case, the most effective treatment method is to cut the shrubs and apply a herbicide such as glyphosate (sold under the trade names Roundup and Rodeo, which are different from the aquatic formulations) to the cut stump in a solution with water; see the product label for the recommended concentration (U.S. Forest Service). This method can be used from mid-summer through winter. It should not be used in the spring because sap flowing up from the roots of the plants to build new leaves will flush herbicide out of the stump (Webster, Jenkins, & Jose, 2007). Repeated cutting can eradicate these invaders without the use of herbicide, but for some of these species, cutting stimulates resprouting if an herbicide is not applied. The same plant must be re-cut for many years before it finally dies. Applying herbicide ensures fewer follow-up removals will be needed. To minimize volunteers' contact with the herbicide and to limit the amount of herbicide accidentally applied to non-target plants, glyphosate may be applied to cut stumps using an herbicide wand with a sponge applicator on the end (Assembly instructions for this wand may be found at www.invasive.org/gist/tools/wand.html). If the risks are minimized in this way, this activity is appropriate for volunteers of middle school age and above. Depending on regulations put forth by the school district or municipal government, the supervisor of the removal activities may need to be a licensed commercial pesticide applicator in the State of Michigan. Compliance with all state and local laws must be assured before removal begins.

With all invasives, it is essential to continue monitoring the area after they are removed. Additional removal activities may be needed in order to exhaust the store of invasive seeds that has built up in the soil over the years. For a detailed timeline of invasive removal and restoration activities, see Section 3.6.

3.4.2. Prevention of Invasives

Although removing invasive plants is a important, preventing them from entering the area in the first place can save time and money. Ornamental plantings, for instance, are one

of the main causes of invasive species outbreaks (Environment Canada, 2008). Not all introduced plants have the ability to become invasive, but several commonly planted horticultural plants are known invaders. Even so, some of these plants continue to be sold commercially and planted by unknowing landowners.

One way in which the Village can prevent invasives from spreading into the Mill Creek Park area and the OEA is to work with the Forest Lawn Cemetery Board to develop guidelines for what can and cannot be planted within the cemetery. Our site visits revealed that Japanese barberry has been planted in the cemetery; one plant was observed growing in the natural area beyond its border, having presumably escaped from the planted population. The barberry plants should be removed and replaced with native plants. Intentional plantings of Japanese barberry in the cemetery may be the source of barberry invasion in the OEA (See Figure 3.6).

Figure 3.6: Japanese barberry in the OEA. (Photo by Rebecca Gajewski)

The Village may also be able to prevent the spread of invasives by revising the landscaping standards included in its zoning ordinance. Currently, Japanese barberry is one of the shrubs listed as appropriate for planting in parking lot screens and buffer plantings (Village of Dexter, 2008). It should be removed from this list. The section of the ordinance detailing parking-lot screens and buffer plantings does include a list of trees not permitted "except where they are considered appropriate for the ecosystem, such as in a wetland environment (Village of Dexter, 2008)." Some of the trees listed, however such as tree-of-heaven and Norway maple, are highly invasive and should not be planted under any circumstances. Black locust is another tree on this list that is considered invasive by some of Michigan's natural resource agencies, including the Department of Natural Resources and Environment (Higman & Campbell, 2009).

3.4.3. Invasives in the Future

Our recommendations for dealing with invasive species can apply to not just the OEA, but the entire project area. Once Mill Creek Park has been built and JJR restores the surrounding natural areas, monitoring for invasives in these areas will be necessary to ensure the quality of the recreated habitat. In addition, negotiations with the private landowners on the west side of the creek should continue so that both sides of the creek may eventually be restored. In its current state, the west side of the creek also suffers from the presence of invasives, namely reed canary grass, and the future health of the natural areas surrounding Mill Creek Park will be in jeopardy with such a large invasive population so close by. Therefore, it is very important for the Village to continue to work with the landowners to implement some type of joint restoration strategy. Private citizens may adapt the recommendations presented here for their own restoration efforts.

3.4.4. Natural Disturbances

Flooding appears to occur naturally in the OEA, so it is not a restoration concern. Nevertheless, it is important to maintain this natural cycle. Future disturbances to the Mill Creek flow regime should therefore be avoided. Such disturbances might include the building of new dams upstream or channelizing the creek bed. Care must be taken in placing trails along the creek to ensure that the stream's banks are not raised to accommodate new trails. Such action may prevent floodwater from overtopping these banks and entering the floodplain forest (see Chapter 1).The fire regime is the only natural disturbance that must be re-established in the OEA. Controlled burns of the dry-mesic forest will stimulate native species growth and slow spreading invaders. Burns may be conducted either by volunteers under the supervision of an experienced crew leader or by an independent contractor hired to conduct the entire operation. If volunteers conduct the burns, their tasks will mainly be to create fire breaks to prevent the fire from spreading into areas that should not be burned, and to patrol the perimeter of the fire with water backpacks and fire swatters to put out any fire that may spread beyond the fire break. These activities can be physically strenuous, so volunteers should be of at least high-school age. The Michigan Department of Natural

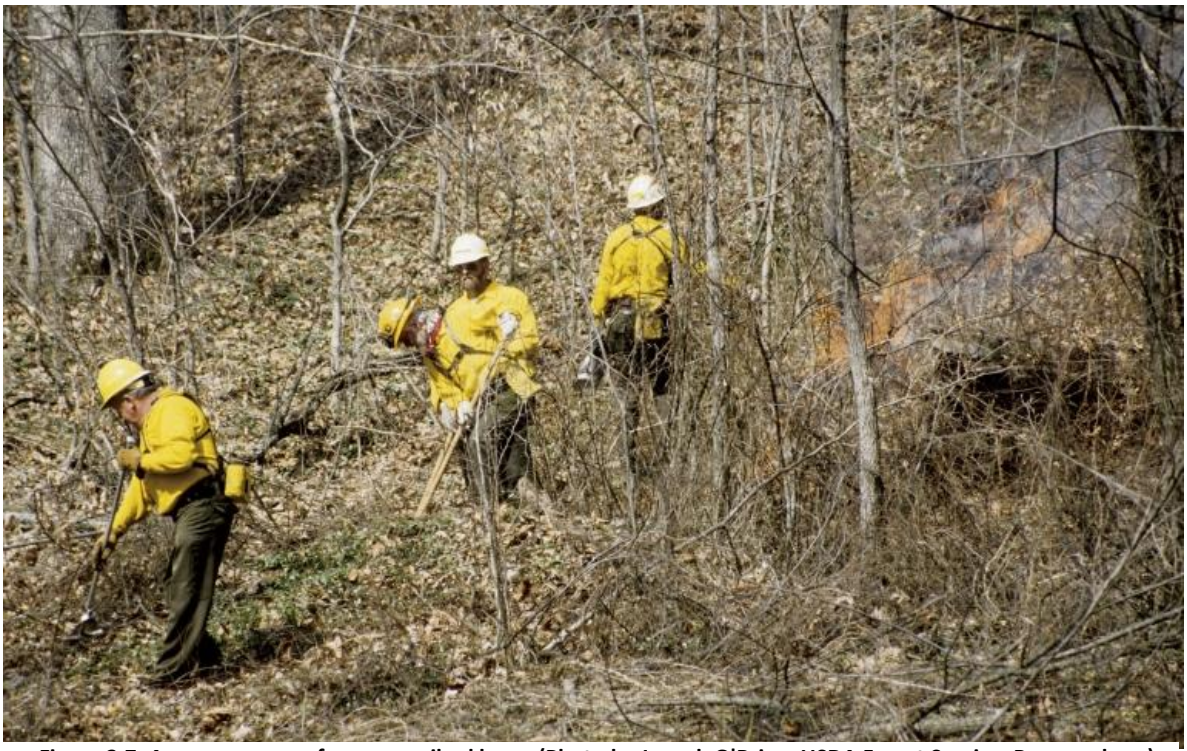


Figure 3.7: A crew prepares for a prescribed burn. (Photo by Joseph O'Brien, USDA Forest Service, Bugwood.org)

Resources and Environment and the Michigan United Conservation Clubs have posted a detailed online guide to planning a prescribed burn (See Sargent and Carter, 1999, in Works Cited). The guide is aimed toward managing grasslands, but the same techniques can be used for a prescribed burn in a forest environment.

If it is undesirable to have volunteers conduct the burn work, several local independent contractors or environmental consulting firms may be hired to complete the burn instead (See Table 3.2). A complete list of independent contractors located throughout Michigan and the Midwest can be found on the Michigan Prescribed Fire Council website at http://mifirecouncil.org/consultants.

Table 3.2: Independent contractors licensed to perform prescribed burns.

Contractor Name	Address	Contact Information
PlantWise, LLC	David Mindell 224 Charles St Ann Arbor, MI 48103	Phone: 734-665-7168 Email: plantwise@aol.com Website: www.plantwiserestoration.com
JFNew	605 South Main St Suite 1 Ann Arbor, MI 48104	Phone: 734-222-9690 Email: info@jfnew.com Website: www.jfnew.com
Appel Environmental Design	Mike Appel 613 N 5th Ave Ann Arbor, MI 48104	Phone: 734-395-1060 Email: appel@umich.edu
David Borneman, LLC	1123 Mixtwood St Ann Arbor, MI 48103	Phone: 734-645-8476 Email: davidborneman@yahoo.com Website: www.restoringnaturewithfire.com

3.4.5. Safety of Visitors

The main safety concern in the OEA is the presence of poison ivy. Other issues are the presence of man-made debris, boardwalks, bridges, and trails in disrepair, and dead ash trees.

- ***Poison ivy***. Poison ivy should only be removed in areas where children might come into contact with it—that is, along trails or in areas where students may wander off trail. Although it is irritating to humans, it is a native plant that has significant ecological value, producing berries that are an important food source for birds (Pennsylvania State University, 2003). It is impossible to remove all the poison ivy in the OEA, so efforts must be concentrated only in the areas where visitors travel. Hand-pulling may control it, but only if the entire plant root is removed. If any fragment of the root system is left in the soil, the plant will sprout again (Hartzler 2001). Only people with a known tolerance to poison ivy toxins should try to remove it by hand. Spraying the plants with a chemical herbicide such as glyphosate

(described in the Invasive Species section) is an alternative option to hand removal. Glyphosate is nonselective, meaning it will kill any plant it contacts, so extreme care must be taken to avoid spraying desirable plants (Hartzler 2001). Glyphosate may also be used to control poison ivy vines climbing trees. It can be sprayed directly on the vine—it will not harm the tree if the herbicide only touches its bark—or the vine can be cut and glyphosate sprayed on the stump to kill the rest of the plant (Hartzler, 2001). It may also be prudent to cut and remove a section of vine that is growing at a height at which children might come in contact with it. Touching the vine can produce the same allergic reaction as touching the leaves. If volunteers or workers do accidentally touch the vine or leaves, the contacted area of skin may be washed with rubbing alcohol, which deactivates the irritating oil in the plant. As with invasive species control, it may require several follow-up treatments to ensure that the target plants are entirely eradicated. *Important note: Prescribed burning of the dry-mesic forest should take place only after any poison ivy is removed. Poison ivy may be carried in the air as soot particles and cause allergic reactions in sensitive people coming into contact with the smoke*.

- ***Debris***. Any refuse that has been dumped in or on the edges of the forest should be removed immediately. The old barbed-wire fence at the southern boundary of the OEA should also be removed before children are allowed to explore the area.

- ***Boardwalks and bridges***. Missing and loose boards in the boardwalks and bridges should be replaced before students are taken into the OEA. The structures should be inspected for safety to ensure that the foundations are not rotten or damaged. The stairs on the northern end of the boardwalk

Figure 3.7: Missing board on one of the OEA bridges. (Photo by Rebecca Gajewski)

overlooking the wetland should be replaced. We also recommend investigating the possibility of installing new boardwalks in areas that are flooded or muddy for most of the year. At Ann Arbor Greenhills School, further discussed in Chapter 4, such structures may keep students out of the mud and facilitate classroom activities in the OEA.

- ***Trails***. The trails through the OEA should be re-established along the creek and wetland and through the floodplain forest, where they have disappeared. Figure 3.8 shows both where the trails previously ran and where they currently exist. This map also illustrates where the trails have been lost over the years and where they should be re-established. In rebuilding these trails, it is important to comply with all Americans with Disabilities Act (ADA) regulations for trails in natural areas. Children of all abilities should be able to benefit from the OEA. Slope, surface, width, and the installation of handrails are important considerations in accessible trail design,. For instance, trails should not have more than a five-degree slope, be at least 36 inches in width, and be covered with a hard material, such as rocks with broken faces rather than rounded gravel, that is stable and will not wash away in a flooding event (Zeller, Doyle and Snodgrass, 2006). In addition to meeting the needs of all students at Creekside Intermediate School, compliance with all ADA regulations will enhance Dexter Community Schools' ability to receive state and federal grants in the future. Future SNRE master's projects or a contracted engineering firm may explore how these trails could best be developed and where they should be located. The Accessibility Guidebook for Outdoor Recreation and Trails developed for the U.S. Forest Service offers detailed guidelines for making trails compliant with the ADA (see Zeller, Doyle, & Snodgrass, 2006).

- ***Dead trees***. The dead trees standing on the borders of established trails should be cut down. The logs can be removed from the OEA or used as markers to line the trails. If ash trees killed by the emerald ash borer are felled, those logs cannot be moved outside of the Lower Peninsula, because the area has been quarantined to prevent further spread of the emerald ash borer (Michigan Department of Agriculture, 2007).

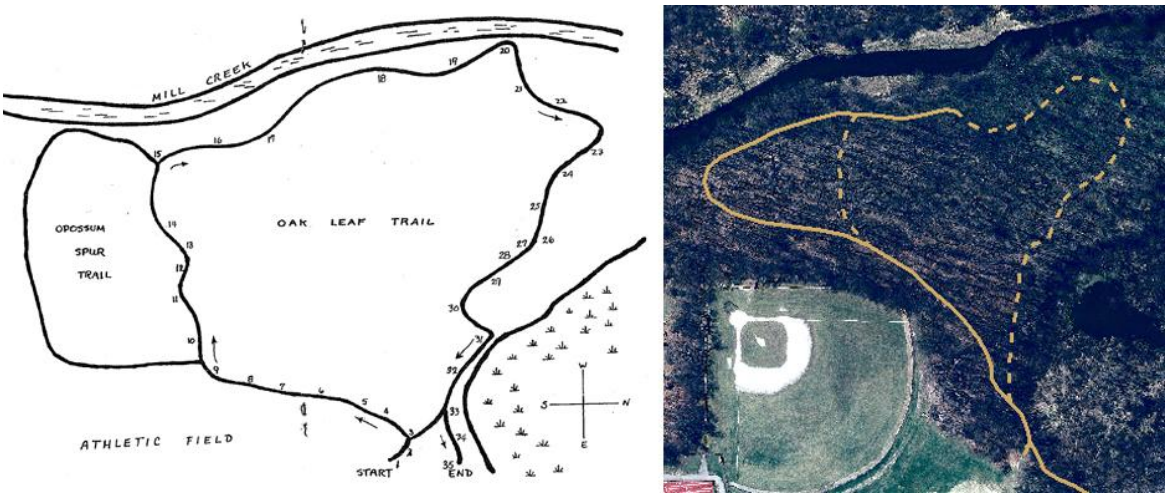


Figure 3.8: Map of trails in the OEA from the early-90's Oak Leaf Trail Guide and map of the current state of the trails. Solid lines show intact trails and dashed lines show approximately where the trails have been lost. (Current map by Rebecca Gajewski)

3.5. Suggested Timeline of Restoration Activities

Year	Activity
Year 1	• Remove garlic mustard (spring through mid-summer) and dame's rocket (spring) • Begin removal of invasive shrubs (mid-summer through winter) • Begin removal of poison ivy (spring through summer) • Repair damaged bridges and boardwalks • Remove debris and other safety hazards • Begin re-establishing trails
Year 2	• Continue removal of garlic mustard (spring through mid-summer), dame's rocket (spring), invasive shrubs (mid-summer through winter), and poison ivy (spring through summer), checking for any regrowth • Begin removal of purple loosestrife, if removing by hand (spring through mid-summer) • Perform a prescribed burn of the areas infested with reed canary grass (early spring) • Treat resprouting reed canary grass with herbicide spray (late fall) • Begin raising beetles for biological control of purple loosestrife • Continue developing trails

Year	Activity
Year 3	• Continue removal of garlic mustard (spring through mid-summer), dame's rocket (spring), invasive shrubs (mid-summer through winter), and poison ivy (spring through summer), checking for any regrowth • Release beetles for biological control of purple loosestrife (spring through summer) • Continue trail maintenance and repair
Year 4	• Continue removal of invasive species and poison ivy as needed, checking for any regrowth • Monitor progress of biological control of purple loosestrife, and release more beetles if needed (spring through summer) • Begin removal of dead trees • Continue trail maintenance and repair
Year 5	• Continue removal of invasive species and poison ivy as needed, checking for any regrowth • Continue removal of dead trees • Continue trail maintenance and repair
Year 6	• Continue removal of invasive species and poison ivy as needed, checking for any regrowth • Perform a prescribed burn of the dry-mesic forest (fall) • Continue trail maintenance as needed
Year 7	• Monitor invasive species and poison ivy, removing as needed • Continue trail maintenance as needed
Year 8	• Monitor invasive species and poison ivy, removing as needed • Perform a prescribed burn of the dry-mesic forest (fall) • Continue trail maintenance as needed
Year 9 and beyond	• Continue monitoring invasive species and poison ivy, removing as needed • Continue performing prescribed burns of the dry-mesic forest every 5-10 years • Continue trail maintenance as needed

Chapter 4: The Outdoor Education Area: An Outdoor Education Plan

Come forth into the light of things, let Nature be your teacher.

~ William Wordsworth

Revitalizing the Creekside Intermediate School's Outdoor Education Area (OEA) as an educational area is one step in restoring the ecological health of the Mill Creek watershed. Through classroom instruction in the OEA, teachers at Creekside Intermediate School can help students build and strengthen their connection to the local environment and community. This process will encourage both students and teachers to become stewards of Mill Creek, creating a group of people that care about the watershed and its ecosystems. The proper use of educational opportunities provided by the OEA can thus help promote the ecological health of the entire area. This group, with its newly-formed concern and connection to the local environment, can help create a base of people eager and willing to volunteer their time to both restoring and maintaining the ecological health of Mill Creek. Additionally, the impacts of the OEA spread beyond the

Figure 4.1: Entrance to Creekside Intermediate School's Outdoor Education Area (Photo by Katherine Hollins)

borders of the schoolyard. Stormwater quality, creek water quality, and invasive species in the OEA can all affect Mill Creek and its surrounding areas downstream. If the OEA is a valuable and maintained resource, it can help ensure the ecological health of neighboring areas. The more formal learning taking place in the OEA at Creekside complements the informal educational opportunities in Mill Creek Park. Interpretive signage both educates park visitors about aspects of Mill Creek and enhances students' learning experience at the OEA.

4.1. Needs

Figure 4.2: Mill Creek as seen from the OEA (Photo by Katherine Hollins)

Creekside Intermediate School possesses a unique resource in its Outdoor Education Area. The OEA is natural area right on school property, making it easy for classes to study the ecology of the area. Historically the OEA had been used for science-related activities (self-guided tours with a booklet), science lessons (observations), and sometimes for art, English, and counseling services (Teachers, 2009). Unfortunately, both the Trail Guide and the OEA have fallen out of use by many teachers. The Trail Guide seems out of date for teachers' purposes, and there are comfort and safety issues with the OEA itself.

Many U.S. schools have some sort of natural area nearby, whether it is a stand of trees in the schoolyard, a nearby park, or a designated outdoor educational area like the one at Creekside. Despite these superb outdoor resources, Creekside teachers face many of the same barriers that face teachers who wish to teach in outdoor settings elsewhere. Restraints on planning time, viewing outdoor experiences as extra or unnecessary, perceived conflicts with standards, lack of science knowledge, and lack of comfort with elements of teaching

outdoors (such as safety and student behavior) can all prevent teachers from using nearby natural areas for class (Archie, 2001; Dillon et al., 2006).

Figure 4.3: Raccoon tracks in the OEA, demonstrating one of many species present. (Photo by Katherine Hollins)

A key problem is a lack of knowledge about the OEA and how to use its elements to meet classroom needs. At the moment, teachers lack an accessible teaching tool to use in the OEA. For the most part, however, educational materials previously devised for the OEA are no longer current or relevant. Teachers need a resource they can easily use to identify the OEA's various biotic and abiotic elements and explain them for their students. Teachers at Creekside have also expressed a lack of knowledge and confidence in their ability to use the OEA for classroom instruction, a concern shared by teachers at larger scales (Meichtry & Smith, 2007). This perception indicates the need for a resource to provide teachers with strategies for using the OEA.

Secondly, many of the OEA trails have fallen into disrepair and require maintenance before they are safe and usable for teachers and students. For example, the OEA contains poison ivy. This, in addition to other factors, has shown to be of concern for teachers taking their classes into the OEA. A safe and well-maintained OEA will allow teachers to feel more comfortable taking students into the area for instruction. Thus, Creekside has a need for immediate OEA trail maintenance as well as a longer term management and ecological restoration plan to ensure the OEA remains a sustainable resource in the future.

In addition to updated and usable resources and OEA maintenance, Creekside also requires a plan for the long-term sustainability of these resources and of the program as a whole. Long-term sustainability includes a plan for volunteer bridge and trail maintenance as well as ecological restoration. A regular crew of volunteers doing bridge and trail

maintenance (including students, parents, and community members) would allow the teachers to use the OEA without spending too much time maintaining it.

Any curricular resources need to be adaptable and easy to use in the long term, even considering future curricular changes. The recommendations and products provided by our team will help to overcome these barriers and meet the needs of teachers in Dexter.

4.1.2. Benefits of Outdoor Education

As schools try to adhere to the demands of the No Child Left Behind legislation, students are permitted to spend less and less time outdoors learning about their environment (Cleaver, 2007). Natural and social science have meanwhile been sacrificed in favor of those subjects most heavily weighted in standardized tests. Nonetheless, outdoor education has numerous benefits.

First, educational programs that allow children to be outdoors and bring the outdoors inside greatly increase their interest in the natural environment. The inclusion of outdoor education programs can serve to reconnect children with nature and provide a more personal experience with the environment (Monroe, 2005). When comparing a traditional indoor program and an outdoor program teaching the same material, children involved in outdoor programs have shown a marked increase in cognitive learning and awareness of environmental subjects (Eaton, 1998). The outdoor classrooms created by the Boston Schoolyard Initiative showed such results. Teachers who utilized outdoor classrooms felt that involving their students in outdoor hands-on learning had important academic benefits. Students were reported to be more engaged in learning about their surroundings and were able to understand, remember, and integrate the material in a more lasting way (Becker-Klein, 2008).

Figure 4.4: Children engaging in and learning about their surrounding natural environment. (Photo by The Virginia Department of Conservation and Recreation)

Furthermore, outdoor education is an effective way to teach science, with the potential to improve test scores and get students engaged in learning (State Education & Environment Roundtable, 2000). It is an effective way to teach science concepts, can align with state and national standards, and can encourage students to take an active role in learning, constructing their own knowledge through inquiry, experiences, and questions, as called for by constructivist theory (Tobin 1993; Jacobson, McDuff, & Monroe, 2006). Indeed, the use of local natural environments to teach or reinforce science lessons has been shown to improve students' academic achievement and enhance students' engagement with the learning process (Mayer & Fortner, 1987; State Education & Environment Roundtable 2000; Cronin-Jones, 2000; Archie, 2001; Sobel, 2004). Finally, direct experience of natural settings can provide more meaning and purpose to education and provide a better connection between what children are learning in school and the life of the community. This style of learning fits well with Dexter Community Schools' desire to use inquiry-based learning.

Creekside Intermediate School currently lacks a long-term OEA Management Plan for both the physical maintenance of the site and continued safe and comfortable teacher and student use. Teachers at Creekside often identify the level of upkeep of outdoor education areas as a challenge to taking classes outside. Creekside's OEA has seen the unfortunate effects of a lack of a long-term management plan. However, with a management plan to guide into the future, the OEA can be maintained as a viable resource.

Figure 4.5: Greenhills students participating in a stream monitoring activity. (Photo by Ann M. Novak)

4.2. Research Methods

The Mill Creek Park Recreation Master Plan identifies the OEA as an important resource that must be included in plans for the health of Mill Creek as a multi-functional landscape. To address the needs of teachers and students using the OEA, our team first gathered broad information about Creekside Intermediate School and the OEA, then

narrowed the scope of our inquiry to arrive at the specific products useful and relevant to the school and its students.

4.2.1. Site Visits

To gain and understanding of the OEA, its current state, accessibility, and the resources it contains, we conducted several OEA site visits. These visits were crucial for our team becoming fully knowledgeable of the OEA. Information was collected during different seasons, providing information on the state of the area during various times of year. To ascertain the composition and overall health of the area, our team collected data on both the plant and animal species. We assessed the condition of the boardwalks and trail to determine the accessibility and usability of the OEA in its current state and what measures would be necessary to create a safe and usable space for both teachers and students.

Our team also visited Greenhills School in Ann Arbor, Michigan, to learn about its successful science program based on an on-site natural area. Though the school is private, Greenhills is quite similar to Creekside in its physical layout. Like Creekside, Greenhills has a wooded area with a creek flowing through it—enough area for a trail loop and a few bridges to avoid wet spots. Ann Novak, the seventh-grade science coordinator at Greenhills, led us on a tour of the area and shared course materials with us.

4.2.3. Meetings with Teachers and Administration

To create a useful educational product, it is important to have an understanding of the target audience, what they already know, and their interests (Jacobson, 1999). Involving various parties in the process helps give everyone a stake in both the process and the outcome. Accordingly, we made it a priority to involve key stakeholders in our efforts to gather knowledge that would help develop new resources and recommendations for using the OEA. Not only was knowledge of the physical space imperative, but so was a knowledge of the people involved and their needs. To make a product useful, it is important to have an understanding of the target audience, what they already know, and their interests (Jacobson, 1999). These stakeholders included Dexter Community Schools Superintendent Rob Glass,

curriculum consultants Linda Kuzon and Sarah Dansky, interested teachers and staff from both Creekside Intermediate and Mill Creek Middle Schools, and an afterschool childcare coordinator. These meetings proved invaluable in assessing each party's interests, needs, and goals.

The aforementioned stakeholders were involved at several stages in the process. We held an initial meeting with the superintendent, assistant superintendent, and interested teachers, with the goal of gauging their overall interest in maintaining the OEA and using it for classroom instruction, as well as the feasibility of doing so. Sessions with curriculum consultants helped further define the specific needs of the school. Teachers and other interested staff at Creekside and Mill Creek Middle School were invited to identify specific products and recommendations that could be easily implemented and valuable to both the teachers and their students. Subsequent meetings served to solicit critiques of the draft OEA Guide and further mold our products to the needs of teachers and staff.

4.2.4. Teacher Survey

Our team created an e-mail survey (Appendix N) and distributed it to teachers at Creekside in order to assess how much and how they use the OEA. The survey also served as a tool to assess how interested teachers were in using the area in the future, and for what purposes they might want to do so. Another goal was to ascertain what barriers, if any, might be preventing teachers from taking students to the OEA for classroom instruction or other purposes.

4.2.5. OEA Guide

We explored different models for a guide to the OEA that could be effective without adding too much to the curricular activities the teachers were already using and thus considered extension activities from Projects Wet, Wild, and Learning Tree, conservation and environmental education programs for kindergarten through high school students. Students needed to find the materials visually interesting, engaging, and interactive. With this purpose in mind, we consulted the Coloring Book series from Harper Perennial. Another goal

was to give the students the ability to identify plants with the guide, but not overload them with a detailed list of every species. Thus, we looked through existing identification guides for facts and used the Michigan Floristic Quality Assessment to determine the most important species in the OEA (Herman, et al., 2001; Barnes and Wagner, 2004; Sibley, 2009). We also considered various materials from the field monitoring science unit at Greenhills School in Ann Arbor.

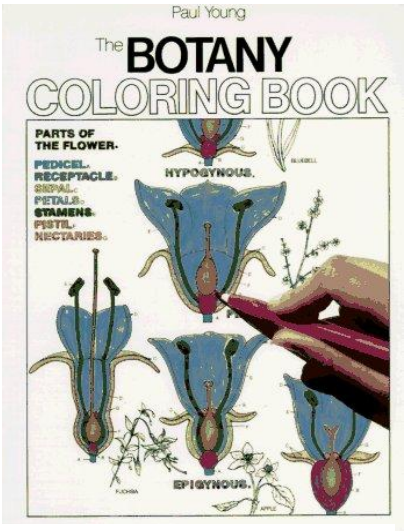


Figure 4.6: The Botany Coloring Book by Harper Perennial served as an example for the OEA Guide. (Image by Harper Perennial)

4.3. Results

4.3.1. Site Visits

Seasonal site visits provided information about the various flora and fauna present in the OEA. Many of the boardwalks and trails are in disrepair. Boards were found to be missing from the bridges. Passage along the trail is somewhat impeded in some locations. This may make it difficult for teachers to take students along the trail. It was also observed that the OEA is prone to flooding at certain times of year. In particular, some of the lower lying areas closer to Mill Creek are wet from flooding in the spring (see Ch. 3 for more in-depth results).

Figure 4.7: Greenhills students helping to place woodchips on trails. (Photo by Ann M. Novak)

Greenhills School in Ann Arbor can serve as a model for Creekside Intermediate because of 1) its exemplary use of an on-site natural area as an outdoor classroom and 2) its success in student, parent, and community volunteers to maintain trails and bridges

and manage invasive species. The Greenhills program makes use of hands-on observation and testing of a small creek quite close to the school building, with a small boardwalk structure that makes testing less muddy, as well as simple yet effective learning activities. Students carry out these activities during every trip to the creek, and record them in handouts that they bind together in a creek-related science portfolio.

The involvement of parents as volunteers is an important factor in the program's success. Parents serve as chaperones to aid the teacher in monitoring students spread out along a creek. The availability of volunteers allows for the division of work between teams: for example, a trail team that works with the donated woodchips and a bridge team that works with donated lumber. At the school's opening day each fall, a majority of the work is done by one-time volunteers and follow-up work is completed by committed task forces. The day's events include student-led tours of the trails and the creek and opportunities for teachers to speak on the benefits of the program.

4.3.2. Meetings with Teachers and Administration

Our meetings with teachers and administrators proved to be very fruitful. In initial meetings, the superintendent and curriculum coordinators confirmed that they were very interested in revitalizing the OEA for use in instruction. Further meetings enabled us to understand the specific needs of Creekside teachers and students. Given the recent integration of the Battle Creek Curriculum into science classes, teachers said that they did not need additional curricular materials. However, teachers did express a need for a teaching tool to help them identify and take advantage of the resources offered by the OEA.

4.3.3. Teacher Survey

The email survey distributed to Creekside teachers proved to be a useful tool (Appendix N). The survey results provided a very useful overview of the OEA's current use, potential future use, and the barriers that teachers saw to using the OEA more extensively. In fact, 71.4 percent of responding teachers said they do not currently use the OEA in any capacity, and even those who do use it do so rarely (Figure 4.8). However, 84.6 percent of

teachers showed interest in using the OEA for future class lessons and activities (Figure 4.9). The majority of respondents teach science, but there were also a number of them who teach social studies, math, language arts, and after school programs. Of the teachers who responded to the survey, 55.6 percent also expressed interest in using the OEA for capstone projects and environmental stewardship activities, such as invasive species removal (Figure 4.9).

Teachers tagged only a few issues as challenges in using the OEA. A majority (64.3 percent) said that the presence of poison ivy was very problematic; a majority also said a lack of knowledge of the OEA's features impeded them from using the area for instruction (Figure 4.10). Otherwise, it seems that teachers are open to and enthusiastic about using the OEA.

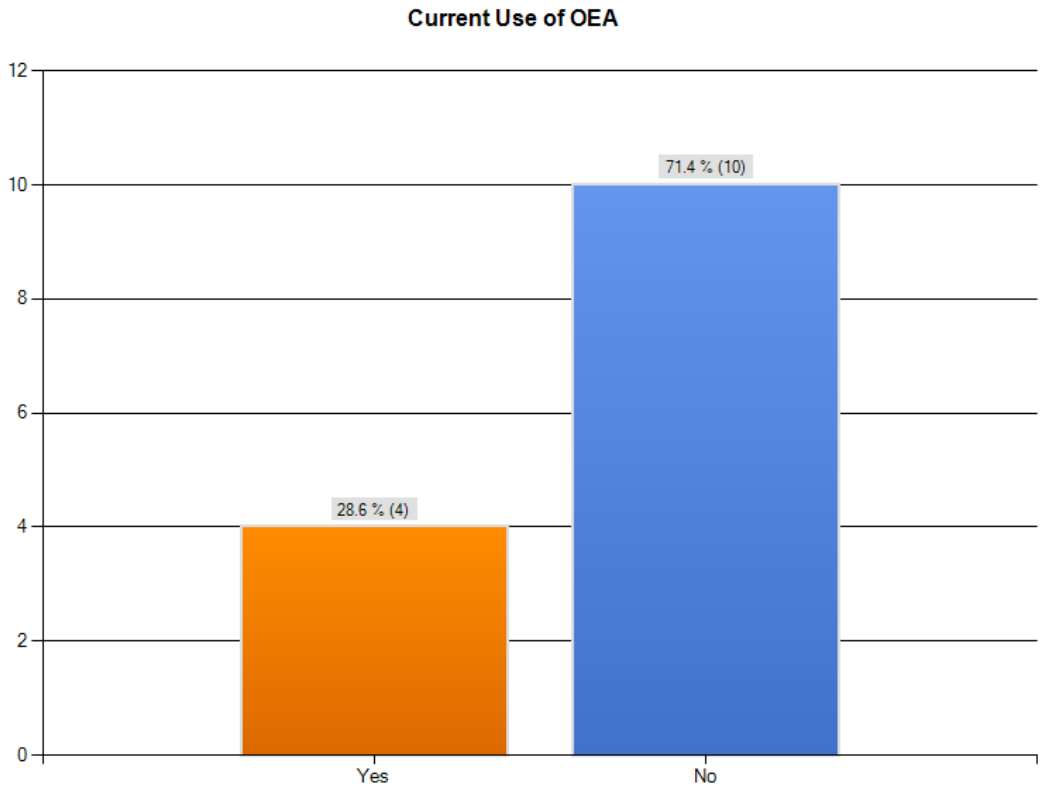


Figure 4.8: Teacher responses regarding current use of the OEA

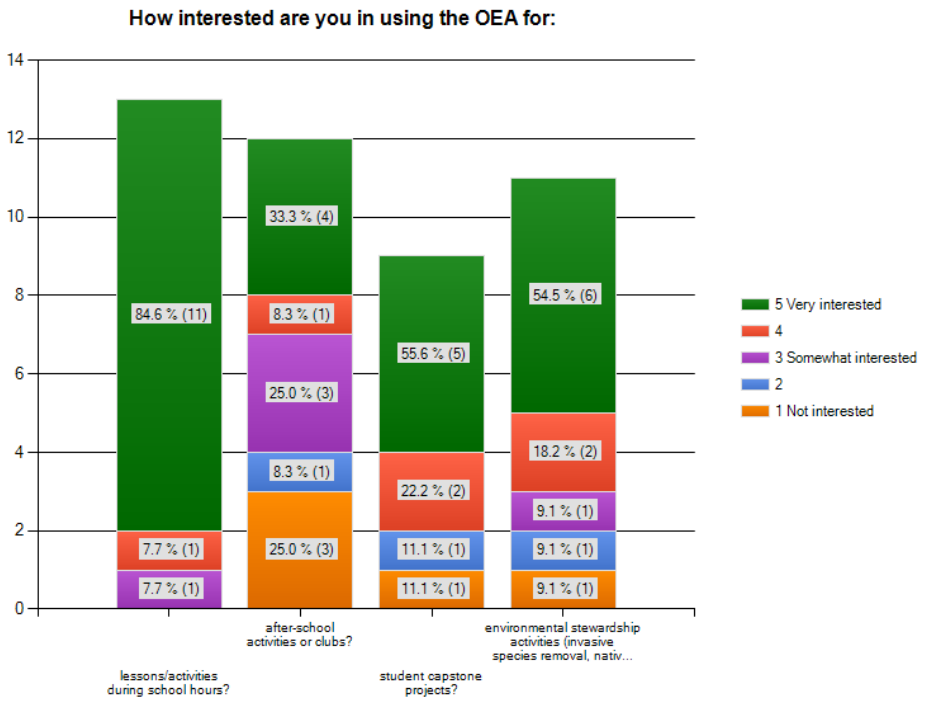


Figure 4.9: Teacher interest in using the OEA

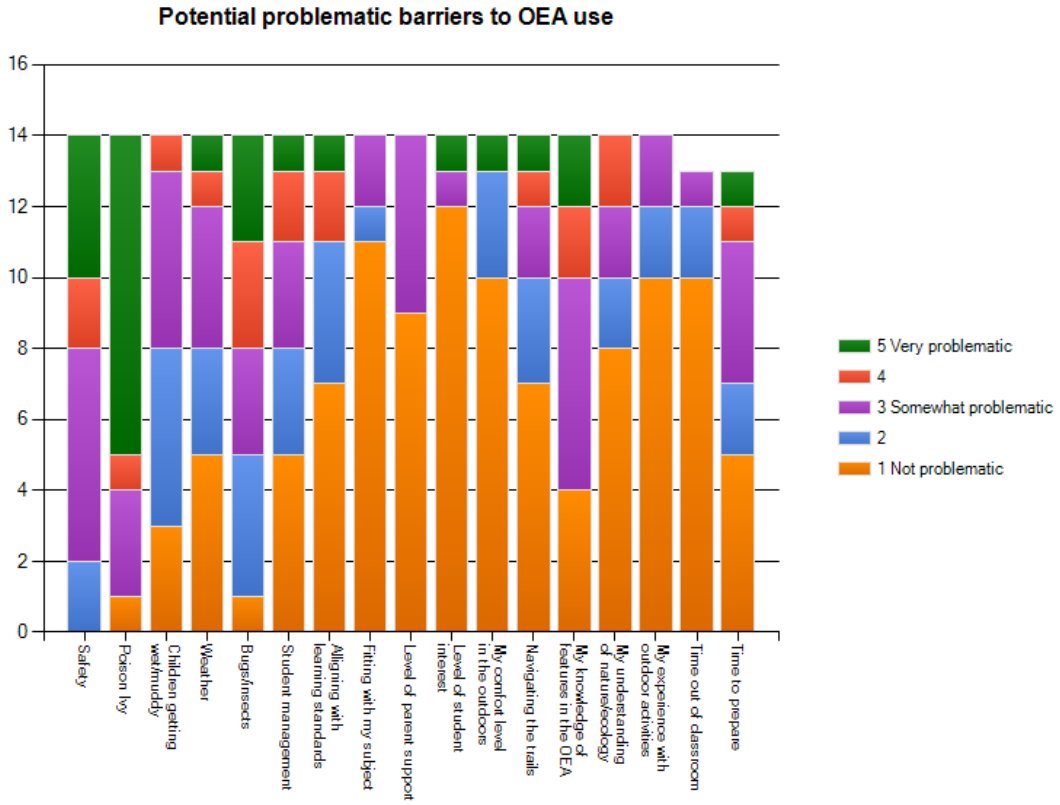


Figure 4.10: Potential barriers to using the OEA

4.3.4. OEA Guide

The Coloring Books Series by publisher Prentice Hall served as a model for making a guide to the OEA. In this series, students color-code parts of the plants, animals, or maps they are studying to match the color of the relevant vocabulary. In the Geography Coloring Book, for example, students color the name of a country green, then also color the boundaries of that country green on a map; in the Botany Coloring Book, students color the name of a flower partly yellow and then color the actual image of that flower partly yellow. This method is good for reinforcement and gives students three modalities or intelligences in which to learn the subject matter: verbal, visual or spatial, and kinesthetic. The text is read and traced, the natural subjects are observed or created, and there is the actual act of moving one's pencil on the page. These successful methods informed and influenced our development of a similar product tailored to the OEA.

4.4. Recommendations

A strong tie has been demonstrated between teachers' confidence and the frequency with which outdoor learning is used as part of the curriculum (Meichtry & Smith, 2007; Gruver & Luloff, 2008). Teachers who are more confident in using the outdoors for education will be more likely to integrate it into their existing schedule and lessons. As teachers gain confidence, they can then serve as additional resources, providing knowledge and support to other teachers who would like to incorporate outdoor instruction into their schedules (Burke, Greenglass, & Schwarzer, 1996). An accessible guide to the OEA will help teachers familiarize themselves with the ecology of the area and its educational uses, and will help them become more confidence in their ability to use the OEA effectively. As a result, teachers will be more likely to take students outdoors for classroom instruction.

The OEA Guide is designed to be flexible enough to be used in a variety of ways, depending on teachers' needs. The Guide includes a short summary of ecological issues in the OEA and Mill Creek Park area, some ideas for using the OEA in teaching, a list of plant and animal species in the OEA, and many pages devoted to individual plant species. The

Tips for taking classes to the OEA

1. Plan ahead. You may want to make the OEA the centerpiece of an extensive unit. Starting weeks or months in advance allows for this.

2. Become oriented to the OEA. Visit in advance to identify hazards, discuss accommodations for students with disabilities, and decide if/how many parents or volunteers will be needed.

3. Provide enough stations to keep groups small so every student has a chance to see, hear, and do.

4. Establish ground rules prior to leaving the classroom and adapt classroom discipline to the outdoor environment.

5. Stick to simple activities at first. Start small and build as both you and the students become more familiar with the OEA.

6. Show more than tell. Students will be eager to experience the OEA and the outdoor setting lends itself to hands-on inquiry learning.

7. Provide supplemental materials. Take advantage of the OEA maps and species list and individual pages provided in the OEA Guide.

8. Evaluate. Examine the entire experience--activities, logistics, handouts, timing, staffing--for what worked well and what needs changing.

Tips adapted from Field Trips: The Good, Bad and Ugly; A Recipe for Outdoor Classroom Management; and More Than a Fish Planting- Making the Most of the Streamside Experience

individual species pages are the heart of the Guide, and can be used to identify species in the field as well as to help students continue learning in the classroom by color-coding the vocabulary and images on each page. Students can also cross-list information in the "Plants of the OEA" section with images that they color on the individual species pages; for example, they learn from the table that the Sugar Maple has a high tolerance for shade, and then use this information to color in the "sunlight needs" as low on the individual plant page. (See Table 4.1 for Plants of the OEA, Figure 4.11 for example individual species page, and Appendix O for complete OEA Guide)

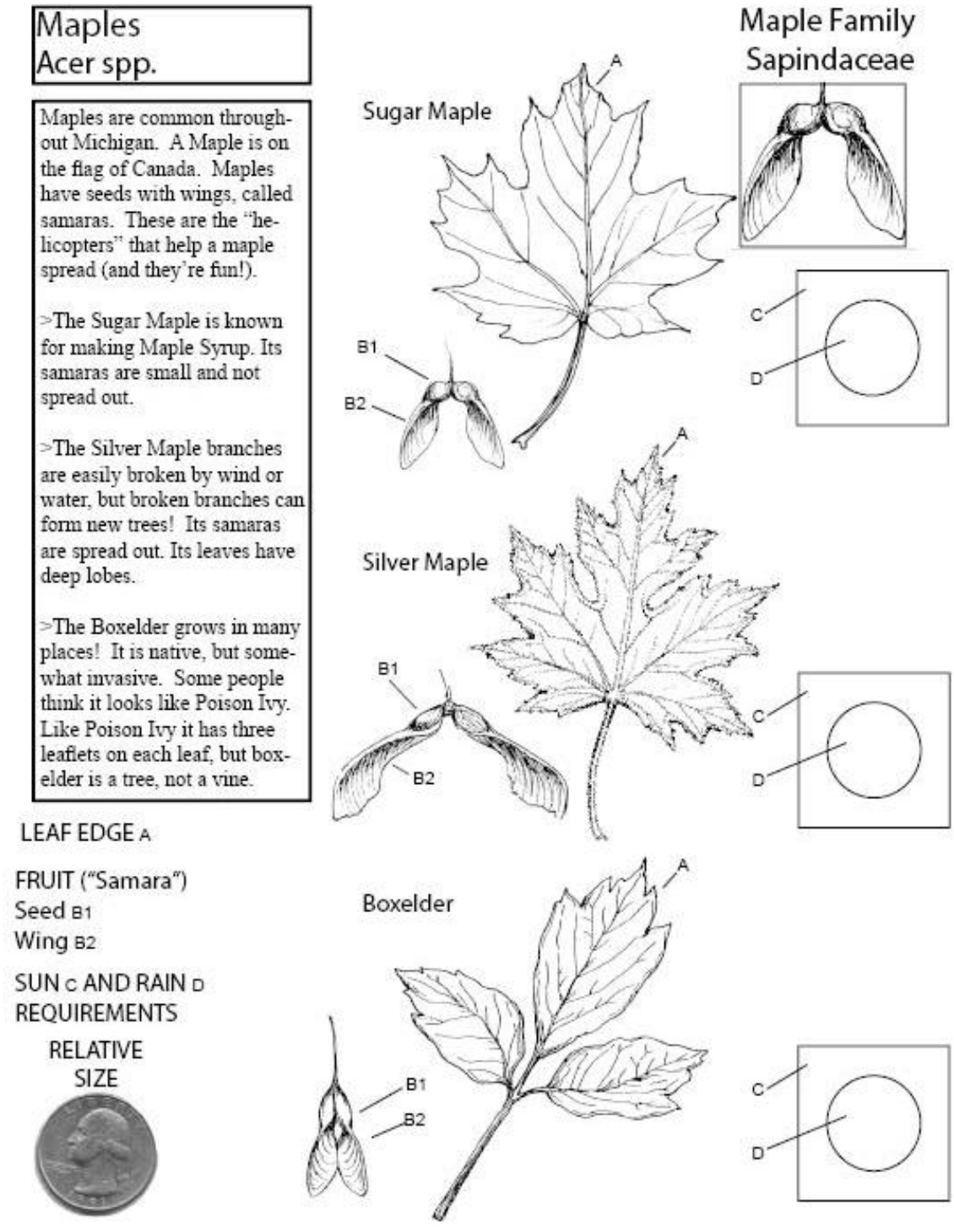


Figure 4.11: This page can be used in the field or the classroom for identification or retaining knowledge gained in the field

Table 4.1: Plants of the Outdoor Education Area

Latin names	Common Names	Woody/ Herbaceous	Native/ Nuisance	Conservation Importance (0-10)	Hydrology	Shade Tolerance
Alliaria petiolata	Garlic Mustard	Herbaceous	Nuisance1	0	Mesic	High
Lythrum salicaria	Purple Loosestrife	Herbaceous	Nuisance1	0	Wetland	Low
Phalaris arundunacea	Reed Canary Grass	Herbaceous	Nuisance1	0	Wet Mesic	Low
Hesperis matronalis	Dames Rocket	Herbaceous	Nuisance2	0	Upland	High
Delphinium elatum	Larkspur	Herbaceous	Nuisance2	0	Upland	High
Lysimachia nummularia	Moneywort	Herbaceous	Nuisance2	0	Wet Mesic	High
Phragmites australis	Phragmites	Herbaceous	Nuisance2	0	Wet Mesic	Low
Elaeagnus umbellata	Autumn-olive	Woody	Nuisance1	0	Dry Mesic	Med
Berberis thunbergii	Barberry (Japanese)	Woody	Nuisance1	0	Dry Mesic	High
Rhamnus cathartica	Buckthorn (Common)	Woody	Nuisance1	0	Dry Mesic	High
Lonicera maackii	Honeysuckle (Maack's)	Woody	Nuisance1	0	Upland	High
Acer negundo	Boxelder	Woody	Nuisance2	0	Wet Mesic	Low
Prunus avium	Mazzard	Woody	Nuisance2	0	Upland	Med
Rosa multiflora	Multiflora Rose	Woody	Nuisance2	0	Dry Mesic	Med
Typha latifolia (e.g.)	Cattail	Herbaceous	Native	1	Wetland	Low
Ulmus americana	American Elm	Woody	Native	1	Wet Mesic	Med
Prunus serotina	Black Cherry	Woody	Native	2	Dry Mesic	Low
Acer saccharinum	Silver Maple	Woody	Native	2	Wet Mesic	Low
Toxicodendron radicans	Poison Ivy	Woody	Nuisance1	2	Mesic	Med
Zanthoxylum americanum	Prickly-ash	Woody	Native	3	Upland	High
Vitis riparia	Riverbank Grape	Woody	Native	3	Wet Mesic	Low
Viburnum lentago	Nannyberry	Woody	Native	4	Mesic	Low
Physocarpus opulifolius	Ninebark	Woody	Native	4	Wet Mesic	Low
Aster praealtus (e.g.)	Asters	Herbaceous	Native	5	Mesic	Low
Arisaema triphyllum	Jack-in-the-Pulpit	Herbaceous	Native	5	Wet Mesic	Med
Ranunculus hispidus	Swamp Buttercup	Herbaceous	Native	5	Mesic	Low
Parthenocissus quinquefolia	Virginia Creeper	Woody	Native	5	Mesic	Med
Asarum canadense	Wild Ginger	Herbaceous	Native	5	Upland	High
Anemone quinquefolia	Wood Anemone	Herbaceous	Native	5	Mesic	High
Ostrya virginiana	Hophornbeam	Woody	Native	5	Dry Mesic	High
Tilia americana	Basswood	Woody	Native	5	Dry Mesic	High
Crataegues spp.	Hawthorn	Woody	Nuisance2	5	Upland	Med
Viburnum trilobum	Highbush-cranberry	Woody	Native	5	Wet Mesic	Low
Quercus rubra	Red Oak	Woody	Native	5	Dry Mesic	Med
Carya ovata	Shagbark Hickory	Woody	Native	5	Dry Mesic	Med
Acer saccharum	Sugar Maple	Woody	Native	5	Dry Mesic	High

Quercus bicolor	Swamp White Oak	Woody	Native	5	Wet Mesic	Med
Fraxinus americana (e.g.)	White Ash (mostly dead)	Woody	Native	5	Dry Mesic	Low
Quercus alba	White Oak	Woody	Native	5	Dry Mesic	Med
Salix nigra (e.g.)	Willow	Woody	Native	5	Wetland	Med
Hamamelis virginiana	Witch-hazel	Woody	Native	5	Dry Mesic	High
Carpinus caroliniana	Musclewood	Woody	Native	6	Mesic	High
Cephalanthus occidentalis	Buttonbush	Woody	Native	7	Wetland	Low
Arisaema dracontium	Green Dragon	Herbaceous	Native	8	Wet Mesic	Med
Staphylea trifolia	Bladdernut	Woody	Native	9	Mesic	High

KEY
Hydrology: Wetland, Wet Mesic, Mesic, Dry Mesic, Upland = (-5), (-4 to -2), (-1 to 1), (2 to 4), (5). Based on the DNR Floristic Quality Assesment (FQA)
Conservation Importance: Invasive Plants = 0 (notice Poison Ivy, a "nuisance" plant, has more ecological importance than an invasive plant), Very important plants = greater than 5. A plant with a low score for the state may be locally more rare.
Native/Nuisance: In this table, "nuisance" plants are either 1) non-native and invasive (e.g. Japanese barberry), 2) native and invasive (e.g. Boxelder), or 3) toxic (e.g. Poison Ivy).
Shade Tolerance: "High" = can grow in dark forests, "Med" (Medium) = can grow in various light conditions, and "Low" = requires plentiful sunlight (fields/edges).

A management plan provides guidance to both the short-term and the long-term maintenance of the OEA (see recommendations in Chapter 3). This guide highlights areas that are of particular concern and corresponding methods to be employed to create a safe, comfortable, and usable space for teachers and students. Teachers will feel more comfortable and confident in taking their students into the OEA if they perceive it as safe and well maintained.

The OEA Guide should be evaluated every five years to ensure it remains useful and continues to accomplish its original goals. Any update or redesign of the Guide should be based on the following principles. The OEA should be assessed to determine if the Guide's listing of different species and their locations is still accurate. Even in the case of minor updates, it is essential to include teachers in the process, since they are not likely to use the Guide unless they see it as useful and relevant to their interests. First, teachers' needs may have changed, and if so, the Guide should be adapted to meet these needs. Second, teachers' interest in using the OEA may have expanded. The Guide is currently tailored to science teachers; yet teachers of other subjects may also be interested in using the OEA in the future, and the Guide should accommodate their specific needs as well. Regular evaluation and

adaptation, as needed, will ensure that the OEA Guide remains a viable resource for all who are interested in using it.

The OEA Guide and Management Plan are immediately available, and Creekside can implement them in the near term. In the future, the school can take additional steps to ensure that the OEA is used in an effective way. An outdoor teaching area should include staff mentoring and on-going professional development. "School ground projects… sometimes become plagued by a stop and go pattern of activity as children graduate and their parents volunteers naturally move on" (Evergreen, 2003). To avoid this problem, it would be ideal for the school to have a dedicated point person or small group of people to oversee the use and success of its outdoor teaching program. This person or group would take a variety of approaches to encourage and support teachers in using outdoor instruction: for example, workshops on using the area, supplementary curriculum materials, mentoring and support, and case studies of other schools with thriving outdoor education programs. This combination of strategies has been shown to lead to successful outdoor education programs (Monroe & Kaplan, 1988; Sobel, 2004; Woolf, 2006). Such strategies bolster teachers' feelings of efficacy in using outdoor education areas and, as confidence grows, so does the likelihood of integrating environmental and outdoor education into the classroom (Gruver & Luloff, 2008).

The presence of point person or core group of people is also crucial in order to keep the program alive. In the OEA's initial stages, Creekside had a dedicated teacher to organize the program and develop and serve as a resource to other teachers. After this teacher retired, however, no one took on responsibility for managing the area, and the OEA fell into disuse.

Professional development has also shown to be an important factor in increasing teachers' use of outdoor education areas. Professional development sessions are an effective tool for teaching teachers how to use the outdoors for instruction (Kenny, Militana, & Donohue, 2003). Teachers will then be more likely to integrate outdoor learning into their lessons throughout the year (Gruver & Luloff, 2008). There are several local groups that provide professional development workshops for teachers on these topics: notable examples include the DTE Freshwater Institute, the Great Lakes Stewardship Initiative (GLSI) Summer Institute, and the Michigan Association for Environmental and Outdoor Education (MAEOE) are some local groups that provide professional development workshops on these topics. (See

Appendix M.) Interested teachers at Dexter Community Schools should take advantage of these resources by attending one of many workshops provided by these organizations, which could provide additional valuable material on outdoor education and further increase the use of the OEA.

4.5. Suggested Timeline of OEA Recommendations

Year	Recommendation
Year 1	• Carry out ecological restoration recommendations detailed in Chapter 7: Outdoor Education Area Management Plan • Repair damaged bridges and boardwalks • Remove debris and other safety hazards • Use OEA Guide to educate both teachers and students about the species contained in the OEA and their importance to the ecosystem health of the area
Years 2-5	• Establish a OEA point person of small group of people to oversee maintenance and use of the OEA • Pursue professional development opportunities to obtain additional skills in using the OEA for classroom instruction
Year 5	• Continue OEA maintenance and monitoring • OEA point person or team evaluate the effectiveness of the current resources and adapt as necessary
Year 6 and beyond	• Continue OEA maintenance and monitoring • Continue to pursue professional development opportunities in outdoor education • Evaluate program every five years

Chapter 5: Interpretation

I'll interpret the rocks, learn the language of flood, storm and the avalanche. I'll acquaint myself with the glaciers and wild gardens, and get as near the heart of the world as I can
~ John Muir, *Yosemite Valley*

Mill Creek Park has the potential to serve both the ecological community and the human community. Interpretation can help serve both purposes. As visitors learn about the restoration work being conducted, they are more likely to support it, and may also become interested in doing their part to help support the landscape. Interpretive programs can benefit from volunteer efforts. For example, volunteers can place and maintain signs or lead guided tours. Interpretation also encourages volunteering by fostering excitement about the park and its unique features. Interpretive programming can complement other outdoor education efforts by targeting casual visitors and broadening the scope of the Park's education efforts. Interpretation provides a link between people and the landscape, helping them understand the natural environment and become better stewards of the land.

5.1. Interpretation: The Village's Need

Interpretive programs help enhance visitors' experiences in natural areas and parks. These programs help make the surrounding environment understandable to the visitors in a similar way that a translator might make a foreign language

Figure 5.1: Static signs are just one form of interpretive programming. (Photo by Judy Baxter, flickr.com)

understandable to a non-native speaker (Jacobson, 1999).

As established in the JJR & ECT Mill Creek Park Recreation Master Plan, community members and government officials in Dexter saw the opportunity to establish an interpretive program for the new Mill Creek Park. Such a program would inform visitors about a range of topics, including the history of the area; new management practices, such as stormwater treatment features and habitat restoration; the surrounding environment and ecosystems; and recreation opportunities in the area. While the park planning process provided some guidance for interpretive programming, it did not produce any specific plans.

Not all parks have interpretive programs, but these programs can provide many benefits such as garnering support for a cause or encouraging a particular type of behavior (Jacobson, 1999). The interpretation of management and restoration programs can help increase public support for these programs and inspire visitors to take on conservation activities of their own. As community members and visitors learn about the reasons for certain management practices, they are more likely to understand and approve of them (Jacobson, 1999). Interpretive programs with static materials, such as signs, can also serve as structural cues to show that the area is being monitored and maintained. They tell park visitors that, although certain areas may not be manicured, they are a purposeful natural landscape, and are managed as part of the park (Nassauer, 1988, 1995).

Case Study: Demonstration Sites

Haile Plantation is a wealthy suburban neighborhood near Gainesville, Florida. Many of the natural buffers in the neighborhood are most effectively managed with controlled burns.

Before implementing controlled burns throughout the community, the managers of Haile Plantation established demonstration burns in the neighborhood's golf course "out of play" areas. In addition, they created a variety of educational materials for the residents including a brochure, a poster, and interpretive signs placed at the burn sites.

Survey results from before and after the educational outreach and demonstration burns indicate that residents increased their knowledge about fire management as well as their acceptance of prescribed burns as a management practice for the neighborhood. For example, initial concerns about smoke from the burns were reduced and 84% of respondents indicated their approval of using prescribed burns for the management of other areas in the neighborhood.

Demonstration areas combined with other forms of interpretation are useful tools for gaining support from visitors and residents for certain management practices.

(*Monroe, Babb, & Heuberger, 2006)*

Interpretive programs can also meet educational goals—for instance, explaining the history of an area or indicating the significance of a particular object (Jacobson, 1999). Some studies have shown that visitors become frustrated when no interpretation is present – they want to feel that the site is providing a learning experience (Hughes & Morrison-Saunders, 2002). In addition, interpretive programming can attract new visitors and encourage repeat visits (Moscardo & Woods, 1998). Researchers and park managers alike recognize that both children and adults are important audiences for interpretive educational efforts. People of all ages want to know more about the environment and are interested in learning about places where they live and visit (Ben-Ari, 2000).

With many new possibilities for managing natural areas, serving the local community, and attracting visitors, Mill Creek Park will be a perfect location for interpretive programming.

5.2. Research Methods

Once members of an organization decide to implement an interpretive program, they must work through a number of different issues. It is extremely important to think through the entire process of interpretive programming before initiating it. The following guidelines for program managers, adapted from Monroe (2005), provide a useful guide for creating an interpretive program.

1. Assess the need for the program.
    - Consult stakeholders to determine your target audience and their level of knowledge.
    - Set appropriate bounds for the program according to your organization's time frame, financial resources, and human resources available for creation, or consultation and review, and future maintenance.
2. Design the interpretive program.
    - Create objectives that address what you want your audience to learn.
    - Design the program using best practices for communication, given your determined mode of communication and resources.

- Create draft materials and plans for implementation: for example, where interpretive signs will go, how volunteers will be trained, and how the program will be assessed.

3. Pilot-test the program.
    - Check all materials for accuracy, using experts if necessary.
    - Test the program with the audience to gain feedback on appropriateness and interestingness.
    - Revise and retest materials.
4. Produce materials and implement the program.
5. Evaluate the program.
    - Use your previously devised evaluation plan to determine if the program is meeting its original objectives.
    - Some evaluations may require pre-implementation data collection to allow for the measurement of subsequent changes.
    - Use any results to improve the program and document its successes.

We have attempted to follow the guidelines above in formulating our own recommendations for Mill Creek Park's interpretive program.

5.2.1. Stakeholder Consultation

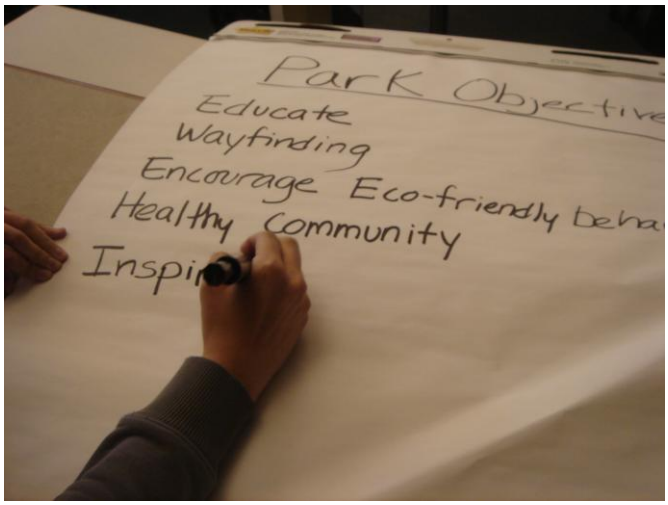


Figure 5.2: Community members at the Interpretation Visioning Session provided a wide variety of ideas. (Photo by Katherine Hollins)

During these stages, it is important to involve community members and stakeholders to give them greater ownership of the plans. If this is done, they will be better able to support the organization implementing its program, while providing a greater source of creativity and pool of ideas for problem solving (DeYoung, 2009). Because they are able to contribute to the end product, they are more likely to be

committed to its success, and are less likely to oppose it (Wondolleck & Yaffee, 2000); the final products are thus much more likely to be effective, reducing wasted time and energy. In general, the involvement of stakeholders helps organizations target their program more precisely and reduce the need to overhaul programs after they are created because they prove to be ineffective or unpopular (Michigan Department of Natural Resources Grants Management, 2006).

Involving stakeholders does not simply mean inviting the public to a presentation of products that have already been designed. Rather, stakeholders should have a say throughout the entire process, from pre-planning to implementation and evaluation (Jacobson, McDuff & Monroe, 2006). They must be provided with appropriate background information about the topic, situation, or project so they can contribute effectively. In addition, providing participants with guidelines and rough examples to manipulate can foster more effective participation than asking them to initiate ideas from scratch (DeYoung, 2009). Finally, participants should be told how their contributions will influence the final product or decision (Bechtel & Churchman, 2002).

Our team strove to encourage public participation from the outset, holding an Interpretation Visioning Session at the Dexter District Library on July 29, 2009. The session was open to the public, but a few stakeholders were personally invited by e-mail or telephone. We selected these individuals based on their previous work with the Mill Creek Park Planning Commission or their connection to educational institutions (Dexter Community Schools and the Dexter Historical Society), as well as recommendations by community leaders.

A key goal was to provide attendees with enough background knowledge about interpretation to participate effectively. Accordingly, the session began with a brief

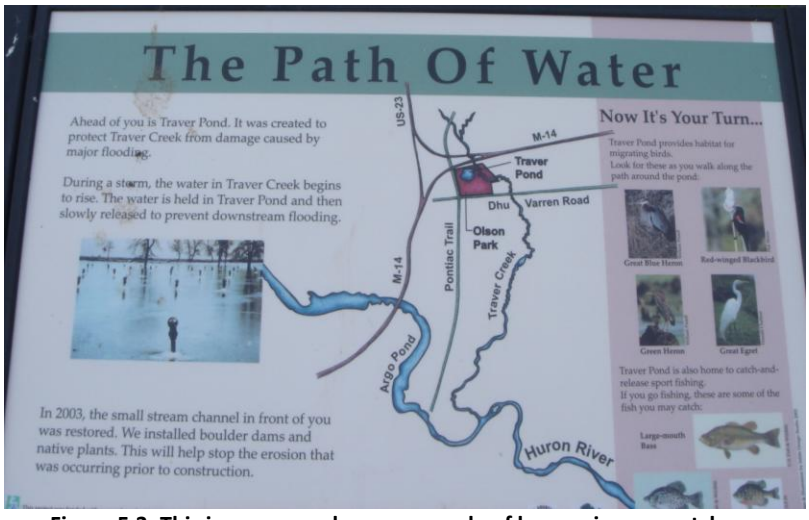


Figure 5.3: This image served as an example of how a sign can catch visitors' attention with an illustrative diagram and connected images. (Sign by City of Ann Arbor Parks and Recreation, photo by Katherine Hollins)

presentation about interpretation, providing examples and discussing the purposes of interpretation, different types of interpretation, and various best practices for developing interpretive programs (See Appendix P).

The initial contributions of the broader community provided an excellent source of information and an invaluable starting point for our planning. It would have been ideal to have broad, sustained public participation throughout the process; however, our project's limited timeline would have created a burdensome commitment for participating community members. Thus, after the initial Visioning Session, we mainly worked with the Village of Dexter Parks and Recreation Commission (PaRC). As a result, the more informational, consultative format of the Visioning Session gave way to a partnership with a smaller team. During monthly meetings with the PaRC, we presented information and options and solicited their ideas and suggestions and were able to make steady progress towards an interpretive program well suited to the community's needs.

5.2.2. Assessing the Audience

As established in the steps above, effective interpretive programming requires planners to identify a target audience and assess their needs. In this way, the program can engage their interests and reach out to them in a way that considers their initial level of understanding (Monroe, 2005; Ben-Ari, 2000). From there, the creators must settle on the objectives of the interpretive program. Such objectives can range from entertaining and educating to changing people's behavior or advocating for a particular cause (Jacobson, 1999; Monroe, 2005).

Involving community members in the initial stages allowed us to identify potential target audiences, make an informed assessment of their current knowledge and needs, and establish possible objectives for the interpretation program. Further discussions with the PaRC helped us narrow the objectives and establish the scope for the interpretive program in its current phase.

5.2.3. Creating a Program

Figure 5.4: A site visit to nearby Olson Park provided excellent examples of interpretive signs. (Photo by Katherine Hollins)

In creating interpretive materials and programs on environmental subjects, it is important for the interpreters to collaborate with research biologists, field scientists, and other experts. In this way, the interpretation accurately reflects the resource management, the scientists can help improve the materials and verify their accuracy, and the information is presented in an accessible way for the target audience (Ben-Ari, 2000).

Fortunately, our team members have a diverse variety of experiences and expertise, with backgrounds in biology and ecology, environmental engineering, geographic information systems, and environmental education. We worked together to establish products that were scientifically correct, interesting, and easy for park visitors to understand. When topics were beyond our purview, we contacted outside experts in the relevant field. For example, Nancy Van Blaricum from the Dexter Area Museum reviewed the historical aspects of our signs, and Barry Lonik, a local paddling expert, provided information for our Mill Creek recreation sign. Maintaining contact with the PaRC ensured that the content suited the community's needs.

5.3. Results

By establishing clear objectives, using collaborative means and empirical models to create the content, and actively using input from stakeholders, our team was able to begin creating an effective interpretive program for Mill Creek Park.

5.3.1. Stakeholder Consultation for Audience Assessment and Objective Definition

As a result of the Interpretation Visioning Session, we were able to compile a collection of ideas for the future interpretive program at Mill Creek Park. Attendees included community members, members of the Village Council, and staff from Dexter Community Schools, the Dexter municipal government, JJR, and ECT. In addition to establishing their own objectives, attendees identified potential target audiences and their possible reasons for visiting Mill Creek Park. They also discussed a number of options for presenting interpretive programs, including a variety of sign styles, guided walks, and audio tours. Then the attendees proposed a range of possible themes as well as specific topics for individual aspects of the program. A detailed summary of the information gathered at the Interpretation Visioning Session can be found in Appendix Q.

In the next stage, the PaRC took the information gathered at this session and narrowed the scope of what was to become the present interpretive program. Based on input from the Visioning Session and the PaRC's current resources, they decided that, at present, a series of static signs was the most appropriate path. The signs would be primarily educational and focus around the themes of history, ecology, and recreation. Each theme was assigned a color to differentiate the signs while maintaining continuity: brown for history, green for ecology, and blue for recreation.

5.3.2. Creating a Program: Best Practices

With these considerations in mind, our team researched best practices for interpretive signage, including font sizes, color usage, format, locations, materials, and suppliers. Many of the guidelines we devised are intended to make static interpretive signs accessible to a wide variety of users, with varying needs and abilities.

5.3.3. Content Writing

Content should be written at a fifth to eighth grade reading level and should be accessible to people who have difficulty reading English (Jacobson, 1999; Smithsonian

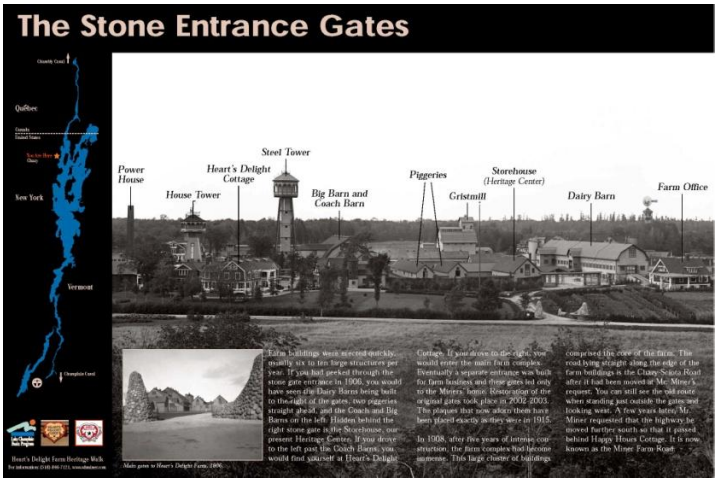


Figure 5.5: This sign uses photographs and labels to aid readers in understanding the text (Sign by Lake Champlain Basin Program).

Accessibility Program). The Flesch-Kincaid test is a simple way to measure readability based on number of words, sentences, and syllables. Programs such as Microsoft Word will automatically calculate the Flesch-Kincaid reading level after checking spelling if the user selects "Show readability statistics" in the Word Options: Proofing dialogue box.

To maintain an appropriate reading level and aid in understanding, the information presented should adhere to the following guidelines for effective communication and learning (Monroe, 2005; DeYoung, 2009; Smithsonian Accessibility Program):

- Include no more than 3 to 7 items.
- Avoid or explain jargon or complex technical language.
- Use complementary images and diagrams to aid readers' understanding.
- Use the active voice when writing.
- Ensure that the writing flows clearly throughout the text.
- Group similar items together.
- Link information to what the audience already knows.
- Limit sentences to 25 words or fewer.
- Limit lines to 55 characters or fewer.
- Avoid hyphenating words at the end of lines.

Of course, effective interpretive signs should go beyond simply being readable and easy to understand. The following are several useful suggestions to consider (Tilden, 1957; National Park Service, 1999; Ben-Ari, 2000; U.S. Forest Service)

- Use content to illustrate information and relationships, rather than just listing facts.

- Use titles and images to catch the attention of the reader.
- Establish a main idea that readers can easily remember for each sign.
- Engage the readers by asking them to do an activity or think about a topic.
- Satisfy a variety of audience interests by connecting ecology and natural history to health, water quality, or other themes.
- Focus on the features the signs are meant to interpret, rather than on the signs themselves.

5.3.4. Text and Legibility

In addition, the text itself must be readable. Pure white should generally be avoided as a background color, as it often creates a glare that makes reading more difficult. However, interpreters should use caution when text overlays images and they should ensure that background colors contrast with the typeface between 75 and 95 percent. One way to test for contrast is to photocopy the desired text-background combination in black and white, then check to see if the text is readable. This will ensure the text is suitable for individuals with poor vision, and will remain readable even with a glare (Harpers Ferry Center Accessibility Committee, 2009).

For consistency and readability, standard fonts should be used throughout (Smithsonian Accessibility Program):

- Use either a san-serif or a simple serif font.
- Use fonts with both upper and lower-case letters.

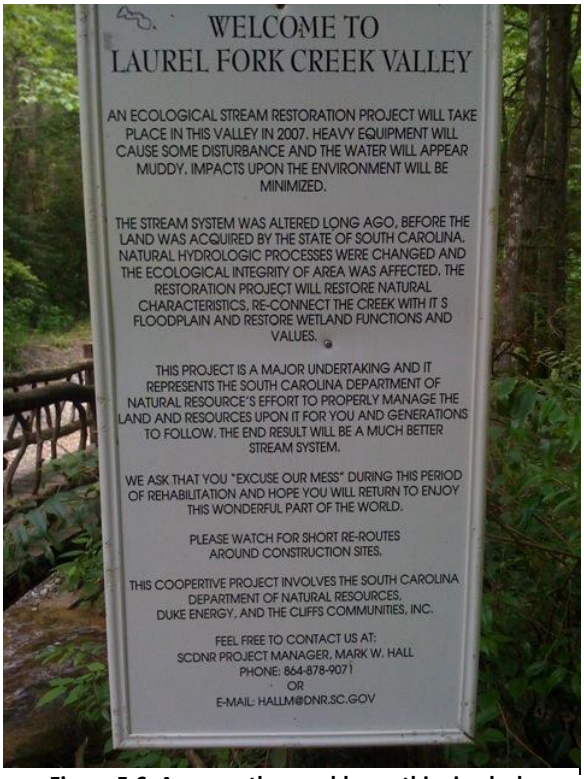
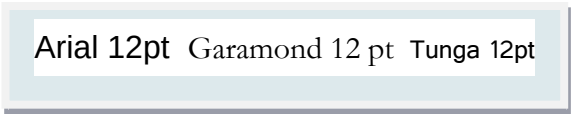


Figure 5.6: Among other problems, this sign lacks images or diagrams to aid in understanding or attract viewer attention and does not divide the text with section subtitles (Photo by R. Martin).

- Use bold and italicized writing sparingly and only for emphasis.
- Do not use stretched or condensed fonts.



In choosing font sizes, sign creators should consider which font is being used, how far away viewers are expected to be from the signs, and which audiences are being targeted. Varying fonts may have different print sizes even if they have the same point size. Table 5.1 indicates the *minimum* recommendations, based on various viewing distances, for font size in outdoor interpretive signs if they are to be accessible to viewers with low vision. In general, font size should be doubled with each additional three feet of viewing distance. In estimating distance, sign creators should be sure to consider the effects of crowding on actual viewing distance. Reprinting signs or other interpretive materials in Braille is one way to increase accessibility; however, fewer than 10 percent of individuals with vision impairments read Braille. Large print or audio versions are often better options for this reason. In addition, many publications can be stored online and made available to electronic readers.

Table 5.1: Font size recommendations (U.S. Forest Service Region 2, 2007)

Text Category	Minimum size (pt.)	Size doubled for ≥1m viewing	Size used in draft signs (Adobe Garamond Pro)	
			18x24”	24x36”
Captions	24	48	27	30
body text	36	72	40-41	50
Subtitles	40-48	80-94	50 (bold)	56 (bold)
Titles	60-72	120-144	108	103-115

Just as text must be legible for various types of users, images and diagrams should be legible to users with varying levels of vision. This is especially important for technical drawings created to aid visitors’ understanding or maps intended to help them find their way in the park. Vischeck (www.vischeck.com) allows the simulation of colorblind vision of images in order to ensure legibility. In the comparison below, for example, the diagrams remain legible even though the colors look different.

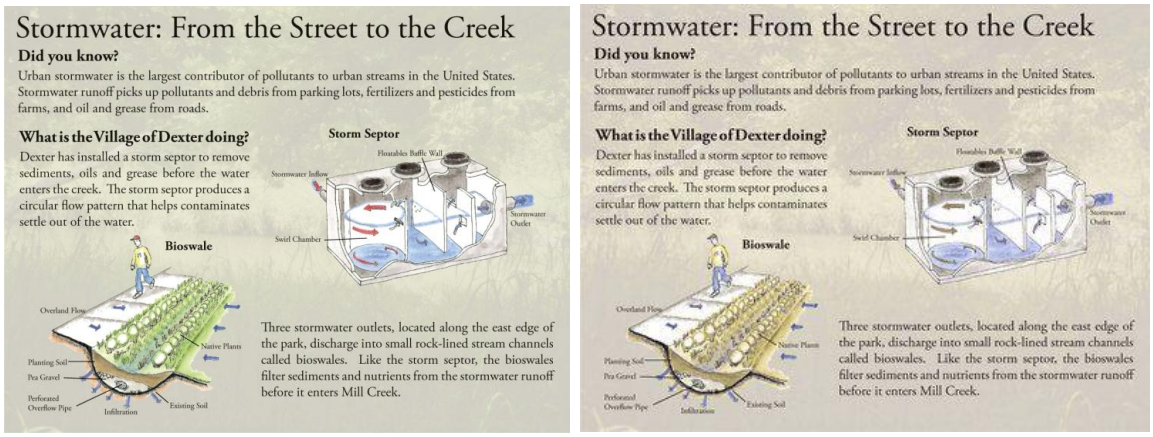


Figure 5.7: Original sign (left) and a simulation of what the sign would look like to a person with red-green color deficit vision. (Images by Katherine Hollins and Vischeck)

5.3.5. Installation

When installing signs, the audience must be considered. In particular, there should be a balance between the needs of wheelchair users and those of visitors with poor vision. In general, the bottom edge should be approximately 32 inches from the ground for angled signs and between 24 and 36 inches for upright signs. Signs angled toward the visitors at 30-45 degrees are accessible for the widest range of viewers (U.S. Forest Service Region 2, 2007; Harpers Ferry Center Accessibility Committee, 2009).

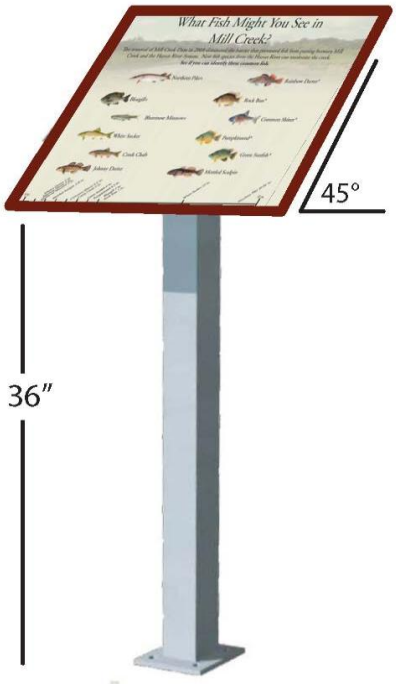


Figure 5.8: Signs should be angled at approximately 45° with the bottom edge approximately 36 inches above ground level.

5.3.6. Location

An interpretive sign's location can either enhance or diminish its effectiveness. Signs should be placed where there is enough visitor traffic to warrant them. It is equally important to place signs near enough to interpreted features for visitors to associate the signs with the features, but not so close that the signs obstruct visitors' view of the features. To increase accessibility, signs should be placed near

sidewalks, parking areas, or ADA-accessible trails. Safe, hard surfaces should be maintained in front of signs to ensure comfortable reading by visitors (Harpers Ferry Center Accessibility Committee, 2009). While each park will have a unique set of opportunities for interpretation, the U.S. National Park Service recommends the following list for consideration (Harpers Ferry Center Accessibility Committee, 2009):

- active management or restoration areas
- scenic views
- recreation facilities
- unique natural features
- unique historical or cultural sites

In addition, planners must take care to avoid creating a "sign garden" or contributing to the "museumification" of the natural environment (Gobster, 2007). Too many signs, especially in a small area, focus a disproportionate amount of attention on the signs rather than the natural features, and can discourage human interaction with the environment. This may be appropriate for some locations, such as a botanical garden where visitors go to learn about the individual plants, or sensitive areas that could be degraded by too much human activity. However, the interpretive programming should support the park's goals. As information about the benefits of interacting with the natural environment increases and people's contact with nature decreases, for adults and children alike, interpretive planners must consider what purposes the park is intended to serve (Gobster, 2007). They may decide to interpret only certain sections of the park or interpret them in ways that encourage interaction with the environment. For example, a sign may encourage viewers to touch a plant or look for signs of specific animals living in the area.

5.3.7. Wayfinding

Once trails are established in the park, wayfinding signs with a map of the park are necessary to orient visitors. Such signs should be placed at trail heads and access areas, and should include accessibility information for those trails (Harpers Ferry Center Accessibility

Committee, 2009). Maps are traditionally oriented with directional north at the top of the page or sign. Yet current research suggests that wayfinding maps with a "heads up" or "forward up" orientation are easier to understand and allow for easier navigation. When the forward direction lies at the top of the map, readers do not have to rotate the map mentally in order to determine their location or the direction they want to travel (Seager & Stanton Fraser, 2007; Porathe, 2008).

5.4. Recommendations

Based on best practices, guidance from the Interpretation Visioning Session, and work with the PaRC, our team developed a series of six potential interpretive signs for Mill Creek Park. The sign titles, themes, and topics are listed in Table 5.2 below. The Village should continue the process of developing these draft signs by following the process outlined in this section. Starting on a small scale will allow for greater flexibility and make changes easier when necessary.

Table 5.2: Potential signs created for Mill Creek Park

#	Sign Title	Theme	Topic Addressed
1	History of Mill Creek Dam	history	Background information on Mill Creek Dam
2	Mill Creek: A Water Trail	recreation	Information about paddling along Mill Creek
3	Welcome to Mill Creek Park: Dexter's Waterfront Destination	history	The community process of removing Mill Creek Dam, plus other Dexter information
4	Stormwater: From the Street to the Creek	ecology	Stormwater management
5	A little Space Keeps Mill Creek Safe	ecology	Riparian buffers
6	What Fish Might You See in Mill Creek?	ecology	Fish likely to be found in Mill Creek

5.4.1. Stage 1: Finalize Content and Plans

1.a Complete Draft Materials

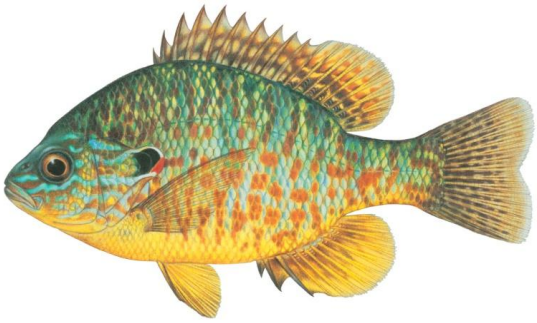
The next step for implementing this program is to finalize the content. After reviewing each of the signs, planners must choose one supplier of fish images for the fish sign (6). Table 5.3 below outlines three image sources and their associated information. The sample images following the table have symbols corresponding to the names listed in the table, as well as the images used in the draft sign.

Table 5.3: Mill Creek fish image options

Artist/Photo Source (symbols correspond with images)	Price (number available)		Contact Information	Type of Image	Use Terms	Misc.
	New	Existing°				
^ Joe Tomelleri: American Fishes	N/A	$175 (12)	Joe Tomelleri www.americanfishes.com joe@americanfishes.com	Illustration	• For single sign use only. • Discounted pricing for future uses may be available.	Referred by Michigan DNRE
*** Emily Damstra: Michigan Science Art**	$350 (1)	$100 (11)	Emily Damstra esdamstra@umich.edu	Illustration	• For single sign use only. • Other uses must obtain further permissions.	Freelance with Michigan Science Art
+ Michigan Sea Grant	N/A	Free with photo credit	Todd Marsee marsee@umich.edu	Photo	• May use multiple times with photo credit.	Photos require editing (removal of background)

° Existing availability numbers are based on the most recent list of fish to be used in the sign

^Green Sunfish



^Pumpkinseed

*Common Shiner

*Mottled Sculpin

+Common Shiner

+Blue Gill

1.b Complete plans for implementation

1.b.i Determine sign location

Once the content is finalized, the PaRC should decide where to place the signs. Our recommendations are based on the initial suggestions from the Mill Creek Park Recreation

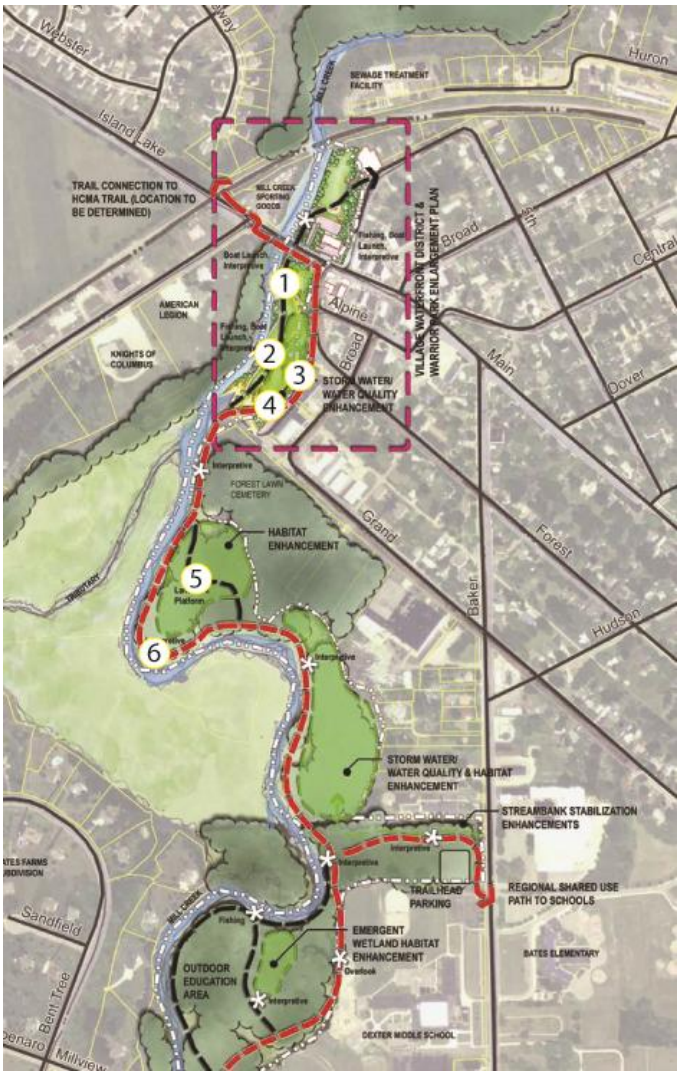
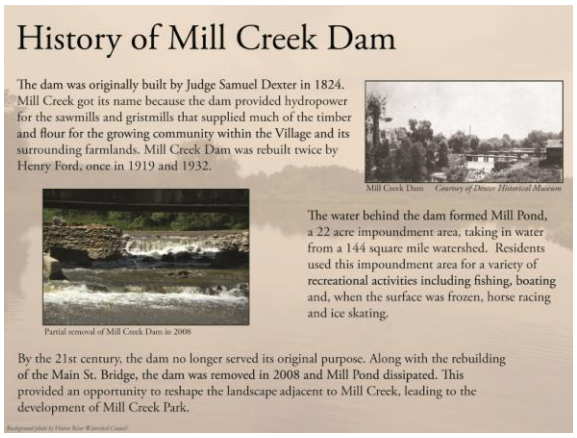


Figure 5.9: Map from Mill Creek Master Plan (p. 29) overlain with our suggested locations. (Image by JJR)

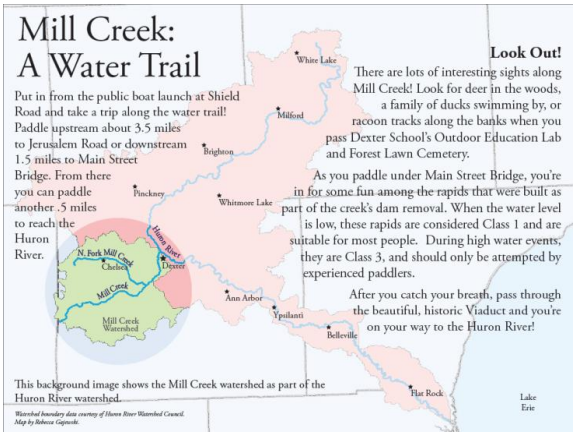
Master Plan. They also consider accessibility and the potential for an overabundance of signs in a small area. We suggest placing the signs in the following locations:

1) History of Mill Creek Dam: near dam site
2) Water Trail: near rapids; indicates alternative launch site upstream
3) Welcome: near entrance; gives information about entire park and nearby Dexter amenities; available to individuals who do not want to enter further
4) Stormwater: near bioswale and swirl concentrator
5) Buffer: in buffer zone, near habitat enhancement
6) Fish: near creek; could be moved to a dock or fishing spot if built

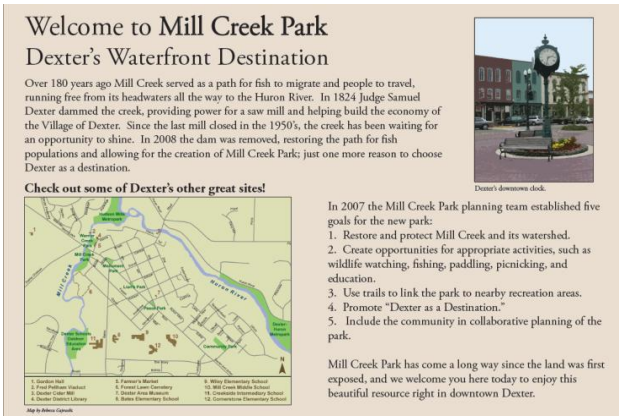
Signs 5 and 6 allow the interpretation to be spread out so as not to overwhelm the area, but stop before reaching the OEA. Starting in a more contained area and spreading farther in the future will maintain consistency. The PaRC may later determine that different styles of interpretation are more appropriate for different areas: for instance, less prominent interpretive programming might help maintain the "naturalness" of less manicured areas.



1



2



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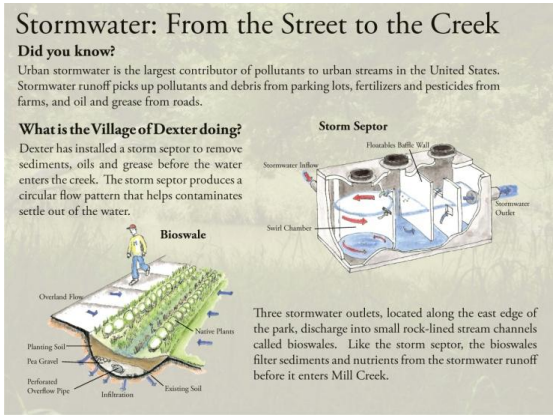

4

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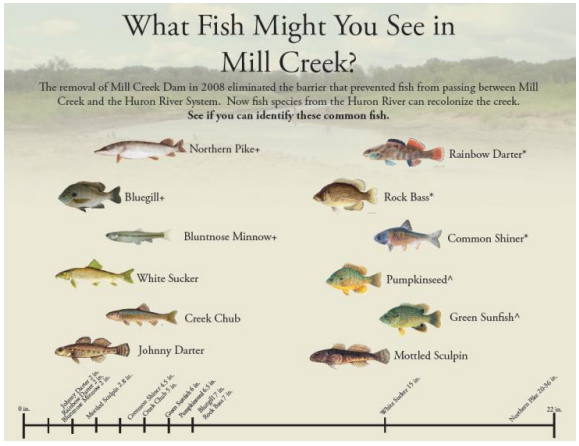


6

Figure 5.10: Completed signs (Signs by Katherine Hollins and Alison Richardson)

1.b.ii Selecting Sign Material

In this stage, planners should select the material for the signs, keeping in mind durability, cost, look, and purpose. If the PaRC foresees changing the signs every three years, a less expensive, but less durable material may be appropriate. If the PaRC wants a longer-lasting product, that will tend to cost more. Table 5.4 below shows a selection of common interpretive sign materials that allow for colorful images, pictures, and text.

Table 5.4: Material options

Type of Material	UV ray protection (years to fade)	Mounting Specifications	Other Details	Materials
Digital High Pressure Laminate	10y	⅛ inch board needs frame ½ inch board can be pedestal mounted		digital print fused into plastic similar to Formica
Alumilite	7-10y (reds fade faster)	2 6ft posts recommended	has UV overlay	2 layers of aluminum with a sturdy black corrugated plastic between
Dibond Aluminum	3-5y	2 6ft posts recommended		2 layers of aluminum with a layer of solid black plastic between
.08mm thickness aluminum	5y	2 6ft posts recommended	has UV overlay	thicker aluminum similar to street signs
Corrugated Plastic	2y	framing recommended	faint horizontal lines can be brittle	layered plastic
Fiberglass Graphics		should use mounting provided by Pannier		digital print fused into fiberglass
Aluminum with baked enamel finish			scratches easily resistant to weather will not rust	aluminum, enamel
Expanded PVC	use white, black, gray for minimum fade	use 6mm gauge or thicker for pedestal mounting	warps in heat not good in moist outdoor environments can be scratched	plastic

(personal communication, M. Milhaupt, L. Peters, L. Ivey, B. Schwartz, J. Mohler, T. Smith, Z. Mallory, K. Macyda).

1.b.iii Choose a Manufacturer

Selecting a sign material will help to determine which company should manufacture the signs. Table 5.5 gives a selection of suppliers for different types of materials. All prices listed below should be viewed as minimums, since printing proofs, purchasing mounting equipment, and shipping the signs will increase the total cost. Once a supplier is selected, it is

Table 5.5: Supplier options

Sign Supplier	Material	Cost 18x24	Cost 2x3	Mounting/Installation	Location
iZONE http://www.izoneimaging.com	Digital High Pressure Laminate	$243	$485	recommends Best Exhibits	Texas
Fossil Inc. http://www.fossilinc.com/	Digital High Pressure Laminate (1/2")	221	386	Mounting single post = 225 double post = 450	Deer Park, NY
FastSigns P# 734-677-1500	.08 Aluminum	98	181	installation- $90/hour (ex. pre-dug hole, 4x4 wooden posts = 15min/sign)	Ann Arbor
	Alumilite	40	85		
Signs in One Day	Dibond Aluminum	87	158	Recommend 2 (6 ft.) posts at $18 each	Ann Arbor
	.08 Aluminum	69	127		
Signs By Tomorrow	Dibond Aluminum	60	94		Ann Arbor
	Corrugated Plastic	29	42		
Kolossos (based on quantity discount)	.08 Aluminum	58			Ann Arbor
	Dibond Aluminum	36	65		
	Corrugated Plastic	38	50		
Zeke Mallory	Heavy duty Aluminum	~45	~75		
Pannier	Fiberglass			should use Pannier frames	Pittsburgh, PA
Best Exhibits http://www.best-exfab.com/	alternative frame supplier	~130	~260-440		

important to determine their design guidelines and be certain that the files fit those guidelines. Some suppliers will modify non-matching files for a fee. Despite the typical extra fee for printing proofs, this is a crucial step. Each material and printing process may create a slightly different visual result; by reviewing proofs of the signs in advance, planners can ensure that the final product meets their expectations.

1.b.iv Determine Assessment Approach (see Stage 4)

1.b.v Determine Maintenance Plan

Planners should establish a workable maintenance plan to preserve the program's quality and accessibility. This can be as simple as assigning a PaRC member to conduct a biannual review of the condition of each sign.

5.4.2. Stage 2: Pilot Testing

Our team recommends that the PaRC pilot test all interpretive signs before fully implementing them. Some pilot testing has already occurred through sharing the development of the signs with the members of the PaRC. The next step can be to create mock-ups for community members to view, so they can provide comments and suggestions. An alternative is to place temporary signs in the park and evaluate their effectiveness. By pilot testing and consulting with stakeholders, the PaRC can make sure the materials are accomplishing their objectives before committing to full implementation (Monroe, 2005).

5.4.3. Stage 3: Implementation

Once pilot testing is complete and any necessary changes have been made, the program can be implemented as planned.

5.4.4. Stage 4: Evaluation

After the program has been fully implemented, the PaRC should evaluate the program to determine if it should continue as is, or be revised (Monroe, 2005). This evaluation can take on many forms, depending on the PaRC's current resources. An evaluator can simply visually assess the signs for damage due to normal wear or vandalism and correct any problems. He or she can observe park visitors, counting how many people stop to read the signs and how long they stay. For a more involved evaluation, the evaluator may want to create a survey to distribute to park visitors, asking if they are stopping to view the signs and why or why not, and assessing what those visitors who do read the signs are learning the. The goal of such an in-depth evaluation is to verify the program is meeting its original objectives.

While an in-depth evaluation may seem daunting, it can provide planners with valuable information. It can inform a decision to maintain, expand, or remove an interpretive program, and it can guide the use of limited funds toward the most valuable aspects of the program. An in-depth evaluation will also supply the PaRC with concrete data to demonstrate the program's success when applying for future grant money (North American Association for Environmental Education, 1993). There are a number of free online resources to guide users in evaluating their programs, including My Environmental Education Evaluation Resource Assistant or MEERA (meera.snre.umich.edu) and the Free Management Library's "Basic Guide to Program Evaluation" (managementhelp.org/evaluatn/fnl_eval.htm).

5.5. Future Opportunities and Alternative Modes of Interpretation

The PaRC is in a good position to move forward with its interpretive programming using static interpretive signs; yet there are a number of other options for broadening the program in the future. Given funding and opportunity, and if the small-scale introduction is successful, the PaRC can expand the program to include interpretation of the park's ecological management practices or demonstration areas, as well as other topics raised in our initial Interpretation Visioning Session. In addition, the PaRC may even consider in-stream interpretation. For instance, Michigan Heritage Water Trails

(www.wmich.edu/glcms/watertrails/index.htm) provides educational interpretation that is intended to be visible from navigable waterways in Michigan.

As the Mill Creek Park interpretive program grows, the PaRC may want to expand into alternative forms of interpretation. From static signs to interpretive walks, each kind of program has both advantages and disadvantages.

Figure 5.11: Sample sign used along the Michigan Heritage Water Trails

A post-and-brochure program is relatively inexpensive to implement and is easily modified. However, brochures can often lead to litter problems, and may not take full advantage of users' attention spans (Hughes & Morrison-Saunders, 2002). Static signs are more expensive and challenging to change once in place, but often allow for more attractive and engaging graphics. Audio tours also require substantial initial investments, and have problems similar to those of the post-and-brochure method, but they also allow for a new and exciting method of engaging visitors. A guided tour has the potential to go into much more detail and make the information more personal; at the same time, the presentation quality may vary greatly among presenters. Table 5.6 summarizes the pros and cons of a number of these options (Jacobson, 1999).

Table 5.6: Pros and cons of different interpretive programs

Interpretation Program	Advantages	Disadvantages
Static Signage	• low cost per visitor • available at all times • consistent • low maintenance • viewed at visitor's pace • good for brief, simple, clear exhibits and graphic illustrations	• less personal • inflexible • visitors must read • subject to vandalism and deterioration
Guided Tours / Public Presentations	• personal • able to tailor to audience • flexible • interactive • able to include more complex concepts/information • effective for high visitation periods	• requires trained interpreter • limited availability • performance is variable • high cost (salary for guide or training for volunteers)
Post and Brochure	• inexpensive • potentially useable offsite (supports visitors with mobility restrictions) • minimal visual intrusion • has souvenir value • source of reference information • can be produced in foreign language/Braille • read at visitor's pace • easily modified • relatively easy to design • suited for sequential information	• source of litter • requires more effort by visitor • few visitors complete circuits • requires regular maintenance • not seen as progressive
Audio Tours	• available (depending on mode of dissemination) • consistent • uses different senses (supports visitors who are blind) • potentially available offsite (supports visitors with mobility restrictions) • mobile devices are recommended over built-in audio information because of fewer maintenance issues	• expensive • difficult to change • requires high maintenance • requires special equipment (to create and use) • distribution may be limited

Although the PaRC is still in stage two of a five-step process for implementation, it has already made a solid start in helping park visitors get the most out of their experience. By following these recommendations, the PaRC can create a successful interpretive program that meets its objectives and satisfies visitors to Mill Creek Park.

5.6. Guidelines and Summaries

Guidelines summary for continuing to implement static interpretive signs	

Stage 1	• Complete draft materials – choose fish images
	• Complete plans for implementation
	  ○ choose a location for each sign
	  ○ choose a sign material
	  ○ choose a sign supplier
	  ○ determine how and when the program will be assessed
	  ○ create a maintenance plan

Stage 2	• Check materials for accuracy • Pilot-test program with audience • Revise and retest
Stage 3	• Produce and place materials (should not be completed before trails are established)
Stage 4	• Evaluate the program • Improve and/or continue the program • Re-evaluate program according to predetermined schedule

Guidelines summary for creating any interpretive program	

Stage 1	• Assess the need for the program
	  ○ determine target audience
	  ○ determine scope of program

Stage 2	• Design the program
	  ○ create objectives
	  ○ design using best practices
	  ○ create draft materials and plans for implementation

Stage 3	• Pilot-test the program
	  ○ check materials for accuracy
	  ○ test program with audience
	  ○ revise and retest materials

Stage 4	• Produce materials and implement the program

Stage 5	• Evaluate the program
	  ○ determine if program is meeting original objectives
	  ○ use results to improve program and document success

Chapter 6: Volunteer Program Management

The idea is to find one thing to do in your life that doesn't involve spending or voting, that may or may not virally rock the world but is real and particular (as well as symbolic) and that, come what may, will offer its own rewards.

~Michael Pollan, Why Bother? *In The New York Times, April 20, 2008*

Volunteer stewardship will be an important part of the ecological restoration and management of Mill Creek Park and the Dexter Community Schools' OEA. By recruiting and using volunteers, the Village and its schools will be able to complement contractor-based restoration services or even eliminate the need for them entirely. Thus, a volunteer program could save the Village money. It could also benefit its participants by giving them a sense of attachment to the area, the satisfaction of serving their community and the environment, and opportunities for physical exercise and social interaction.

This chapter explores possible steps to building and maintaining a volunteer program for Mill Creek Park and the OEA. First, it addresses the need for volunteers in ecological work in general, and in Dexter in particular. Second, the chapter explains the methods we used to identify the most common and most effective practices in volunteer stewardship and the results of our research. Finally, our findings serve to provide timely recommendations and options for the Village of Dexter, its parks, and its schools.

6.1. Need for Volunteer Program

The term "stewardship" has been given various definitions, but in general it refers either to volunteer work organized by or for municipalities or to landowners acting on ecological values (Fuchs, 2004). Fuchs defines stewardship as "voluntary conservation-

oriented activities undertaken by "grassroots" and nonprofessional individuals and nongovernmental organizations that are motivated by a desire to experience nature, a passion for natural values, and a concern for sustaining ecological integrity into the future" (Fuchs, 2004).

Many literary sources and professionals in the volunteer management field recognize the importance of volunteer stewardship as part of any ecological restoration, monitoring, or greening project. In the U.S., Canada, the U.K., and Australia, federal governments both encourage and rely on volunteer work (Fuchs, 2004; Measham & Barnett, 2007; U.S. Environmental Protection Agency, 2010). At a local level, organizations such as the City of Ann Arbor Natural Areas Preservation (NAP), Matthaei Botanical Gardens and Nichols Arboretum (MBGNA), the Legacy Land Conservancy (LLC; formerly the Washtenaw Land Trust), and the Stewardship Network (the SN) could not function without the help of volunteers.

Research conducted abroad, elsewhere in the United States, and in Michigan shows the importance of volunteer work. "Volunteers play a key role in natural resource management: their commitment, time and labour constitute a major contribution towards managing environments… throughout the world" (Measham & Barnett, 2007). A University of Michigan study, which interviewed local groups, concluded that "volunteers are essential to ecological restoration efforts. They help with monitoring, clearing invasive plants, collecting seeds, planting, and many other activities that are directly involved with land stewardship. In addition, numerous volunteers perform services are less directly tied to the land, including disseminating information via newsletters, for example, and maintaining databases" (Grese et al., 2000). Even researchers who see room for improvement in volunteer stewardship note that volunteer contributions "continue to be enormous, invaluable, and essential for recovery" (Fuchs, 2004).

Stewardship programs often have benefits beyond those they provide to the ecosystems they are protecting. Such programs benefit the volunteers themselves and society at large. For example, volunteering "represents an important means of participating in civil society, and has been proposed as an indicator of societal health, with research suggesting positive relationships between volunteer activity levels, physical health, and life satisfaction" (Whiteley, 2004 in Measham & Barnett, 2007). Volunteer programs can also help

organizations save money. For example, long-term monitoring would be "difficult to fund through other mechanisms" (Measham & Barnett, 2007). In this vein, using volunteers' time and skills can help organizations to acquire grant money. For example, volunteer work is often considered to be a contribution in kind or a donation with monetary value, thus increasing the amount a funder is likely to provide or match. The state of Minnesota, for example, counts "conservation volunteer" contributions at $16 per hour (Minnesota Department of Natural Resources, 2010). Finally, volunteers can improve a program by contributing expertise that only a local would understand, including undocumented history of a site, important local people to involve, and insights from day to day observations (Measham & Barnett, 2007; Zevit, 2007; DeYoung, 2008).

Table 6.1: Benefits of stewardship to the volunteer and the community

What People Need	Benefits to Individuals	Benefits to Community
Understanding	eco-literacy, skills	awareness/concern among citizens
Exploration/learning	skills, engagement	attachment, desire/ability to act
Meaningful work	sense of accomplishment	repetition, role modeling
Psychological restoration	solo time in nature	spillover (different actions)
Exercise	physical activity	reciprocal relationship
Friends	social activity, networking	sense of community

A new wave of volunteerism is sprouting up, despite the recent economic downturn (Roush, 2009). President Obama has even called for a new era in public service with his United We Serve program (U.S. Government, 2010). Environmental volunteerism has also increased (HandsOn Network, 2010), partly because of the benefits to the volunteers themselves (Measham & Barnett, 2007). The U.S. Congress specifically honors committed stewardship volunteers nominated by state agencies (Minnesota Department of Natural

Resources, 2010). Volunteering has also been suggested as a useful way for those who are unemployed to fill their time, allowing them to retain their skills, networks, and overall employability (Lawrence, 2009). On the other hand, some critics believe governments are exploiting volunteers so as to reduce strain on their budgets (Measham & Barnett, 2007), although volunteers may value other benefits more highly than financial compensation.

Due to ecological changes spurred by the removal of the Mill Creek Dam, the local ecosystem is expected to be in flux for the next few years. Dam removals and other disturbances in an ecosystem are commonly followed by massive incursions by invasive species (Stanley & Doyle, 2003). These invasions impact human inhabitants in many ways, such as disturbing recreation sites, disrupting the lives of fish populations, changing property values due to aesthetic and accessibility concerns, and affecting various industries (MacFarland, 2010). Thus, ecological monitoring and restoration are crucial for the Village

Table 6.2: Benefits of volunteers vs. contractors in restoration work (based on Mauritz, 2005).

Volunteers	Both	Contractors
direct citizen participation (and related benefits)	instilled with environmental values	informed about most up-to-date techniques
local knowledge of project sites	important knowledge and experience	experience with ecological restoration projects
free labor, require supervision	financial benefits	costly, but insured
long-term commitment (this is their home)	commitment to place vs. project	day-to-day dependability (this is their livelihood)
adaptive to unique projects	adaptability vs. consistency	consistency between projects
finding/increasing skilled community members	capacity building vs. saving on time/costs	certifications in place; no recruitment necessary

of Dexter and its neighbors, both now and in the long term. Dexter is a small community with a small staff; approximately 12 people make up the paid leadership of the village (Village of Dexter, 2010). Meanwhile, restoration contractors are expensive. A volunteer

stewardship program would be an outstanding way for Dexter to save money while achieving its ecological goals.

Currently, Dexter does not have a clear plan for recruiting volunteers. The Mill Creek Park Recreation Master Plan notes the need for volunteers for education, restoration, and long-term monitoring efforts, but does not specifically say how to accomplish this goal (JJR & ECT, 2009). This chapter is meant to provide the background necessary for the staffs of Dexter's government and schools to begin a volunteer program. It ends with specific recommendations designed specifically for Dexter.

6.2. Research Methods

Our team used a variety of methods to learn about volunteerism in restoration activities, to determine what information a volunteer program coordinator needs, and to find strategies suited to Dexter's specific needs. We surveyed the extensive literature on volunteer motivations, as well as some literature about the benefits for organizations that use volunteers. We also focused our research on interviews with and presentations by professionals in the field, especially regarding their personal and professional experience in forming and sustaining volunteer programs. In addition, personal volunteer and volunteer coordination experiences enhanced our understanding (e.g. Ms. Gajewski for the Huron-Clinton Metroparks, Ms. Hollins for the MBGNA, and Mr. O'Dowd for Clearwater, Inc., and The Nature Conservancy).

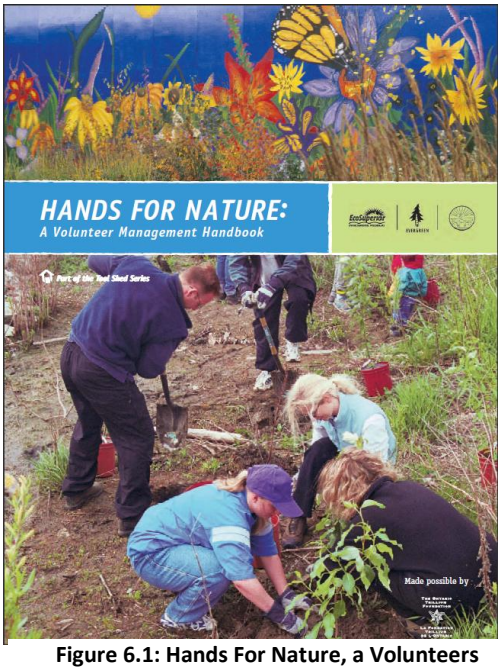


Figure 6.1: Hands For Nature, a Volunteers Coordinator's Guide from the Evergreen Foundation in Canada. (Photo by Hands for Nature)

6.2.1. Review of Literature

There are countless materials that suggest ways to recruit and retain long-term volunteers. One has only to type "care and feeding of volunteers" into an online search engine to find a plethora of resources. Energize, Inc., is an organization especially praised by volunteer managers for its suggestions and its supply of many templates for documents often used in volunteer programs (Energize, Inc., 2010). For stewardship programs, the volunteer management manual of the Evergreen program in Toronto, Canada, is particularly useful. This resource is based on the experience of hundreds of volunteer program coordinators and volunteers in the field. Its five chapters reflect several considerations that any volunteer management program needs to explore: 1) working with volunteers, 2) recruiting volunteers, 3) retaining and supporting volunteers, 4) preventing volunteer burnout, and 5) recognizing volunteers. The sixth chapter addresses "motivating your volunteers through the maintenance season"—a time when volunteer commitment often declines (Evergreen, 2003). Academic literature addresses volunteer motivation, using survey research and interviews with both small volunteer agencies such as the Natural Areas Preservation program (NAP) in Ann Arbor, Michigan, and large ones such Chicago Wilderness (Grese et al., 2000; Miles, Sullivan, & Kuo, 2000; Measham & Barnett, 2007).

6.2.2. Working with NAP

Ann Arbor's NAP is a highly regarded municipal stewardship agency and served as one of the most important sources for our recommendations to the Village of Dexter. It has an extensive ecological restoration program that relies heavily on volunteer work. We attended volunteer workdays with NAP and interviewed its staff. Interviews with NAP's volunteer and outreach program coordinator, Jason Frenzel, revealed information about sources of volunteers, service-learning and volunteering opportunities at Ann Arbor schools, and the challenges of starting a new program from scratch. Others at NAP assisted with ideas about supplies (for example, the "volunteer tub" or "workday tub") and volunteer training.

6.2.3. Working with MBGNA

The Matthaei Botanical Gardens and Nichols Arboretum (MBGNA) is an exemplary program based at the University of Michigan, but connected in many ways to the surrounding city and community. It has a number of garden and natural areas maintained through volunteer restoration work by both students and community members. Our project research and previous research by Weng (2009) at various arboreta focused on volunteering among college students; their lessons, however, reflect other research and shed light onto some of the motivations and concerns of young adults and teens—a crucial pool of potential volunteers, even for Dexter. Interviews with Tara Griffith, MBGNA's volunteer program coordinator, Jeffrey Plakke, its natural areas manager, and MBGNA Director, Robert Grese were invaluable. Ms. Griffith has many years of volunteer coordinating experience with both NAP and MBGNA, and shared her insights on organizing, recruiting, and retaining volunteers. Mr. Plakke had special insights into volunteers' workday needs, having led a number of workdays with volunteers and students seeking to fulfill course requirements. Director Grese has years of experience teaching courses on ecological restoration and related subjects, and has attended many volunteer workdays himself. His suggestions and lecture materials added significantly to our understanding of both ecological restoration and volunteer management.

6.2.4. Working with the Stewardship Network

Figure 6.2: Fostering Long-Term Volunteers: Stewardship Network Conference Breakaway Session. (Photo by Thomas O'Dowd)

The Stewardship Network is an association of professionals working on ecological restoration and related projects. Although it focuses primarily on Michigan, the Network reaches more than 4,500 people from all over the country with its annual conference and other events. Within Michigan, Stewardship Network "clusters" help people build even stronger networks with other professionals in their immediate area. Members of

our team attended the Network's 2010 Conference, titled *The Science, Practice & Art of Restoring Native Ecosystem*, as well as a few meetings of the Huron Arbor Stewardship Network Cluster, based in Washtenaw County (Stewardship Network 2007, 2010). These events gave us access to a number of different workshops and discussions on how to carry out ecological restoration projects, including a few that specifically focused on the task of managing volunteers (see Frenzel et al., 2010). We also accessed the Network's website and minutes from past Huron Arbor Cluster meetings on volunteer management (Huron Arbor Cluster, 2007 & 2008). Through the Stewardship Network, we met volunteer program coordinators such as Aunita Erskine. Ms. Erskine is a volunteer steward for NAP's Furstenberg Native Garden, for MGBNA, and at Shanghai Prairie (a new and as yet unsupported park). Her experience in many roles in different groups makes her a good source of real-life experience.

6.3. Results

It can be a challenge to start a volunteer program where one does not already exist. Fortunately, an abundance of knowledge about volunteer programs is available. Experts and the literature suggest taking several detailed steps to start and run a program. The best practices of volunteer management are detailed below.

Figure 6.3: A volunteer coordinator in the planning stages. (Photo by Dragi Markovic)

6.3.1. Program Organization and Funding

Volunteer Programs can take many forms. They can be part of a municipal government (with its leadership employed by the municipality) or a separate non-profit entity. They can be funded by Park or environmental agency appropriations or by grants (from state governments, NGOs,

or private foundations). They can be staffed solely by volunteers or by volunteers under the coordination of a few employees (Clewell & Aronson, 2007).

6.3.2. Program Leadership

Most programs hire a volunteer program coordinator to focus solely on recruiting and maintaining volunteers (Evergreen, 2003; Grese, 2008), and NAP hires several (NAP Newsletter, Autumn, 2008). Program coordinators may also be volunteers themselves (Frenzel et al., 2010). "The volunteer program coordinator is one of the first positions that should be filled to help build momentum and ultimately sustain volunteer interest" (Evergreen, 2003). The coordinator of a new program, even if he or she focuses solely on volunteer issues, has many responsibilities: recruiting volunteers; fundraising and budgeting; forming partnerships with other organizations; planning informational and celebratory events; planning work for workdays; serving as contact person (with name, phone number, and e-mail open to all); arranging and maintaining plants, tools, and supplies for the workdays; running the actual workdays (an art unto itself); following up with volunteers to thank them; and doing all the other ongoing tasks to make sure volunteers return (Evergreen, 2003; Frenzel et al., 2010). These can be classified into three main roles played by volunteer program coordinators: planning, workday leadership, and outreach.

Volunteer program coordinators for new programs may have no choice but to handle all these tasks themselves. Though it might be useful for a coordinator to understand or even experience each of these tasks, our research reveals that this is quite a challenge (e.g. Frenzel et al., 2010). Coordinators can deal with this challenge by delegating duties to other volunteers. If funding is available, they can pay others to assist with volunteer coordination, including workday planning, recruiting, workday leadership, and follow-up through the Stewardship Network's "Volunteer Workday Services" (Stewardship Network, 2010). Nonetheless, delegating to local volunteers appears to be a more sustainable practice.

1) Planning: The coordinator's main role is planning the program. Planning includes translating the goals of the organization into tasks that volunteers can do, creating a schedule for completing these tasks, and managing a budget for them. This means deciding what the volunteer program's goals are, and which activities are the safest, most effective, and most

rewarding for volunteers. By putting the plan in writing, the program coordinator can provide a reference for communicating with volunteers and other departments in the organization (Evergreen, 2003).

Some Questions to Consider When Developing a Project Plan:

- *What do you want to do?*
- *Why is this important?*
- *When will you do it (timeline)?*
- *Who will do the work?*
- *Who are you accountable to?*
- *Do you have the necessary support to begin involving volunteers?*
- *Will you need to fundraise for your project?*
- *What safety issues are relevant for your project/property?*

(Evergreen, 2003)

For volunteers' comfort and safety, the coordinator must choose activities that are most appropriate for them, given both their physical abilities and local laws or ordinances about certain ecological restoration techniques, such as the use of fire or herbicide. Young children, teens, middle-aged, and elderly persons all have different needs. Many organizations do not allow volunteers to use power tools or herbicide (Huron Arbor Cluster, 2007), although some do allow volunteers to do so, including children over a certain age. Any volunteer program coordinator should understand the laws and ordinances for certifications. In Ann Arbor, volunteers have to be certified by Washtenaw Extension. In Michigan, The Nature Conservancy (TNC) pays for its volunteers to be certified by Washtenaw Extension (Frenzel et al., 2010). Program coordinators should also make sure in advance that volunteers have access to parking and bathrooms (Huron Arbor Cluster, 2008). Programs should consider liability insurance, and always use waivers (see Figure 6.2). (U.S. Environmental Protection Agency Office of Water, 1996, p. 59).

To ensure effectiveness, the volunteer program coordinator needs to decide priorities for each site, such as which invasive species and which area to focus on. This might mean consulting an expert if he or she is not one (Wright, in Frenzel et al., 2010). It also involves finding the appropriate balance between overarching ecological goals and the capabilities of the volunteers and staff. One solution is breaking up tasks into manageable chunks to be done one at a time (Evergreen, 2003), with steady progress toward the goal in a logical step-by-step order (Pearson, 2010).

Some critics believe that stewardship programs focus on social goals at the expense of ecological goals and lack the planning and monitoring necessary to ensure scientifically

VOLUNTEER RELEASE & WAIVER OF LIABILITY

Required by the City of Ann Arbor Natural Area Preservation for all volunteers

City of Ann Arbor Natural Area Preservation

Please read carefully! This is a legal document that affects your legal rights!

I want to participate in the volunteer activities of the City of Ann Arbor's Natural Area Preservation (NAP) unit. As a NAP Volunteer, I freely, voluntarily, and without duress, execute this Release under the following terms:

1. **Assumption of risk.** I understand that my work for NAP may include activities that are hazardous and/or physically strenuous, and I may be exposed to personal injury or damage to my property as a result of my activities, the activities of other persons, or the conditions under which my services are performed while participating in NAP volunteering. Though NAP will provide me with support, supervision, training, and supplies to accomplish assigned tasks, I agree to the following:
   - I will follow all instructions provided by NAP, its employees, or Park Stewards.
   - I will only use equipment that I know how to operate and use safely.
   - I will not undertake any activity for which I do not feel sufficiently prepared or able and until I have received instructions.
   - I will take all reasonable precautions to avoid injury to myself and to others and damage to property.
   - Finally, I agree to assume the risk of injury or harm and release the City of Ann Arbor and NAP, its officers, directors, employees, and other volunteers (hereafter "NAP") from all liability for injury, illness, death, or property damage arising from my work for NAP.
2. **Waiver and Release.** I hereby release and forever discharge and agree to indemnify and hold harmless NAP from any and all claims, liabilities, losses, damages, costs and expenses resulting from injury or death of any person or persons property damage or that may arise out of my work as Volunteer. I understand that this release discharges the above entities from any liability that may result from my work whether caused by the negligence of NAP.
3. **Medical treatment.** I release and discharge NAP from any claim that arises or may arise due to any first aid, medical treatment, or service rendered to me.
4. **Insurance.** NAP does not have responsibility for providing any health, medical or disability insurance coverage for me. IT IS MY RESPONSIBILITY AS A VOLUNTEER TO ENSURE I HAVE MEDICAL/HEALTH INSURANCE.
5. **Photographic release.** I grant to NAP the right to use photographic images and video or audio recordings of me that are made by NAP or others during my volunteer work for NAP.
6. **Duration of Release.** My agreement to the terms in this Release & Waiver applies as long as I volunteer for NAP.
7. **Other.** I agree that this Release is intended to be as broad and inclusive as permitted by the laws of Michigan, and that this Release is governed by and will be interpreted according to the laws of Michigan. I understand that should any part of this Release be ruled invalid by a court, the other parts will remain valid and continue to be in effect.

I certify that I am at least eighteen (18) years of age or have had this document signed by my parent or guardian.

Name of Adult (please print)	*If signing for a minor, their name(s)*
Street Address	
City *State* *Zip*	
Phone *Email*	
Signature *Date*	

Figure 6.0.1: NAP volunteer waiver

sound actions (Fuchs, 2004). While the program coordinator needs to plan activities that are rewarding to the volunteers (discussed further in the Volunteer recruitment and retention sections), they must also meet ecological needs. Fuchs highlights the importance of outside expertise, but notes that "stewardship groups rarely have funding for consulting with professional experts" (Fuchs, 2004). However, experts are often willing to give their informal assistance due to their interest in a particular issue or place. For example, Richard Wolinski, wildlife ecologist with the Michigan Department of Transportation, discussed the flora and fauna of the OEA with this our team on a volunteer basis.

Scheduling: The Program Coordinator should create a schedule at the beginning of each year. Regular days and times help the volunteer community to grow, because volunteers get to know one another and fit workdays into consistently open slots in their schedules (Huron Arbor Cluster, 2007, 2008). MBGNA and NAP both schedule one workday a month, with particular groups taking particular days (Matthaei Botanical Gardens and Nichols Arboretum, 2010). In the first year, however, the coordinator might only plan four to five actual workdays.

Budgeting: Tools, supplies (including snacks), and possible training, if not a salary, for the volunteer program coordinator will require a budget and budget manager.

Professional Development: Programs exist for a volunteer program coordinator to get training and support. Michigan State University Extension has trainings and materials to help new coordinators (Michigan State University Extension, 2003), and the Stewardship Network has webcasts and other materials online (Stewardship Network, 2007). Also, many area Volunteer Coordinators are happy to assist. For example, Aunita Erskine (NAP, MBGNA) has offered to co-lead a workday or two with Dexter's volunteer coordinator (personal communication), and the other volunteer coordinators interviewed for this report are more than willing to answers phone calls and emails.

2) Workday Leadership. There should be one person to supervise each workday as an overseer and troubleshooter (Huron Arbor Cluster, 2007). The volunteer program coordinator may play this role at the outset of the program, but should delegate it to others as the program develops. The workday leader is responsible for welcoming and signing in volunteers for purposes of record keeping, and is also responsible for orienting and training volunteers new to the organization or the task at hand. This person must also monitor the

time and morale of the group, making sure that progress is being made and that people are having fun, staying hydrated, keeping warm or cool as needed, and getting breaks. These roles have been called "time-watcher" and "vibe-watcher" in other contexts.

The duty of running the workdays is easily delegated. Program coordinators should look to people who have regularly volunteered in the past to find reliable workday leaders, because broadly recruiting from the general public for these positions can yield less committed volunteers (Frenzel et al. 2010). However, volunteers will recoil if they feel they are undertaking too much too fast; for instance, it may be overly taxing for them to attempt an entire workday alone to start (Frenzel et al., 2010). In order to become more comfortable at the job, they may need to shadow an experienced leader for a while, share leadership of workdays to gain experience, or simply have the experienced leader on call in person or via cell phone. For a fee, they can even obtain assistance from a Stewardship Network volunteer program coordinator (Stewardship Network, 2010). The program coordinator can further lighten the load of workday leaders by delegating program and office logistics to others; the leader can then focus solely on the workday (Huron Arbor Cluster, 2007).

When handing over this role, it is important for the program coordinator to let the workday leader make his or her own decisions. Besides giving the workday leader greater ownership, this releases the program coordinator of the burden of thinking of everything (Frenzelet al., 2010). A useful framework is the TNC "Formula for Effective Crew Leaders": workday leaders are more effective when they have more autonomy and more responsibility for handling logistics.

Another way to reduce a workday leader's burdens to prepare a "workday tub" full of all the information a crew will need on any given workday (Frenzel et al., 2010). A workday tub contains all the educational materials, logistical materials, and supplies for safety and comfort that a workday leader and volunteers may need. By having these supplies on hand, a leader needs less time to prepare for a workday because he or she does not have

Figure 6.4: A workday leader gives instructions. (Photo by the Arizona Trail Association)

to collect all of the sign-in sheets and carry out other small tasks every time the crew goes out. Meanwhile, it relieves the workday leader of the responsibility to be an expert. The information is in the tub, and the workday leader can focus on the specific task for that day. All paper supplies are laminated; the tub itself is made of hard plastic and can be sealed

Figure 6.5: NAP workday tub. (Photo by Thomas O'Dowd)

Figure 6.6: Location and task booklets. (Photo by Thomas O'Dowd)

Figure 6.7: The workday tub easily fits into the backseat or trunk of a car, and can weigh under 30 pounds. (Photo by Thomas O'Dowd)

tightly to protect the contents (Frenzel et al., 2010). A workday leader may want to have a whiteboard or poster paper welcoming volunteers and outlining the tasks for the day, including a schedule. The work crew thus has a resource to tell them what they are supposed to do, for how long, and when to take breaks.

3) Outreach and Communication. Tracking volunteers is crucial to keeping in touch with them and sustaining the program. Whenever possible, the program coordinator should keep records of hours volunteers have worked, tasks they have performed, and sites they have restored, and should include photographs as much as possible. This information and imagery will help with advertizing, recruiting, and reporting in-kind contributions (Huron

Arbor Cluster, 2007). Sign-in sheets are important means of obtaining names, e-mail addresses, phone numbers, and other useful information about volunteers, such as their personal interests. NAP and MBGNA have ready-made forms requesting this information from new volunteers, which helps in making a volunteer database (Evergreen, 2003). (See Appendix R for a sample). Program coordinators can find managing this paperwork to be a challenge. MBGNA, for example, faces the challenges of dealing with piles of paper and the tedious task of data entry. Unfortunately, this problem may have no solution, although some organizations have volunteers sign directly into a laptop brought to a workday (Tara Griffith, personal communication). There could, however, be a simple system in which all the workday leaders, using an in-office or Google-spreadsheet database, enter data for their own workdays at the end of each day. All e-mails should be added to a listserv.

Outreach volunteers are also in charge of recruitment materials. Volunteers interested in art, marketing, or public relations would enjoy this role. Record keeping is not very exciting, so the creative and social aspects of this role can be emphasized. Such work includes creating flyers, newsletters, and notices to communicate how people can become involved. Some organizations use the latest social marketing media such as Facebook and Twitter (Frenzel, personal communication). The more prepared the organization is to

NAP Workday Tub Contents

Comfort and Safety:

- *First aid kit (though most organizations may not administer drugs).*
- *Sun screen and bug spray (natural and conventional brands).*
- *Emergency phone numbers, NAP & City phone numbers*

Park Information Booklet:

- *Park information: history, ecosystem types, noteworthy species*
- *Map.*
- *Restoration history: dates, locations, tasks, species*

Specific Task Booklet (e.g. Shrub Cutting Workday):

- *Rationale for removing invasives (specifically shrubs)*
- *History of using this technique.*
- *Identification of invasives (photos and descriptions)*
- *How to cut shrubs*
- *What to do with cut plants*
- *Before and after photographs*

Important Forms Binder:

- *Extra sign-in sheets and waiver forms*

Education Binder:

- *Brochures, etc.*
- *Volunteer job descriptions (See Appendix for a NAP example)*

Food/Drink Supplies:

- *Waterproof table cloth*
- *Reusable cups*

communicate with volunteers about its expectations, the benefits of volunteering for both volunteers and the organization, and appreciation for the work of the volunteers, the more prepared volunteers will be to participate (Evergreen, 2003). In general, the more a program does to make them feel welcome, the better. After all, "volunteers who feel they belong, return" (volunteer program coordinator quoted in Evergreen, 2003).

As in the case of workday leaders, the program coordinator may need to ease the new communications leader into the role. "Build their confidence by recruiting them to design flyers and write media releases. When they have mastered these tasks, mentor them in the more difficult task of coordinating media strategies and serving as media contacts" (Evergreen, 2003). The communications person is also in charge of following up workdays with thank-you messages to the volunteers, using (in order of increasing effectiveness) e-mail, telephone, or regular mail, or even the website, newspaper, or other media in which the workday was advertised (Huron Arbor Cluster, 2007; Frenzel et al, 2010).

6.3.2. Recruitment

In the course of planning, the Volunteer Program coordinator should write a recruitment plan. "Having a volunteer recruitment plan in place means not waiting for volunteers to walk through the door and offer to help, but rather going out and actively seeking volunteer help for areas of the project that require support" (Evergreen, 2003). This includes knowing what kind of work, skills, and experience the organization needs, and what opportunities, such as trainings and side benefits, the organization can offer its volunteers and the community. Articulating this to the public is part of the organization's recruitment message (a topic discussed below).

Volunteer jobs: It is important to identify the volunteer skills and work your organization requires. "From the point of view of environmental managers much interest has focused on defining tasks suitable to volunteers" (Measham and Barnett, 2007). "Before you begin to recruit, know what you need your volunteers to do"

Figure 6.8: A University of Michigan School of Public Health advertisement.

(Evergreen 2003). Volunteers can serve in a variety of capacities. At Matthaei Botanical Gardens and Nichols Arboretum (Matthaei Botanical Gardens and Nichols Arboretum, 2010), volunteers serve as docents, visitor services workers, ecological restoration workers, and gardeners (Griffith, in Frenzel et al., 2010). NAP has short, one-page job descriptions that describe specific tasks such as "shrub remover" or "burn worker." These descriptions lay out the expectations of each job in writing, and make the volunteers feel more like employees with both rights *and* responsibilities (Evergreen, 2003; Frenzel et al., 2010). The website www.volunteer.ca offers ideas for writing volunteer job descriptions. Such summaries can be placed wherever volunteers might need them, such as on the program website or in the workday tub.

Volunteers' tasks should take into account their varying levels of responsibility, commitment and experience (Evergreen, 2003). NAP, for example, has volunteer stewards who take on a more committed role in specific parks. Some groups have special workday leaders such as fire crew chief (see the section on workday leadership, above). The number of volunteers needed will vary with the type of project. For tasks requiring a larger commitment, an organization can recruit a group or divide the tasks into smaller jobs. Organizations should "[d]esign a greater number of jobs requiring short, concentrated effort with a definite end point, a smaller number of positions with more involved, coordinating responsibilities and much fewer positions with ongoing but less time-consuming responsibilities" and recruit differently for the different roles (Evergreen, 2003).

Potential volunteers: Organizations should identify target groups, from a variety of backgrounds whose members have diverse skills and experiences (Evergreen, 2003). Stewardship has broad appeal, even to those "who hold historically adversarial positions… Witness the coming together in restoration projects of scientists and artists, naturalists and hunters, environmentalists and corporate executives, diverse ethnic groups, elders and youth" (Havinga, 1999). This is a great pool from which to select, but the program coordinator should start somewhere more specific.

The initial volunteers are likely to be people who love the place in which they will be volunteering—those people who, as Tara Griffith stated, have made an "initial investment as a non-volunteer." In other words, they may have formed attachments to the place as hikers, bird-watchers, fishers, and so on (Frenzel et al., 2010). Research has shown that people who

see and use parks frequently have a special attachment to them (Ryan, 2005). These tend to be the park's neighbors. "Living down the street or owning a nearby business gives people an extra connection to the work being done and often makes a perfect fit for short but regular volunteer roles" (Evergreen, 2003).

A whole host of other organizations often participate in stewardship and greening activities. These include gardening clubs, horticultural societies, university affiliates (where it is possible to find ecologists, restorationists, and students with the skills to identify plants), and home builders associations, which tend to include people with carpentry skills. Parents, teachers, community members, members of local organizations, churches, and schools are also often interested in volunteering (Evergreen 2003). "Many businesses support the employee volunteer efforts by allowing them time off or letting them modify their work schedule to make time to volunteer" (Evergreen 2003).

Potential Business Partners

DaimlerChrysler:

- *Owner of the Chelsea Proving Grounds (Sylvan Township)*
- *Covering hundreds of acres—the most significant landowner in the Mill Creek Watershed (HRWC 2006)*
- *Potential polluter—should take interest in protecting Mill Creek downstream of their site*

Dexter Area Chamber of Commerce:

- *Source of more businesses seeking to fulfill their social responsibilities, as many are (Buck, 2008)*

It is very helpful to recruit volunteers from both elder and younger members of the community. Many retired people have time, knowledge, and life experience to offer, while youth tend to be energetic and may want to build experience and resumes (ACTION, 1976).

Figure 6.9: The Chelsea Proving Grounds, DaimlerChrysler's massive car testing compound in the Mill Creek Watershed. (Photo by the Huron River Watershed Council).

Scout troops, whether made up of boys or girls or whether their members are younger or older, often have members or chapters seeking volunteer work. For instance, scouts helped develop Creekside Intermediate School's original OEA. Scouts, members of youth-oriented nonprofit groups, and other young people may be motivated to volunteer in order to obtain badges or other

accomplishments (Evergreen, 2003). Students from high schools or elementary schools might have public service requirements for graduation or entry to the honor society, or specific classes that require service work. For example, Creekside Intermediate School has sixth-grade capstone projects, and many Ann Arbor schools do service work or service-learning: Greenhills School incorporates trail-building and stream monitoring into its science unit. Both the youth and the elderly, as well as certain other groups, may have more time available. Seniors, retirees, university students, and stay-at-home parents might be able to work during business hours, and staff and attendees at summer day camps may be able to help during vacation season (Evergreen, 2003).

One challenge of relying on students is that the student body changes each year, so their participation tends to be short lived. Although individual students may have a high turnover rate, however, the student groups that work with MBGNA present a reliable source of volunteers from year to year (Griffith in Frenzel et al., 2010). Similarly, a new volunteer organization may be able to gain a consistent source of volunteers if it form a strong relationship with an existing group—for instance, a sports team, an honor society, or a service club such as Circle K. Another characteristic of youth volunteers is that "if you hook the kids, you hook the parents." In other words, parents tend to become highly invested in their children's activities and may end up becoming volunteers themselves (Evergreen, 2003; Huron Arbor Cluster, 2007; Clark, 2010).

It is important to consider volunteers of varying ability levels. "People with developmental and physical challenges are often interested and capable of participating in stewardship activities such as weeding, watering, and much more" (Evergreen, 2003). Self-help groups and social-service agencies may help in finding such individuals.

Volunteer diversity: In recruiting volunteers, some organizations may be tempted to rely on a single group, such as church or school groups. Nevertheless, stewardship leaders note that healthy social landscapes, like natural ones, gain resilience from diverse niches and resources (Clark, 2010). The involvement of volunteers from a variety of age groups, backgrounds, and ethnicities will strengthen the program and thus the community itself, by involving a diversity of skills, perspectives, and experiences, and creating stronger social bonds.

While many American adults volunteer (44 percent, compared with 27 percent of Canadians and 48 percent in the United Kingdom), volunteer organizations tend not to be very diverse (Measham and Barnett, 2007). In most places volunteer groups are dominated by Caucasians, have slightly more women than men, more people with higher education and income levels, more part-time versus full-time workers, more individuals aged 35-44, and more retirees (Evergreen, 2003; Measham & Barnett, 2007; Grese, 2008; Jacquart, 2010). A study for NAP found that the ethnic makeup of Ann Arbor is quite different from the ethnic makeup of volunteers, and that NAP should address this imbalance in order to improve its services to all residents (Kufeji & Frenzel, 2010). NAP is seeking to adjust its recruiting efforts to draw on a more representative group of participants (Jason Frenzel, personal communication).

Specific Recruiting Techniques

1) Create a recruitment message. A recruitment message explains the project, what volunteers will be asked to do, skills and attributes necessary for those tasks, and the time commitment required. It also addresses how the tasks will benefit community members and other key stakeholders, as well as meet the volunteers' own needs and interests (Evergreen, 2003). Strike a light-hearted tone and emphasize the community benefits of the project; if the outreach is inviting rather than demanding, people will be more convinced.

2) Appeal to motivations. Many volunteers have some combination of the following motivations: 1) desire to help the environment; 2) desire to learn or demonstrate personal skills; 3) desire to socialize; and 4) desire to reflect, relax, and restore themselves psychologically (Grese et al., 2000). Recruitment materials that address these motivations might draw more participants. For example, if appealing to people's motivation to help the environment, the recruitment materials might say: "Is a healthy water supply important to you? Participate in a [Mill Creek Park] planting day and make a difference in your community." "This would be a rousing message to local environmentalists and others concerned about their community" (Evergreen, 2003). Additionally, outreach materials can appeal to groups with specific interests (Jacquart, 2010). For example, invasive species affect hunters, fishers, boaters, gardeners, and homeowners in different ways, and recruitment materials might be designed to reflect their different motivations.

3) Use visual aids. Recruitment efforts should use tangible examples, including photos and stories about normal and respected people doing stewardship work. Using visual aids such as before-and-after photographs, even if they depict some other site, helps show that real places have had real success (Frenzel et al., 2010; Jacquart, 2010). A simple logo can contribute to the group's easy recognition.

Figure 6.10: Before and after pictures of a stream restoration project. (Photo by Biohabitats, Inc.)

4) Recruit individuals. Bringing the recruitment message to individuals helps target specific audiences, shows that genuine people run the organization, and gives a starting point for word of mouth, which wide-net advertisements in newspapers can augment. For example, for a school naturalization project, one should speak with parents at drop-off and pickup times. Conversations with individuals can help a recruiter discover the special skills and experience that potential volunteers can offer, as well as what they desire (Frenzel et al., 2010). Recruiters should be sure to:

- Attend meetings where they can reach a variety of individuals with different interests.
- Always have information on hand so they are able to give people details they can share with others afterwards.
- Participate in community events and bring a display. More exposure means a larger audience from which to recruit. (Evergreen, 2003).
- Consider making door-to-door visits in the community (Huron Arbor Cluster, 2007).

- Recruit for special volunteer dates, such as Martin Luther King, Jr. Day of Service (January), National Volunteer Week (April), Corporate Season of Service (August through October), and Make a Difference Day (October).
- Ask volunteers to recruit their friends: "Ask current participants to attend a 'bring-a-friend'" event and recruit from the new faces. Having a connection with the project is a great reason to get and stay involved" (Evergreen, 2003). More than 50 percent of people who volunteer do so because they are asked by a friend, coworker, or acquaintance (McClintock, "Quick tips for Volunteer Management" in Evergreen, 2003).

5) Advertise on paper and online. Here we have several recommendations:

- Cast a wide net: advertise in local papers (such as The Dexter Leader, AnnArbor.com, community, senior center, and church bulletins, and university or high school papers (Huron Arbor Cluster, 2007).
- Use promotional flyers and ads (Evergreen, 2003). Based on the Recruitment Message, materials should be "simple and succinctly address the what, where, why, who and how of the project. Offer added incentives such as the chance to receive training and learn new skills. Don't forget to include all relevant contact information."
- Treat public-service announcements, human-interest news articles on radio or local television, and event listings as free forms of advertising.
- Use billboards liberally—for instance, at restaurants, supermarket boards, libraries, and coffee shops (Evergreen, 2003).
- Posting through existing volunteer groups. This technique, in fact, might work best. In Southeast Michigan, such organizations

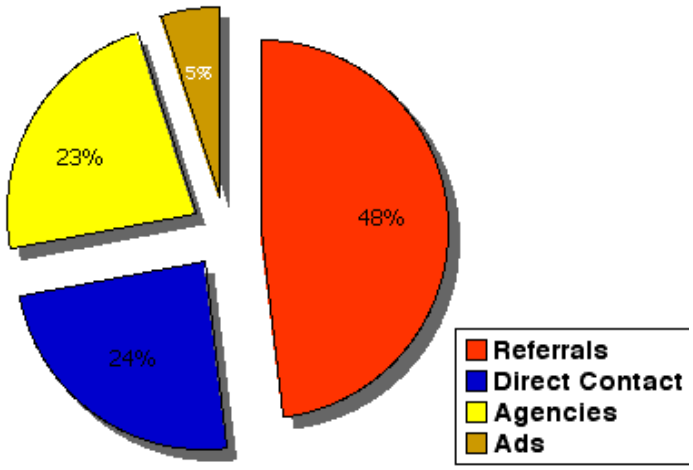


Figure 6.11: How job-seekers find jobs. (Chart by QuintCareers.com)

include the Metroparks, the Stewardship Network, Southeast Michigan Land Conservancy, or the Legacy Land Conservancy (formerly Washtenaw Land Trust). Some organizations use rapidly emerging social media such as Facebook and Twitter (Jason Frenzel, personal communication).

6) Recruit at events. One way to jumpstart awareness of the new volunteer program is through a volunteer initiation party with food and fun activities, such as tours of the site or slideshows of past work and fun times. This might coincide with the park's grand opening. These events are useful opportunities to enlist new volunteers (Suzie Heiney of Legacy Land Conservancy, personal communication). At such an event, people who sign up for a volunteer event mailing list enter into a raffle for prizes. People can also share their insights about the park with the volunteer program coordinator.

7) Engage and empower. If people are involved in the decision-making process for restoration and management plans, they may be more likely to return (Frenzel et al., 2010) and more likely to support the project (Monroe, 2005). For example, Bob Grese tells the story of a park neighbor who opposed any restoration work at all in a prairie across the street from her house, but especially prescribed burning. When she was involved and allowed to influence some aspects of the restoration—such as where *not* to burn—she became excited about the project and eventually became a park steward (Grese R. , 2008). A number of researchers in natural resource management recommend participation as a tool to encourage mutual understanding with neighbors who might oppose the project (Wondolleck & Yaffee, 2000; Monroe, 2005; De Young, 2010). In this way, stewardship programs could complement other education and outreach efforts.

6.3.3. Running an Actual Workday

A workday leader must welcome volunteers, provide basic information, and explain how the project will work. He or she should introduce new volunteers to one another and to staff members, as well as show them the layout of the site or office. Knowing where the bathrooms, food, and seating are, along with the schedule, can have a surprisingly profound

effect on a person's level of comfort (Huron Arbor Cluster, 2008). By reviewing the project plan with volunteers, the program coordinator can keep them fully informed.

Figure 6.12: Workday leader and volunteer. (Photo by Thomas O'Dowd)

Training: Many volunteers enjoy receiving training as a form of recognition. Training can include showing new volunteers techniques for working efficiently, while giving them a chance to meet one other, learn new skills, and brush up on old skills (Evergreen, 2003). Volunteers can undergo training on special training days, as they sometimes do at MBGNA, or on the day of the event, as at NAP. Either way, the workday leader should be prepared with tasks and tools, ready to engage volunteers as soon as they arrive (Wright, in Frenzel et al., 2010). After some training, volunteers should be allowed the freedom to make their experiences their own—for instance, more or less social, or faster or slower paced. Some supervision is necessary, however, as volunteers can perform tasks incorrectly and do damage to the site. One restorationist tells a story of a volunteer who picked hundreds of native Ohio Buckeye seedlings from the forest only because "[i]t just didn't look right." (Schultz,2010). This example shows the need for good supervision.

Time management: Lack of time can be the largest barrier to volunteering and can cause burnout (Evergreen, 2003). Hence the following recommendations:

- "Enforce a maximum 3-hr work period: leave them wanting more rather than exhausting them" (Huron Arbor Cluster, 2008).
- Make sure to take breaks for snacks, water, and discussion (Huron Arbor Cluster, 2007).
- Give volunteers the chance to learn beyond the training and "remember that the goal is as much environmental education as actual work" (Huron Arbor Cluster, 2008).

In other words, scheduling time for volunteers' other purposes—to learn, socialize, teach others, and so on—will encourage them to stay committed. Perhaps the adage to remember is "all work and no play make volunteering a dull game."

Food and fun: Volunteer program coordinators are especially keen on the need to provide volunteers with food (Frenzel, 2010). Balance seems to be a key aspect. Volunteer program coordinators should serve 1) both savory (esp. goldfish crackers) *and* sweet (esp. chocolate) foods; 2) both healthy and "junk" food; 3) foods for people with specific dietary needs, such as vegans or diabetics; and 4) both food *and* drink (esp. hot spiced cider). In the end, anything homemade—especially cookies—seems to pay off. As for fun, the project's needs should not interfere with a volunteer's experience: enjoyable activities and enjoyable co-workers create an incentive to return. Program coordinators should consider the following options to make volunteering a pleasurable experience:

- Allow volunteers the chance to switch to more enjoyable tasks.
- Create a social atmosphere through coffee, potlucks, picnics, birthdays, and built-in chat-time.
- Create project scrapbooks with project history, comments, and photographs. This can contribute to pride and a sense of belonging (Evergreen, 2003).

6.3.4. Retention

"Experienced and committed volunteers are the essence of a project. Keeping volunteers interested and engaged is what makes a good project great" (Evergreen, 2003). Experienced volunteers are familiar with the program and eliminate the need for constant training. These committed volunteers provide inspiration and leadership to new volunteers (Evergreen, 2003). However, volunteer retention in small towns has proven to be difficult. Sustainable sources of funding, volunteer burnout, leadership retention, a lack of young volunteers, and transportation all seem to be recurring problems. Volunteer opportunities, including leadership roles, in bigger nearby municipalities may draw away potential volunteers and leaders. A small group of individuals tends to take on most of the burden

leading to burnout (The Ontario Trillium Foundation, 2010). The following are some potential solutions.

Address Motivations. Retention is mostly about meeting the volunteer's needs. Some "argue that an improved understanding of what motivates volunteers is required to sustain volunteer commitments to environmental management in the long term"; the goal is to avoid disparity between volunteer expectations and organization objectives (Measham and Barnett, 2007). Again, volunteers tend to have the following motivations: 1) desire to help the environment, 2) exploration and learning, 3) reflection and restoration, and 4) personal and social goals (Grese et al., 2000).Some examples of how the coordinator can do this include granting volunteers certifications for official trainings, such as "certified chainsaw operator" and encouraging groups to volunteer together.

Fight burnout. It is normal for volunteers to come and go, and they will. Programs run the risk of creating a frequently changing pool of volunteers, or losing volunteers in which they have invested a great deal (Evergreen, 2003). One survey "confirmed that volunteer burnout is the most significant challenge facing community greening groups" (Evergreen, 2003). Volunteers can experience burnout if a volunteer coordinator ignores the less tangible side benefits of volunteering (Measham & Barnett, 2007) or volunteers' motivations. A program coordinator should try to keep updated on an individual by periodically assessing his or her interest level (Frenzel, et al., 2010). Specific actions that may be taken to avoid volunteer burnout are to work fewer hours, address important priorities first, and to take breaks, even if the day is busy (Evergreen, 2003).

Give volunteers a sense of accomplishment. Organizations can show volunteers the impact they have on the project and the environment by using stories, statistics, photographs of people doing work and relaxing together, tours of past and current successes, maps, and other materials (Grese et al., 2000; Evergreen, 2003; Pearson, 2010). This feedback is important for outreach and retention, and gathering it can be an activity for students or a task for a specific volunteer (Evergreen, 2003). A focus on accomplishments will encourage volunteers to keep coming back.

It is important to recognize volunteers' efforts. Again, training is a highly valued form of recognition, especially among outreach and communication volunteers. Social events are meaningful to longer-term volunteers; in fact, the most effective tactic may be to

Figure 6.13: "Piles of Weeds and empty plant pots are a great way to see how much has been done, even if the site doesn't look radically altered" (Evergreen, 2003); (Pearson, 2010). (Photo by Friends of the Rouge)

combining training with social events (Evergreen, 2003). Year-end summary reports and celebrations—perhaps during National Volunteer Appreciation Week in April—may add to volunteers' sense of accomplishment. Tara Griffith explained how MBGNA gave volunteers free massages one April, with masseuses gaining volunteer hours (Frenzel et al., 2010). Others suggest awards for significant restoration contributions, such as winning the Garlic Mustard Challenge or being knowledgeable about some part of natural history. Rewards can include t-shirts, food, kneeler pads, mugs, tote bags, magnets, and flair buttons. MBGNA even has a "freebie" table with donated gifts (Frenzel et al., 2010).

Encourage a sense of belonging. Connecting to other people in the group and other similar groups helps volunteers see how their work fits into the bigger picture. "Encourage a sense of camaraderie, shared interests, and shared contacts to create a stable, enjoyable, and welcoming group" (Huron Arbor Cluster, 2008). It is also helpful to recognize each volunteer's individual importance. Coordinators tend to treat volunteers as paid staff. For example, they invite them to the coffee or even incorporate their ideas as appropriate. Allowing people to choose their role within the group empowers them and can perhaps reveal a better fit within the organization. Program coordinators should work with individuals to help them choose another role if certain aspects of their participation are not going as planned. (Evergreen, 2003). Some internet

Figure 6.14: Volunteers celebrate on top of a pile of garlic mustard. (Photo by Legacy Land Conservancy)

resources might help improve communication may also promote group solidarity. These include: groups.google.com or yahoo.groups.com (listservs) and flickr.com (to share photos), (McKibben & students, 2007).

Team solidarity. Giving a volunteer group a collective identity may help in retaining them for more than a trivial amount of workdays. The program coordinator should name the program—perhaps "Friends of Mill Creek Park"—and create a logo for it. Particular crews can be given fun names such as "Recon Volunteers" or "Invasives Strike Team" (Hillmer & Mack, 2010). Activities like the Stewardship Network's Garlic Mustard Challenge (for which groups around the state try to bag the most Garlic Mustard) also could create camaraderie. Volunteer programs can also benefit from the team solidarity of existing groups such as Master Gardeners in-training, clubs at the University of Michigan or elsewhere in the area, sports teams, or businesses. Groups of volunteers could focus on a specific area and give it a name (Pearson, 2010). Such socialization requires more than introducing people to the area once; frequent, regular workdays lead to personal connections. Pearson suggests events include "pot lucks and beyond," possibly at the end of each stage of a project, in order to thank and reward the hard-working volunteers (Pearson, 2010).

Professional growth. Some volunteers may hope use their volunteer experience to improve their careers. One study found that employment relationships and experience were key motivating factors for volunteers. Strategies may include matching those interested in a learning a particular skill, for example, with others who can teach them that skill. Organizations can also provide volunteers with access to books, publications, and other resources such as information on internships (Evergreen, 2003), as well as give volunteers opportunities to meet with experts (Frenzel et al., 2010).

6.3.5. Monitoring

Ecological restoration is not about quick fixes, but requires studying the ecological trajectory an ecosystem is on, and trying to correct or maintain this trajectory. Monitoring plays an important part in this process before, during, and after any plants are pruned or planted. Different groups' desires and different projects require varying levels of inspection. Some projects might monitor transects or grids, established by markers or GPS points and re-

Figure 6.15: Monitoring can be fun. (Photo by Huron River Watershed Council)

visited at regular intervals. Some projects might require a less formal approach to monitoring—for example, a group of nature enthusiasts walking or canoeing through the park to check for certain rare or invasive species. If Dexter contracts out much of the large-scale restoration and trail-building work, monitoring crews will be useful in ensuring that the work is on track and that its benefits remain after the work is done. Contracting out monitoring is costly; there may be significant benefits in involving local people in the monitoring process (Zevit, 2007).

6.3.5. Criticisms of Volunteer Programs

Some wonder if there is a conflict in stewardship programs between the side benefits of volunteering and the main goals of protecting ecosystems. Fuchs (2004) wonders whether such programs sometimes give volunteers tasks beyond their means. For example, the Garry oak ecosystems in Canada contain 117 species at risk, most of which are "cryptic and/or difficult to identify, extremely rare, and poorly understood, which limits the applicability of non-expert stewardship to the overall recovery program" (Fuchs, 2004). Fuchs believes that work in these kinds of sensitive places should be conducted or at least led by expert scientists; but stewardship groups are often reluctant to engage in the "careful planning, assessment, and expert consultation" necessary before embarking on invasive species removal programs, "and stewards rarely have the resources, expertise, or interest to institute scientifically meaningful monitoring programs" (Fuchs, 2004).

Other criticisms include an overemphasis on social goals at the expense of ecological goals. "Although social goals and objectives clearly embody their own intrinsic values, it is perhaps self-evident to state that, within a recovery context, ecological goals and objectives must be the primary focus. Social goals and objectives, such as partnership- and community-building, and enjoyable or educational experiences, must be viewed as valuable side benefits and/or means to ecological ends" (Fuchs, 2004). Another cynical view is one that government agencies take advantage of volunteer efforts to perform tasks that governments

once did, especially ecological tasks such as monitoring (Measham & Barnett, 2007). While this is important to consider, municipalities like Dexter, Michigan, may have justified volunteer needs because of budget and staff limitations.

Dexter is not dealing with especially rare or sensitive ecosystems and is only in the planning stages of performing stewardship work along Mill Creek. Therefore, a combination of ecological and social goals for stewardship work seems appropriate, such as the goals of incremental removal of invasives and incremental growth of a volunteer community.

6.4. Recommendations

Our specific recommendations for the Mill Creek Park volunteer program are based on the S.M.A.R.T. criteria for program management. S.M.A.R.T is an acronym for goal-setting criteria: goals should be Specific, Measurable, Attainable, Relevant, and Time-bound. The criteria are useful in establishing and following up on program goals. S.M.A.R.T. goals for the Volunteer Program are detailed in following timeline. This timeline begins with "Year 1"; it is at the Village's discretion to determine which year is Year 1 (2010, 2011, 2012, etc.). Each task has a specific measureable outcome (for example, 2-4 workdays rather than "some" workdays), is attainable due to its reasonable level of ambition, is relevant to the ultimate goal of restoring Mill Creek as a functioning ecological and community location, and is bound to a specific time frame.

6.5. Suggested Timeline of Volunteer Program Activities

Year	Activity
Year 1	• Hire or appoint a volunteer program coordinator, who may be either a paid staff member or a volunteer. • The program coordinator reads this document, shadows Jason Frenzel, volunteer coordinator for natural area preservation NAP, Ann Arbor, and meets with Aunita Erskine of NAP/MBGNA. • Establish "Friends of Mill Creek" group as branch of the Parks and Recreation Committee or as a not-for-profit group. • Focus on planning, pre-restoration monitoring, acquiring tools and creating outreach materials. By the end of the first year, the five-year plan should be made official. • Have a table with information and a sign-up sheet at the grand opening of Mill Creek Park. Use the excitement of the moment to generate interest in park stewardship. • Advertise with Stewardship Network, with University of Michigan groups, and in local newspapers. Recruit 15 to 25 volunteers who volunteer at least once over the course of the year. • Run 2-4 workdays in specified area, perhaps with the assistance of a volunteer manager from another local group or a paid volunteer manager from the Stewardship Network. Borrow tools, or ask volunteers to bring their own. Take pictures! • Hold a year-one celebration party or pot-luck. Present awards to as many of the volunteers as possible—their numbers are small, and the entire program exists because of them. Show thanks!
Year 2	• Focus on training workday crew leaders, acquiring tools, and expanding membership of "Friends of Mill Creek" • Run 4-6 workdays, with committed "Friends" shadowing 1-2 (as part of training to become workday crew leaders), and perhaps workday crew leaders running 1-2 workdays. Take pictures! • Hire an Outreach Coordinator or delegate these duties to someone with interest/skills in print and digital media. Outreach coordinator expands reach of the program's advertising. Recruit an additional

	10-20 volunteers, for a total volunteer list of 25-45 people volunteering at least once and 15-25 volunteering at least twice. • Develop workday tub materials with the help of the outreach coordinator; some images and information in this Masters Project can be laminated and added to the tub. • Hold the annual celebration party/pot-luck. Present awards to workday crew leaders and the most committed volunteers (e.g., those who attend at least twice, recruit the most friends, or are particularly effective or efficient).
Year 3	• Avoid second-year burnout: survey volunteers about the program so far (including their satisfaction levels and ideas for improvement). Possibly also conduct systematic informal interviews. Results should be shared with volunteers via listserv and/or newsletter; suggestions should be specifically addressed and implemented as much as possible. • Outreach coordinator expands reach of the program's advertising, incorporating previous years' photos. Recruit an additional 10-20 volunteers, for a total volunteer list of 45-55 people volunteering at least once and 25-35 volunteering at least twice. • Annual celebration party or pot-luck. Present awards.
Year 4	• Write a grant proposal.
Year 5 and beyond	• Hold a 5-year celebration for the volunteer program.

Volunteer Program Recommendations

Forming	Hiring a Volunteer Program Coordinator
	Program Structure: Government Branch or Non-Profit
Planning	Start Simple!
	Learn from Local Experts
	Attend Huron Arbor Stewardship Network Cluster Meetings; WAVC Meetings
	Attend Stewardship Network Conference
	Define Mission of the Volunteer Program
	Create a Mission Statement (define balance of social and ecological goals)
	Set "S.M.A.R.T." Goals
	Make stewardship Project Plan
	Read the ER and OEA sections of this document, define Program goals
	Walk the site with Local Restoration Expert (e.g. Dick Wolinski, SNRE students, Metropark staff)
	Determine Stewardship Priorities (outcomes, locations, techniques)
	Volunteer "Job Descriptions" (See NAP example); May be an outreach activity
	Plans for Individual Workdays (many jobs with well-defined tasks and goals)
	Schedule of Workdays (either regular days or during holidays; mind the seasons)
	Fundraising and budgeting
	Purchase tools and supplies for the workdays, or borrow them
	Apply for grants
	Create Safety Plan
	Create a Liability Waiver
	Create an Emergency Action Plan with List of Important Contact Information
	Purchase/Develop First Aid Kits
	Organizational Policy on who uses Herbicides, Chainsaws, other sharp tools.
	Forming partnerships with other organizations (e.g. Metroparks, SNRE, LLC)
Outreach	Create a Recruitment Plan: priority groups and actions
	Create Outreach Materials
	Business cards with Names, Email Addresses, and Phone Numbers
	Flyers/brochures for handing out when tabling at events
	Create info sheets on the organization, its mission, volunteer opportunities/benefits
	Create Media Briefs
	Recruitment through Existing Groups
	Neighbors: American Legion, Knights of Columbus, Mill Creek Sports Shop, Bates Farm
	Service Groups: Dexter Churches, Boy Scouts, High School Seniors/Service club
	Restoration Groups: Wild Ones, SN, NAP, Legacy Land Conservancy
	Businesses seeking Make-a-Difference Days (Motor Companies)
	Self-help groups or social service agencies: Recruit Special Needs Volunteers
	Run informational events
	Make volunteer recruitment a major part of Mill Creek Park opening day
	Table at community meetings and anywhere else possible
	Retention
	Fight Burnout (make sure the activities are 'fresh' for each individual
	Show Accomplishments: Photos, Maps, Statistics
	Run celebration events
	At the end of each year if possible (potluck, free massages, etc.)
	Give awards (for commitment, special skills, or to everyone)
	Communicate Regularly with Volunteers
	Create a List-Serve
	Send personalized "thank you" notes to all workday attendees.
	Send updates about regular or one-time workdays/events

KEY
High Priority
Medium Priority
Lower Priority

Workday Leadership	Learn from Local Experts	
	Shadow NAP Coordinator+Park Steward; MBGNA+LLC Workdays	
	Prepare the Workday Tub (see list in sidebar above)	
	Run Workdays	
	First year: 4-5 workdays, mostly about training and fun	
	Ask Aunita Erskine to help lead, or pay a Stewardship Network workday coordinator	
	2-3 hour workdays with training, socialization, reflection, and debrief	
	Second Year: At least 5 workdays.	
	Develop Workday Leaders from existing volunteers (they shadow Program coordinator's workdays).	
	Workday Crew Leaders get certified in Herbicide Use and Chainsaw (2nd year and beyond)	
	Washtenaw Extension Training	
	Keep Track of Events, Activities, and Progress	
	Keep a detailed sign-in record (see NAP example)	
	Take as many photos as possible (people working and before/after pictures of projects)	

KEY	
	High Priority
	Medium Priority
	Lower Priority

Monitoring	Learn From Local Professionals	
	Shadow Leslie Science Center Photo-Monitoring Day (e.g.)	
	Shadow NAP Monitoring Day	
	Shadow Huron River Watershed Council Monitoring Day	
	Shadow Legacy Land Conservancy	
	First Year: Initial Documentation	
	As many Photos as possible	
	Create checklists of plants and animals (walk with local experts)	

KEY	
	High Priority
	Medium Priority
	Lower Priority

Glossary

accessible
Able to be reached, read, understood, traveled on, or otherwise obtained by individuals with varying levels of ability

allelopathy
The inhibition of growth in a species of plant due to the presence of chemicals produced by another species

biodiversity
The variation of species within a given ecosystem or area

conservation
Management and protection of the environment and natural resources in ways that prevent the loss or deterioration of those resources

conservation biology
The scientific study of how to maintain, protect, and restore biological diversity (the diversity of life on Earth)

controlled burn (prescribed burn)
Intentionally setting fire to an area to simulate a natural disturbance

constructivist theory
Learning theory in which children learn by constructing their own knowledge through inquiry, experiences, and questions

cue of care
A sign or symbol left in place that indicates the maintenance or ownership of an area

disturbance
A discrete event that disrupts the structure of a population, community, or an ecosystem and alters the physical environment, substrate, or resources (White and Pickett 1985). Examples: fire, successful colonization of an invasive species

dry-mesic forest
Forest ecosystem characterized by soils that exist along a gradient from dry to moist (mesic)

ecological enhancement
A partial measure to restore an ecosystem – one that does not return the ecosystem to a state of wholeness

ecological health

"The condition of an ecosystem in which its dynamic attributes are expressed within 'normal' ranges of activity relative to its ecological stage of development" (SER 2004: 7). The 'dynamic attributes' are the ecological processes and functions of the ecosystem, such as nutrient cycling, decomposition of dead matter, transformation of light and chemical energy, conversion of carbon dioxide into sugars by photosynthesis, and control of microclimate.

ecological integrity

A condition in which an ecosystem has its characteristic biodiversity, composition of species, and community structure, and in which it can completely sustain its normal processes and functions (SER 2004: 7).

ecological restoration

The return of an ecosystem to a state of wholeness whereby the ecosystem exhibits integrity, health, self-organization, and self-sustainability.

ecological self-organization

When the functions and development of the ecosystem are generated from its internal processes

ecological self-sustainability

The ecosystem can persist over long time periods even though some internal changes may occur in response to changes in the environment

ecology

The scientific study of the interactions and relationships between organisms and between organisms and the non-living environment

ecosystem

A complex association of living organisms and the non-living environment that all interact with each other, and which is characterized by flows of matter and energy among living and non-living components

ecosystem services

The goods and services that are produced by ecosystems and upon which humans depend. Examples of ecosystem service include goods such as plants, animals, fungi, soil, and water, and include services such as air purification, oxygen production, soil formation, water purification, and flood protection.

floodplain

Land area near a river and stream which experiences periodic flooding during times of high water flows

fluvial

Regarding a river or stream

geographic information system
Integration of cartography and database management to display and analyze information linked to location using mapping software

geomorphology
The study of the characteristics, origin, and development of land forms

glyphosate
A non-selective herbicide that kills any green vegetation it comes into contact with

hydrology
The study of the occurrence, movement, distribution, and properties of water throughout the Earth

impermeable
Unable to allow water to pass through

inquiry-based learning
A learning approach in which learners actively engage in an experience, question, seek information and use this information to build their knowledge

interpretation
A program that seeks to explain an object, phenomenon, or area in a way that brings greater understanding to the audience

invasive
Term which describes species which are so aggressive that they outcompete and displace other species for space, light, and nutrient resources

landscape
Two or more ecosystems that interact by means of the flows of energy, water, nutrients, and living organisms. Also referred to as an 'ecological landscape'.

low impact development
A fundamental paradigm shift from contemporary stormwater management to the inclusion of materials and functions that attempt to mimic the natural hydrology of the landscape by retaining water where it falls and allowing infiltration

museumification
The discouraging of human interaction with nature through barriers, restrictions, or methods of description

outfall
Downstream end of pipe where stormwater is discharged back onto the landscape or into a body of surface water

pervious
Open to water flowing through

regime
The frequency or pattern of a natural disturbance

resilience
Ability of an ecosystem to recover after an ecological disturbance

riparian
Regarding the ecosystem area or zone in proximity to and influenced by a body of water

serif
Projections from the main strokes in certain fonts such as Times New Roman

shrub-carr
Type of wetland dominated mainly by shrubs and other woody vegetation

stakeholders
Individuals that will be affected by or served by the program or project in question

stewardship
Volunteer work by/for municipalities or landowners acting on ecological values

stormwater management
Overseeing activities for controlling stormwater runoff for the purposes of mitigating downstream impacts

stormwater runoff
The portion of precipitation which flows overland instead of infiltrating into the ground or evaporating or transpiring back into the atmosphere

subwatershed
A portion of a watershed which is draining through or to a particular point in the land

sustainability
the ability of a system to maintain processes, functions, and productivity over time

transpiration
Loss of water from plants to the atmosphere

watershed
The entire area of land draining into a particular river system

Appendices

APPENDIX A: Key Findings about Rivers and Streams from Scientific Research

Summarized from: Allan and Castillo (2008: Chapters 1 and 14) and Wiens 2002.

General Finding	Specific Findings
Rivers and streams are ecosystems and ecological landscapes that are heterogeneous (not uniform in structure and function).	• Within each system, discrete patches (such as habitat patches) exist. • Within each system, boundaries or 'ecotones' between patches often exist. • Variation exists among patches in terms of their chemical, physical, and biological characteristics (e.g., nutrient flows, productivity, and quality of habitat for plants and animals). • As a landscape consisting of two or more ecosystems, each river or stream is often heterogeneous at a variety of spatial scales.
Fluvial systems are hierarchical in their structure and function.	• Processes at the patch scale (within and between patches) combine and contribute to patterns at the higher scales. • Patterns and processes at the larger scales affect patterns and processes of patches (smaller scales).
River and stream systems are highly open systems.	• They receive energy (e.g., light and organic matter) and material inputs (e.g., sediments) from external sources. • They transport organic matter, nutrients, and sediments downstream and onto riparian and floodplain areas. • They exhibit extensive connectivity in three dimensions: longitudinal (upstream-downstream), lateral (between stream channel and adjacent land), and vertical (between surface and underground areas, especially for groundwater flow). • Both abiotic (non-living) and biotic (living) processes are affected by interactions and exchanges between patches across the landscape.
Both time (temporal) and space (spatial) scales are important in understanding fluvial systems.	• Both temporal and spatial scales are important in understanding the hydrologic and geomorphologic factors that are critical to the ecological processes of river and stream ecosystems and landscapes.
Models are useful tools for understanding rivers and streams.	• Models can help build and strengthen our understanding of the structure, function, and processes of these systems, even though fluvial systems exhibit much diversity.

APPENDIX B: Reasons for the High Frequency of Low Ecological Success in Ecological Restoration Projects on Streams and Rivers

Reason For Low Success	Details and References

Project too limited in focus.	• Restoration project has too narrow a focus (National Research Council 1992).
	  ○ Example: Some projects focus only on fish populations and fishery enhancements (National Research Council, 1992; Katz et al., 2007).
	  ○ Example: Some projects focus primarily on water quality and agricultural impacts on riparian areas (O'Donnell & Galat, 2007 on non-navigable rivers in Upper Mississippi Basin) or on water quality management and flow modifications (Follstad-Shar et al., 2007 on fluvial systems in southwestern U.S.)
	• Some scientists have suggested that heavy reliance on one methodology, such as Rosgen's method, especially if the method is not applicable to all stream systems, will continue lead to failures that could be avoided (see comments in Malakoff, 2004).
	  ○ Rosgen approach in stream restoration is a widely used approach based nearly entirely on restoring geomorphic characteristics of stream channels, but it focuses very little on biotic processes (Hilderbrand et al., 2005). "Although stabilization of the stream channel is quite important, stopping at a geomorphic end point is similar to ensuring that mining excavations in terrestrial landscapes are filled after a job is completed, and then not proceeding with revegetation." (Hilderbrand et al., 2005).
	• Most restoration projects fail because they do not restore or reestablish the proper disturbance regimes and the proper physical and ecological processes (Schiff, 2005 cited in Smith et al., 2008).

Reason For Low Success	Details and References
Team of experts with too little diversity of expertise.	• Low success often occurs because of limited number of experts on a project team, especially during the design phase. Too many fluvial restoration efforts in the past have relied primarily on engineers and engineering approaches (Palmer et al., 2003). • Palmer et al. (2003: 3) emphasized the need for multidisciplinary team of experts in restoration projects, in place of the typical reliance on engineers: "To be most successful, teams should be composed of geomorphologists, engineers, and ecologists". • Rationale for multidisciplinary teams for stream restoration projects: • Recommendations for multidisciplinary teams are supported by peer-reviewed ecological and geomorphic research. o Environmental context is crucial for many local and regional systems – and ecologists and geomorphologists understand the importance of this environmental context (Palmer et al., 2003). For example, fluvial geomorphologists understand importance of local geomorphic dynamics and can incorporate that understanding into restoration plan and actions in fluvial systems (Palmer et al., 2003). Also, need fluvial ecologists on restoration teams because they understand how local biodiversity, community composition, and ecological processes are inter-twined with dynamics of water flow and sediments, as well as local context of hydrology and geomorphology (Palmer et al., 2003).
Used limited and less comprehensive methods to understand flow regimes and sediment transport.	• Reliance on modeling or equation-based approaches to understand channel dynamics and sediment regimes for restoration work is often insufficient (Palmer et al., 2003). o Fluvial geomorphologists understand the importance of local geomorphic dynamics and can incorporate that understanding into restoration plan and actions in fluvial systems better than sole reliance on equation-based approaches (Palmer et al., 2003).
Lacked useful assessment data to evaluate true level of success of the project.	• Lack of baseline (pre-restoration) data and/or lack of post-restoration data (National Research Council, 1992). • Number of parameters was too few or too qualitative (Palmer et al., 2003). • Assessment parameters did not focus on the ecological functioning of the stream or river (Palmer et al., 2003). • Time frame used for assessing the success of the restoration via post-restoration monitoring was too short (National Research Council, 1992).
For urban streams, lacked a meaningful incorporation and integration of economic, social, and political factors.	• Restoration of urban streams has usually focused on just ecological and hydrological factors, and not enough on economic, social, behavioral, and political factors that are associated with use of the system and potential success of restoration projects (Walsh et al., 2005).

APPENDIX C: Myths of Ecological Restoration

Summarized from Hilderbrand et al. (2005).

Myth	Description
Myth of the Carbon Copy	• Adherence to the belief that an ecosystem can be restored to a previous or an ideal state, typically to a state prior to significant human disturbance. Seen in a variety of restoration projects in the United States. • This myth has its roots in notions of ecological succession that leads to a specific endpoint, though that is not necessarily what ecologists consider to be true for many communities. • Alternative to trying to create the system prior to some disturbance is to restore the system to be functionally equivalent rather than taxonomically equivalent (i.e., system is same or similar in function to what it was before, even though it does not have all of the same species present).
Myth of the Field of Dreams	• If a project puts too much emphasis on restoring physical or structural conditions and does not consider other ecological parameters, then the restoration efforts are rooted in this myth. • Those believing in this "field of dreams" approach to restoration ignore the fact that some uncertainty exists when building ecological communities or ecosystems by assuming that assembly processes of a community or ecosystem simply follow a predictable, repeatable trajectory. • Restoring physical features and structural habitat can be a useful step, but should not be the only step for most restoration projects. ○ Example given by Hilderbrand et al. (2005): Rosgen approach in stream restoration: widely used approach based almost entirely on restoring geomorphic characteristics of river/stream channels, but which focuses little on biotic processes.

Myth of the Cookbook	• Refers to following a prescribed methodology, especially the over-use of a restoration method that is in the published literature or continued use of a methodology that is a locally unsuccessful restoration method.
	• Over-use of recipes for restoration, such as engineering approaches or the Rosgen method, are common in stream restoration projects.
	• Possible problems with cookbook methods:
	  ○ Ignores idiosyncrasies of the given system/area being restored – so one method does not fit all situations even though they may look similar.
	  ▪ These idiosyncrasies include different community assembly rules/mechanisms and unique ecological history.
	  ○ Ignores uncertainty within the given system/area being restored.
	• Advantages of cookbook methods:
	  ○ Easy to use when the restoration project has very limited time, money, or information.
	  ○ May be better than doing nothing.
	• Alternative approaches to avoid this myth:
	  ○ Use a management or restoration method that varies across the landscape being restored. This recognizes the difficulties of predicting an ecosystem's specific responses to modification and restoration.
	  ○ Also, using restoration techniques that mimic the features or processes of the specific natural system could likely lead to more successful restoration and add to the system's resilience.

APPENDIX D: Ecological Restoration Goals and Objectives in the Mill Creek Park Recreation Master Plan

Goal: "Restore and protect the Mill Creek and its watershed consistent with today's best practices of system stewardship." (Mill Creek Park Recreation Master Plan 2009: 18)

Objectives:

1. To improve water quality and to improve erosion control.
- Will involve use of stormwater management methods such as bioretention and biofiltration.

2. To maintain long-term sediment control by developing an appropriate process.

3. To restore native habitat.
- Includes restoring wetlands and 'bottom' vegetation.

4. To restore and improve the natural riparian buffers of Mill Creek within the project area.

APPENDIX E: Key Design Opportunities for Ecological Restoration or Enhancement as Proposed in the Mill Creek Park Recreation Master Plan

I. Habitat Enhancement Zones

A. Focus of the Habitat Enhancement Opportunities

1. To replace habitat that was lost because of removal of the dam.
2. To restore the spawning, rearing, and feeding functions of the habitats needed by aquatic species.
   - To be accomplished by stabilizing the stream banks and channel bottom of Mill Creek.
3. To conduct pre-treatment of stormwater before it is discharged from Dexter into Mill Creek.
4. To reduce the sediments deposited into Mill Creek and wetlands by the small tributary originating at the Baker Road stormwater outfall.
5. To provide environmental education and wildlife viewing. Also, improve habitat for migratory birds, waterfowl, and mammals.
6. To control plant species that are invasive and exotic.

B. Summary of Approaches

- Will take a 'phased approach' for implementation.
- Will likely require assistance of volunteer groups to aid in control of invasive species, installation of vegetation, stabilization of streambank, construction of habitat structures, and monitoring (long-term).
- Will require heavy construction equipment (backhoes, front-end loaders, and small bulldozers) and licensed contractors for some habitat improvements. These improvements include:
  - Earthwork for facilities to pre-treat stormwater.
  - Some habitat enhancements associated with creek bottom restoration.
  - Some habitat enhancements associated with streambank stabilization.
- Priority for construction: high to low depending on available funding, successful construction of secondary trails, and needs of local schools.

II. Riparian Buffer

- The Master Plan seems to refer to this as primarily the habitat restoration right along the stream edge, not necessarily all of the ecological riparian zone. Overall area is between former dam site and Shields Road.
- Requires stabilization of streambanks.

APPENDIX F: Objectives Proposed in the Grant Application Submitted by the Village to the NOAA Coastal and Marine Habitat Restoration Project Grant

Objectives of the Village's Grant Application

A. Improve Habitat Conditions Within The Formerly Impounded Stream Channel Of Mill Creek (4,000 feet of stream channel formerly impounded by the dam).

B. Facilitate Connections Between Fish Communities Of The Huron River Watershed And Mill Creek.

C. Provide Habitat For Waterfowl And Amphibians By Restoring And Enhancing Riparian Wetlands Habitats In Formerly Impounded Areas.

D. Improve Water Quality By Implementing Stormwater Management Practices.

E. In Conjunction With The Dexter School System, Provide Opportunities For Environmental Education.

F. Engage Other Stakeholders, Including Neighboring Land Owners, In Implementing Protective Measures and Restoring Stream Habitat On Private Property.

APPENDIX G: Key Project Elements and Restoration Methods as Proposed by the Village in their Grant Application Submitted to the NOAA Coastal and Marine Habitat Restoration Project Grant

A. Stream Restoration and Fisheries Habitat Enhancement

1. Basic Plan.

- Stabilize stream channel, stabilize streambank, provide flow diversity, increase channel habitat diversity, increase recruitment of woody debris, restore riparian buffer vegetation, and increase stream shading.
- Use natural materials (e.g., natural stone, coarse woody debris, native vegetation).

2. Methodology

- Use detailed topological surveys, supplemented by field-collected data on channel cross-section and profile.
- To guide the design process: develop hydrologic and hydraulic modeling; use Rosgen's natural channel design principles and adapt them to local conditions.
    - p.5, NOAA grant application: "The design team has extensive experience with these principles and has used them successfully" on other projects.
- Habitat restoration measures to be "considered during development of the plan", but not limited to (quoted from p. 6, NOAA grant application):
    - "Restoration of the high-quality riffle-pool sequences that were part of this high gradient reach of the creek before it was dammed".
    - "Use of soft-shore bioengineering techniques such as brush layering, live fascines, and root wads and installation of stream buffer plantings to stabilize eroding streambanks and provide stream shading".
    - "Installation of habitat structures such as native boulders and coarse gravel substrates, lunker structures, rock and log vanes, J-hooks and rock or log weirs that incorporate coarse woody debris, native stone and other natural materials".
    - "Installation of stone dikes, and rock or log weirs where needed to address potential channel headcutting and provide additional in-stream habitat".

B. Riparian Wetland Restoration: Phase 1 Improvements

1. Basic Plan

- Restore wetland habitat that will be lost as result of dam removal. Restoration done in conjunction with improvements on riparian buffer.
- Use restored wetlands to store floodwater.
- Use restored wetlands to treat stormwater from adjacent development within Dexter, thereby assisting with improvement of water quality in Mill Creek.

2. Methodology

- Spoil piles along stream's edge (on both sides of stream) provide an elevated area that can hold back flow of stormwater so that wetlands could treat the stormwater. It seems that JJR and ECT's plan is to maintain the dredge spoil piles along the streambank and to protect them from erosion (currently some erosion/bank slumping is occurring). Eradicate non-native invasive species (most likely using herbicides and prescribed burns; also, use of purple loosestrife beetle).
- Monitor the programs to eradicate invasive plants and restore wetland habitat.

C. Riparian Wetland Restoration: Phase 2 Improvements

1. Basic Plan

- Same as Phase 1.

2. Methodology (Dexter's NOAA grant application, p. 7)

- Phase 2 "… consists of permitting, developing the construction documents and implementation of the wetland habitats shown on the Mill Creek Park Recreation Master Plan …". Project to be competitively bid.
- Determine the elevations of spoil piles and adjacent wetland areas by using detailed topological surveys.
- Determine locations of stormwater outlets that presently discharge into proposed wetland areas by using detailed topological surveys.
- Determine the elevation of Mill Creek during flood events by using hydrologic and hydraulic models. This information to be used to establish the appropriate height of the berm and proposed outlet structures that will enable overflow of flood waters into the wetland areas.
    - It seems that the "berms" might be part of the dredge spoils piles.
- Determine the amounts of stormwater discharges by using hydrologic and hydraulic models.
- "Key areas within the habitat restoration area may be excavated to provide for submergent wetland habitats and the excavated material utilized to create higher elevation islands to increase overall habitat diversity."
- "An existing tributary that has been severely eroded due to strormwater discharges will be stabilized and a revegetation plan utilizing native species will be prepared to restore native wetland plant communities and stabilize streambanks where needed."

D. Monitoring

1. Basic Plan (Dexter's NOAA grant application, p. 9)

- To measure the ecological and economic benefits of the Project.
    - Will be conducted during construction phase.

2. Methodology (Dexter's NOAA grant application, p. 10)

- Fisheries:
    - Biannual fish sampling to estimate: species abundance, species composition, overall diversity, and percentage of gamefish.
    - Use Peterson mark-recapture methodology or similar methods.
- Mussels and Macroinvertebrates:
    - Mussels: Sample bi-annually; measure species composition and abundance.
    - Macroinvertebrates: Use volunteers in Huron River Watershed Council's "Adopt-a-Stream" program to sample macroinverts using existing sampling procedures.
- Stream Habitat Quality:
    - Document annual changes in visual appearance of habitat enhancements by using photomonitoring locations.
    - Assess cross-section shape of stream and qualitatively assess bank stability, both biannually, by using permanent transects.
    - Measure riffle-pool formation and assess % of pool and run habitats by conducting longitudinal surveys on biannual basis.
- Wetland Habitat Quality:

- Use MDEQ protocols to assess success of wetland mitigation areas by using transects, vegetation plots, and photomonitoring points.
- Measurements to include: species lists, species cover, number and % of invasive species, and floristic quality index.
- Done on “as needed” basis by volunteers and hired maintenance contractors (local). Hired workers to be paid from funding other than NOAA funds obtained by Village of Dexter.

APPENDIX H: Criteria for Ecologically Successful River Restoration

Reproduced and quoted directly from Palmer et al. (2005, p. 214, Table 1).

"**Table 1.** A provisional summary of guidelines that could be used to evaluate the five criteria for ecologically successful river restoration. The list is not comprehensive. The effort, cost and complexity of the evaluation process should be commensurate with ecological risk, project cost and societal concern. Simple and inexpensive methods should be employed whenever possible. The indicators for each standard are illustrative of possible assessment tools for each criterion, the specific indicator selected for a project will depend on the project focus (e.g. biological, water quality, geomorphic)"

Criteria	Evaluation guidelines	References
Guiding image of dynamic state	The guiding image should take into account not only the average condition or some fixed value of key system variables (hydrology, chemistry, geomorphology, physical habitat and biology) but should also consider the range of these variables and the likelihood they will not be static. It should explicitly recognize human-induced changes to the system, including changes in the range of key variables. Ideally, this plan should consider local as well as watershed-scale stressors, and should consider how much local restoration can contribute to watershed-level restoration. Indicators: presence of a design plan or description of desired goals that are not orientated around a single, fixed and invariable endpoint (e.g. static channel, temporally invariant water quality).	Poff *et al*. (1997), Bohn & Kershner (2002), Jungwirth, Muhar & Schmutz (2002), Gilman, Abell & Williams (2004), Poole *et al*. (2004)
Ecosystems are improved	Appropriate indicators of ecological integrity or ecosystem health should be selected based on relevant system attributes and the types of stressors causing impaired ecological conditions. The expected rate of improvement will vary with the degree of impairment, the degree to which restoration reduces key stressors, and the sensitivity of the selected indicators to changes in stressor levels. Change may be relative to a reference site or away from a degraded state (see text). Indicators: water quality improved; natural flow regime implemented; increase in population viability of target species; percentage of native vs. non-native species increased; extent of riparian vegetation increased; increased rates of ecosystem functions; bioassessment index improved; improvements in limiting factors for a given species or life stage (e.g. decrease in percentage fines in spawning beds or decrease in stream temperature).	Barbour *et al*. (1999), Karr & Chu (1999), Middleton (1999), Bjorkland, Pringle & Newton (2001), Bailey, Norris & Reynoldson (2004), Lepori *et al*. (2005)
Resilience is increased	System should require minimal on-going intervention and have the capacity to recover from natural disturbances such as floods and fires, and to recover from further human encroachment. Indicators: few interventions needed to maintain site; scale of repair work required is small; documentation that ecological indicators (see 2 above) stay within a range consistent with reference conditions over time.	Holling (1973), Loucks (1985), Gunderson (2000), Weick & Sutcliffe (2001)
No lasting harm	Pre- and post-project monitoring of selected ecosystem indicators (see 2 above) should demonstrate that impacts of the restoration intervention did not cause irreversible damage to ecological properties of the system. Indicators: little native vegetation removed or damaged during implementation; vegetation that was removed has been replaced and shows signs of viability (e.g. seedling growth); little deposition of fine sediments because of implementation process.	Underwood (1996), Biggs *et al*. (1998), Sear, Briggs & Brookes (1998), Steinberger & Wohl (2003)
Ecological assessment is completed	Ecological goals for project should be clearly specified, with evidence available that post-restoration information or data were collected on the ecosystem variables of interest (see 2 above). The level of assessment may vary from simple pre- and post-comparisons to rigorous statistically designed analyses (e.g. using before–after, treatment–control or both types of comparisons) but results should be analyzed and disseminated. Indicators: available documentation of preconditions and post assessment.	Kondolf (1995), Bash & Ryan (2002), Downs & Kondolf (2002), Downes *et al*. (2002), Gilman, Abell & Williams (2004)

APPENDIX I: Active River Area (ARA) Framework: Summary of Key Aspects and Components

Based on Smith et al. (2008)

Overview: What is the basic approach of the ARA framework?

- It identifies the areas of a watershed that are important for maintaining physical (e.g., geomorphological) and ecological processes that create, maintain, and alter the diverse habitats and environmental conditions in the fluvial system (Smith et al., 2008: 3). Uses GIS (Geographic Information System) modeling to help identifying the essential places where those critical processes occur.
- After identifying those areas, the ARA framework helps form the basis for making decisions about policy formation, protection, restoration, and management of the watershed (Smith et al. 2008: 2).
    - Thus, the ARA framework assesses the physical and ecological processes within the watershed and helps make decisions about conservation, management, and restoration within the system.
- U.S. EPA lists different types of assessments that evaluate the health and integrity of the components of freshwater ecosystems; classifies ARA framework as a type of landscape condition assessment. "Landscape condition assessments identify green infrastructure that provides important ecosystem services such as natural flood storage, pollutant filtering, fish & wildlife habitat, and carbon storage." (U.S. EPA Web site: http://www.epa.gov/owow/nps/healthywatersheds/examples.html).

Fundamental Steps (see Smith et al., 2008: 3-19)

- First, the 'active river area' is defined by describing the five primary components of the area: 1) material contribution areas, 2) meander belt, 3) floodplains, 4) terraces, and 5) riparian wetlands. Smith et al. 2008 provide clear explanations of these components of the active river area and key processes within each component in their Tables 2.1, 2.2, and 2.5, as well as their text on pages 4-19.
- Second, dominant physical (e.g. hydrology, sediment transport) and ecological processes and key attributes of these components are defined for the active river area.
- Third, relationships between the positions of each active river area component in the watershed and the dominant process and key habitat characteristics of each of those components are illustrated.
- Fourth, GIS modeling develops a spatial model of important areas that contain both physical habitats and the space necessary for key processes, attributes, and disturbance regimes that are all necessary for maintaining a healthy system and protecting biodiversity.
- Finally, the information and maps are used in the decision-making processes involved in conservation, management, and restoration of fluvial ecosystems and their biodiversity.

Describing the Dominant Processes and Attributes

- The ARA framework uses the current scientific knowledge about the dominant physical and ecological processes and the key attributes of fluvial systems to help maintain and restore the integrity and health of streams and rivers.
- Knowledge of the following processes and attributes are used in the ARA framework: hydrology, sediment transport, transport and transformation of organic and inorganic materials, connectivity, and water quality/temperature.

Watershed Position and Watersheds As Nested Hierarchies

- Watershed position and watershed hierarchy affect the interaction between physical and ecological processes and the interaction between these processes and key attributes.
- The fundamental idea here is that the active river area components and their dominant processes and habitat features have a spatial context – the physical location and position of these components, processes, and habitats influence their interactions and functions. This understanding is valuable to further understanding the primary components of the active river area.

Delineating the Active River Area

- The actual spatial extent (size and position) of an active river area is determined mainly by hydrology (e.g. flow characteristics), stream power (discharge times slope of the surface or channel), and capacity to transport sediment. These factors influence many fluvial processes and habitats.
- Delineating the active river area requires the use of key GIS techniques.
    - First, GIS methods, including the use digital elevation models (DEMs), are performed to identify floodplains, terraces, and meander belts.
    - Second, GIS is used to identify riparian areas beyond just the areas of floodplains wetted by over-the-bank flows, but that have a certain likelihood of being wet because of 1) runoff from nearby upland areas and/or 2) groundwater near or at the surface.
    - Lastly, GIS is used to add the material contribution layers.
- Smith et al. (2008) emphasized that their methodology for delineating active river areas is not the sole, authoritative method. Other methods or approaches could work as well as their method for delineating active river areas and that further research and modification could produce more effective methods of delineation.
- Field assessment of stream reaches, subwatersheds, and riparian areas is needed. Field data is collected so the following can be identified and evaluated: existing conditions, changes in the area from natural processes (physical and ecological) and attributes, and the likelihood for actual protection and restoration projects.
- Many different tools and techniques can be used by practitioners to assess and then conduct the restoration techniques for the given project. Smith et al. (2008) reviewed a variety of these manuals and handbooks, which goes beyond the scope of this current report.

APPENDIX J: Matrix of Recommended Native Plants

type	botanical name	common name	heighth	width	ecological comment	availability	where to use in bioswale?
fern	*Adiantum pedatum*	Northern maidenhair	12-24"	--	Shelter for amphibians	widely available	--
fern	*Asplenium platyneuron*	Ebony spleenwort	1-2'	--	Interesting foliage	--	--
fern	*Athyrium filix-femina*	Common ladyfern	2-3'	--	Attractive	widely available	upland
fern	*Cystopteris bulbifera*	Bulblet bladder fern	48"	--	Rock loving fern	available	--
fern	*Cystopteris fragilis*	Brittle bladder fern	1-3'	--	Evergreen	available	--
fern	*Dryopteris carthusiana*	Shield fern	18-36"	--	Attractive	available	--
fern	*Dryopteris goldiana*	Goldie's woodfern	--	--	--	--	--
fern	*Matteuccia struthiopteris*	Ostrich fern	3-5'	--	Attractive	widely available	--
fern	*Onoclea sensibilis*	Sensitive fern	18-24"	--	Shelter for amphibians	widely available	wet meadow, upland
fern	*Osmunda cinnamomea*	Cinnamon fern	2-4'	--	Nesting material	widely available	wet meadow, floodplain, upland
fern	*Osmunda claytoniana*	Interrupted fern	6'	--	Produces brown spores in June	available	wet meadow, floodplain
fern	*Osmunda regalis*	Royal fern	2-5'	--	Interesting foliage	available	wet meadow
fern	*Phegopteris hexagonoptera*	Broad beech fern	1-2'	--	Attractive	available	--
fern	*Polystichum acrostichoides*	Christmas fern	2-3'	--	Attracts Ruffed Grouse	widely available	--
fern	*Pteridium aquilinum*	Bracken fern	1-6'	--	Edible, shelter for small animals	--	upland
fern	*Thelypteris palustris*	Eastern marsh fern	--	--	Attracts birds	--	wet meadow, floodplain
grass	*Andropogon gerardii*	Big bluestem	4-8'	--	Host plant for Delaware Skipper and Dusted Skipper	available	wet meadow, upland
grass	*Brachyelytrum erectum*	Bearded shorthusk	--	--	Host plant for Northern Pearly Eye	--	--
grass	*Bromus latiglumis*	Earlyleaf brome	1-6'	--	Florets during the summer	--	--
grass	*Carex crinita*	Fringed sedge	2-5'	--	Food for many birds	--	wet meadow
grass	*Carex gracillima*	Graceful sedge	--	--	--	--	--
grass	*Carex grayi*	Gray's sedge	--	--	--	--	--
grass	*Carex muskingumensis*	Muskingum sedge	2-3'	--	--	widely available	--
grass	*Carex pensylvanica*	Pennsylvania sedge	8"	--	Attracts birds	widely available	--
grass	*Carex sprengelii*	Sprengel's sedge	18-24"	--	Food for many birds	widely available	upland
grass	*Carex stipata*	Awl-fruited sedge	2-3'	--	Food for many birds	available	wet meadow
grass	*Carex stricta*	Tussock sedge	1-3'	--	Host plant for several moths	available	emergent
grass	*Carex vulpinoidea*	Fox sedge	1-3'	--	Attracts birds	--	wet meadow
grass	*Elymus canadensis*	Canada wildrye	2-4'	--	Host plant for Zabulon Skipper	available	upland
grass	*Elymus hystrix*	Eastern bottlebrush grass	--	--	Host plant for Northern Pearly Eye	--	--
grass	*Elymus villosus*	Hairy wildrye	3-6'	--	--	--	--
grass	*Eragrostis spectabilis*	Petticoat climber	8-18"	--	Red and purple blooms in the Fall	available	--
grass	*Glyceria striata*	Fowl mannagrass	--	--	--	--	wet meadow
grass	*Juncus effusus*	Common rush	--	--	Attracts birds	--	emergent, wet meadow
grass	*Juncus tenuis*	Poverty rush	1-3'	--	used by waterfowl, muskrats, and fish	--	upland
grass	*Koeleria macrantha*	Prairie Junegrass	1-2'	--	Attracts birds	available	--
grass	*Panicum virgatum*	Switchgrass	4-5'	--	Host plant for Delaware and Dotted Skippers	widely available	wet meadow, floodplain, upland
grass	*Schizachyrium scoparium*	Little bluestem	2-3'	--	Host plant for several Skipper moths	widely available	upland
grass	*Schoenoplectus acutus var. acutus*	Hardstem bulrush	9-15"	--	--	available	--
grass	*Scirpus cyperinus*	Woolgrass	3-6'	--	Host plant for Dion Skipper	available	wet meadow
grass	*Sorghastrum nutans*	Indiangrass	3-8'	--	Host plant fo Pepper and Salt Skipper	available	upland
grass	*Spartina pectinata*	Prairie cordgrass	4-8'	--	Attracts birds	widely available	wet meadow, floodplain
perennial	*Actaea pachypoda*	White baneberry	1-3'	--	Conspicuous fragrant flowers	available	--
perennial	*Actaea rubra*	Red baneberry	1-3'	--	Attractive red berries	available	--
perennial	*Allium cernuum*	Nodding onion	1-2'	--	Attracts hummingbirds and butterflies	available	--
perennial	*Allium tricoccum*	Ramp	6-10"	--	Edible	available	--
perennial	*Anemone canadensis*	Canadian anemone	1-2'	--	Used by waterfowl, muskrats, and small rodents	available	wet meadow, floodplain
perennial	*Anemone quinquefolia*	Nightcaps	4-8"	--	Spring wildflower	available	--
perennial	*Anemone virginiana*	Tall thimbleweed	2-3'	--	Attractive white flower	available	--
perennial	*Aquilegia canadensis*	Eastern red columbine	2'	--	Attracts birds, hummingbirds, and butterflies	widely available	upland
perennial	*Arisaema triphyllum*	Jack in the pulpit	1-3'	--	Attracts birds	available	upland
perennial	*Asarum canadense*	Canadian wild ginger	4-8"	--	Host plant for Pipeline swallowtail butterfly	available	--
perennial	*Asclepias incarnata*	Swamp milkweed	2-4'	--	Host plant for Monarch and Queen butterflies	widely available	wet meadow

type	botanical name	common name	heighth	width	ecological comment	availability	where to use in bioswale?
perennial	*Asclepias syriaca*	Common milkweed	--	--	Host plant for Monarch butterfly	--	--
perennial	*Asclepias tuberosa*	Butterflyweed	18-24"	--	Host plant for Monarch and Queen butterflies	widely available	upland
perennial	*Caltha palustris*	Cowslip	12-18"	--	Attracts birds	widely available	emergent
perennial	*Cardamine concatenata*	Cutleaf toothwort	6-12"	--	Attracts butterflies	available	--
perennial	*Caulophyllum thalictroides*	Blue cohosh	1-3'	--	Yellow, Green, and Brown Flowers in April and May	available	--
perennial	*Chelone glabra*	White turtlehead	1-4'	--	Host plant for Baltimore butterfly	available	wet meadow
perennial	*Claytonia virginica*	Virginia springbeauty	4-12"	--	Edible	available	--
perennial	*Dicentra canadensis*	Squirrel corn	6-10"	--	Attracts chipmunks and mice	available	--
perennial	*Dicentra cucullaria*	Dutchman's breeches	10"	--	Attracts bees	available	--
perennial	*Enemion biternatum*	Eastern false rue anemone	8-16"	--	Attracts bees	available	--
perennial	*Erythronium americanum*	Yellow trout-lily	3-6"	--	Yellow flower in the Spring	available	--
perennial	*Eupatoriadelphus maculatus var. maculatus*	Spotted trumpetweed	2-7'	--	Attracts birds	available	--
perennial	*Eupatorium perfoliatum*	Common boneset	3-6'	--	Attracts butterflies	available	wet meadow
perennial	*Eurybia macrophylla*	Bigleaf aster	1-3'	--	Host plant for Pearl Crescent	available	--
perennial	*Fragaria virginiana*	Virginia strawberry	6"	--	White flowers in the Spring	available	upland
perennial	*Geranium maculatum*	Wild geranium	1-3'	--	Attracts birds	available	upland
perennial	*Helenium autumnale*	Common sneezeweed	2-5'	--	Attracts butterflies	widely available	wet meadow
perennial	*Helianthus divaricatus*	Woodland sunflower	--	--	Attracts birds	--	--
perennial	*Helianthus strumosus*	Paleleaf woodland sunflower	7'	--	Attracts birds	available	--
perennial	*Hepatica nobilis var. acuta*	Sharplobe hepatica	4-6"	--	Attractive foliage	available	--
perennial	*Hepatica nobilis var. obtusa*	Roundlobe hepatica	4-6"	--	Attractive foliage	available	--
perennial	*Impatiens capensis*	Jewelweed	--	--	Attracts birds and hummingbirds	--	wet meadow, floodplain
perennial	*Iris virginica*	Virginia iris	3-6'	--	White, pink, and blue flowers in May	available	--
perennial	*Liatris aspera*	Tall blazing star	1-4'	--	Attracts many butterflies and hummingbirds	available	upland
perennial	*Liatris cylindracea*	Dwarf blazing star	8-24"	--	Attracts butterflies	available	--
perennial	*Liatris spicata*	Dense blazing star	3-4'	--	Attracts birds, hummingbirds, and butterflies	widely available	--
perennial	*Lilium michiganense*	Michigan lily	2-5'	--	Orange flowers in July and August	available	--
perennial	*Lobelia cardinalis*	Cardinal flower	1-6'	--	Attracts birds, hummingbirds, and butterflies	widely available	wet meadow, floodplain
perennial	*Lobelia siphilitica*	Great blue lobelia	2-3'	--	Attracts birds and hummingbirds	widely available	wet meadow, floodplain
perennial	*Lupinus perennis*	Wild lupine	1-2'	--	Host plant for Frosted Elfin and Elf	available	--
perennial	*Maianthemum racemosum ssp. racemosum*	Feathery false lily of the valley	1-3'	--	Attracts birds	available	--
perennial	*Maianthemum stellatum*	Starry false lily of the valley	8-10"	--	White flowers in May and June	available	--
perennial	*Mitella diphylla*	Twoleaf miterwort	1-3'	--	White flowers throughout the Spring	available	--
perennial	*Monarda fistulosa*	Beebalm	2-5'	--	Attracts birds, hummingbirds, and butterflies	available	wet meadow, upland
perennial	*Oenothera biennis*	Common evening-primrose	2-6'	--	Attracts birds and hummingbirds	available	--
perennial	*Oligoneuron rigidum var. rigidum*	Stiff goldenrod	1-5'	--	Attracts butterflies	available	--
perennial	*Packera aurea*	Golden ragwort	1-3'	--	Attracts bees	available	--
perennial	*Penstemon digitalis*	Smooth white beardtongue	2-5'	--	Attracts hummingbirds and bumblebees	available	--
perennial	*Penstemon hirsutus*	Hairy beardtongue	16-24"	--	Attracts hummingbirds and hosts Baltimore	available	
perennial	*Phlox divaricata*	Wild blue phlox	8-18"	--	Attracts butterflies	available	--
perennial	*Physostegia virginiana*	Obedient plant	4'	--	Attracts hummingbirds and butterflies	widely available	wet meadow, floodplain
perennial	*Podophyllum peltatum*	Mayapple	12-18"	--	White and pink flowers in Spring	available	--
perennial	*Polygonatum biflorum*	Smooth Solomon's seal	1-5'	--	Attracts birds and butterflies	available	--
perennial	*Pycnanthemum virginianum*	Virginia mountain mint	2-3'	--	Attracts butterflies	available	wet meadow, upland
perennial	*Ratibida pinnata*	Pinnate prairie coneflower	3-5'	--	Attracts birds, and butterflies	available	upland
perennial	*Rudbeckia hirta*	Black-eyed Susan	1-2'	--	Host plant for several butterflies	available	upland
perennial	*Rudbeckia laciniata*	Cutleaf coneflower	3-12'	--	Attracts birds	available	floodplain
perennial	*Sanguinaria canadensis*	Bloodroot	12-14"	--	White flowers in March and April	available	upland
perennial	*Silphium terebinthinaceum*	Prairie dock	3-8'	--	Attracts birds	available	--
perennial	*Sisyrinchium albidum*	White blue-eyed grass	8-15"	--	White flowers throughout the Spring	--	--
perennial	*Sisyrinchium angustifolium*	Narrowleaf blue-eyed grass	12-18"	--	Blue flowers throughout the Spring	widely available	--
perennial	*Solidago caesia*	Wreath goldenrod	1-3'	--	Attracts birds and butterflies	available	--
perennial	*Solidago speciosa*	Showy goldenrod	1-5'	--	Attracts birds and butterflies	available	upland

type	botanical name	common name	heighth	width	ecological comment	availability	where to use in bioswale?
perennial	*Symphyotrichum laeve var. laeve*	Smooth blue aster	2-4'	--	Attracts birds and butterflies	available	--
perennial	*Symphyotrichum novae-angliae*	New England aster	6'	--	Host plant for several butterflies	available	--
perennial	*Thalictrum dasycarpum*	Purple meadow-rue	2-6'	--	Flowers in the Spring and Summer	available	wet meadow
perennial	*Thalictrum dioicum*	Early meadow-rue	8-28"	--	White and green flowers in April and May	available	--
perennial	*Thalictrum thalictroides*	Rue anemone	9"	--	Flowers in the Spring	available	upland
perennial	*Tiarella cordifolia*	Heart-leaf foamflower	6-12"	--	White flowers throughout the Spring	widely available	--
perennial	*Tradescantia ohiensis*	Bluejacket	2-3'	--	Ornamental in gardens and meadows	widely available	upland
perennial	*Trillium grandiflorum*	Large-flower wakerobin	12-15"	--	Attractive white flower	available	--
perennial	*Uvularia grandiflora*	Largeflower bellwort	1'	--	bell-shaped, pale yellow flowers	available	--
perennial	*Verbena hastata*	Swamp verbena	2-5'	--	Host plant for Common Buckeye Moth	available	wet meadow
perennial	*Verbena stricta*	Hoary verbena	1-4'	--	Host plant for Common Buckeye Moth	available	--
perennial	*Verbena urticifolia*	White verbena	--	--	White flowers throughout the Summer	--	--
perennial	*Vernonia missurica*	Missouri ironweed	--	--	Bright violet flowers	--	--
perennial	*Veronicastrum virginicum*	Culver's root	2-6'	--	Attracts butterflies and bees	available	wet meadow, upland
perennial	*Zizia aurea*	Golden zizia	1-3'	--	Host plant for Black Swallowtail butterfly	available	upland
shrub	*Alnus incana ssp. rugosa*	Speckled alder	12-36'	--	Host for Green Comma butterfly	--	floodplain
shrub	*Amelanchier canadensis*	Canadian serviceberry	20'	8-10'	Attracts birds	widely available	--
shrub	*Amelanchier laevis*	Allegheny serviceberry	20-25'	15'	Attracts birds	widely available	upland
shrub	*Betula pumila*	Bog birch	6-12'	--	Cute shrub	--	--
shrub	*Ceanothus americanus*	New Jersey tea	3-4'	3-5'	Host plant for several moths	widely available	--
shrub	*Cephalanthus occidentalis*	Buttonbush	3-6'	3-6'	Host plant for Titan Spinx and Hydrangea Spinx moths	widely available	emergent, floodplain
shrub	*Cornus alternifolia*	Alternate-leaf Dogwood	15-25'	20-25'	--	widely available	upland
shrub	*Cornus amomum*	Silky dogwood	6-10'	6-10'	Attracts birds	widely available	floodplain
shrub	*Cornus racemosa*	Gray dogwood	10-15'	10-15'	Host plant for Spring Azure	widely available	upland
shrub	*Cornus rugosa*	Roundleaf dogwood	6-12'	--	Attracts butterflies	--	--
shrub	*Cornus sericea*	Redosier dogwood	8-10'	8-10'	Red branches during winter have high aesthetic value.	widely available	floodplain
shrub	*Corylus americana*	American hazelnut	6-12'	--	Attracts birds and squirrels	available	upland
shrub	*Dasiphora fruticosa ssp. floribunda*	Potentilla	3-4'	3-4'	Attracts butterflies	widely available	--
shrub	*Dirca palustris*	Eastern leatherwood	3-6'	--	Yellow flowers and dark green leaves.	available	--
shrub	*Hamamelis virginiana*	Witch hazel	15-20'	8-12'	Attracts birds	widely available	--
shrub	*Hypericum prolificum*	Shrubby St. Johnswort	3'	--	Yellow flowers	available	--
shrub	*Ilex verticillata*	Common winterberry	6-8'	6-8'	Host plant for Henrys Elfin butterfly	widely available	--
shrub	*Juniperus communis var. depressa*	Common juniper	3-6'	--	Valuable wildlife habitat and food	available	--
shrub	*Lindera benzoin*	Spicebush	6-8'	6-8'	Host Plant for Spicebush Swallowtail, Promethea silkmoth, and Eastern Tiger Swallowtail.	widely available	--
shrub	*Photinia melanocarpa*	Black chokeberry	3-6'	--	Attracts birds	widely available	--
shrub	*Physocarpus opulifolius*	Common ninebark	6-8'	6-8'	Attracts birds	widely available	floodplain
shrub	*Prunus americana*	American plum	35'	--	Host many butterflies	available	--
shrub	*Ptelea trifoliata*	Hop tree	12-36'	--	Attracts birds and butterflies	available	--
shrub	*Rhus aromatica*	Fragrant sumac	3-4'	6-8'	Host plant for several moths	widely available	--
shrub	*Rhus copallinum*	Winged sumac	20-35'	--	Attracts birds	available	--
shrub	*Rhus glabra*	Smooth sumac	10-20'	--	Attracts birds and butterflies	available	--
shrub	*Rhus typhina*	Staghorn sumac	10-12'	12-15'	Attracts birds	widely available	--
shrub	*Ribes cynosbati*	Eastern prickly gooseberry	2-5'	--	Attracts birds	--	--
shrub	*Rosa blanda*	Early wild rose	2-5'	--	Thornless or near-thornless species of rose	available	--
shrub	*Rosa carolina*	Carolina rose	1-3'	--	Attracts birds	available	--
shrub	*Rosa palustris*	Swamp rose	6-8'	--	Attracts birds	available	--
shrub	*Rosa setigera*	Climbing prairie rose	6-12'	--	Attracts birds	available	--
shrub	*Rubus allegheniensis var. allegheniensis*	Allegheny blackberry	--	--	blackberries!	--	--
shrub	*Rubus flagellaris*	Northern dewberry	--	--	--	--	--
shrub	*Rubus occidentalis*	Black raspberry	3-6'	--	Attracts birds.	available	--
shrub	*Sambucus nigra ssp. canadensis*	Black elder	12'	--	Attracts birds.	available	--
shrub	*Sambucus racemosa var. racemosa*	Red elderberry	10-20'	--	Attracts birds.	available	--

type	botanical name	common name	heighth	width	ecological comment	availability	where to use in bioswale?
shrub	*Spiraea alba*	White meadowsweet	3-6'	--	Host plant for Spring Azure	available	wet meadow, floodplain
shrub	*Spiraea tomentosa*	Steeplebush	3-6'	--	Host plant for Columbia Silkmoth	available	--
shrub	*Staphylea trifolia*	American bladdernut	10-15'	10-12'	Produces three-chambered bladder fruits	widely available	--
shrub	*Vaccinium angustifolium*	Lowbush blueberry	6"-2'	6"-2'	Berries relished by many species, including humans	widely available	--
shrub	*Vaccinium corymbosum*	Highbush blueberry	6-12'	6-12'	Berries relished by many species	widely available	--
shrub	*Vaccinium macrocarpon*	Cranberry	6-12"	--	Attracts birds	widely available	--
shrub	*Viburnum acerifolium*	Mapleleaf viburnum	4-8'	3-6'	Attracts birds and butterflies	widely available	--
shrub	*Viburnum lentago*	Nannyberry	15-20'	6-10'	Attracts birds and butterflies	widely available	floodplain, upland
shrub	*Viburnum rafinesquianum*	Downy arrowwood	3-6'	--	Provides food for birds and small mammals	available	upland
shrub	*Zanthoxylum americanum*	Prickly ash	12-25'	--	Host plant fo several swallowtail butterflies	available	--
tree	*Acer nigrum*	Black maple	75-125'	--	Produces samaras	widely available	--
tree	*Acer saccharum*	Sugar maple	50-60'	30-40'	Attracts birds	widely available	upland
tree	*Asimina triloba*	Pawpaw	15-20'	10-20'	Attracts birds and butterflies	widely available	--
tree	*Betula alleghaniensis*	Yellow birch	60'	35-45'	Used by hummingbirds and butterflies	widely available	--
tree	*Carpinus caroliniana*	Musclewood	25-35'	20-25'	Attracts birds	widely available	--
tree	*Carya cordiformis*	Bitternut hickory	50-100'	--	Host to Luna, Funeral Dagger, and Giant Regal	widely available	--
tree	*Carya glabra*	Pignut hickory	50-100'	--	Attracts birds and butterflies	widely available	--
tree	*Carya ovata*	Shagbark hickory	60-80'	60-80'	Attracts squirrels and birds	widely available	--
tree	*Celtis occidentalis*	Common hackberry	40'	30'	Host to several butterflies	widely available	floodplain
tree	*Cornus florida*	Flowering dogwood	25-30'	20-25'	high aesthetic value	widely available	--
tree	*Crataegus crus-galli*	Cockspur hawthorn	25-30'	--	Host to many butterflies	widely available	--
tree	*Fagus grandifolia*	American beech	50-80'	--	Host to Early Hairstreak butterfly	widely available	--
tree	*Juglans cinerea*	Butternut	40-60'	30-50'	Rare	widely available	--
tree	*Juglans nigra*	Black walnut	50-70'	50-60'	Host to Luna and Regal moths	widely available	--
tree	*Juniperus virginiana*	Eastern red cedar	30-40'	--	Host to Olive Butterfly	widely available	--
tree	*Liriodendron tulipifera*	Tuliptree	70'	35'	Highly aesthetic leaves	widely available	--
tree	*Nyssa sylvatica*	Blackgum	30-50'	20-30'	Attracts birds	widely available	--
tree	*Ostrya virginiana*	Eastern hop-hornbeam	40'	25'	Attracts birds	widely available	--
tree	*Platanus occidentalis*	American sycamore	75-100'	--	Highly aesthetic bark	widely available	--
tree	*Populus tremuloides*	Trembling Aspen	36-72'	30'	Host to several butterflies	widely available	upland
tree	*Prunus americana*	American plum	35'	--	Host to many butterflies	widely available	--
tree	*Quercus alba*	White oak	60-80'	45-50'	Host to Edwards Hairstreak butterfly	widely available	upland
tree	*Quercus bicolor*	Swamp white oak	50-60'	40-50'	Attracts many birds and mammals	widely available	floodplain, upland
tree	*Quercus imbricaria*	Shingle oak	50-60'	50-60'	handsome	widely available	--
tree	*Quercus macrocarpa*	Bur oak	50-70'	50-70	Host plant for several butterflies	widely available	floodplain, upland
tree	*Quercus muehlenbergii*	Chinkapin oak	36-72'	--	Attracts birds, hummingbirds, and butterflies	widely available	--
tree	*Quercus prinoides*	Dwarf chinkapin oak	25'	--	This plants acorns are highly prized by wildlife.		--
tree	*Quercus rubra*	Northern red oak	60-75'	50'	Attracts birds and butterflies	widely available	upland
tree	*Quercus velutina*	Black oak	50-60'	--	Attracts hummingbirds and butterflies	widely available	--
tree	*Sassafras albidum*	Sassafras	15-30'	15-25'	Host to several butterflies	widely available	--
tree	*Tilia americana*	American basswood	60-80'	--	Used by many mammals, birds, and honeybees	widely available	floodplain, upland
vine	*Clematis virginiana*	Virgin's Bower	12-15'	--	Attracts hummingbirds and butterflies	available	--
vine	*Dioscorea villosa*	Wild yam	variable	--	--	--	--
vine	*Menispermum canadense*	Common moonseed	variable	--	White, green, and brown flowers	--	--
vine	*Parthenocissus quinquefolia*	Virginia creeper	3-40'	--	Host plant for several moths	widely available	--
vine	*Smilax tamnoides*	Bristly greenbrier	variable	--	--	--	--
vine	*Vitis riparia*	River-bank grape	35'	--	Relished by birds and mammals	--	--

Autumn-olive

Elaeagnus umbellata

Description: Small to large shrub, growing up to 20 feet tall.

Leaves: Oblong shape, dark green on top and covered with silvery metallic scales below. Arranged alternately on the stem.

Stems: Reddish-gray to golden tan, with silvery metallic scales on newer twigs. Buds shaped like a crab claw. Larger branches may have long, sharp thorns.

Flowers: Yellowish-white tube shaped flowers. Very fragrant.

Fruit: Abundant bright red to pink berries speckled with silver scales. Edible.

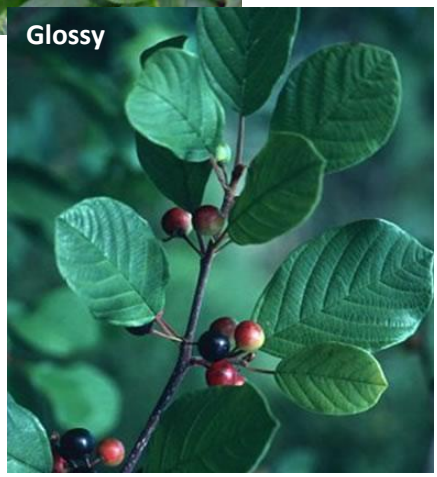
Photo credits: Chris Evans, River to River CWMA, Bugwood.org – James H. Miller, USDA Forest Service, Bugwood.org – Pennsylvania Dept. of Conservation and Natural Resources Forestry Archive, Bugwood.org – Barry Rice, sarracenia.com, Bugwood.org – Nancy Loewenstein, Auburn University, Bugwood.org

Common and Glossy Buckthorn

Rhamnus cathartica and R. frangula

Description: Tall shrub to small tree, growing up to 25 feet tall.

Leaves: *Common buckthorn*: Oval to egg-shaped leaf with fine teeth and a pointed tip. Glossy, dark green in color with narrowly arcing veins. Leaves arranged opposite each other, slightly offset
.
Glossy buckthorn: Oval leaf with toothless edges with a small point at the tip. Glossy, dark green in color with straighter, parallel veins. Leaves arranged oppositely each other, slightly offset.



Stems: Dark gray stems with buds shaped like deer hooves. Common buckthorn twig tipped with a thorn. Bark is slightly flaky, dark or silvery gray with horizontal lighter stripes. Inner bark is bright orange or yellow.

Flowers: Small, yellowish-green with four or five petals.

Fruit: Dark purple-blue to black berries. NOT EDIBLE.

Photo credits: Chris Evans, River to River CWMA, Bugwood.org – Stephen L. Solheim, University of Wisconsin, Stevens Point – Paul Wray, Iowa State University, Bugwood.org – Chris Evans, River to River CWMA, Bugwood.org – Robert Vidéki, Doronicum Kft., Bugwood.org

Dame's Rocket

Hesperis matronalis

Description: Perennial herbaceous plant which can reach 4-5 feet in height.

Leaves: Narrow, triangular shape with a rounded base. Leaves are toothed and hairy on both sides, alternately arranged, and become progressively smaller up the stem.

Stems: Stout and hairy.

Flowers: Showy clusters of 4-petalled flowers. May range in color from purple to white. Can be confused with phlox, which has 5-petalled flowers.

Fruit: Small seeds contained in narrow, 2-4 inch long pods.

Photo credits: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org – The Dow Gardens Archive, Dow Gardens, Bugwood.org – Richard Old, XID Services, Inc., Bugwood.org – Mark Frey, The Presidio Trust , Bugwood.org

Garlic Mustard

Alliaria petiolata

Description: Biennial herbaceous plant which can reach 2-4 feet in height.

Leaves: Triangular or heart-shaped with large teeth, oppositely arranged. Leaves smell like garlic when crushed, and may be used in cooking.

Stems: Stout with slight ridges. One plant may have several stems.

Flowers: Clusters of small white flowers with 4 petals.

Fruit: Small black seeds contained in narrow, 1-3 inch long pods.

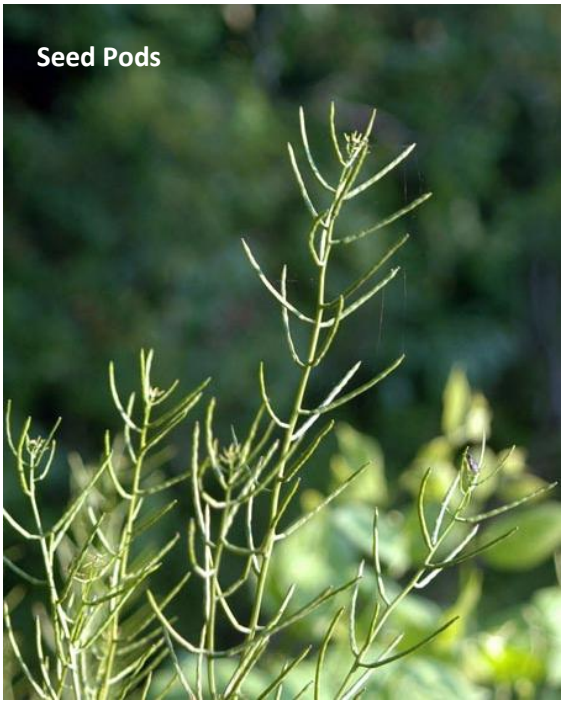
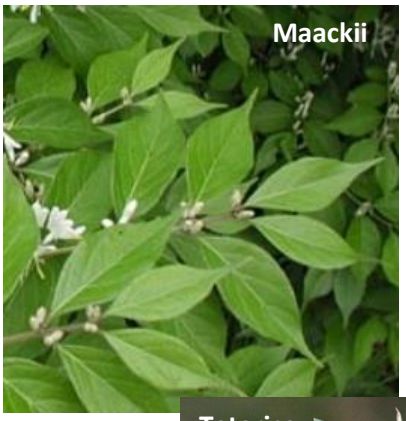


Photo credits: All photos by Chris Evans, River to River CWMA, Bugwood.org

Honeysuckle

Lonicera maackii and L. tatarica



Description: Large shrub to small tree growing up to 15 feet tall.

Leaves: *L. maackii*: Elliptical leaf with an elongated pointed tip, dark green above, lighter below. Leaves arranged opposite each other on the stem.

L. tatarica: Oval-shaped blue-green leaves arranged opposite each other on the stem.

Stems: *L. maackii*: Arching stems with deeply ridged, brown, ropy bark.

L. tatarica: Gray to tan "peely" bark. Many stems give it a twiggy appearance.

Flowers: Yellow, white, pink, or red tube-like flowers that are very fragrant.

Fruit: Abundant clusters of bright red or orange berries. NOT EDIBLE.

Photo credits: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org – Ohio State Weed Lab Archive, The Ohio State University, Bugwood.org – James H. Miller, USDA Forest Service, Bugwood.org – Leslie J. Mehrhoff, University of Connecticut, Bugwood.org – Chuck Bargeron, University of Georgia, Bugwood.org – Steve Baskauf

Japanese Barberry

Berberis thunbergii

Description: Small dense shrub reaching 3-6 feet in height.

Leaves: Small oval or spoon-shaped with smooth edges. Clustered in tight bunches close to the branch. Leaves may be green to purple and turn deep red in the fall.

Stems: Red-brown to gray stems grow in an arching form. Stems are somewhat ridged with single spines protruding beneath leaf clusters. Bright yellow inner bark.

Flowers: Small yellow 4-part flowers hang down from the stem individually or in clusters of 2-4.

Fruit: Red oblong berries hang down from the stems. Fruits remain on the plant into the winter. Not edible.

Photo credits: Steve Manning, Invasive Plant Control, Bugwood.org – James H. Miller, USDA Forest Service, Bugwood.org – James H. Miller, USDA Forest Service, Bugwood.org – Leslie J. Mehrhoff, University of Connecticut, Bugwood.org – Barry Rice, sarracenia.com, Bugwood.org

Purple Loosestrife

Lythrum salicaria

Description: Perennial herbaceous wetland plant. Reaches 4-10 feet in height.

Leaves: Elongated, triangular, hairy leaves with smooth edges.

Stems: Squared, semi-woody stems with 5-6 sides.

Flowers: Bright purple flowers with 5-7 petals. Arranged in tall spikes that bloom throughout the summer.

Fruit: Abundant small seeds white or tan in color.

Photo credits: Steve Dewey, Utah State University, Bugwood.org – K. George Beck & James Sebastian, Colorado State University, Bugwood.org – Richard Old, XID Services, Inc., Bugwood.org – Gary L. Piper, Washington State University, Bugwood.org

Reed Canary Grass

Phalaris arundinacea

Description: Perennial grass that can dominate wetlands. Reaches 2-10 feet in height.

Leaves: Smooth, flat leaves that grow 1-4 feet long and taper gradually. Leaves have a papery membrane (ligule) at their base.

Stems: Thin, hairless, round stems.

Flowers: Spreading flower heads that can be brown, green, or purple, appearing in May-July.

Fruit: Abundant small grain.

Photo credits: Richard Old, XID Services, Inc., Bugwood.org – Joseph M. DiTomaso, University of California – Davis, Bugwood.org – Mark Frey, The Presidio Trust , Bugwood.org – Paul A. Graham

APPENDIX L: Coordinate Locations of Invasive Species in the OEA

*Note: This list does not include every invasive individual.

Coordinates were taken using the WGS 1984 datum.

RECORD NUMBER	LATITUDE	LONGITUDE	SPECIES
1	+42.3287285	-83.8901489	Autumn-olive
2	+42.3283976	-83.8906339	Honeysuckle
3	+42.3283688	-83.8905551	Garlic mustard / Dame's rocket
4	+42.3284449	-83.8906193	Garlic mustard / Dame's rocket
5	+42.3282776	-83.8910057	Autumn-olive
6	+42.3282791	-83.8910316	Autumn-olive
7	+42.3278513	-83.8918366	Garlic mustard / Dame's rocket
8	+42.3275108	-83.8918584	Garlic mustard / Dame's rocket
9	+42.3274898	-83.8919049	Garlic mustard / Dame's rocket
10	+42.3265624	-83.8919497	Japanese barberry
11	+42.3266358	-83.8919117	Japanese barberry
12	+42.3265536	-83.8922006	Honeysuckle
13	+42.3265754	-83.8921897	Buckthorn
14	+42.3265610	-83.8923396	Japanese barberry
15	+42.3265927	-83.8923931	Japanese barberry
16	+42.3266244	-83.8924146	Buckthorn
17	+42.3266214	-83.8925867	Autumn-olive
18	+42.3266707	-83.8926437	Honeysuckle
19	+42.3267059	-83.8925673	Autumn-olive
20	+42.3267900	-83.8926681	Japanese barberry
21	+42.3269420	-83.8927649	Reed canary grass
22	+42.3279482	-83.8923250	Buckthorn
23	+42.3273242	-83.8920245	Japanese barberry
24	+42.3278560	-83.8918300	Japanese barberry
25	+42.3285688	-83.8905586	Honeysuckle
26	+42.3285643	-83.8905236	Garlic mustard / Dame's rocket
27	+42.3285544	-83.8904871	Autumn-olive
28	+42.3288195	-83.8903171	Honeysuckle
29	+42.3288172	-83.8903194	Honeysuckle
30	+42.3289873	-83.8903517	Japanese barberry
31	+42.3290219	-83.8902810	Japanese barberry
32	+42.3292141	-83.8903791	Garlic mustard / Dame's rocket

33	+42.3293832	-83.8902758	Honeysuckle
34	+42.3293886	-83.8902711	Japanese barberry
35	+42.3294498	-83.8903966	Honeysuckle
36	+42.3294985	-83.8903638	Garlic mustard / Dame's rocket
37	+42.3294244	-83.8904151	Honeysuckle
38	+42.3296839	-83.8904441	Honeysuckle
39	+42.3296689	-83.8904100	Japanese barberry
40	+42.3296645	-83.8903357	Japanese barberry
41	+42.3296840	-83.8903920	Buckthorn
42	+42.3297754	-83.8903194	Honeysuckle
43	+42.3294719	-83.8903229	Buckthorn
44	+42.3294944	-83.8904197	Honeysuckle
45	+42.3297339	-83.8903659	Autumn-olive
46	+42.3297467	-83.8903726	Honeysuckle
47	+42.3296474	-83.8904487	Garlic mustard / Dame's rocket
48	+42.3298739	-83.8904659	Garlic mustard / Dame's rocket
49	+42.3298651	-83.8904447	Honeysuckle
50	+42.3298908	-83.8904353	Autumn-olive
51	+42.3297618	-83.8904244	Autumn-olive
52	+42.3296683	-83.8903071	Honeysuckle
53	+42.3288150	-83.8901607	Autumn-olive
54	+42.3289113	-83.8900939	Autumn-olive

APPENDIX M: Outdoor Education Professional Development Opportunities

Great Lakes Stewardship Initiative – GLSI's goal is to increase awareness and understanding of the ecology of the Great Lakes so that Michigan's residents become active and effective stewards of the Great Lakes and advocates for strategies that support the long-term sustainability of the Great Lakes fisheries. They provide community or place-based education, school-community partnerships, and sustained professional development for area teachers. They can assist the outdoor science program by providing resources for outdoor teaching and professional development opportunities for the OEA liaison.

DTE Freshwater Institute – The DTE Freshwater Institute for Teachers offers a year-long professional development program. Teachers learn to conduct water-related, place-based environmental science lessons and projects with their students. The program is coordinated by the Great Lakes Water Studies Institute at Northwestern Michigan College.

Michigan Association for Environmental and Outdoor Education (MAEOE) – MAEOE is a professional association supporting and advancing environmental education in a variety of settings, including K-12 classrooms, nature centers, camps, youth programs, government agencies, as well as for-profit and non-profit organizations. MAEOE provides a many workshops and conferences year round, providing information and resources on a variety of environmental and outdoor education topics.

APPENDIX N: Creekside Teacher Survey and Results

1. What grade level(s) do you teach?

	Response Percent	Response Count
5	57.1%	8
6	57.1%	8
answered question		14
skipped question		0

2. What subject(s) do you teach?

	Response Count
	14
answered question	14
skipped question	0

1. After School Child Care Program
2. Science, ELA, Social Studies
3. counseling lessons
4. Math Social Studies
5. math, language arts
6. science & soc. st.
7. science (2), ELArts, social studies
8. Math and Science
9. Math, Science and LA
10. LA/SCI
11. All
12. All
13. Language Arts, Science, Social Studies
14. all except science

3. Do you currently use the Outdoor Education Area (OEA)?

	Response Percent	Response Count
Yes	28.6%	4
No	71.4%	10
If yes, for which subjects/lessons/activities?		5
answered question		14
skipped question		0

1. Last year we used the OEA after school. Our students cleared the path of trees, branches, litter, etc. but stopped at schools end. We have new after school staff who may be interested in using the area. They talked about making bird houses, feeders, etc.
2. VERY rarely. When a student needs to escape the institution type atmosphere of the school due to a high emotional need, I sometimes take them for a walk out there. (i.e. a boy's father was dying)
3. I have been the one that has cleared the trails and began re-establishing the old route.
4. It is currently under brush and would need to be cleaned up and organized better to use it effectively
5. The poison ivy has scared us away. I used to use it as a 7th grade teacher for science labs. Then I used it as a 5th grade teacher for science and Language arts - we use to find a spot down by the creek and write short stories.

4. How interested are you in using the OEA for:

answered question	14
skipped question	0

	1 Not interested	2	3 Somewhat interested	4	5 Very interested	Response Count
lessons/activities during school hours?	0.0% (0)	0.0% (0)	7.7% (1)	7.7% (1)	**84.6% (11)**	13
after-school activities or clubs?	25.0% (3)	8.3% (1)	25.0% (3)	8.3% (1)	**33.3% (4)**	12
student capstone projects?	**11.1% (1)**	**11.1% (1)**	0.0% (0)	22.2% (2)	**55.6% (5)**	9
environmental stewardship activities (invasive species removal, native tree planting)?	9.1% (1)	9.1% (1)	9.1% (1)	18.2% (2)	**54.5% (6)**	11

5. What aspects of the subject(s) you teach are the most conducive to being taught in the OEA?

answered question	12
skipped question	2

	Response Count
	12

5. What aspects of the subject(s) you teach are the most conducive to being taught in the OEA?

1. After school care program would use area as an opportunity for a nature walk, bird watching, etc.
2. We are starting a new science curriculum, so I don't know if there would be a connection/time to add to the curriculum to use the OEA. Some teachers are piloting it and it is a demanding curriculum (kit included). But, as we get used to the new curriculum, I am hopeful that there would be some natural opportunities to supplement with actual hands on in our own OEA.
   I am interested in starting a garden that students would be able to maintain, harvest, and prepare food to serve in the cafe - start with something like pumpkins. This would require a soil test once an area is secured for a school garden. Also would require parent/family support to water during the summer months. This ties in as part of a capstone project for Social studies - Where Does Our Food Come From - that I am hoping to begin in the spring.
3. Our grief groups and family (divorce) groups could really benefit by participating in self reflection writing activities while dispersed along a wooded trail. Groups are run during the school day.

   A ropes course for a whole class (30 kids) could be taught out there too, which teach team building and problem solving - two other aspects of my counseling program.
4. None of the subjects that I teach. However, I feel that outdoor education is very important.
5. observations
6. erosion? groundwater? ecosystems?
7. Species adaptation
8. Science ecosystems
9. Systems and Survival: This includes body systems and plant and animal survival. Ecology is interwoven in the subjects.
10. science
11. Science - Ecology/ Ecosytems
12. Obviously, science is the most natural fit for the OEA, but I would love to utilize the area for Language Arts and environmental education.

6. What other school-related activities might benefit from incorporating the OEA?

answered question	8
skipped question	6

	Response Count

6. What other school-related activities might benefit from incorporating the OEA?

	8

1. After school care program would use the area as an opportunity for a nature walk, bird watching, collect litter, etc.
2. Writing
   Well, actually, our imagination is the only limitation here.
   A variety of science classes, obviously.
3. What's not so obvious is some of the benchmarks for social studies curriculum, such as the comparison of a microcosm to a macrocosm first done with insects and plants and moved up to large animals and the environment to finally human interrelationships with the environment. To sustain our planet we must think beyond ourselves personally and as a culture.
4. Sixth grade science curriculum is directly related to the OEA.
5. Writing
6. Ecology Club?
7. Art/Poetry/many more we could brainstorm
8. Leadership Group
   After school projects

7. How problematic are the following (potential) barriers to using the OEA?

answered question	14
skipped question	0

	1 Not problematic	2	3 Somewhat problematic	4	5 Very problematic	Response Count
Safety	0.0% (0)	14.3% (2)	**42.9% (6)**	14.3% (2)	28.6% (4)	14
Poison Ivy	7.1% (1)	0.0% (0)	21.4% (3)	7.1% (1)	**64.3% (9)**	14
Children getting wet/muddy	21.4% (3)	**35.7% (5)**	**35.7% (5)**	7.1% (1)	0.0% (0)	14
Weather	**35.7% (5)**	21.4% (3)	28.6% (4)	7.1% (1)	7.1% (1)	14
Bugs/insects	7.1% (1)	**28.6% (4)**	21.4% (3)	21.4% (3)	21.4% (3)	14
Student management	**35.7% (5)**	21.4% (3)	21.4% (3)	14.3% (2)	7.1% (1)	14
Time out of classroom	**76.9% (10)**	15.4% (2)	7.7% (1)	0.0% (0)	0.0% (0)	13
Time to prepare	**38.5% (5)**	15.4% (2)	30.8% (4)	7.7% (1)	7.7% (1)	13
Aligning with learning standards	**50.0% (7)**	28.6% (4)	0.0% (0)	14.3% (2)	7.1% (1)	14
Fitting with my subject	**78.6% (11)**	7.1% (1)	14.3% (2)	0.0% (0)	0.0% (0)	14
Level of parent support	**64.3% (9)**	0.0% (0)	35.7% (5)	0.0% (0)	0.0% (0)	14
Level of student interest	**85.7% (12)**	0.0% (0)	7.1% (1)	0.0% (0)	7.1% (1)	14
My comfort level in the outdoors	**71.4% (10)**	21.4% (3)	0.0% (0)	0.0% (0)	7.1% (1)	14
Navigating the trails	**50.0% (7)**	21.4% (3)	14.3% (2)	7.1% (1)	7.1% (1)	14

7. How problematic are the following (potential) barriers to using the OEA?

My knowledge of features in the OEA	28.6% (4)	0.0% (0)	**42.9% (6)**	14.3% (2)	14.3% (2)	14
My understanding of nature/ecology	**57.1% (8)**	14.3% (2)	14.3% (2)	14.3% (2)	0.0% (0)	14
My experience with outdoor activities	**71.4% (10)**	14.3% (2)	14.3% (2)	0.0% (0)	0.0% (0)	14

8. Would you be interested in working with a group of Master's students from the University of Michigan to increase the usability of the OEA?

answered question	**14**
skipped question	**0**

	Response Percent	Response Count
Yes	**71.4%**	**10**
No	28.6%	4
If yes, please provide your name and email address below.		10

OEA Guide - Table of Contents

Introduction: Why an OEA Guide?

The original Trail Guide was an interpretive brochure that had information about the plants, animals, and other features of natural history found at the OEA. In it were numbered informational blurbs, each written for a specific trail location, identified with numbered posts. It was great—aesthetically pleasing and pretty comprehensive—but the Trail Guide had seen its time. It has been out of use for some years now without being updated along with changes to the curriculum and to the OEA itself. The trails have not been kept the same and the numbered posts were all piled up (apparently after rotting away).

The new OEA Guide builds off of the pros of the original Trail Guide—beautiful images, interesting and important facts—but moves beyond the format of traditional interpretive materials—static interpretation locations and text—to be a more interactive learning process for the students. First of all, when learning local flora and fauna, the emphasis should be on outdoor study and exploration, rather than on reading text. Students

need first-hand experiences to learn natural history and cannot be expected to memorize a lot of text. Secondly, an emphasis should be put on one or two key characteristics—leaf shapes, fruit types, and ecological considerations like plants' requirements for varied amounts of light and moisture. The original trail guide jumped around a little bit.

The new OEA Guide contains: 1) a list of plant species found in the OEA, 2) a list of animal species found in the OEA, 3) individual species pages for the (number) selected species, and 4) maps of the OEA's habitats and invasive species populations.

1) The list of plant species found in the OEA, though not comprehensive, contains the most common species in the OEA. It is meant to be used as a cross-reference to the individual species pages and as a quick reference for finding certain important characteristics of each plant species. These important characteristics are:

Names (both Latin and common names are included for ease of use and to avoid confusion when there are multiple common names).

Status as woody or herbaceous (e.g. trees and shrubs vs. grasses and flowers; although some plants fall into gray areas).

Status as nuisance or native—These terms are not precise, but practical for using this guide [In the table, "nuisance" plants are either: 1) non-native and invasive (e.g. Japanese barberry), 2) native but invasive (e.g. Boxelder), or 3) native but toxic (e.g. Poison Ivy)]. In any of these cases, people are usually interested in controlling the plant, hence "nuisance". "Nuisance1" refers to the most problematic species ecologically or logistically (e.g. Garlic Mustard is a very problematic invasive plant and Poison Ivy is a particular concern for users of this site).

Conservation Importance: this is based on the Michigan DNR Floristic Quality Assessment. Plants get scores on their value to other plants and animals and rareness. Invasive Plants are considered to have no value to the ecosystem, and too prominent, so they get a score of 0 (notice that Poison Ivy, a "nuisance" plant, has more ecological importance than an invasive plant—being native, poison ivy does have some importance to other plants and animals). Very important plants get a score of greater than 5 (note: these are state scores, but plants may have different higher scores in locations where they are rare and lower scores where they are common).

Hydrology: The hydrology column gives an idea of the relative wetness of each plant's ideal habitat. Note that "Mesic" is a term for habitats that are of medium "wetness"—not too dry and not too wet. Because this is a vague catch-all term, hydrology-types have been further divided into "wet mesic" "mesic" and "dry mesic". They are described (in order of "wetness") as: Wetland, Wet Mesic, Mesic, Dry Mesic, Upland. These categories are based on a somewhat arbitrary grouping of various ranges on a "wetness" scale in the FQA. Thus Wetland = (-5),Wet Mesic = (-4 to -2), Mesic = (-1 to 1), Dry Mesic = (2 to 4), and Upland = (5) (Based on the DNR Floristic Quality Assessment (FQA)).

Shade Tolerance: Different species have different light requirements. To have "high" shade tolerance is to be well-adapted to living in dark forests as an understory plant (e.g. Hophornbeam, an understory tree). To have "low" shade tolerance is to be adapted to sunnier locations, such as open fields or open wetlands. Shade tolerance may indicate where a species may invade, or what stage of succession it might come in (e.g. plants with "low shade tolerance are probably "pioneer" species—moving into open areas before other plants).

2) The list of animals species found in the OEA, is far from comprehensive, but shows the basic species of animals in the OEA, and their different kingdoms. To look up rare and endangered species in Washtenaw County go online: http://web4.msue.msu.edu/mnfi/data/cnty_dat.cfm?county=Washtenaw.

3) The individual plant species pages show specific plants that are important for the students and teachers of Dexter schools to get to know. These are the most common native and invasive plants and other plants important or detrimental to the ecosystem. Each page can be used for identification as well as for more in-depth study of plant characteristics and habitats through a system of coloring key features. Students can color each aspect of the plant the same color as its appropriate label (e.g. students color "leaf shape" the same color as the actual edge of the picture of the leaf). The label and image are identified with the same letter or letter-number combination. Note that some characteristics to be colored/learned on each species page coordinates with characteristics on the Plant Table described above. Thus, students wishing to color in the levels of moisture and light each plant requires should refer to the "hydrology" and "shade tolerance" columns of the Plant Table. Some species are grouped by family. In such cases there is family page and a corresponding family symbol (e.g. oak family and birch family).

4) Maps of the OEA: One map shows where the most common habitats are to be found. Students should compare the habitat types on this map with the "hydrology" column on the Plant Table. This will give students an idea of where they might find the species from the individual species pages. The map of invasive species show where major nuisance plants are—and thus helps identify priority locations for ecological restoration/management of the OEA.

Plant Species of the OEA

Latin names	Common Names	Woody/ Herbaceous	Native/ Nuisance	Conservation Importance (0-10)	Hydrology	Shade Tolerance
Alliaria petiolata	Garlic Mustard	Herbaceous	Nuisance1	0	Mesic	High
Lythrum salicaria	Purple Loosestrife	Herbaceous	Nuisance1	0	Wetland	Low
Phalaris arundunacea	Reed Canary Grass	Herbaceous	Nuisance1	0	Wet Mesic	Low
Hesperis matronalis	Dames Rocket	Herbaceous	Nuisance2	0	Upland	High
Delphinium elatum	Larkspur	Herbaceous	Nuisance2	0	Upland	High
Lysimachia nummularia	Moneywort	Herbaceous	Nuisance2	0	Wet Mesic	High
Phragmites australis	Phragmites	Herbaceous	Nuisance2	0	Wet Mesic	Low
Elaeagnus umbellata	Autumn-olive	Woody	Nuisance1	0	Dry Mesic	Med
Berberis thunbergii	Barberry (Japanese)	Woody	Nuisance1	0	Dry Mesic	High
Rhamnus cathartica	Buckthorn (Common)	Woody	Nuisance1	0	Dry Mesic	High
Lonicera maackii	Honeysuckle (Maack's)	Woody	Nuisance1	0	Upland	High
Acer negundo	Boxelder	Woody	Nuisance2	0	Wet Mesic	Low
Prunus avium	Mazzard	Woody	Nuisance2	0	Upland	Med
Rosa multiflora	Multiflora Rose	Woody	Nuisance2	0	Dry Mesic	Med
Typha latifolia (e.g.)	Cattail	Herbaceous	Native	1	Wetland	Low
Ulmus americana	American Elm	Woody	Native	1	Wet Mesic	Med
Prunus serotina	Black Cherry	Woody	Native	2	Dry Mesic	Low
Acer saccharinum	Silver Maple	Woody	Native	2	Wet Mesic	Low
Toxicodendron radicans	Poison Ivy	Woody	Nuisance1	2	Mesic	Med
Zanthoxylum americanum	Prickly-ash	Woody	Native	3	Upland	High
Vitis riparia	Riverbank Grape	Woody	Native	3	Wet Mesic	Low
Viburnum lentago	Nannyberry	Woody	Native	4	Mesic	Low
Physocarpus opulifolius	Ninebark	Woody	Native	4	Wet Mesic	Low
Aster praealtus (e.g.)	Asters	Herbaceous	Native	5	Mesic	Low
Arisaema triphyllum	Jack-in-the-Pulpit	Herbaceous	Native	5	Wet Mesic	Med
Ranunculus hispidus	Swamp Buttercup	Herbaceous	Native	5	Mesic	Low
Parthenocissus quinquefolia	Virginia Creeper	Woody	Native	5	Mesic	Med
Asarum canadense	Wild Ginger	Herbaceous	Native	5	Upland	High
Anemone quinquefolia	Wood Anemone	Herbaceous	Native	5	Mesic	High
Ostrya virginiana	Hophornbeam	Woody	Native	5	Dry Mesic	High
Tilia americana	Basswood	Woody	Native	5	Dry Mesic	High
Crataegues spp.	Hawthorn	Woody	Nuisance2	5	Upland	Med
Viburnum trilobum	Highbush-cranberry	Woody	Native	5	Wet Mesic	Low
Quercus rubra	Red Oak	Woody	Native	5	Dry Mesic	Med
Carya ovate	Shagbark Hickory	Woody	Native	5	Dry Mesic	Med

Acer saccharum	Sugar Maple	Woody	Native	5	Dry Mesic	High
Quercus bicolor	Swamp White Oak	Woody	Native	5	Wet Mesic	Med
Fraxinus americana (e.g.)	White Ash (mostly dead)	Woody	Native	5	Dry Mesic	Low
Quercus alba	White Oak	Woody	Native	5	Dry Mesic	Med
Salix nigra (e.g.)	Willow	Woody	Native	5	Wetland	Med
Hamamelis virginiana	Witch-hazel	Woody	Native	5	Dry Mesic	High
Carpinus caroliniana	Musclewood	Woody	Native	6	Mesic	High
Cephalanthus occidentalis	Buttonbush	Woody	Native	7	Wetland	Low
Arisaema dracontium	Green Dragon	Herbaceous	Native	8	Wet Mesic	Med
Staphylea trifolia	Bladdernut	Woody	Native	9	Mesic	High

KEY
Hydrology: Wetland, Wet Mesic, Mesic, Dry Mesic, Upland = (-5), (-4 to -2), (-1 to 1), (2 to 4), (5). Based on the DNR Floristic Quality Assesment (FQA)
Conservation Importance: Invasive Plants = 0 (notice Poison Ivy, a "nuisance" plant, has more ecological importance than an invasive plant), Very important plants = greater than 5. A plant with a low score for the state may be locally more rare.
Native/Nuisance: In this table, "nuisance" plants are either 1) non-native and invasive (e.g. Japanese barberry), 2) native and invasive (e.g. Boxelder), or 3) toxic (e.g. Poison Ivy).
Shade Tolerance: "High" = can grow in dark forests, "Med" (Medium) = can grow in various light conditions, and "Low" = requires plentiful sunlight (fields/edges).

Animal Species of the OEA

Latin names	Common Names	Class	Major Threat	Habitat of Young	Habitat of Adults
Rana clamitans	Green Frog	Amphibian	None	Aquatic	Riparian
Rana pipiens	Northern Leopard Frog	Amphibian	Pollution	Aquatic	Riparian
[Many Species in U.S.A.]	Crayfish	Arthropod	Invasive Crayfish	Aquatic	Riparian
Cyanocitta cristata	Blue Jay	Bird	None	Edge	Edge
Picoides pubescens	Downy Woodpecker	Bird	None	Forest	Forest
Grus canadensis	Greater Sandhill Crane	Bird	Losing Wetlands	Wetland	Wetland
Picoides villosus	Hairy Woodpecker	Bird	None	Forest	Forest
Mimus polyglottos	Northern Mockingbird	Bird	None	Edge	Edge
Buteo jamaicensis	Red-tailed Hawk	Bird	Cars	Forest	Forest
[Many Species in U.S.A.]	Freshwater Mussels	Bivalve	Pollution	Aquatic	Aquatic
Lepomus cyanellus	Green Sunfish	Bony Fish	None	Aquatic	Aquatic
Etheostoma nigrum	Johnny Darter	Bony Fish	None	Aquatic	Aquatic
Esox lucius	Northern Pike	Bony Fish	None	Aquatic	Aquatic
Lepomis gibbosus	Pumpkinseed	Bony Fish	None	Aquatic	Aquatic
[Many Species in U.S.A.]	Land Snail	Gastropod	Losing Forests	Forest	Forest
[Many Species in U.S.A.]	Slug	Gastropod	Losing Forests	Forest	Forest
[Many Species in U.S.A.]	Water Snail	Gastropod	Losing Ponds	Aquatic	Aquatic
[Many Species in U.S.A.]	Dragonfly	Insect	None	Aquatic	Riparian
Papilio cresphontes	Giant Swallowtail Butterfly	Insect	Losing Forests	Forest	Forest
Vasates aceriscrumena	Maple Spindle Gall Mite	Insect	None	Maples	Maples
[Many Species in U.S.A.]	Mayfly	Insect	Pollution	Aquatic	Riparian
Disholcaspis spp.	Oak Bullet Gall Wasp	Insect	None	Oaks	Forest
Papilio Troilus	Spicebush Swallowtail	Insect	Losing Forests	Forest	Edge
[Many Species in U.S.A.]	Stonefly	Insect	Pollution	Aquatic	Riparian
Tamias striatus	Chipmunk	Mammal	None	Forest	Forest
Peromyscus maniculatus	Deer Mouse	Mammal	None	Edge	Edge
Sylvilagus floridanus	Eastern Cottontail (Rabbit)	Mammal	None	Edge	Edge
Sciurus niger	Fox Squirrel	Mammal	None	Forest	Forest
Ondatra zibethicus	Muskrat	Mammal	None	Wetland	Wetland
Procyon lotor	Northern Raccoon	Mammal	None	Edge	Edge
Vulpes vulpes	Red Fox	Mammal	None	Edge	Edge
Didelphis virginiana	Virginia Opossom	Mammal	None	Edge	Edge
Odocoileus virginianus	White-tailed Deer	Mammal	None	Edge	Edge
Emydoidea blandingii	Blandings Turtle	Reptile	Losing Wetlands	Wetland	Wetland
Chrysemys picta	Painted Turtle	Reptile	Losing Ponds	Riparian	Aquatic

Sistrurus catenatus	Eastern Massasauga Rattler	Reptile	Losing Wetlands	Riparian	Riparian

EXPLANATION:
Animals are listed by class, as this is a grouping used by scientists and everyday people
"Major Threat" indicates if there is something endangering a whole species or not. All individual animals face some "threats", but "none" here means no one thing threatens this animal species's survival.
The two "Habitat" columns indicate species that start out life in a different habitat than they live as adults.

Boxelder
Acer negundo

Maple Family
Sapindaceae

Boxelder is a very well-adapted tree--maybe too well-adapted! It grows anywhere it can get a little sun and water, but especially "edge" places like ditches, roads, and schoolyards! It takes over, so it is sometimes considered an invasive species, even though it is native! The Boxelder's samara helps it spread around. Notice the "wings" are close together, unlike the other Maple Family members. Boxelder has a compound leaf with three leaflets that look like the three leaflets of poison ivy. Can you tell them apart?

LEAF EDGE A

FRUIT ("Samara") B

FLOWERS C

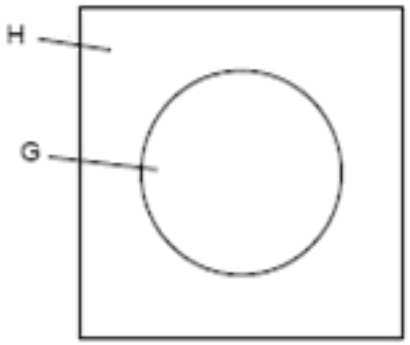
BARK PATTERN D

BUDS E

NATIVE RANGE F

SUN G AND RAIN H REQUIREMENTS

RELATIVE SIZE



CommonBuckthorn
Rhamnus cathartica

Buckthorn Family
Rhamnaceae

The name Buckthorn makes sense because this plant has small thorns at the tip of some branches. If that wasn't bad enough, this species is invasive, meaning it takes over our forests and blocking the sunlight from other plants. Birds try to eat the fruits but don't like them, so they spit them out, leaving new seedlings all over the forest. Some people try to remove buckthorn to make way for native species. They use clippers, chemicals, or fire!

LEAF EDGE A

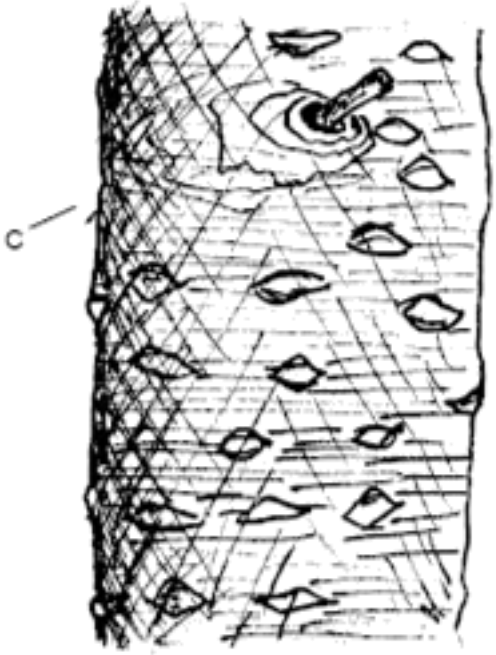
FRUIT B

BARK PATTERN C

BUDS and Thorn D

(INVADED) RANGE E

SUN F AND RAIN G REQUIREMENTS



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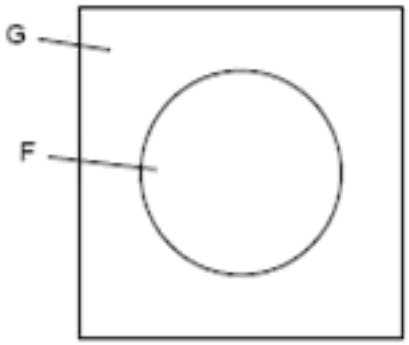
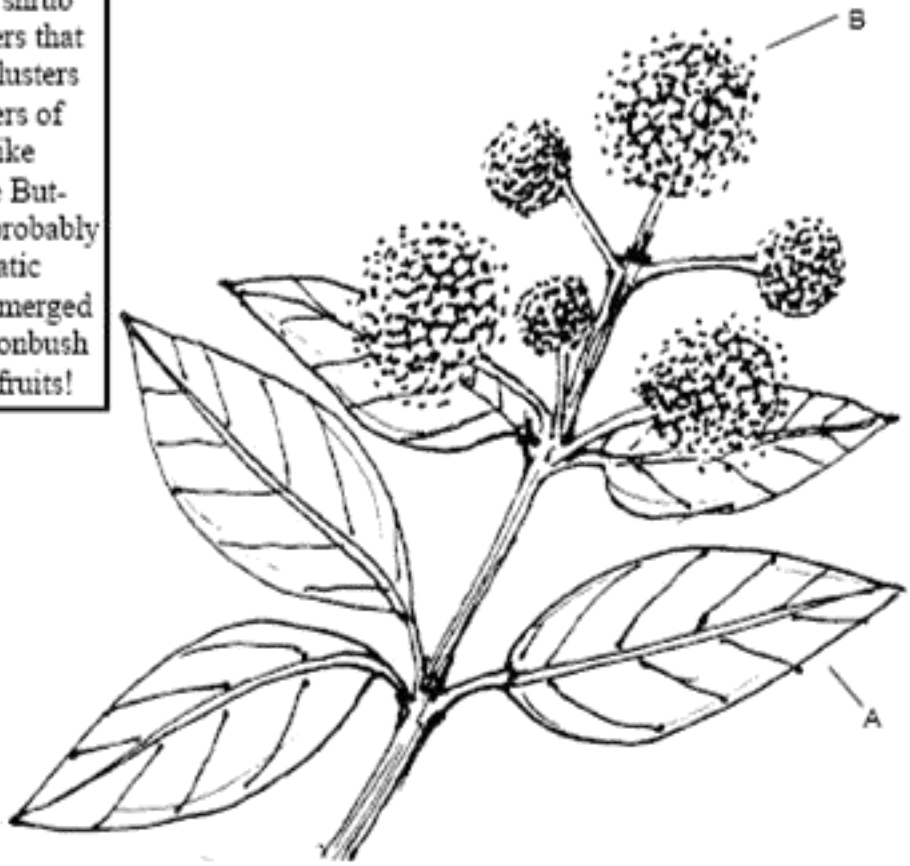


Buttonbush
Cephalanthus occidentalis

Coffee Family
Rubiaceae

Buttonbush is a wetland shrub that has clusters of flowers that look like buttons. The clusters of flowers become clusters of fruits, which each look like little seeds. Can you see Buttonbush? If so, you are probably in a wetland. Many aquatic creatures live on the submerged parts of the stem of Buttonbush shrubs and birds eat the fruits!



LEAF EDGE A

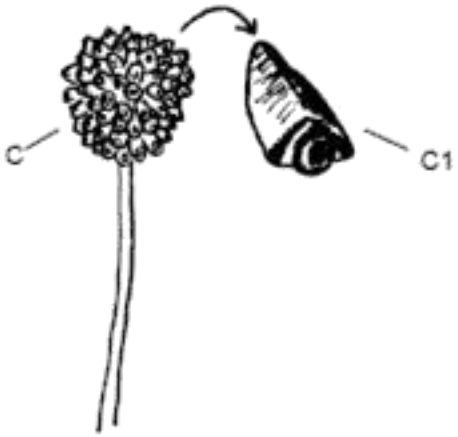
FLOWER CLUSTER B

FRUIT CLUSTER C

FRUIT C1

NATIVE RANGE E

SUN F AND RAIN G REQUIREMENTS



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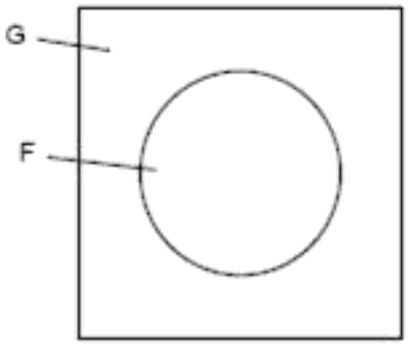


Riverbank Grape
Vitis riparia

Grape Family
Vitaceae

This vine can be tasty. It is a vine, but luckily, it doesn't have "leaves of three" so you shouldn't mistake it for Poison Ivy. Notice that its thick, brown, flaky bark has no hairy rootlets like poison ivy either. In fact, hanging on this hard, woody vines is fun!

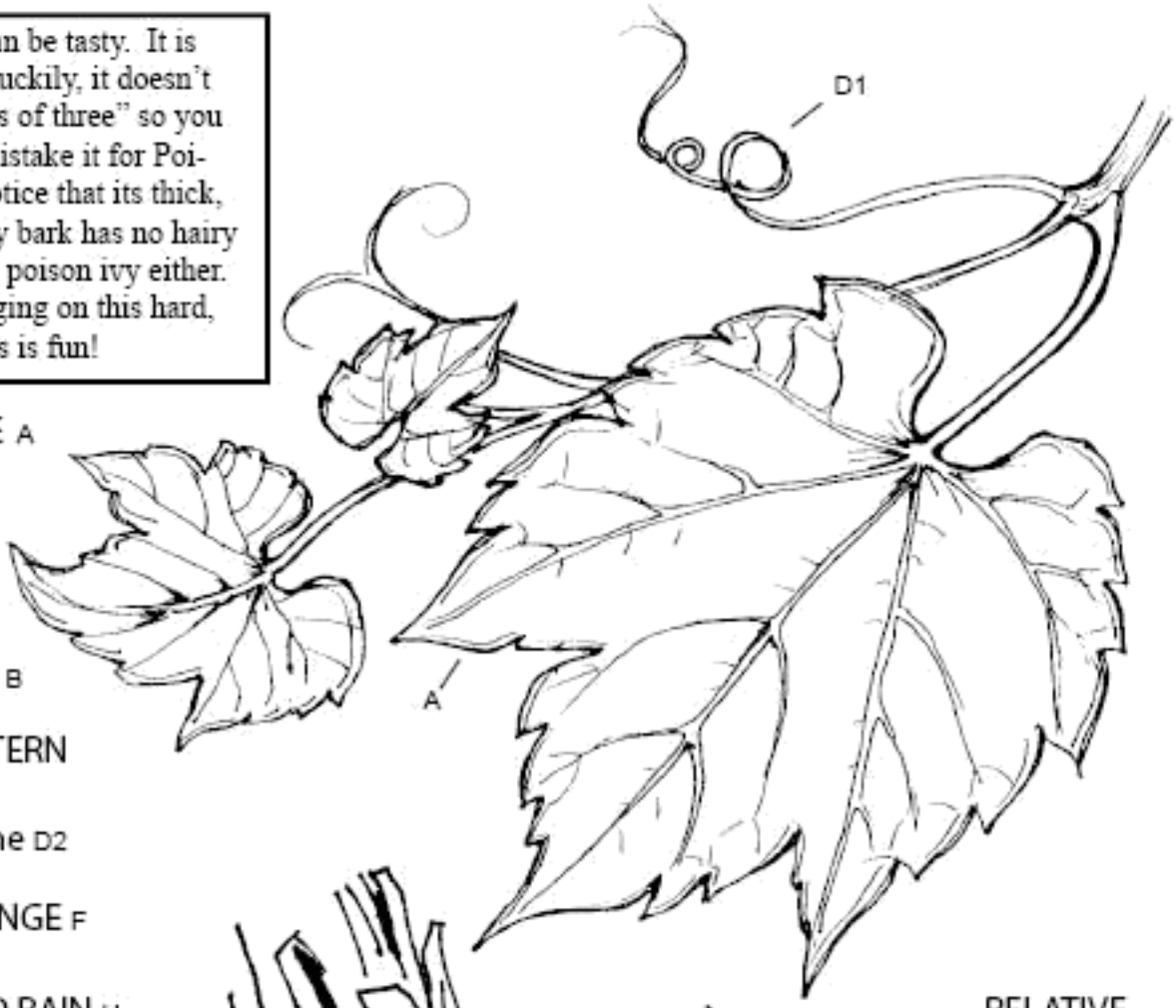
LEAF EDGE A

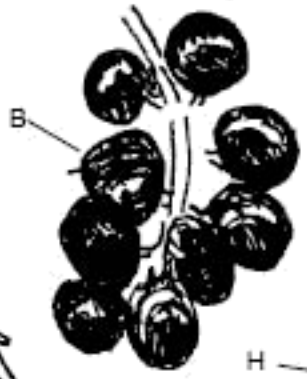
CLUSTER OF FRUITS B

BARK PATTERN
Tendrils D1
Mature Vine D2

NATIVE RANGE F

SUN G AND RAIN H REQUIREMENTS





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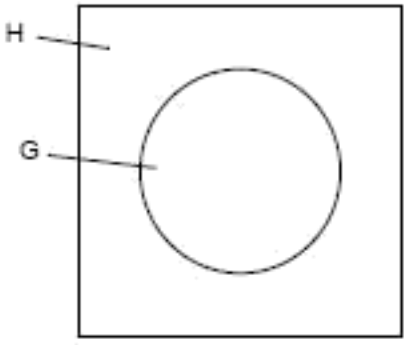


Hawthorn
Crataegus spp.

Rose Family
Rosaceae

This plant has "thorn" in its name for a reason--watch out! It is related to roses, so its fruit also looks like a rose "hip". The "spp." in the latin name means there are many species of Hawthorn that are hard to tell apart. One reason this is the case is that this tree often clones itself! Two trees may look like different species, but turn out to be the same plant--very tricky!

LEAF EDGE A

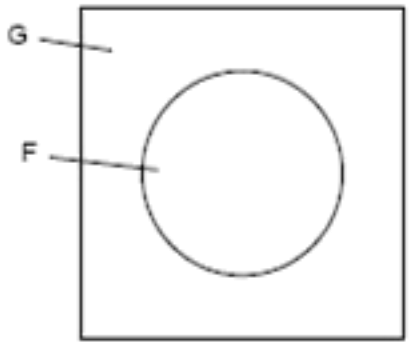
FRUIT B

BARK PATTERN C

NATIVE RANGE E

SUN F AND RAIN G REQUIREMENTS

RELATIVE SIZE



Maples
Acer spp.

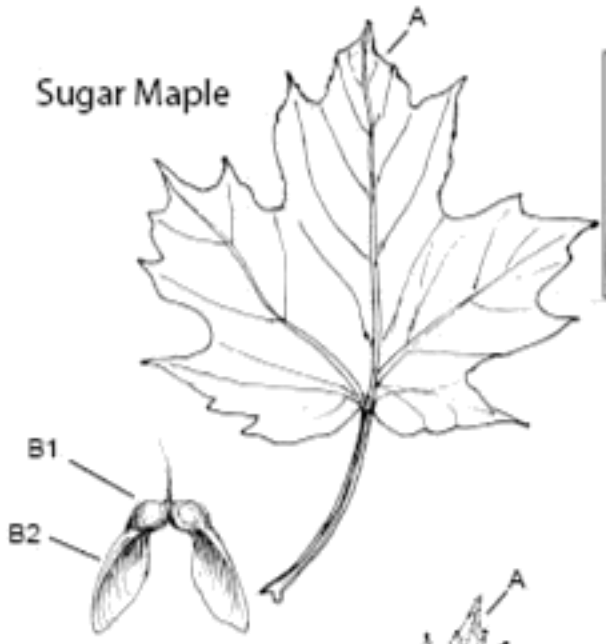
Maple Family
Sapindaceae

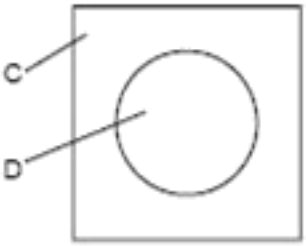
Maples are common throughout Michigan. A Maple is on the flag of Canada. Maples have seeds with wings, called samaras. These are the "helicopters" that help a maple spread (and they're fun!).

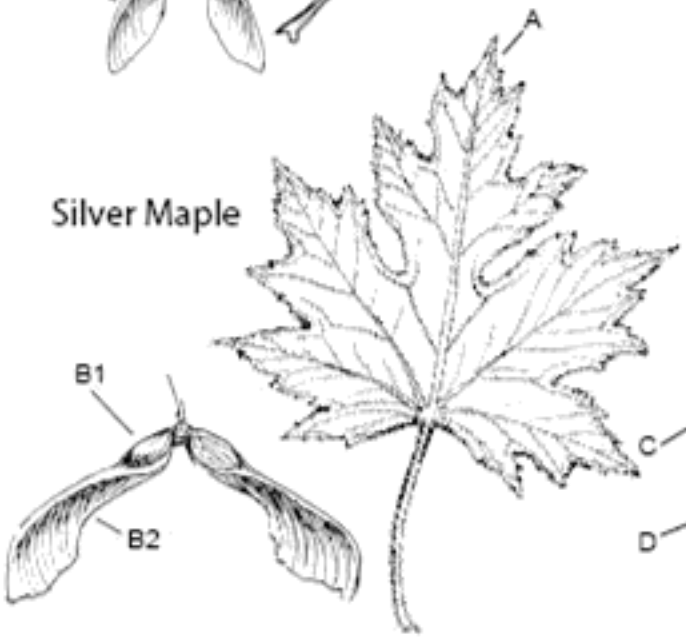
>The Sugar Maple is known for making Maple Syrup. Its samaras are small and not spread out.

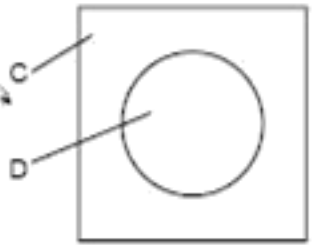
>The Silver Maple branches are easily broken by wind or water, but broken branches can form new trees! Its samaras are spread out. Its leaves have deep lobes.

>The Boxelder grows in many places! It is native, but somewhat invasive. Some people think it looks like Poison Ivy. Like Poison Ivy it has three leaflets on each leaf, but boxelder is a tree, not a vine.







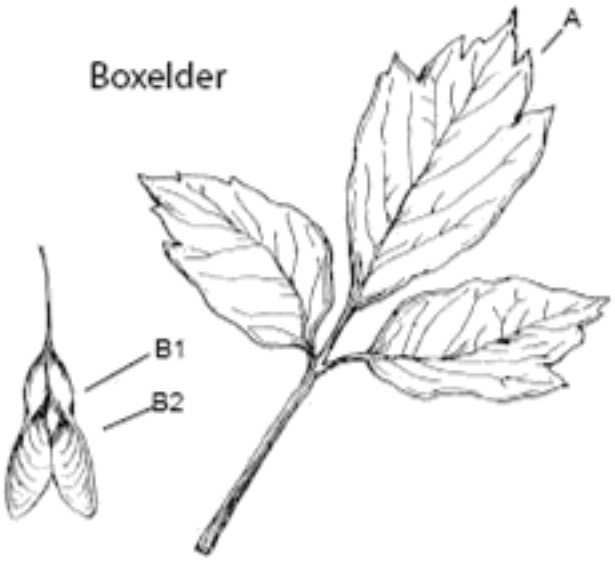


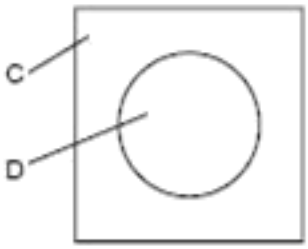
LEAF EDGE A

FRUIT ("Samara")
Seed B1
Wing B2

SUN C AND RAIN D REQUIREMENTS

RELATIVE SIZE





Musclewood
Carpinus caroliniana

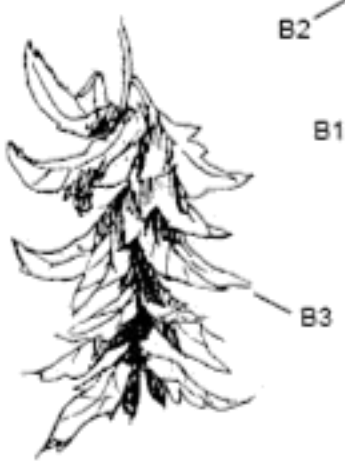
Birch Family
Betulaceae

This tree is sometimes called ironwood or American hornbeam, but musclewood describes the shape of its trunk and branches well--it feels like a flexed human muscle....feel one! Notice the fruits grow in clusters and each one has a leaf-like attachment.

LEAF EDGE A

FRUIT
Leaf-like Bract B1
Nut B2
Cluster of Fruits B3

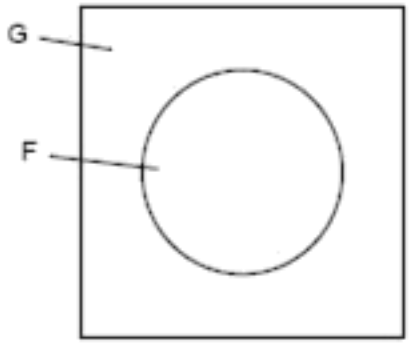
BARK TEXTURE C



RELATIVE SIZE

NATIVE RANGE E

SUN F AND RAIN G REQUIREMENTS



Oaks
Quercus spp.

Oak Family
Fagaceae

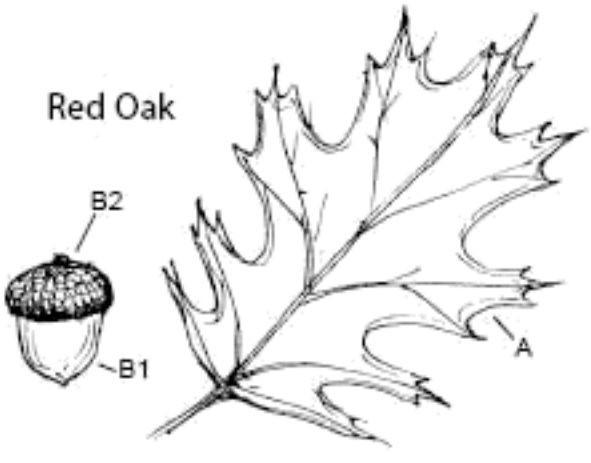
Oaks are common. We have three kinds in the Outdoor Education Area, but Red and White are the most common. Oaks symbolize strength and were once used to make ships.

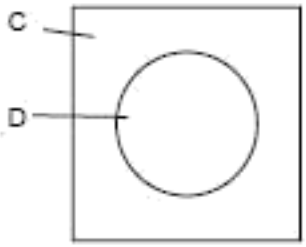
>The Red Oak is very common. (When passenger pigeons lived, it was not as common, because they ate so many!). Its leaves are pointy.

>The White Oak acorn is a squirrel's favorite food. Its leaves have deep, rounded lobes.

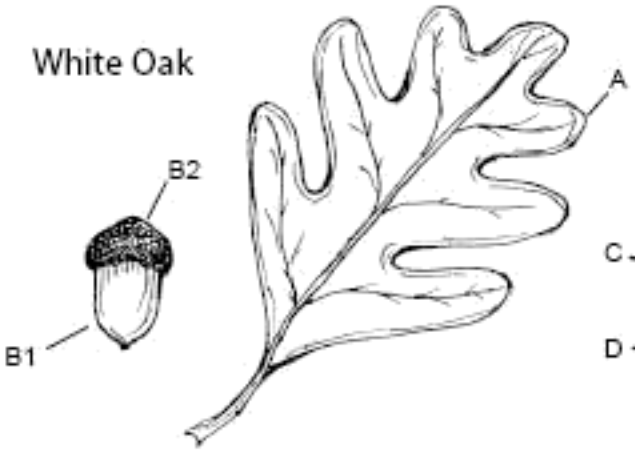
>The Swamp White Oak lives where the ground is wet for much of the year. It has a round edge with very shallow lobes. It's acorn has a long stalk.

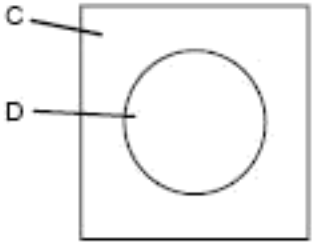
Red Oak





White Oak



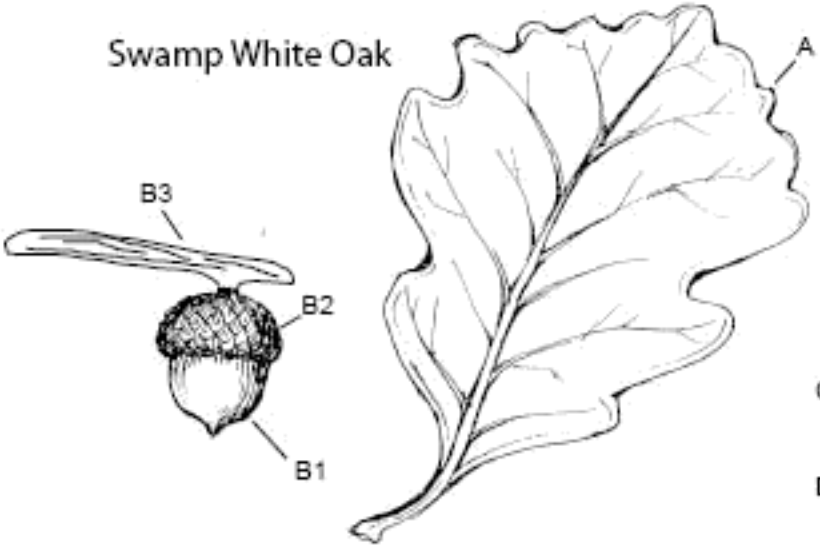


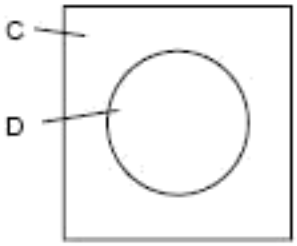
LEAF EDGE A

FRUIT ("Acorn")
Nut B1
Cup B2
Stalk B3

SUN C AND RAIN D REQUIREMENTS

Swamp White Oak





RELATIVE SIZE

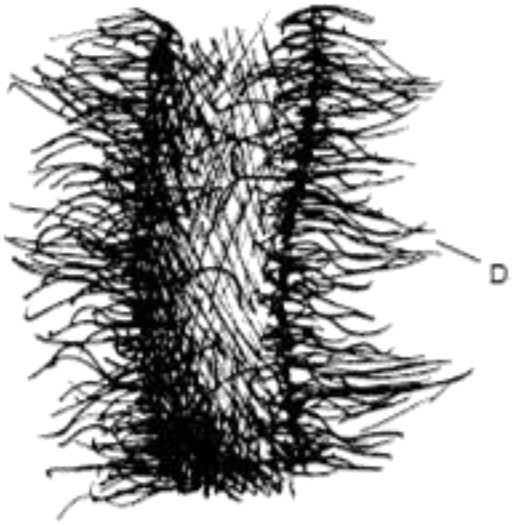
Poison Ivy
Toxicodendron radicans

Cashew Family
Anacardiaceae

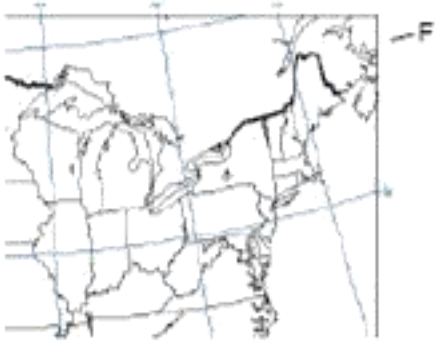
"Leaves of three, let it be" is the common reminder about this toxic plant, although this plant has compound leaves, so what look like three leaves are actually three leaflets. Avoid this plant in its many forms: small herbaceous plant, woody shrub, or woody vine. However, there are many harmless plants that look like poison ivy--especially the Virginia Creeper (p. x). Rootlets on Poison Ivy tend to be thinner than those on Virginia Creeper.

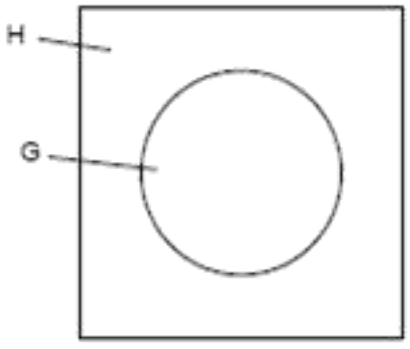
LEAF EDGE A
FRUIT B
FLOWERS C
VINE and ROOTLETS D
NATIVE RANGE F

SUN G AND RAIN H REQUIREMENTS



RELATIVE SIZE





Silver Maple
Acer saccharinum

Maple Family
Sapindaceae

Silver Maple is a "riparian" tree (meaning it lives near water). It has adapted to living near water: if one trunk breaks off in a flood, many more can sprout up. Observe how the branches gently curve. Notice that the underside of the leaf is "silvery". Compare Silver Maple's samara and leaf with Sugar Maple's.

LEAF EDGE A

FRUIT
"Samara" B

FLOWERS (See Sugar Maple)

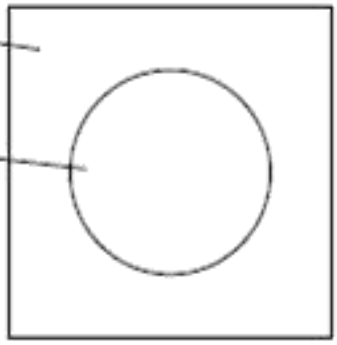
BARK PATTERN D

BUDS E

NATIVE RANGE F

SUN G AND RAIN H
REQUIREMENTS

RELATIVE
SIZE



Sugar Maple
Acer saccharrum

Maple Family
Sapindaceae

Sugar Maple is a common tree and is the tree that gives us Maple Syrup (but not Corn Syrup!). Syrup is basically boiled sap. [Find "sap" in the family name.] Pioneers called a grove of these trees a "sugar bush".

LEAF EDGE A

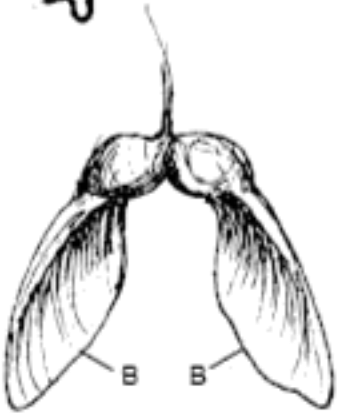
FRUIT
"Samara" B

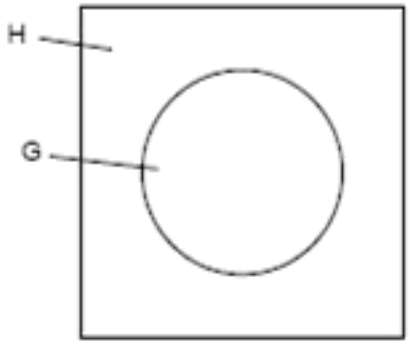
FLOWERS C

NATIVE RANGE F

SUN G AND RAIN H
REQUIREMENTS

RELATIVE
SIZE

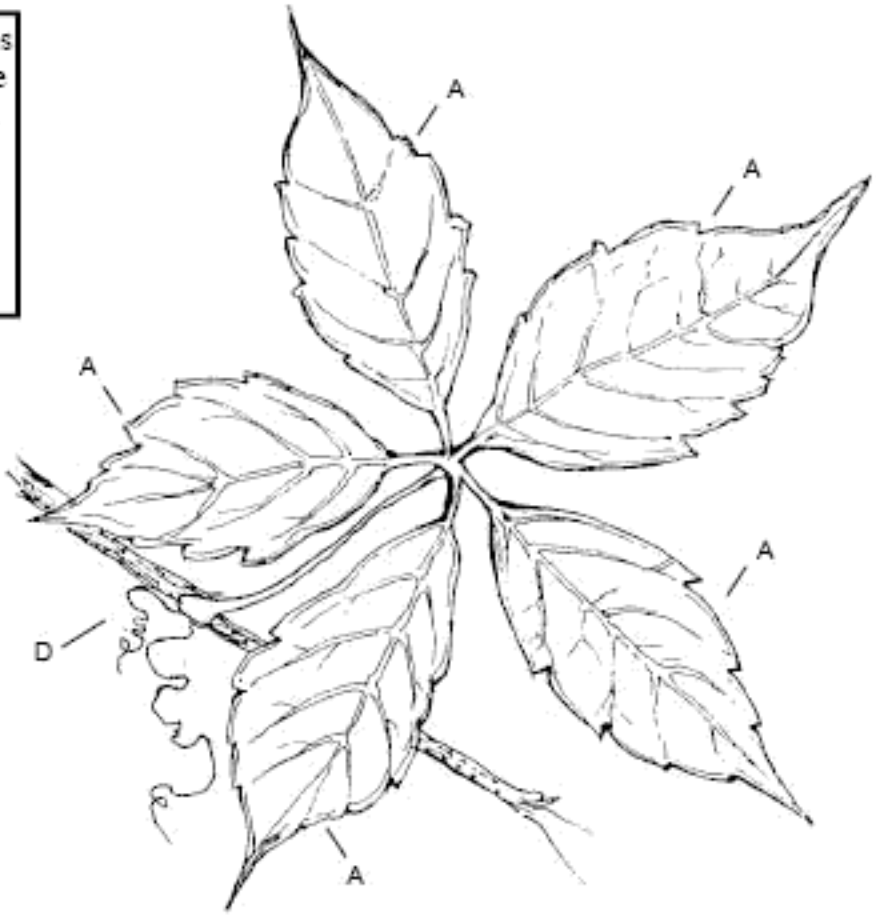




Virginia Creeper
Parthenocissus quinquefolia

Grape Family
Vitaceae

This is a woody vine that climbs trees and houses. In fact, people find the red color it turns in fall beautiful. Its red-green coloration and multiple leaves mean it is sometimes mistaken for poison ivy.



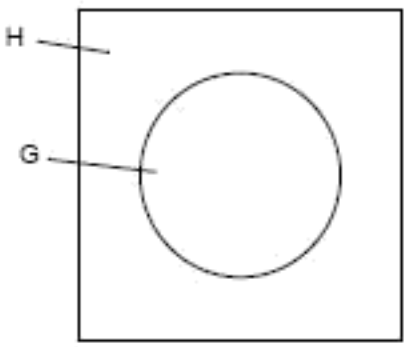
LEAF EDGE A

BARK PATTERN B

NATIVE RANGE F

SUN G AND RAIN H REQUIREMENTS

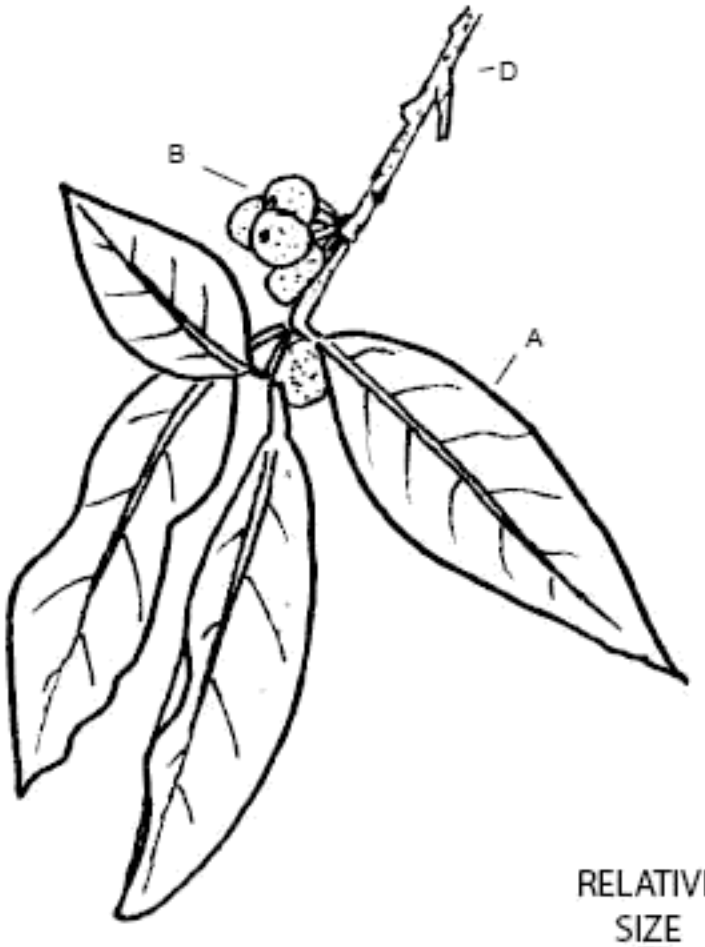
RELATIVE SIZE



Autumn-olive
Elaeagnus umbellata

Oleaster Family
Elaeagnaceae

Autumn-olive is an invasive plant (closely related to Russian-olive). One reason it does so well is because its fruits are so tasty. It is hard to confuse these plump, red, spotty berries for olives. Many parts of this plant can look spotty because they are covered in tiny silver scales--the leaves, stems, and fruits.



LEAF EDGE A

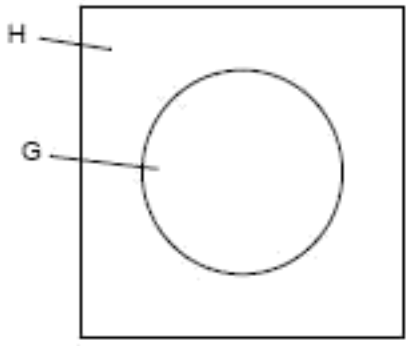
FRUITS B

BARK PATTERN D

(INVADED) RANGE F

SUN G AND RAIN H REQUIREMENTS

RELATIVE SIZE



Barberry
Berberis spp.

Berberidaceae
Barberry Family

Barberry is an invasive shrub that many people plant because of its pretty red fruits that remain on the branches through the winter. However, native animals don't eat those fruits, and barberry takes up space native plants could use. Barberries also have thorns, and what's worse, these thorns have a chemical that causes infection! Another problem with barberry is that it grows in thick colonies of clones, so it is hard to remove! Keep your eye out for a small shurb with hundreds of little spoon shaped leaves.

LEAF EDGE A

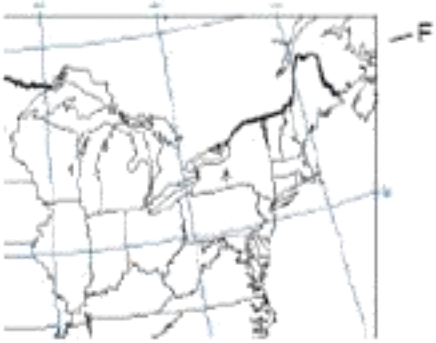
FRUIT B
FLOWERS C

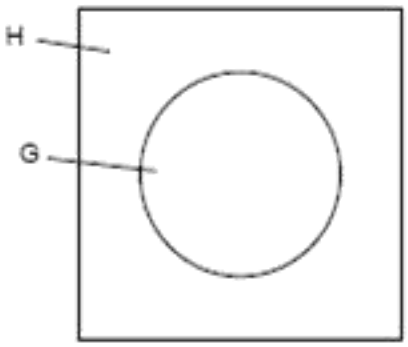
BARK PATTERN D

(INVADED) RANGE F

SUN G AND RAIN H REQUIREMENTS

RELATIVE SIZE

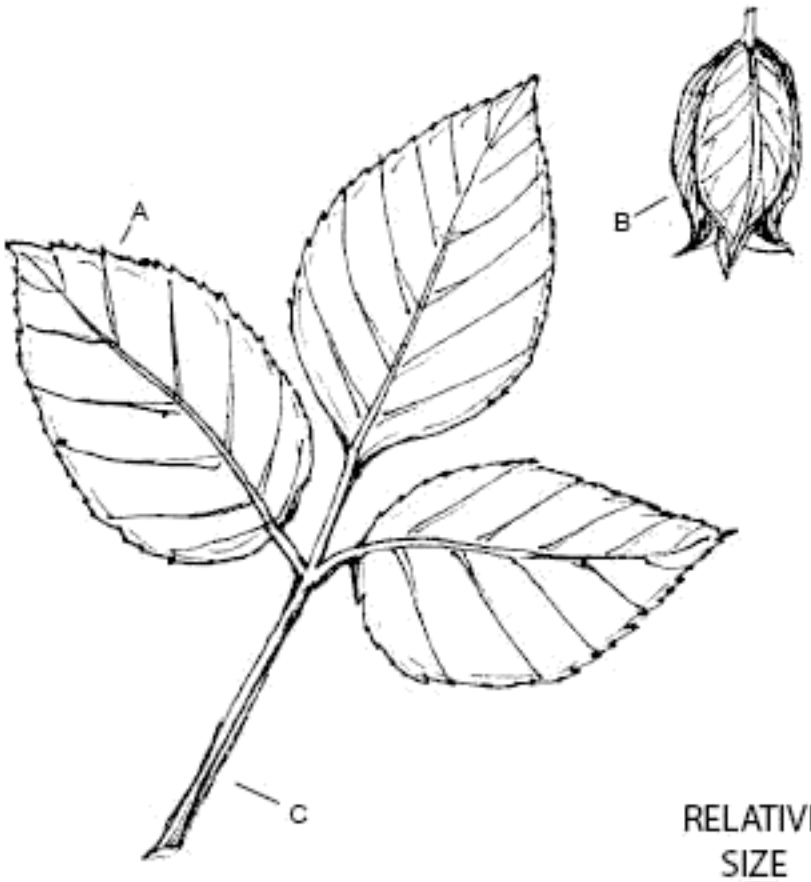




Bladdernut
Staphylea trifolia

Bladdernut family
Staphylaceae

Bladdernut gets its name from its unusual fruit--a papery capsule or "bladder"--that contains black seeds. Bladdernut gives us a good example of how a plants fruit looks somewhat like its flower. Like Poison Ivy and Boxelder, Bladdernut has compound leaves with three leaflets, but bladdernut's leaves do not have lobes, or "fingers".



LEAF EDGE A

FRUIT B

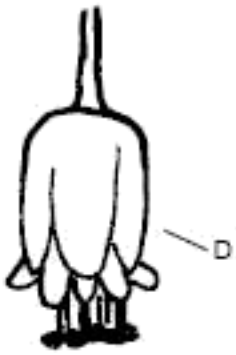
BARK PATTERN C

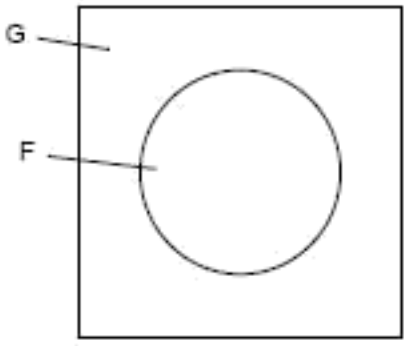
FLOWER D

NATIVE RANGE E

SUN F AND RAIN G REQUIREMENTS

RELATIVE SIZE

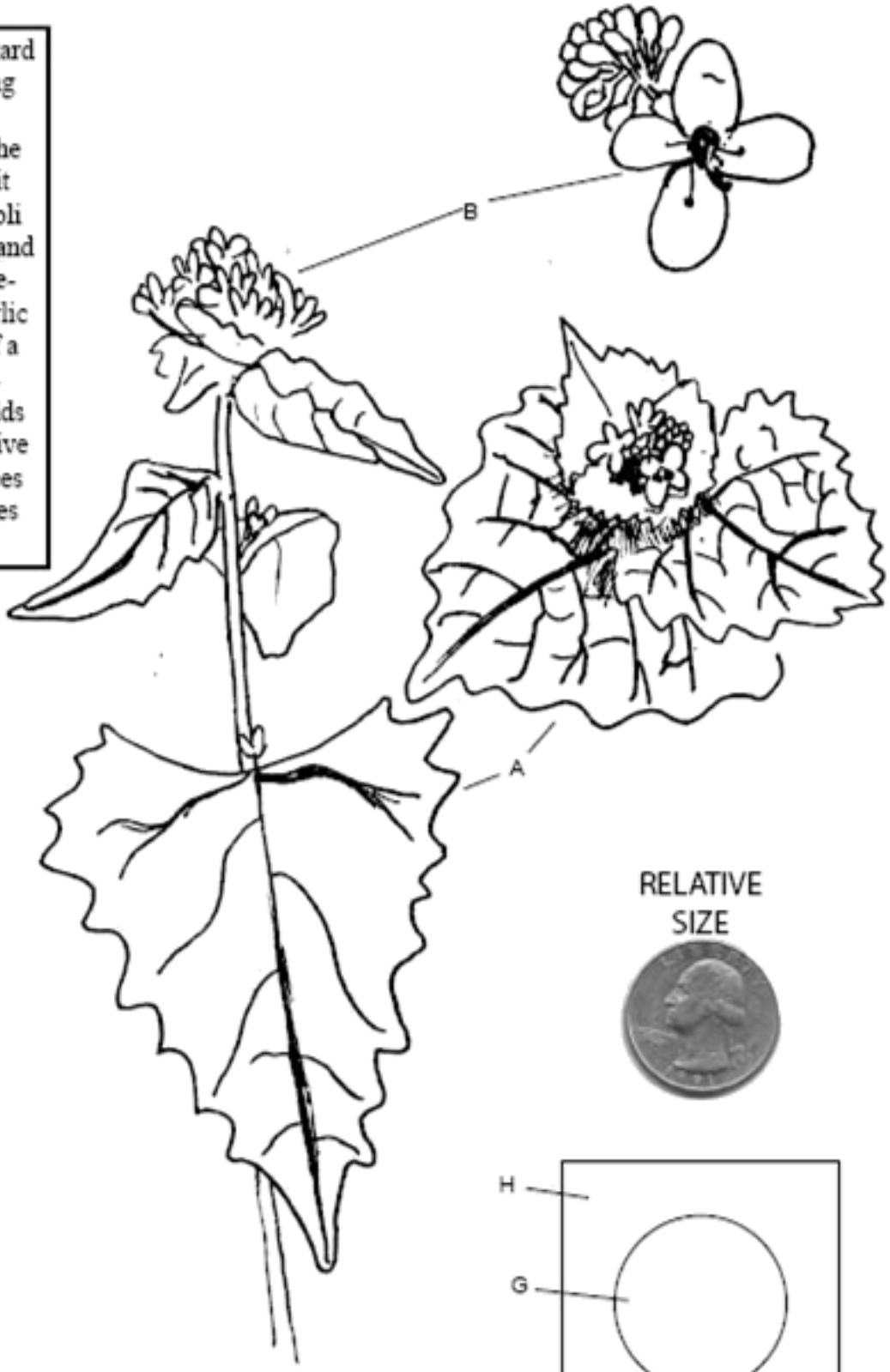




Garlic Mustard
Alliaria petiolata

Mustard Family
Brassicaceae

This is not a tree! Garlic Mustard is an herbaceous plant (meaning it usually has green stems and does not have wood). It is in the Mustard family, which means it is a little spicy to taste. Broccoli is also in the Mustard Family, and you can see the resemblence between the top of unopened Garlic Mustard flowers and the top of a piece of broccoli. Garlic Mustard spreads quickly across fields and sunny forests, keeping native herbaceous plants and baby trees from growing. Luckily it comes up easily by hand!



LEAF EDGE A

FLOWERS B

(INVADED) RANGE F

SUN G AND RAIN H REQUIREMENTS

RELATIVE SIZE

Maack's Honeysuckle
Lonicera maackii

Viburnum Family
Caprifoliaceae

Maack's Honeysuckle is one type of honeysuckle that grows like a shrub (some are vines). It gets its name from the sweet nectar you can suck from its flowers. Most honeysuckles in the United States are invasive species, and Maack's Honeysuckle is even banned in some states! In some forests it grows so thick that it is the only plant able to live! Maack's other name is Amur Honeysuckle from the Amur River between Russia and China. Notice that this is an "opposite" plant, meaning each leaf grows right next to another leaf. On this plant the fruits even grow in pairs. Unfortunately they do not taste very good to birds or humans!

LEAF EDGE A

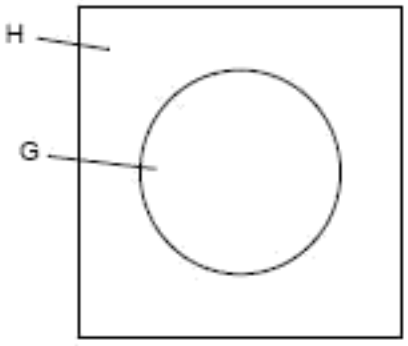
PAIRED FRUITS B
FLOWER C

BARK PATTERN D

NATIVE RANGE F

SUN G AND RAIN H
REQUIREMENTS

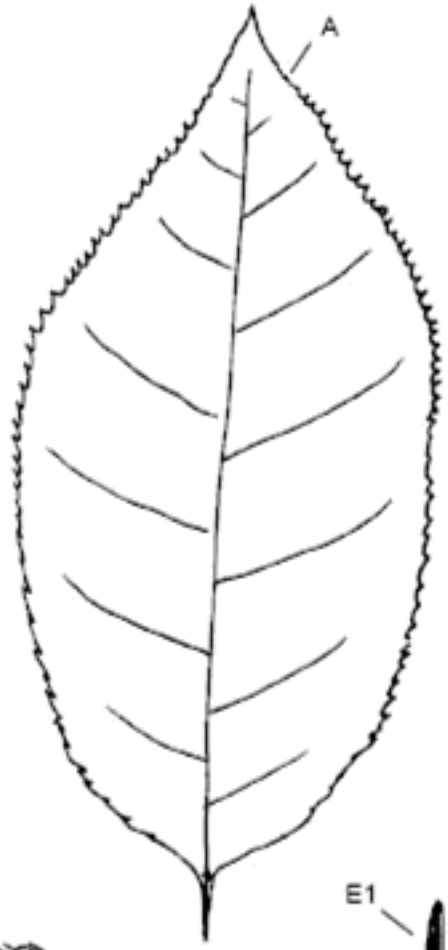
RELATIVE SIZE



Nannyberry
Viburnum lentago

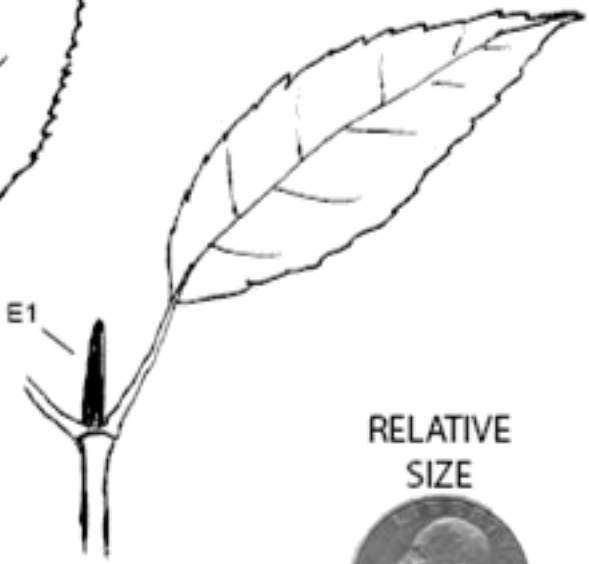
Viburnum Family
Caprifoliaceae

This plant is a shrub that usually has many stems. Its flowers form a flat-topped bunch with no aroma. The flower buds (the buds the flowers emerge from) have a very distinct shape. This plant's funny name comes from the belief that female ("nanny") goats like to eat the berries while male ("billy") goats do not.



LEAF EDGE A

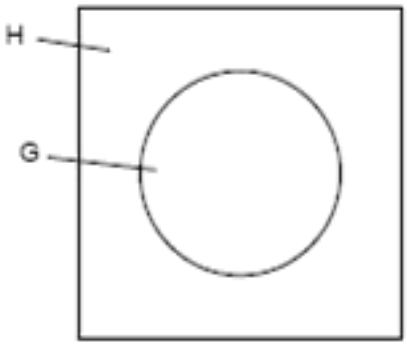
BUDS
Leaf Bud E1
Flower Buds E2



NATIVE RANGE F

SUN G AND RAIN H REQUIREMENTS

RELATIVE SIZE



APPENDIX P: Summary of Interpretation Visioning Session Presentation

What is interpretation? Interpretation is translating, in a similar way that you might translate from one language to another. It is taking something that people might not fully understand and presenting it in a way that is accessible to them. It is presenting some piece of information to the audience that they do not already know. It is educating the audience, helping them understand what they are seeing, whether that be information about ecosystems, management practices, or what the area used to be like. Interpretation might also inform the audience about what they can or cannot do in the area. Most importantly, however, interpretation engages the audience by asking them to think, look, or do something. It asks them to think about themselves, links the topic to something they already know or that is relevant to their lives. It relates to things they care about, and helps the visitors have the most successful trip possible.

While interpretation can come in many formats, static signs are very commonplace in parks similar to what Mill Creek park will be. Many of the principles discussed here in relation to signs can be applied to other interpretive programs, such as guided tours, or brochures. Good signs have themes, are attractive, are brief and clear, and involve the reader. The themes should be easy to understand and easy to remember. The signs must attract the audience either with colors, visuals, or titles. They should be brief, containing approximately five or fewer ideas, and just enough text to develop them. They should engage the audience by arousing curiosity, inviting participation, or providing entertainment. Throughout, they should maintain relevance to the target audience. In general, people will spend less than one minute reading a sign, and even less time if they are not hooked by an attractive title, graphic, or question. In most cases, a 5^{th} to 7^{th} grade reading level is appropriate for sign text.

From static signs to interpretive walks, each type of interpretive program has pros and cons.
For example a post-and-brochure program is relatively inexpensive to implement and is easily modified. However they can often lead to litter problems, and may not take full advantage of the attention span of the users. Static signs, however are more challenging to change once in place and are slightly more expensive, but often provide a venue for more attractive and engaging graphics. Audio tours also require substantial initial investments, and similar problems of post-and-brochure, but allow for a new and exciting method of engaging the visitors. While a guided tour has the potential to go into much more detail and make the information more personal, the quality of the presentation may vary greatly among presenters.

The entire group of participants was then asked the following questions

Who is the Audience?
Who do you expect to visit the park?
What are their motivations for being there?
Who do you want to target?
What do you want to accomplish with the interpretation?
(all of this is to establish the purpose of the interpretation and who is the audience)
Where does the interpretation belong? – For this question, a map was provided, along with pictures of the sites corresponding to the locations established on the map in the Master Plan. However, they were made aware that a) these sites could change, and b) some types of signs may require specific locations, while others can be more generally placed.

For the remainder of the meeting, the participants were separated into three groups and asked to address the following questions considering their answers to the above questions:
How do we present the information? (This addresses the type of interpretive program, whether it be a podcast or a post-and-brochure)
How do we tie everything together? (What type or types of themes did they want to be maintained throughout the park and interpretive program)
What, specifically, do we want to see there? (This addresses specific topics to be included in any interpretive program)

APPENDIX Q: Interpretation Visioning Session Summary Notes

Wednesday, July 29, 2009
Dexter District Library

Background Questions

Who is the Audience?

- residents
- families
- students
- visitors from whole region
- recreational visitors
- passive and active recreation
- downtown visitors
- downtown workers
- varying ages (kids, sr. citizens)

Why are they there?

- take a break/relax
- field trips (teachers/students)
- curious about new area
- nature viewing, bird watching
- exercise
- fishing
- history
- kill time
- paddling
- close access to open space
- connection to Border to Border Trail
- Scientific monitoring (water, wildlife)
- Habitat restoration
- volunteering
- scout projects

What do you want to accomplish with the interpretation?

- education
- wayfinding
- encourage more eco-friendly behavior
- healthy community
- inspiration
- sense of ownership
- instructions/rules
- connection to larger area

How do we present the information?

Signs

- 2 post sign
- glass signs (like in AA)
- integrated into existing permanent structure
- larger sign w/ lots of info at beginning
- emphasis on pictures and diagrams
- include wayfinding on each
- wayfinding should include where you are and where you can go (locations in park/ destinations in downtown)
- 3 sets of signs – color coded (green = ecology; brown = history; blue = informational) – themed colors set the tone and tie it together
- big kiosk in a central area with lots of information (for a subset of users who might not walk the system (can still learn without being immersed – more accessible) – where the big sidewalk comes down… 2nd point of river walk – don't want to ruin the view at the top. other smaller individual signs are scattered (other locations for larger kiosks?)
- rotating signs with changing information (seasonal? 5 years? yearly?) … will things get stale?
- low signs for kids
- interactive – box where you reach in and feel to try to guess
- trivia questions on each sign with answers at end
- big educational signs
- "2-liners" – "notice X over there"
- want low maintenance
- combination of signs and post-brochure
- Don't want people stopping and blocking exercisers on the main multi-use trail (maybe have signs on littler "turnouts")
- sponsored by businesses

Post and Brochure

- contribute to litter
- no

Guided Walks

- semi-annual, annual, weekends
- groups could sign up for
- teachers might lead
- programs that incorporate curriculum
- focus on special event/topic
- ex. Owl walk, weekend walk
- Challenges – who will do it? funding? bank of existing volunteers?

Podcasts

- dial in when you get there
- electronic version of post and brochure
- … the future of interp?
- touch-screen kiosk
- buy the recording
- download the podcast (website/library)
- website talks about destination (places to see in Dexter) and includes podcast

Other

- info marked on pavement
- eye-catching animal tracks to lead the way

What do we present?

How do we tie everything together?

- history
- sense of ownership
- common wayfinding symbol
- different types of info in different areas (near school v. "waterfront")
- passive v. active engagement (interactive signs)
- inspiration
- inspiring volunteers

What specific topics do we want to see?

- history of each area
- significant historical areas
- observation decks – highlight fish present
- what types of wildlife you'd expect to see
- pointing out what looking at
- stormwater… ecological restoration
- stream ecology (could include what individuals can do, habitat/stream buffers)
- habitat enhancement (including fish and fish habitat enhancement, wildlife in general)
- watershed protection (medallions on sewers "don't dump")
- streambank stabilization, sediment flows, water quality, dynamics of banks, importance for fish habitat
- food web of stream and surrounding habitats
- grist mill
- cemetery
- viaduct
- dikes from creek dredging (1904)
- arch
- Henry Ford

- “How to use the park”
- Safety – river flooding, awareness, info about seasonal trail
- incorporate safety into history… you are in a flood plane
- exercise examples
- reason for dam removal
- reason for X feature
- outdoor ed area (focusing on certain age group)

Additional points and questions

- Do you need to have a sign directing you to the canoe launch? (Will you be able to see the launch?)
- avoid overkill of info / “sign garden”
- potential for creation of a library of ideas/designs/info/themes for the Village
- brainstorm w/ school teachers about info on signs/interpretive work (also get input from students)
- arts culture and heritage will have a sign
- trash cans…

City of Ann Arbor
Natural Area Preservation

Natural Area Preservation
VOLUNTEER SIGN-IN

Park: _____ Activity: _____ Date: _____ Start time: _____ to: _____

Workday Leaders (list all): _____

Private Groups: _____ Phone Number(s): _____

Hours Present	Volunteer with us before?	PRINT *FULL* NAME	PHONE NUMBERS (Home & Emergency)	Changes to ADDRESS or EMAIL	GROUP NAME	Special needs/ Allergies?	Events/News-letter by snail mail or email?	Where did you hear of this event?
			H: E:					
			H: E:					
			H: E:					
			H: E:					
			H: E:					
			H: E:					
			H: E:					
			H: E:					

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