Milwaukee River Greenway Habitat Plan

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Milwaukee River oxbow, Lincoln Park

Executive Summary

This initial Habitat Plan is guided by the following Master Plan planning objectives. Periodic updates are recommended as information gaps are addressed, and stakeholder and funding commitments obtained.

1) Complete biotic inventory and map of existing plant and animal communities, vegetation, and wildlife habitat types. Complete biotic inventories are never literally achieved, as the word "biotic" includes all life forms, and inventories typically focus on particular groups, such as birds, fish, insects, or vegetation. This initial Habitat Plan compiles and summarizes known information on the major biotic groups in the Greenway, and provides a wealth of new original data. The collection of biotic inventory data is ongoing and should continue. Funding for this study enabled completing original mussel, lichen, and insect surveys, and outside funding was utilized to complete additional original surveys for birds, mammals, reptiles, and amphibians. This study also acquired all available third party data for all vertebrates (including fishes), some invertebrates, and plants. All original and third party data were aggregated, proofed, and transformed into GIS layers and checklists. Data gaps and additional information needs were also identified. Most animal communities and some plant communities are well inventoried. The greatest remaining deficiencies are for botanical and invertebrate inventories. Major community types have been mapped, and point-level occurrence data are provided for exploring known locations of rare species.

2) Identify species that will be the focus of management efforts. Recommend targeted species that have a strong or unique role in an ecosystem – keystone, umbrella and flagship types. Focal Species for each project area are recommended. Keystone, Umbrella, and Flagship species are defined, and can be applied to projects if desired during a design phase when project limits and social constraints are known.

3) Develop goals for vegetation and wildlife habitats based on criteria such as: pre-settlement vegetation, current plant and animal distributions; settlement pattern limitations; corridor-wide ecological capability, etc. Conduct a public process to establish consensus on habitat objectives. Public review and input on goals was completed through several public meetings and plan reviews by stakeholders. The overall goal of the Habitat Plan is to restore as much richness of native plant and wildlife communities within the Greenway as possible, within the confines of social and biological constraints. Many stakeholders expressed uncertainties over continuing resource availability (funding and personnel) to complete and maintain habitat projects, resulting in ever shifting goals to match anticipated resources. This is a common uncertainty in ecological planning, therefore goals set forth in this plan are expected to be continually reviewed and revised. Recommended specific goals for habitats and wildlife are addressed in several ways, but will need to be matched to funding opportunities and stakeholder commitments that will guide the final design and implementation of feasible projects. In Section 3 remaining information needs, such as additional biotic and light pollution inventories, are identified. Progress towards filling these information needs can be tracked as studies are completed. In Section 4 goals are provided for each project area as opportunities, with priority projects identified in Table 6. Metrics for measuring the success of projects through monitoring are given in Table 7. While no "final" project goal targets are

identified at this time, owing to the above mentioned social factors, ongoing success can be measured by tracking the number of projects completed as evidenced by monitoring metrics.

4) Create and implement a framework for long-term monitoring and adaptive management of plant and animal communities. This objective is met within Section 5. Adaptive management is the process whereby monitoring data is fed back into management decisions, which allows for management activities to respond to what is and isn't working. Implementation of data collection and habitat management can proceed as stakeholders adopt commitments to these actions.

5) Increase the ecological literacy of the public through educational components (outreach, public events, workshops, field trips). This objective is met by recommending community science programs suitable for informing monitoring goals, and recommending some novel programs such as citizen adoption of turtle nest site protections. Additional education and outreach programs are recommended and implementation of programs will proceed as stakeholders adopt commitments to these actions. The Urban Ecology Center is a coalition leader in this area.

MILWAUKEE RIVER
GREENWAY

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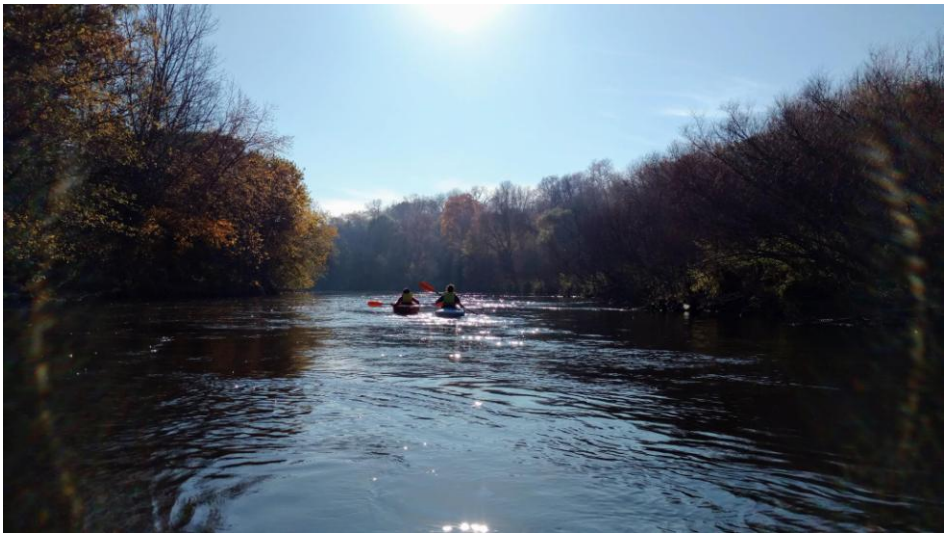


1. INTRODUCTION

The Milwaukee River Greenway is a seven mile section of the Milwaukee River from East North Avenue to West Silver Spring Drive. It forms a wide valley landscape at its northern end and a narrower, steep walled, valley at its southern end, providing a semi-natural setting surrounded by compact urban neighborhoods. Green space within the mostly narrow and deep river valley, including its slopes and bluff tops, includes a variety of wetland, woodland, shrub, and old field habitats. These green areas are set among urban parks, urban trails, floodplains, and urban and industrial backyards. The Milwaukee River Greenway Master Plan (Plunkett Raysich Architects 2010) created a comprehensive strategy for the river's renaissance. This community based plan made recommendations for preservation, revitalization, management, and improved public access and recreation. It sets forth a vision for a unique urban wilderness containing restored natural communities and shared recreational opportunities. The Master Plan includes steps for habitat restoration to enhance the ecological integrity of communities of plants and animals that include a wide diversity of mollusks, crustaceans, insects, fishes, amphibians, reptiles, birds, and mammals. The Master Plan identifies desired improvements within the corridor in the five principal categories of remediation, restoration, signs, governance, and trails.

The Master Plan also recognized that the Greenway is currently home to a wide diversity of wildlife occupying this densely urban setting, including several species recognized as State or Federal Endangered, Threatened, or Special Concern species. Wildlife and people coexist within the Greenway, and there is a desire to balance use with ecological integrity, including preservation of wildlife habitat corridors. The Greenway contains approximately 515 acres of land within a Primary Environmental Corridor (SEWRPC 2010), 148 acres of which is covered by the river channel itself. Twelve parks and more than 28 miles of hiking, biking and water trails are within the Greenway, which crosses four jurisdictions, all with a vested interest in the area's health and productivity. Milwaukee County is the primary land holder in the area, and the City of Milwaukee, the City of Glendale, and the Village of Shorewood oversee portions of riverbank as well as associated commercial areas and neighborhoods.

To assist with accomplishing these goals, the Master Plan identified a need for a Habitat Plan to advance on-the-ground conservation in the Greenway, and as a necessary preliminary step in prioritizing habitat restoration projects. The Master Plan identified several unique locations for habitat – Lincoln Park Islands, Estabrook Park/Estabrook Falls, Hubbard Park, Koenen Nature Preserve, Cambridge Woods, Riverside Park (Urban Ecology Center), and Milwaukee Rotary Centennial Arboretum. It also briefly discussed fishes, bats, amphibians, reptiles, and birds, as wildlife groups to address. The following Habitat Plan objectives were identified:

1. Complete an inventory and map of existing plant and animal communities, vegetation, and wildlife habitat types.
2. Identify species that will be the focus of management efforts. Recommend targeted species that have a strong or unique role in an ecosystem – keystone, umbrella and flagship types.

3. Develop goals for vegetation and wildlife habitats based on criteria such as: pre-settlement vegetation, current plant and animal distributions; settlement pattern limitations; corridor-wide ecological capability, etc. Conduct a public process to establish consensus on habitat objectives.
4. Create and implement a framework for long-term monitoring and adaptive management of plant and animal communities.
5. Increase the ecological literacy of the public through educational components (outreach, public events, workshops, field trips).

In 2012 the Milwaukee River Greenway Coalition (now River Revitalization Foundation) commissioned some biodiversity studies to inform the development of a Habitat Plan. Technical reports on lichens, dragonflies, and damselflies were completed in 2012 (Rutherford 2012), and mussels in 2013 (Casper and Dare 2013), and work was begun on amphibian and reptile inventories (G.S. Casper, unpublished data). In 2014 the Milwaukee Estuary Area of Concern program (AOC; https://dnr.wi.gov/topic/greatlakes/milwaukee.html) provided major funding to perform a more comprehensive fish and wildlife biodiversity study along the Milwaukee River, to address fish and wildlife habitat and population impairments in the Area of Concern, within which the Greenway is nested. Work on the Greenway Habitat Plan was therefore postponed in order to include data and conservation recommendations from this comprehensive regional study completed in 2017 (Casper and Robson 2018).

The ground nesting Ovenbird no longer breeds in the Greenway due to an overabundance of urban predators.

The AOC study was conducted by a team of biologists over four years, led by Gary S. Casper (UWM Field Station) and Julia L. Robson (Milwaukee County Department of Parks, Recreation & Culture). It gathered all available data for vertebrates, mussels, crayfish, and odonates; developed a data vetting system for assessing data confidence; and georeferenced biodiversity data into a GIS project. Data were obtained from museum specimen collections, agency and community (citizen) science programs, the literature, and local naturalists and NGOs (including the previous Greenway studies). The AOC study identified which species were impaired, and made recommendations for recovery through habitat projects with metrics recommended for monitoring success. This effort provided checklists of biodiversity for the Greenway which identifies rare species, a methodology for selecting Focal Species for habitat projects, and a wealth of information on species' local status and distribution, critical habitat needs, and appropriate monitoring methods. These findings are now incorporated into this Habitat Plan and add considerable value towards achieving goals and objectives.

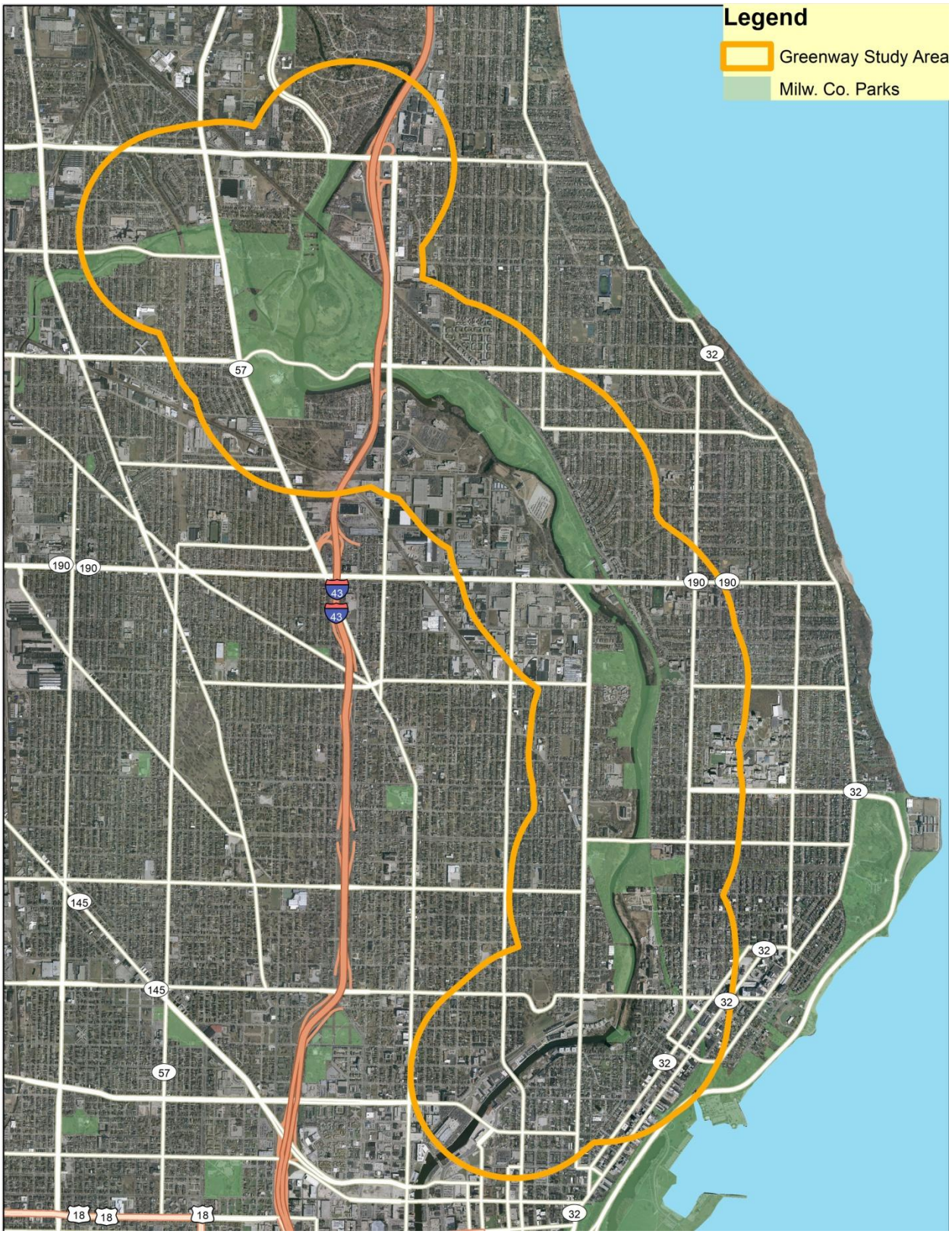
Plan Overview

This plan provides a blueprint for enhancing the ecological state of the Greenway. It reviews a large amount of ecological data on plant and animal communities, and references additional technical data. It then makes a large number of site-specific project recommendations, and calls out priority projects – all of which will require landowner approval and funding to actually achieve. The main recommendations are to prioritize preserving and enhancing the remaining better quality plant communities, manage most areas primarily as wildlife stopover habitat, and control invasive species. The project recommendations may be viewed as a menu of ideas for ecologically enhancing the Greenway. While recommendations are as comprehensive as possible for what are considered to be feasible projects, additional potential projects may come to light in coming years in this socially complex, ever evolving, system. Likewise, some suggestions may never come to fruition. Coalition partners are encouraged to remain open to new ideas as science, climate, and the community continue to change.

Many social factors will weigh into what projects can actually be realized, not the least of which are funding opportunities. As landowners and partners consider applying for funding, this plan identifies desired outcomes for achieving ecological goals. Project proposals will initially require obtaining landowner agreements and identifying funding sources. Project proposals may include detailed planting plans or other technical specifications that often require additional data collection, or are named as preliminary tasks to be funded (i.e., plant and soil surveys, wetland delineations, permitting requirements, etc.), and are usually tailored to match requirements for a specific funding program. For each project area, rare species and plant communities are listed that could benefit from specific restoration actions, and these outcomes can be included in project proposals.

As Greenway partners examine potential projects, they will also need to understand the significant constraints on ecological restoration success that are important in the Greenway, and set expectations accordingly. This heavily urbanized environment is a narrow corridor impacted by light and noise pollution, water and soil contamination, sometimes poor air quality, many invasive species, and overabundant grazers (deer, rabbits). Wildlife and plants utilizing the Greenway must be tolerant of frequent disturbance and habitat fragmentation, as no large continuous habitat patches are possible. These factors impose major constraints on what can be achieved. For example, migratory stopover habitat is a realistic goal, but supporting interior forest or ground nesting birds is not. These constraints are addressed throughout the plan where appropriate.

Ryne Rutherford collecting lichens in the Greenway



Map of the Milwaukee River Greenway with county parklands.

2. Methods

Fish and wildlife data and recommendations from the AOC study were extracted specific to the Greenway and reviewed and refined to the Greenway area. See Casper and Robson (2018) for detailed methods on data collection and vetting. The earlier Greenway-specific studies were also reviewed for any additional relevant information (Casper and Dare 2013, Rutherford 2012, G.S. Casper unpublished data).

Available plant species occurrence and plant community data were also reviewed from SEWRPC (2010), R. Barloga (unpublished data Barloga and Lane 2011), the Milwaukee County Department of Parks, Recreation & Culture (unpublished data on coarse level plant communities from informal surveys, invasive species, and rare and native plants), and the Urban Ecology Center (Callaghan et al. 2015). Plant species occurrence data from Milwaukee River Advocates (Sura Faraj, personal communication 2018) were also reviewed.

All available data were assessed and refined with stakeholder input, then utilized to summarize Greenway biodiversity, and make project and monitoring recommendations.

The backbone of the AOC study was a set of species checklists identifying Species of Local Conservation Interest (SLCI), detailed chapters discussing status and conservation issues for each taxonomic group, and GIS spatial layers mapping rare species occurrences.

What are Species of Local Conservation Interest (SLCI)?

"These are the species we should be paying attention to in our community, lest they disappear."

Species of Local Conservation Interest (SLCI) are species that meet at least one of the following criteria:

a) listed as either state or federally Endangered, Threatened, or Special Concern;
b) listed as Species of Greatest Conservation Need in the State Wildlife Action Plan;
c) considered to be locally rare or declining; or
d) have social value to stakeholders and considered by the community to be desirable;

and, the habitat has the potential to support viable populations of these species.

SLCI found in the Greenway: Northern Leopard Frog, American Mink, and American Kestrel.

The checklists also make "Focal Species" suggestions. Focal Species are species that conservation activities can focus on. They are chosen to represent particular habitat types (e.g., Umbrella Species), have strong community social value (e.g., Flagship Species), or often are important components of functional ecosystems (e.g., Keystone Species). Focal Species choice can vary by project, and is meant to be representative of project objectives.

For this Habitat Plan the SLCI concept was adopted and data for a half-mile buffer of the Greenway extracted (see figure). The SLCI data retained were only post-1989 records that met a vetting confidence level of A–C, which essentially represent trusted records of recent occurrence (see Appendix A in Casper and Robson [2018] for vetting system methods). AOC checklists and project recommendations were then reviewed and Focal Species selected specific to Greenway project areas. Species were selected as Focal Species if breeding populations or migrants could feasibly be supported within the Greenway based on their critical habitat requirements and life history needs. The selection of Focal Species takes into account both biological and anticipated social constraints. Two sets of constraints apply to any successful wildlife conservation program, a paradigm developed by Dodd and Seigel (Dodd and Seigel 1991, Seigel and Dodd 2000, Dodd 2001).

> *Biological Constraints* are the immutable requirements for a species survival imposed by its adaptation to the environment over long evolutionary periods (thousands to millions of years). These include food preferences, dietary needs, specific habitat requirements, social behaviors, environmental tolerance limits (i.e. temperature), predator tolerance, life table parameters, and more. If a species requires a certain type and amount of habitat to support a viable population, or a specific diet, no amount of human desire will change those requirements. We cannot simply tell the eagle to eat wheat, or the fish to live on land.
>
> *Social (Human Imposed) Constraints* describe the limits within which human activities are able to perform. These constraints include finances, manpower, public support, political support, habitat availability, logistics, and many other factors associated with implementing conservation programs. While important, these constraints are usually flexible, sometimes wildly so based on human desire to prioritize resources. They are always more flexible than the *Biological Constraints.*
>
> If the *Biological Constraints* are breached, then regardless of our best intentions the conservation program will fail. These constraints are not “negotiable”, being set by evolution and the physical limits of the species. Moreover, if the *Social Constraints* are inadequate, or are used to override or compromise the *Biological Constraints*, then the program will fail, no matter how noble the intentions of the human participants.

3. Habitat Plan

The results of the AOC and Greenway studies documented sixty-one fish and wildlife SLCI reported from the Greenway during some part of their life cycle, including twelve state or federally listed species (Table 2). These records however include migrants stopping over for brief periods to rest and refuel, and vagrants passing through or sometimes attempting unsuccessfully to establish territories. There may also be additional fish and wildlife SLCI present for which no records are known, especially species that are hard to find or identify. The Habitat Plan differentiates between species that may be supported as breeding populations, and species normally present only as migrants for brief periods. Greenway habitats can play an important role in supporting these two groups of SLCI in the community for future generations.

Species considered to be vagrants, for which the Greenway alone is unlikely to be able to provide sufficient habitat to support viable populations, are not specifically addressed for habitat planning in order to minimize the creation of habitat "sinks" or ecological traps (Hale and Swearer 2016). Ecological traps are situations where species are attracted to deficient habitats that cannot actually support their full life cycle needs. These vagrant species may be occasionally observed in the Greenway, and may use the Greenway as a movement corridor, but are not the focus of habitat planning.

The overall goal of the habitat plan is to restore as much richness of native plant and wildlife communities as possible. This can be achieved through cooperative projects that a) preserve remaining high quality areas; and b) restore native plant communities and fish and wildlife populations where feasible, including repatriating extirpated species. This vision can be achieved over time to the extent practical within the social and biological constraints of the system, chief of which are competing land uses, and fragmented natural areas subject to continuing high disturbance levels. This disturbance includes constant input of invasive species (plant and animal), urban predators, and high levels of recreational use. Pre-settlement communities are not the goal, as many species' critical habitat requirements cannot be met in such small disturbed habitat areas. Moreover, continuing climate change will result in continuing changes to plant and animal communities. Over time, land managers will need to take these ongoing stressors into account and adapt to change.

3.1 Plant Communities in the Greenway

The Greenway falls within the Southern Lake Michigan Coastal Ecological Landscape, the most urbanized landscape in the state, and was mostly forested pre-settlement (Wisconsin Department of Natural Resources, 2015). Original forests were dominated mostly by Sugar Maple, Basswood, and White Ash. Plant communities within the Greenway have not been adequately inventoried, but have been studied to some extent. In sum, large portions of existing green spaces are degraded or non-natural, such as urban backyards, and picnic and golf areas. However significant areas of upland hardwood forest, evergreen stands, surrogate grassland and prairie, riparian shoreline, and shrub habitat exist. While these existing communities could be inventoried and correlated to formal natural community types (op cit.), most are too degraded with altered soil bodies and plant communities to fit these natural community types at this time, hence such effort is not recommended. They are better treated as urban natural areas, comprised of altered soils and plant communities, with ecological goals set for

establishing native plant communities ranked into general habitat types (forest, shrub, grassland, and wetland), with some finer variation where warranted (i.e., lowland vs. upland forest) and an emphasis on restricting the invasion of non-native species. While habitats are not likely to be restored to pre-settlement conditions, they can be stewarded towards communities dominated by native species with diversity sufficient to provide some resilience to ongoing climate change.

Barloga and Lane completed plant surveys in some public portions of the Greenway in 2011 and calculated Floristic Quality Index (FQI) scores for thirteen areas (Figure 1; Barloga and Lane 2011). The survey area boundaries mapped in Figure 1 however are uncertain and estimated posthumously from the author's notes. The FQI provides an objective assessment of vegetation quality of plant communities. The basis of the FQI calculation is the Coefficient of Conservatism (CC), a value given to each plant species on a state-wide basis (Wilhelm and Rerich 2017). Each plant species is assigned a value from 0 to 10 which represent the probability of occurring in landscapes relatively unaltered from those of pre-settlement times. Plant species with high CC values are relatively specialized in their requirements, and thus are found in more restricted habitats. The FQI is a weighted average of the CC scores of all native plant species at a site. The FQI score reflects how disturbed a community is, with disturbed areas having low FQI scores.

Snowberry is a Greenway plant with a high CC score.

FQI values calculated by Barloga and Lane (2011) were for native plants only and used CC scores from Swink and Wilhelm (1994). Subsequently, the Wisconsin DNR has produced updated CC scores specific to Wisconsin (Bernthal 2003). These scores are kept current at dnr.wi.gov/topic/wetlands/methods.html. For this report FQI values were updated using the Wisconsin DNR Floristic Quality Assessment Calculator (ver. 1.10.17). Results are shown in Figure 1 and Table 1. Note that not all of Barloga's original data were available, so not all sites could be recalculated. Where data were missing, Barloga's original calculations were retained, and all values shown in the figures are for native species only. Also, Barloga's survey dates were not available, so these scores are not directly comparable to surveys conducted under current recommended botanical survey protocols (Bernthal 2003). Nevertheless, available FQI scores are useful in assessing the relative quality of the areas surveyed.

In the Greenway, the Cambridge Woods Natural Area (Site 12) had the highest FQI score in both methods, followed by Hubbard Park North Fence to Lodge (Site 10), Hubbard Tunnels to Cambridge Woods (Site 11), Estabrook Park West of Wilson (Site 8), and Kern Park/Pleasant Valley Park (Site 2). These five areas represent the highest quality existing plant communities and are a high priority for protection and enhancement through management actions.

The Milwaukee County Department of Parks, Recreation & Culture (MCP) recently mapped plant communities in the Greenway as shown in Figures 2 and 3. They also have collected data on and have GIS layers for invasive species throughout the Greenway, and for rare and native species at Kern and Pleasant Valley parks, which can be utilized for invasive species control and plant community management plans. Integration of these data with potential wildlife habitat projects are discussed in more detail within the project areas (Section 4).

The Urban Ecology Center has also conducted plant surveys on the east bank between Locust St. and North Ave. (the Milwaukee Rotary Centennial Arboretum project area, including Riverside Park), and produced a detailed management plan (Callaghan et al. 2015). This area had not been previously surveyed by Barloga and Lane (2011). Comprehensive plant surveys were conducted, and the plan maps stewardship management units (Figure 4), with plant survey results and detailed plant community management goals recommended for each unit. Integration of these goals with potential wildlife habitat projects are discussed in more detail in the project area discussion (sections 4.11 and 4.12).

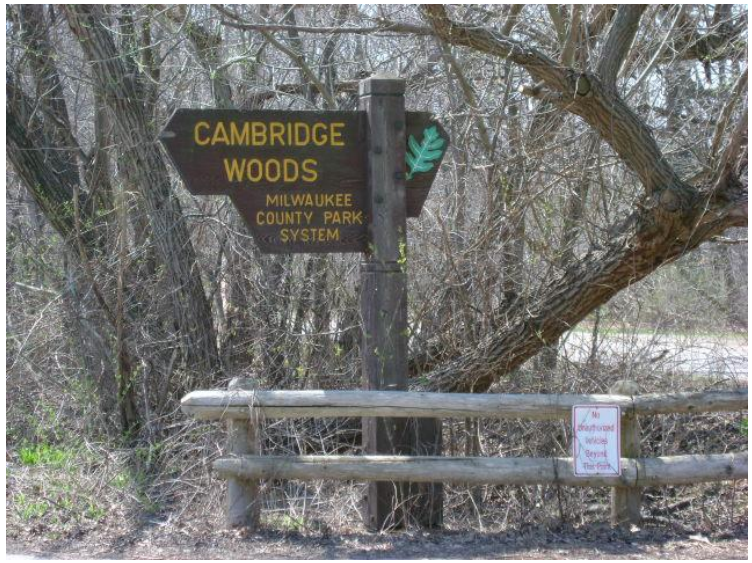
These resources provide an initial baseline inventory of broad plant community types, and provide detailed plant inventories for a few high quality focus areas where rare plant species are identified. Additional plant inventories are needed and should be part of planning for any habitat projects in areas not yet inventoried. Plant and soil communities form the basis of food webs supporting fish and wildlife, including invertebrates such as insects and mussels, grazers such as rabbits and squirrels, and predators such as snakes and hawks. Healthy and diverse plant and soil communities allow for increased wildlife diversity, but do not guarantee it, as most wildlife species have other specific needs relating to specific forage species, spatial area and physical structural requirements (such as den sites), and specific food plants or tolerance levels to pollution and disturbance that often preclude them from colonizing even the most pristine natural plant communities, especially in urban environments. Therefore while plant community restoration and enhancement is fundamentally important, it alone will not succeed in restoring many wildlife populations unless the specific critical habitat requirements for wildlife species are also restored. Therefore, in project and stewardship planning, critical wildlife habitat requirements should be given attention equal to that for restoring and maintaining highly pristine plant communities (for example, salamanders will not succeed in even the most admirably managed forest unless there is also a sufficient breeding pond). Section 4 addresses the integration of plant and wildlife communities into planning.

Webworm Moth, Cambridge Woods

Table 1. Floristic Quality Assessment for Barloga and Lane (2011)*			Species Richness			Native Species Only		Metrics All Species	
Site Name	Site#	Chicago FQI	N_a	N_n	N_{int}	FQI_n	Mean C_n	FQI_a	Mean C_a
Lincoln Creek Hackberry Site	1	21.0		35		22.5	3.8		
Kern Park and Pleasant Valley	2	33.6	84	70	14	35.3	4.2	32.2	3.5
South of Concordia Avenue and Pleasant Valley Park	3	21.2	52	42	10	23.1	3.6	20.8	2.9
Gordon Park Wooded Slopes	4	24.7		36		24.5	4.1		
The Beerline Trail	5	18.7	55	37	18	20.2	3.3	16.6	2.2
West of the Former North Ave Dam	6	8.8	42	18	24	10.4	2.4	6.8	1.0
Estabrook Park Hampton to Capitol W. of Picnic Area #8	7	26.5	51	41	10	26.2	4.1	23.5	3.3
Estabrook Park West of Wilson	8	33.5		35		29.2	4.9		
South of Capitol to North of Hubbard Park	9	21.0							
North of Hubbard Park Lodge	10	47.9							
South of Hubbard Park Tunnels	11	38.4							
Cambridge Woods Natural Area	12	55.1	124	112	15	50.9	4.8	48.4	4.3
Caesar Park East of the River	13	10.8							

* - Calculated from WDNR_FQA_CALCULATORv1.10.17. Note Barloga data are incomplete.

Code	Definition
N_a	total # Species
N_n	Nn = # Native species
N_{int}	Nint = # Introduced Species
FQI_a	FQI all species
FQI_n	FQI native species only
Mean C_a	Mean C-value all species
Mean C_n	Mean C-value native species only



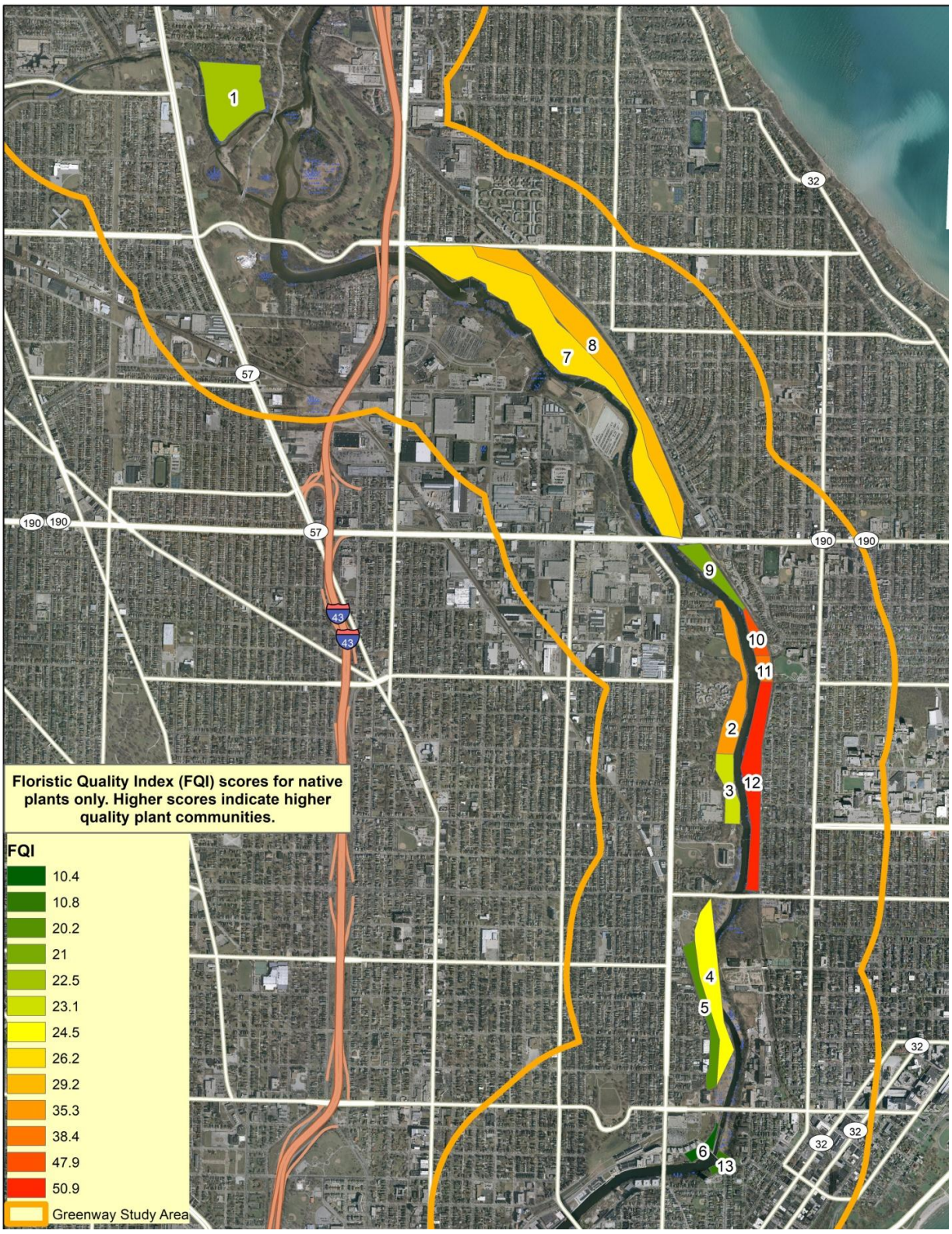


Figure 1. Floristic Quality Index values based on Barloga and Lane (2011)

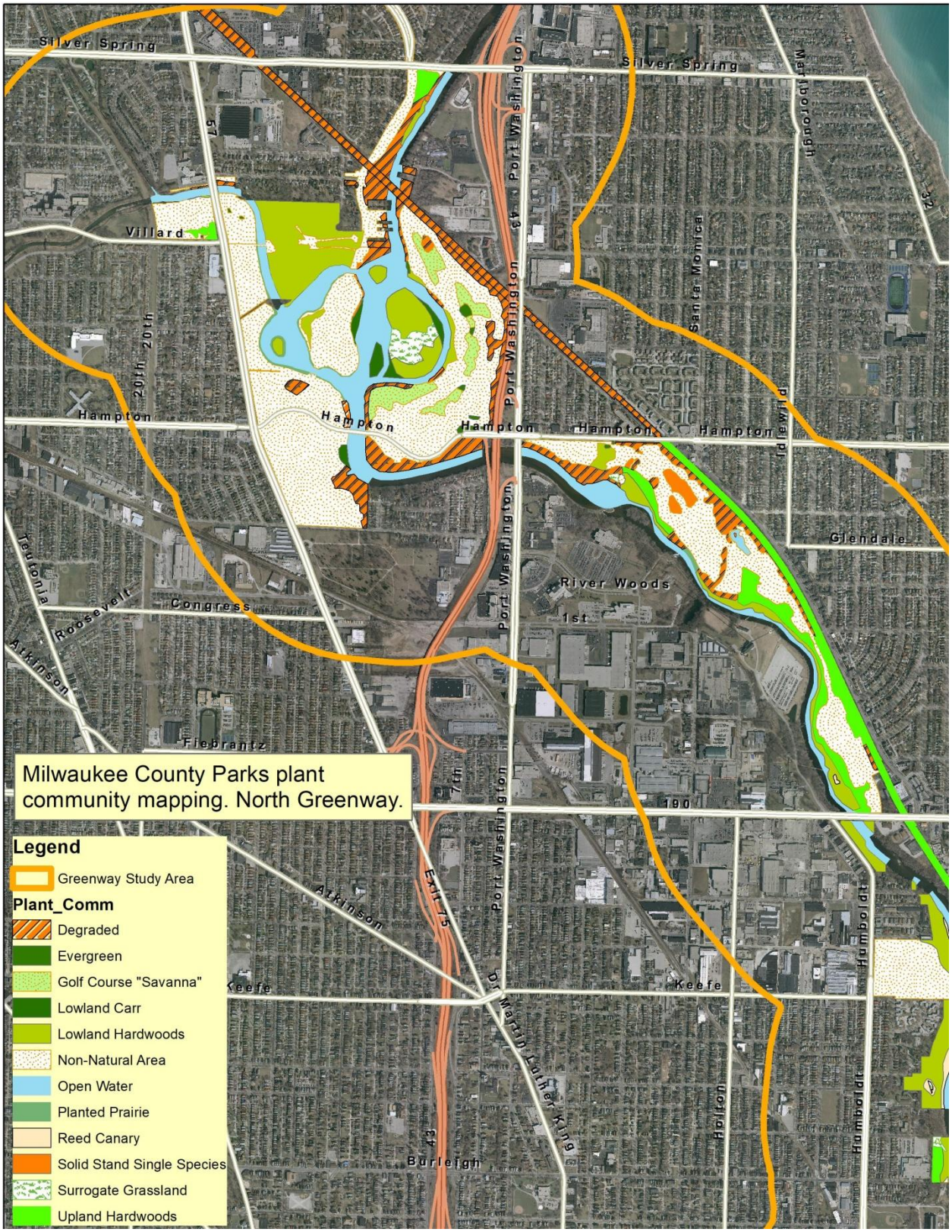


Figure 2. Greenway plant communities (source Milwaukee County Department of Parks, Recreation & Culture).

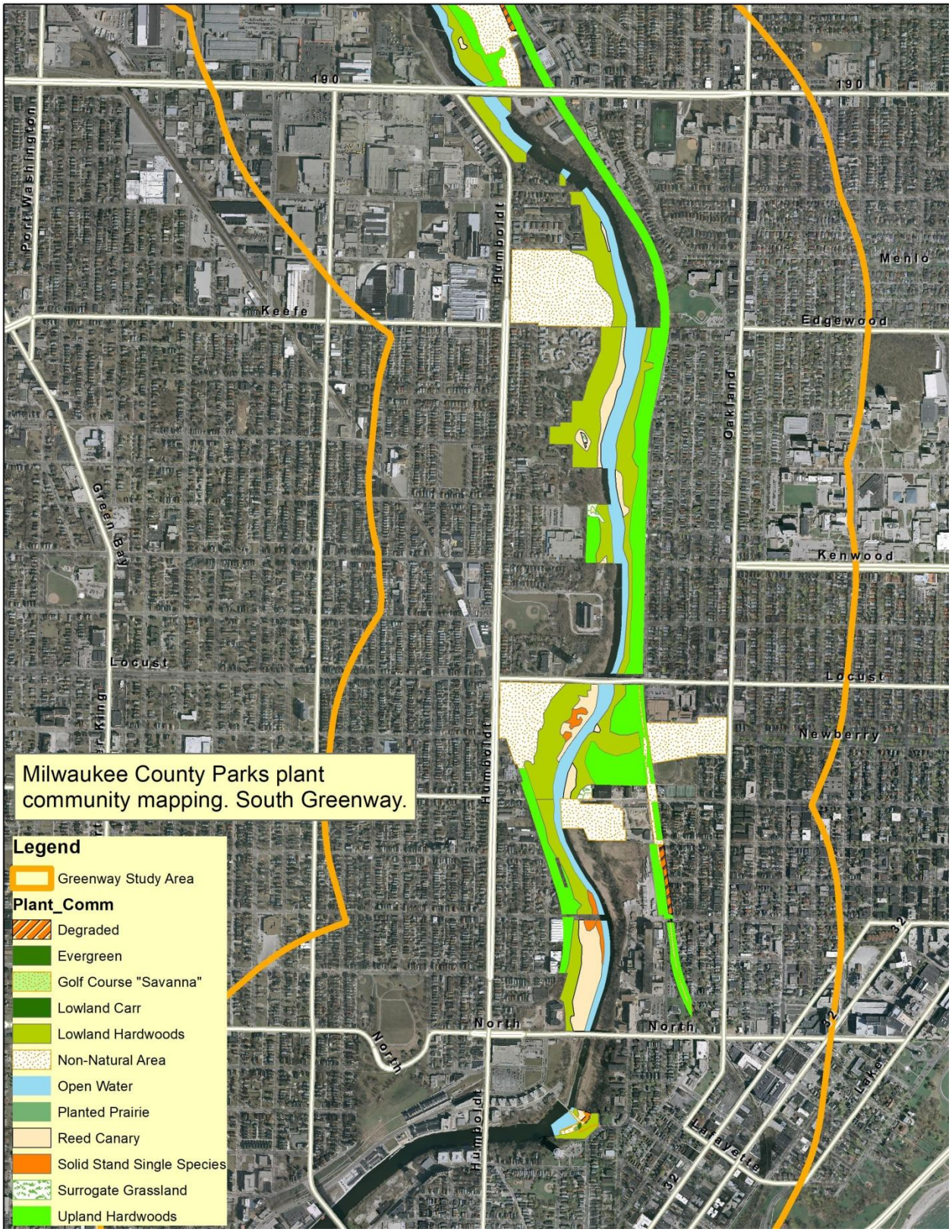


Figure 3. Greenway plant communities (source Milwaukee County Department of Parks, Recreation & Culture).

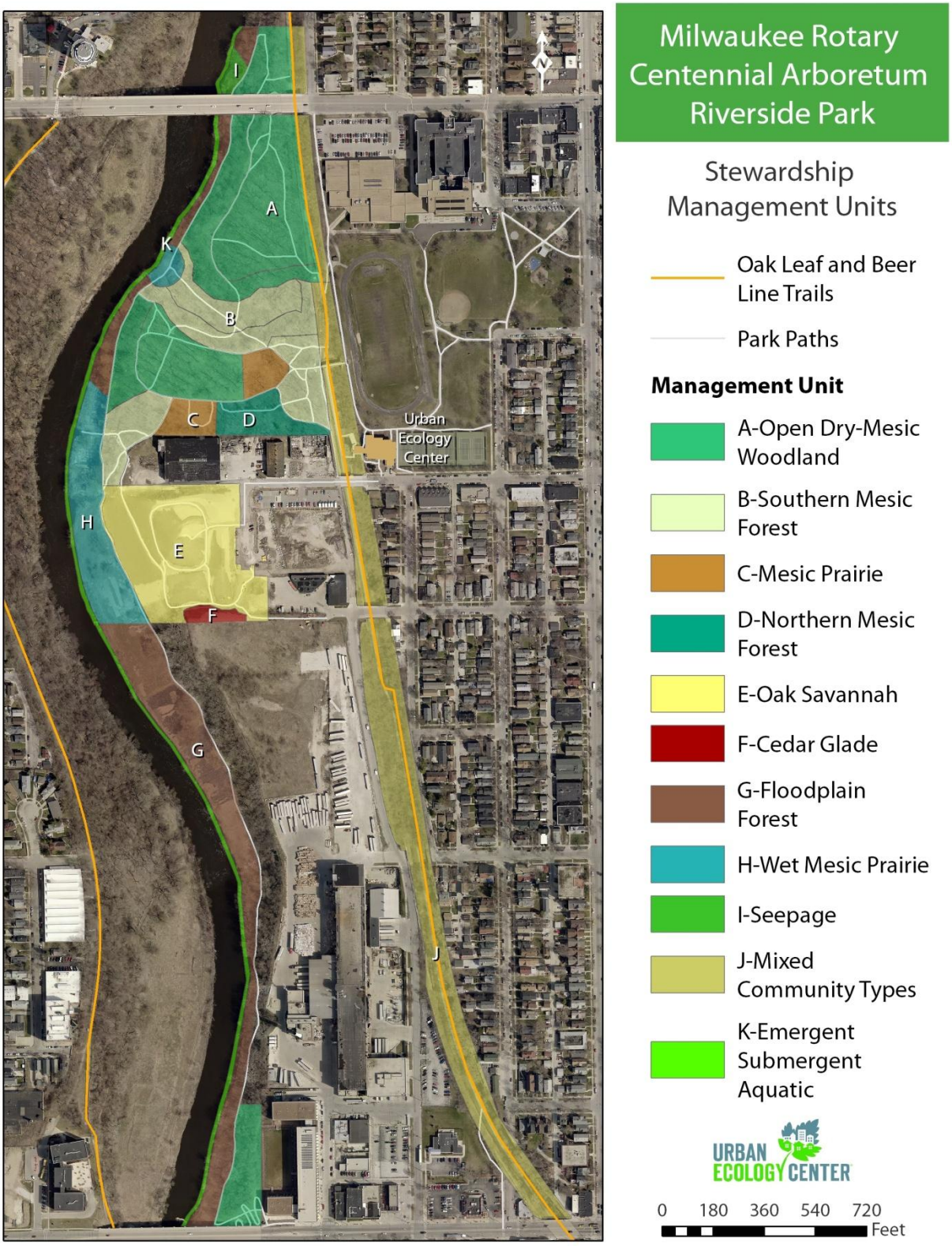


Figure 4. Urban Ecology Center management units from Callaghan et al. 2015.

3.2 Fish and Wildlife Biodiversity in the Greenway

Species Checklists (available at https://www.researchgate.net/project/Milwaukee-Estuary-Area-of-Concern-Wildlife-Assessment) from the AOC study list the extent of potential biodiversity in the Greenway for each of the biotic groups addressed. The Greenway is however more limited in habitat and area than the entire AOC study area (which included the entire northern half of Milwaukee County and a portion of southern Ozaukee County). Table 2 summarizes fish and wildlife SLCI records obtained within the Greenway study area (note that additional SLCI may become established as habitats improve). This provides a snapshot of SLCI diversity in the Greenway, which can be further refined with continuing fish and wildlife surveys.

Table 2. Fish and Wildlife SLCI Known From the Greenway.

Species	Federal Status	WI Status	SGCN	SINS	NHI Tracked	N*
Amphibians (3 species)						
Gray Treefrog[1]						2
Green Frog						5
Northern Leopard Frog	SOC			X		5
Bats (4 species)						
Big Brown Bat		THR	X		X	89
Eastern Red Bat				X		34
Little Brown Bat		THR	X		X	9
Silver-haired Bat		SC	X		X	1
Breeding Birds (30 species)						
Alder Flycatcher[1]						1
American Kestrel						1
American Redstart						13
American Woodcock						3
Black-and-white Warbler[1]						1
Black-billed Cuckoo						4
Black-crowned Night-Heron						6
Blue-winged Warbler						4
Bobolink[1]						1
Brown Thrasher						2
Carolina Wren						8
Chimney Swift						237
Common Nighthawk						4
Field Sparrow						4
Great Blue Heron[1]						52
Great Egret[1]						4
Hooded Warbler[1]						1
Least Flycatcher						1
Merlin						3
Nashville Warbler[1]						2

Table 2. Fish and Wildlife SLCI Known From the Greenway.

Species	Federal Status	WI Status	SGCN	SINS	NHI Tracked	N*
Ovenbird[1]						12
Peregrine Falcon		END	X		X	28
Red-headed Woodpecker		SC	X		X	1
Red-shouldered Hawk[1]		THR	X		X	1
Sedge Wren[1]						2
Veery[1]						1
Vesper Sparrow[1]		SC	X		X	1
Willow Flycatcher						2
Wood Thrush			X	X		17
Yellow-billed Cuckoo				X		10
Fishes (9 species)						
Black Crappie						9
Bluegill						35
Channel Catfish						8
Greater Redhorse						3
Lake Sturgeon[1]		SC	X		X	1
Northern Pike[1]						37
Pumpkinseed						42
Smallmouth Bass						1666
Walleye						273
Mammals (4 species)						
American Beaver[1]						8
American Mink						5
Common Muskrat[1]						6
Coyote						5
Mussels (3 species)						
Elktoe		SC	X		X	4
Ellipse[1]		THR	X		X	4
Spike[1]						4
Snakes (3 species)						
Butler's Gartersnake		SC	X		X	90
Common Gartersnake						8
Dekay's Brownsnake						54
Turtles (2 species)						
Eastern Spiny Softshell						12
Northern Map Turtle						3

* – "Number of Records" is the number of times the species was reported since 1990, not the number of individuals observed. 1 – These species were recorded but the Greenway alone is unlikely to support breeding populations, they may be vagrants, displaced individuals, late migrants, or only foraging in the area. END = Endangered. SC = Special Concern. SOC = Species of Concern. THR = Threatened. SGCN = Species of Greatest Conservation Need (State Wildlife Action Plan). SINS = Species With Information Need (State Wildlife Action Plan). NHI Tracked = Species tracked by the Natural Heritage Inventory (Wisconsin DNR).

Gray Treefrog, a SLCI no longer breeding in the Greenway which could be restored (photo by G. S. Casper)

3.2.1 Mussels

Freshwater mussels (unionid bivalves) are very important components of aquatic ecosystems. They are long lived (20+ years) and highly sensitive to changes in water quality, habitat degradation, and the presence of contaminants. Freshwater mussels are considered to be one of the most endangered groups of organisms in North America (Neves 1983, Cummings and Mayer 1992). They also have considerable economic and cultural value, being used for food, tools and ornamentation (e.g., buttons, pearls; Machtinger 2007, Watters et al. 2009). Over-harvest, siltation, pollution, and competition from exotic species are factors in their decline. Mussels filter-feed on detritus, zooplankton, algae and bacteria, which they extract from the water with their gills (the gills are much larger than is needed for respiration). Juveniles do not filter-feed with their gills, but may feed on interstitial nutrients using cilia on their foot, gills, and mantle for several years before changing to a filter-feeding mode (Tankersley et al. 1997). Adults are typically partially buried, with the posterior edge of the shell exposed during much of the year, rendering them susceptible to predators, desiccation, temperature and other environmental extremes. Many species have life spans of 20–30 years or more, and may spend much of their life buried several centimeters beneath the surface, relying on water to percolate between the substrate particles for food and oxygen. The formation of eggs and sperm is initiated by changes in water temperature and/or light levels, and there appear to be threshold temperatures or light levels that cue reproductive events. Sperm is transferred between sexes by the water current during a typically annual breeding season. Nearly all freshwater mussels are parasites as larvae, mostly on fish. Some species may be capable of parasitizing amphibians as well, including the Paper Pondshell (*Utterbackia imbecillis*), which may utilize American Bullfrog (*Lithobates catesbeianus*) tadpoles in the Milwaukee River (Watters 1997, Watters and O'Dee 1998). For this reason, mussel conservation is closely tied to conservation of their host species (mostly fish), many of which are also in decline (Marshall and Lyons 2008). Information on known host species for mussels is provided in the checklist (Casper and Dare 2018).

Mussels are also especially sensitive to contaminants (Watters et al. 2009), which have been a pervasive problem in the Greenway. Because they accumulate toxins in their tissues over their long and sedentary lives, mussels can be useful bioindicators to monitor contaminant levels and assess aquatic community health (Phillips 1976, Tanabe et al. 1987, Gulf of Maine Council 2004). A number of conservation strategies can be employed to address mussel conservation, including dam removal, pollution abatement, translocations, repatriation, habitat improvements, predator control, and invasive species management.

Casper and Dare (2013, 2018) reviewed all available data and surveyed for mussels in the AOC portion of the Milwaukee River, including the Greenway. This informed the AOC checklist and assigned a SLCI status to all species. AOC-wide, data gaps still exist which more surveys can address, but within the Greenway mussel diversity is now well known. Surveys documented eleven species (Table 3) at four survey sites (see Casper and Dare [2013] for maps and detailed survey results): Site 1 –from the Locust Street Bridge south to mid-Riverside Park; Site 2 – along Hubbard Park ; Site 3 – north from Capitol Drive in Estabrook Park; Site 4 – main channel between the two largest islands in Lincoln Park. Three species (Spike, Lilliput, Ellipse) were found only as dead shells. However, additional live populations may be found within the Greenway if further surveys are conducted. The five most abundant species are the White Heelsplitter, Creeper, Fluted-shell, Giant Floater, and Plain Pocketbook. The abundance of live mussels increased as surveys proceeded upstream.

Mussel biology and potential conservation actions are further discussed in Casper and Dare (2018), with the most relevant actions for the Greenway involving improvements to water quality, and control of predators (Raccoon) and invasive species (i.e., Zebra Mussel, Quagga Mussel, and Asian Clam; Common Carp). However, invasive species control measures involving chemical (i.e., Rotenone) applications may also damage many mussels and their native host fishes.

Elktoe are still present in the Greenway (photo by Illinois Natural History Survey).

Within the Greenway there is potential for restoring some extirpated species (Spike, Lilliput, Ellipse) if and when water quality issues are resolved. One of the more promising developments in mussel conservation is the use of captive propagation to source new populations. Captive propagation of mussels is now commonplace (Haag 2012), but there remains concerns over how this tool is used in conservation practice. Propagated individuals should only be introduced to new, unoccupied, habitat, not into existing populations. Genetics and disease must be carefully considered in developing a captive propagation program, as well as survivability of cultured individuals that may develop non-adaptive traits. When carefully planned, this technique does have excellent potential for assisting with

repatriations within the Greenway, and culture facilities may be available in the Milwaukee, Chicago, and La Crosse regions.

Table 3: Mussel Survey Results (see Casper and Dare 2013 for survey area figures)

Common Name	Scientific Name	WI Status	Site 1	Site 2	Site 3	Site 4	N Live Individual
Elktoe	*Alasmidonta marginata*	SC	4	1	2	7	14
Spike	*Elliptio dilatata*		X	X	X	X	0
Wabash Pigtoe	*Fusconaia flava*		X	X	1	12	13
Plain Pocketbook	*Lampsilis cardium*		1	13	5	11	30
Fat Mucket	*Lampsilis siliquoidea*		1	4	4	10	19
White Heelsplitter	*Lasmigona complanata*		25	23	26	84	158
Fluted-shell	*Lasmigona costata*		X	20	12	4	36
Giant Floater	*Pyganodon grandis*		4	X	4	22	30
Creeper	*Strophitus undulatus*		5	6	19	41	71
Lilliput	*Toxolasma parvus*		X	0	0	X	0
Ellipse	*Venustaconcha*	THR	X	X	X	X	0
N live individuals			40	67	73	191	

X = relict shells only. SC = Special Concern. THR = Wisconsin Threatened Species

3.2.2 Dragonflies and Damselflies

Dragonflies and damselflies (Odonata) play key roles in both terrestrial and aquatic habitats. They are predators as both nymphs and adults, feeding on a variety of prey including nuisance species such as mosquitoes and biting flies. Nymphs can be top predators in fishless wetlands and help structure the wetland community. Dragonfly and damselfly nymphs in turn are an essential food resource for fish and amphibians, and adults are eaten by predators such as birds, bats, shrews, and spiders. They can be indicators of different biotypes and habitats, and have been used as tools to assess the biological health of aquatic habitats and to detect levels of heavy metals such as mercury. They also eat vast quantities of insects which are harmful to humans, and recent work in Asia suggests that dragonfly larvae can be used to control the insect vectors of dengue fever which breed in water containers (Sebastian et al. 1990). Dragonflies and damselflies therefore have a potential health and economic value which is not yet fully exploited (Moore 1997).

Destruction and degradation of aquatic habitats as well as pollutants and introduced species are all leading factors in the loss and imperilment of these insects. Dragonflies and damselflies vary in their sensitivity to different sorts of pollution (Moore 1997). Although they are less sensitive than some other aquatic insects, their conspicuousness makes them valuable for quick assessment of water quality. Their significant ecological importance in aquatic and riparian habitats links their survival to the health of these ecosystems, which have experienced decline and degradation worldwide. Top water quality stressors in streams include pathogens (primarily fecal coliform), nutrients (primarily nitrogen and phosphorous), and heavy metals (primarily mercury, iron, and aluminum). In the AOC, polycyclic aromatic hydrocarbons, or PAHs (http://tx.usgs.gov/sealcoat.html), are also a concern.

At least 20% of all described dragonfly and damselfly species in North America are considered to be at risk, and while nearly two-thirds of U.S. species were appointed as Species of Greatest Conservation Need (SGCN) overall in a 2010 assessment of State Wildlife Action Plans, over half the states neglected to assign dragonfly SGCN, damselfly SGCN, or both (https://xerces.org/ecology-and-conservation-of-dragonflies-and-damselflies/). Wisconsin lists 28 species as SGCN, four as Endangered, one as Threatened, and 23 as Special Concern (Wisconsin DNR State Wildlife Action Plan).

Table 4. Odonata Known From the Greenway.

Common Name	Scientific Name
American Rubyspot	*Hetaerina americana*
Autumn Meadowhawk	*Sympetrum vicinum*
Azure Bullet	*Enallagma aspersum*
Band-Winged Meadowhawk	*Sympetrum semicinctum*
Black Saddlebags	*Tramea lacerata*
Blue Dasher	*Pachydiplax longipennis*
Blue-Fronted Dancer	*Argia apicalis*
Carolina Saddlebags	*Tramea carolina*
Common Green Darner	*Anax junius*
Common Whitetail	*Libellula (Plathemis) lydia*
Common Whitetail	*Plathemis lydia*
Eastern Amberwing	*Perithemis tenera*
Eastern Forktail	*Ischnura verticalis*
Eastern Pondhawk	*Erythemis simplicicollis*
Ebony Jewelwing	*Calopteryx maculata*
Emerald Spreadwing	*Lestes dryas*
Familiar Bluet	*Enallagma civile*
Fragile Forktail	*Ischnura posita*
Halloween Pennant	*Celithemis eponina*
Marsh Bluet	*Enallagma ebrium*
Northern Spreadwing	*Lestes disjunctus*
Orange Bluet	*Enallagma signatum*
Powdered Dancer	*Argia moesta*
Ruby Meadowhawk	*Sympetrum rubicundulum*
Slender Spreadwing	*Lestes rectangularis*
Spotted Spreadwing	*Lestes congener*
Stream Bluet	*Enallagma exsulans*
Sweetflag Spreadwing	*Lestes forcipatus*
Twelve-Spotted Skimmer	*Libellula pulchella*
Wandering Glider	*Pantala flavescens*
White-Faced Meadowhawk	*Sympetrum obtrusum*
Widow Skimmer	*Libellula luctuosa*

Halloween Pennant

The initial Greenway dragonfly and damselfly study identified 20 species in the Greenway, with five species designated as SLCI (Rutherford 2012). Since then the broader AOC-wide study was completed, which revealed that historical data for this group was inadequate to assess modern conservation status, and the checklist was revised to only retain state-listed species as SLCI (Casper and Rutherford 2018). This study documented 32 species within the Greenway (Table 4), none of which are currently designated as SLCI.

There is good evidence that if viable examples of the main habitat types in a region are conserved, most dragonfly and damselfly species would effectively be conserved (Moore 1997). Therefore, the most important conservation recommendation is to establish and manage protected, well managed, habitat areas. In the Greenway, this means planning for protecting and restoring diverse native plant communities and wetland types. The Checklist describes species habitat associations, and some are associated with water and habitat quality factors that may be targets for AOC restoration projects. In these cases, appropriate species may be designated as project Focal Species, and their presence may be considered as part of a metric for habitat recovery (i.e., stream associated, riffle associated, bog associated).

3.2.3 Primary Burrowing Crayfish

Freshwater crayfish are one of the most imperiled species groups in the world. Semi-terrestrial crayfish inhabit burrows in highly seasonal and variable environments, and act as geomorphic agents linking terrestrial and aquatic systems (Helms et al. 2013), an important relationship for the AOC, where Casper et al. (2018d) assessed the status of primary burrowing species.

Crayfish are categorized according to their burrowing characteristics into three broad categories: primary, secondary, and tertiary burrowers (Hobbs 1942, 1981). Relative to other species, primary burrowers construct complex deep burrow structures which serve as drought refugia and winter dens for several amphibians, reptiles, and insects – making them "Keystone Species" in that they provide critical habitat for other species. Nationally, primary burrowers are disproportionately imperiled, comprising only 15% of the total crayfish fauna but accounting for 32% of those crayfish ranked critically imperiled (Welch and Eversole 2006). Primary burrowers spend almost their entire life in and around burrows, only occasionally leaving them to forage on the surface or mate in (often temporary) surface waters. Because they spend most of their lives in burrows they are not limited to surface water; some are rarely found in aquatic habitats and are properly considered terrestrial, rather than aquatic, organisms (Hobbs 1942, 1981; Welch and Eversole 2006). Surface activity is typically nocturnal and during light rains. The burrows are seldom connected to surface water bodies and are typically complex, with a central downward tending shaft that intersects the water table, and several side galleries. Most surface openings are marked by "chimneys" of stacked mud pellets, and burrows are deep, sometimes three meters.

Only three Wisconsin species are classified as primary burrowers: Prairie Crayfish (*Procambarus gracilis*), Digger Crayfish (*Fallicambarus fodiens*), and Devil Crayfish (*Cambarus diogenes*). None are currently found in the Greenway (Casper et al. 2018d), but Digger Crayfish (the rarest crayfish in Wisconsin) is

known to occur within a mile of the Greenway in a system with an aquatic connection to the Milwaukee River. Both Digger and Prairie Crayfish could potentially be established in the Greenway.

Prairie Crayfish may potentially be repatriated in the Greenway (photo by A. Curtes).

3.2.4 Fishes

As water quality has steadily improved, the Greenway is now capable of supporting a more diverse fish and aquatic community, although critical fish spawning habitat remains limited, with warm temperatures, contaminants, invasive species (i.e., Common Carp), and road runoff being continuing constraints. Major issues in fish conservation are habitat loss, siltation, dams, water diversions, and pervasive pollutants in the form of biocides (herbicides, pesticides) and sewage from agricultural operations and suburban systems, pharmaceuticals entering streams from municipal water systems, and other contaminants from road runoff and spills. Living in this chemical soup has greatly impacted fish and other aquatic organisms, resulting in elevated stress levels, pervasive cancers, and hormonal problems including feminization. Many fish consumption advisories remain in effect. Urban systems such as the Greenway present many challenges to recovering fish biodiversity. Fish responses to urbanization are complex, often confounded by agricultural impacts and invasive species interactions within the same system, and subject to evolutionary responses (Brown et al. 2009, Ross 2015).

Many organizations are working towards improving water quality and fish communities in the AOC and Greenway. Some examples are the Wisconsin DNR, the U.S. Environmental Protection Agency, the Milwaukee Metropolitan Sewerage District, the Southeast Wisconsin Regional Planning Commission, researchers at the University of Wisconsin-Milwaukee, and Riverkeepers. Notable actions within the Greenway that have conveyed benefits to fishes are the recent removals of the North Avenue and Estabrook Park dams, and the removal of contaminated sediments in Lincoln Park. Additional contaminated sediment removal just upstream from North Avenue may be addressed in the near future.

Lake Sturgeon is being restored to the Milwaukee River by Wisconsin DNR.

In the AOC-wide study, Casper and Wawrzyn (2018) reviewed all available fish data and assigned SLCI rankings and developed a checklist with critical habitat parameters for all species. They documented nine fish SLCI from within the Greenway (Table 2), although Lake Sturgeon and Northern Pike are probably not spawning there. An additional fish study commissioned by the AOC group from the U.S. Geological Survey is not yet available for review. However, additional opportunities for improving fish habitat in the Greenway are largely limited to addressing road runoff issues (including measures to reduce PAH and road salt contamination), controlling invasive species, and in some areas additional habitat improvements may be possible in backwater and side channel areas (improving native vegetation and aquatic habitat diversity; recent example is the shoal created just downstream from North Avenue).

3.2.5 Amphibians and Reptiles

Amphibians and reptiles (herptiles) are a vertebrate group comprised of salamanders, frogs, toads, lizards, snakes, and turtles. These animals play important roles in ecosystems as predators and prey, interacting with a wide variety of other wildlife. They can often reach high abundance, and this biomass can rival that of all other vertebrates, making them important in nutrient and energy cycling (Burton and Likens 1975, Fritz and Whiles 2018). All except turtles are strictly carnivorous, preying upon insects and other invertebrates, fishes, other herptiles, small mammals, and occasionally nestling birds. They range from completely aquatic (Common Mudpuppy), to strictly terrestrial (Eastern Milksnake), but most have amphibious life cycles requiring spatially linked habitats in both aquatic, semi-aquatic, and terrestrial environments. The AOC area historically supported approximately ten frog and toad, seven salamander, ten to twelve snake, and five to six turtle species (Casper 2008). A key conservation concern common to this diverse group is poor mobility, especially in urban environments where habitat areas are highly fragmented by roads and development. This makes herptiles some of the best indicator species for ecosystem health.

Casper et al. (2018b) reviewed all available herptile data for the AOC (including the Greenway), assigned SLCI rankings, and developed a checklist with critical habitat parameters for all species. Table 2 lists three frog, three turtle, and two snake SLCI now documented from the Greenway (additional non-SLCI species were documented as well). Three new turtle species were recently discovered in the Greenway studies (and subsequently documented further upstream) that had not been previously known from the Milwaukee River – Spiny Softshell (Casper et al. 2018b), Northern Map Turtle (Casper 2015), and Red-eared Slider (Casper et al. 2018b). Moreover, genetic studies of Butler's Gartersnake suggest that the Greenway and other Milwaukee area populations are ancestral to traditionally known Plains and Butler's gartersnakes, and are an unrecognized unique group (Fitzpatrick et al. 2008).

The diversity of herptiles is limited in the Greenway by habitat availability. No salamanders, the most critically impaired group in the AOC, are currently known, although it may be possible to restore Blue-spotted Salamander. Amphibian diversity could be substantially increased by creating fish-free breeding ponds with surrounding terrestrial habitat improvements (the new Riverside Park ephemeral pond created by the Urban Ecology Center is an example). The river may also eventually support the Common Mudpuppy, Wisconsin’s largest and entirely aquatic salamander, if water quality continues to improve

and this species can establish from Lake Michigan populations or be reintroduced (warm temperatures however are a biological constraint for this species).

Frog species are also highly impaired in the Greenway, with diversity limited by habitat availability. Larger bodied species adapted to co-existing with fishes, such as American Toad, Green Frog, and American Bullfrog, are present in fair numbers throughout the AOC, but smaller bodied species are mostly absent (i.e., Spring Peeper, Boreal Chorus Frog, Gray Treefrog). In the Greenway, this is mostly due to the loss of a critical habitat (ephemeral, fish-free, wetlands for breeding) and possibly exposure to infectious diseases (yet to be determined). In addition, Gray Treefrog often hitchhikes, hiding in cars and boats, and occasionally appear in areas where they are not resident. There are no known Gray Treefrog breeding populations within the Greenway at this time.

The floodplain grasslands and surrounding urban landscapes currently support a healthy population of Butler's Gartersnake, along with many DeKay's Brownsnakes and a few Common Gartersnakes, but the currently robust snake population in the North Avenue floodplain area is ephemeral. Snakes occupied this habitat area in response to floodplain grassland habitat created after the removal of the North Avenue dam in 1990. The source populations were probably snakes occupying upstream habitat areas in the Glendale Industrial Park (less developed at the time), Estabrook Park, and Lincoln Park. The North Avenue floodplain area snake population is by no means secure, as this area may be stripped in the near future for additional contaminant remediation, and portions have been planted to or invaded by trees which will shade out the snake habitat over time.

The river currently supports Painted, Snapping, Spiny Softshell, Red-eared Slider, and Northern Map turtles. Nesting areas for these turtles are a critical habitat component and nesting locations are not yet known – providing nesting areas may be an important conservation need.

Potential for establishing additional amphibian and snake species may exist if habitat issues are resolved, including Blue-spotted Salamander, Common Mudpuppy, Boreal Chorus Frog, Gray Treefrog, Northern Watersnake and Eastern Milksnake. Establishing protected turtle nesting areas is also a viable goal.

Eastern Milksnake may be restorable in the Greenway (photo by G. S. Casper).

3.2.6 Breeding Birds

Breeding birds are an important component of the Greenway ecosystems, occupying all habitats including urban backyards. Breeding birds are also very popular with the public, and can be important flagship species for achieving conservation objectives. They use multiple habitats for feeding and nesting activities, and form important links between aquatic and terrestrial habitats. For example, many birds feed on aquatic and semi-aquatic insects and amphibians, then transfer this energy and nutrients through their droppings and corpora (through death or predation) to terrestrial environments. These same mechanisms make birds important vectors of disease, parasites, and invasive species.

Breeding birds are closely associated with habitat quality and extent. To allow for successful reproduction, local habitats must support bird families for extended periods while raising young, provide sufficient food and shelter, and have acceptable levels of stressors such as predation, chemical contaminants, noise, light, infrastructure hazards, and disturbance. Birds are highly mobile and typically find and colonize new habitats quickly, unlike many other animals. While this trait makes them ideal candidates for short-term success in habitat projects, it also makes them vulnerable to habitat "sinks" or ecological traps (Hale and Swearer 2016), which may go undiscovered without long-term monitoring for reproductive success. Where habitat extent and quality criteria are met (habitat looks good), but hidden stressors restrict success, habitats can become a trap, attracting birds that set up territories but do not succeed in reproducing. If ecological traps are produced through habitat projects, this can contribute to long term declines in avian species. For this reason, habitat extent, habitat quality, critical habitat features (food, shelter, roost sites, etc.), and population stressors (i.e., light, noise, predation, parasitism, etc.), should be addressed in conservation planning, and monitoring for success is necessary over multi-year time periods.

Casper et al. (2018c) reviewed all available data and conducted extensive breeding bird surveys throughout the AOC. A checklist with SLCI assignments was completed and records for thirty SLCI were identified within the Greenway, with eighteen of these considered to be feasible for the Greenway to support major parts of their life cycles (Table 2). These eighteen species are recommended as Focal Species for habitat projects and monitoring.

American Redstart is a SLCI currently breeding in the Greenway.

3.2.7 Migratory Birds, Bats, and Insects

Milwaukee County is located along the west coast of Lake Michigan within one of North America's largest migratory bird, bat, and insect flyways (La Sorte et al. 2014). Consequently, migrants flying along Lake Michigan's west coast will fly over Milwaukee and often pause to utilize Milwaukee's natural areas as stopover sites for rest and re-fueling. The Greenway is therefore well positioned as vital stopover habitat for migratory birds, bats, and insects (including Monarch Butterflies, dragonflies and damselflies). Robson and Casper (2018) and Casper and Niemiller (2018) reviewed and summarized historical migrant bird and bat data, collected baseline data on migratory bird activity levels (including in the Greenway, and discussed stopover habitat enhancement and management issues for migrant birds and bats. Hundreds of species of migratory birds, bats, and insects are present in the Greenway each spring and fall, but many are entirely transitory and do not breed in the Greenway.

Monarch Butterfly migrates through and breeds within the Greenway.

3.2.8 Mammals (excluding bats)

Mammals are a dynamic component of the Greenway ecosystem; ranging from mice to deer, with a wide range of habitat and diet requirements. Many species such as Black Bear have disappeared from this urban area and at least three non-native species are now established (Domestic Cat, House Mouse, Norway Rat; Casper et al. 2018e). Public perception of some mammal species can be mixed, particularly regarding "nuisance" species such as White-tailed Deer, Coyote, and Raccoon. Ecological damage caused by free roaming pet cats and dogs can also be difficult to address (Young et al. 2011, Loss et al. 2013, Wald et al. 2016). Mammals have diverse life histories and occupy all Greenway habitats (including urban backyards and tree canopy). They are also highly mobile and road mortality is common. Most mammals other than bats do not migrate, and their diet fluctuates throughout the year depending on the food resources available. The most common species are familiar urban adapted residents (Eastern Chipmunk, Eastern Cottontail, Gray Squirrel, Red Fox), and some can be pests (White-tailed Deer, Raccoon, Virginia Opossum, mice, Norway Rat).

Coyote and Red Fox are well adapted to urban environments and are key apex predators within the Greenway, keeping grazers (White-tailed Deer, Eastern Cottontail) and pests somewhat in check (mice, Norway Rat). It is important to recognize that the presence of these carnivores is key to preserving rare plant communities by keeping grazing in check, not simply by preying upon grazers, but also their presence makes grazers more cautious and less likely to expose themselves, thereby sparing many more exposed plants. These carnivores (and weasels) also play a role in disease control, especially tick-borne diseases, by keeping mice in check (Nupp and Swihart 1998, Way and White 2013, Granter et al. 2014). Virginia Opossum is also important in tick control, preying directly on ticks (Keesing et al. 2009).

Casper et al. (2018e) reviewed all available data and conducted mammal surveys throughout the AOC, including within the Greenway. The AOC mammal checklist designated twelve SLCI (excluding bats), with four of these recorded within the Greenway (American Beaver, American Mink, Common Muskrat, and Coyote; Table 2). American Beaver and Common Muskrat however are likely transitory within the Greenway (as probably are North American River Otter). There may be potential to establish additional mammal SLCI within the Greenway, such as Eastern Fox Squirrel, weasels, and Southern Flying Squirrel.

Southern Flying Squirrel may be restorable in the Greenway.

3.2.9 Bats

As primary predators of night-flying insects, bats are important to the ecology of the Greenway. Bats spend much of their time in airspace habitat foraging for flying insects, where they are susceptible to noise and light pollution, and airspace obstructions such as communication towers and tall buildings take an annual toll. Roosting and drinking habitat is also needed. In the Greenway, water is plentiful in the river, and roosting habitat includes large trees (especially trees with loose bark and large leaves), and buildings and other structures that provide nooks and crannies. Dead and dying trees are important roosting habitat. To support successful reproduction, habitat must provide food (flying insects) and shelter for several months during the maternity season. Within the Greenway, migratory stopover habitat is easier to achieve, needing to support bats for only a few days in transit.

Big Brown Bat is resident in the Greenway.

Another ongoing issue with bats is disease (White-nose Syndrome), which is implicated in declines of mostly impact cave dwelling bats, and will run its course. No actions to address this disease are feasible within the Greenway at this time, however, a vaccine is currently being tested.

Casper and Niemiller (2018) reviewed all available data and conducted comprehensive acoustic bat surveys throughout the AOC, including within the Greenway. The AOC mammal checklist listed six bats as SLCI. Four of these were recorded within and may breed within the Greenway (Big Brown Bat, Eastern Red Bat, Little Brown Bat, Silver-haired Bat; Table 2). The other two (Northern Long-eared Myotis, Tricolored Bat) may occur during migration.

3.2.10 Other Biodiversity

While not assessed in the AOC study, a baseline lichen study was completed with some butterfly assessment (Rutherford 2012), and additional information exists for some arthropod groups that could be assessed, such as insects (bees, butterflies, beetles), isopods, and spiders. These organisms are also important, especially considering how they form much of the food base for fish and wildlife SLCI. While current information is too sparse to make conservation status assignments (such as SLCI), opportunity exists to enhance habitats to better support arthropod diversity.

Generally speaking, diverse native plant communities support diverse native arthropod communities. Actions to minimize known stressors on invertebrates, such as pesticide applications and burning, can also be reviewed and incorporated into habitat management practices. There is opportunity to develop monitoring programs as well, to better understand these organisms and their role in the ecology. Lichen monitoring protocols are available and can be indicators of air quality and climate change (https://elonpreview.weebly.com/).

Lichens such as this Wreath Lichen are often good indicators of air pollution (photo by R. D. Rutherford, Estabrook Park).

4. Project Recommendations

Each chapter in the AOC study results (Casper and Robson 2018) provides summaries of habitat guidelines that can assist in designing specific Greenway projects, with many detailed references provided. A number of general recommendations are outlined here for the entire Greenway, and light pollution, noise pollution, and connectivity issues are addressed in more detail. Beginning in Section 4.5 specific project areas are reviewed in detail with management actions summarized in Table 5. Finally, a set of priority projects are called out in Section 5.

Some common themes for projects are improving plant community diversity, replacement of dying ash trees, control of invasive species, increasing fish and wildlife biodiversity, and addressing light and noise pollution. In each project area, any notable existing plant communities are discussed, and *Candidate Focal Species* identified (which are species which can be supported as reproducing populations, or for which the project area can provide important migratory stopover habitat). Some SLCI in the larger region are unlikely to be supported in the Greenway, including most grassland and forest interior birds with large habitat area requirements, most salamanders and frogs that require ephemeral wetlands and large terrestrial habitat buffers around them, fishes and mussels that cannot tolerate high temperatures or low dissolved oxygen levels, and some habitat specialists.

The selection of Keystone, Umbrella and Flagship species for specific project areas (as recommended in planning objective 2) can be made from the *Candidate Focal Species* lists when projects enter a design stage with landowner approval. These species selections will depend upon final project goals as developed with social constraints addressed (such as permits and funding, see discussion in Section 2). To avoid setting unrealistic goals when designing site restoration and stewardship plans, a multi-disciplinary team of experts on plant communities, fish and wildlife species, and ecological restoration practices, should work together with landowners and stakeholders to finalize specific habitat projects. The focus should be on restoring native plant communities and the critical habitat features needed to support the appropriate project-specific fish and wildlife *Focal Species*. Successful projects will address all social and biological constraints to achieve a functional ecosystem that can be realistically maintained.

Planting lists can be developed by the project restoration ecologist, guided by available data on the presence of native species with high CC values already established on site (i.e., from prior plant inventories), planting lists appropriate to the proposed community type developed by Callaghan et al. (2015; Appendix B), and species appropriate to the proposed community type from Epstein (2017; i.e., for Southern Mesic Forest). Planting plans should incorporate diversity to provide some resilience in the face of ongoing climate change. Plantings can incorporate species whose native range is just south of Milwaukee County, such as Eastern Redbud (*Cercis canadensis*), River Birch (*Betula nigra*), and Sycamore (*Platinus occidentalis*). This follows practices established by Milwaukee County Parks. In this way, climate change induced migration will be slightly hastened so as to improve the resilience of forests. Kendal (2014) however cautions against unintended consequences such as well adapted species being abandoned for under-performing species, or new species causing unexpected changes in the provision

of ecosystem services, place identity, invasiveness, or habitat for wildlife species. This underscores the need to prioritize native species that provide the intended SLCI habitat, while still providing diversity.

Two global goals are improving plant community quality (through plantings and invasive species control), and restoring wildlife species (through provision of critical habitat components and repatriation), to increase biotic richness. These goals are incorporated as site specific recommendations in appropriate project areas.

Improving plant community quality: Plant communities are currently characterized by low diversity and high levels of invasive species throughout the Greenway. This is typical of urban areas where human activities continually input new cultivars and seed, and high grazing levels from deer and rabbits impair growth and reproduction of most native species. Additionally, invasive seed is continually input via bird droppings (i.e., Common Buckthorn, *Rhamnus cathartica*), and spread by mammals (i.e., deer and dogs spreading Garlic Mustard, *Alliaria petiolata*) from sources outside the Greenway. Other invasives enter the Greenway through wind born seeds (i.e., Canada Thistle, *Cirsium arvense*), and water transport from upstream (i.e., Reed Canary Grass, *Phalaris arundinacea*). Controlling invasive species is therefore a perpetual management issue. However, control measures combined with planting and care of native species, and control of grazing, will increase plant community biodiversity where stewardship management can be achieved long-term. Establishing more plant diversity and more native plant species will in turn improve soil conditions for microbes, support higher insect populations, support higher insectivore populations, support higher populations of wildlife feeding on fruits and seeds (i.e., squirrels, birds), improve stopover habitat with greater food and shelter resources, and generally beautify the landscape.

In specific project areas plant community goals are strongly tied to the fish and wildlife *Focal Species* they are intended to support. For example, if *stopover habitat* is the main objective for a site (such as where habitat is restricted to a narrow linear band), then plants providing food and shelter for birds, bats, and insects are the priority in a planting and stewardship plan. Where habitat is intended to support specific fish and wildlife Focal Species as resident breeding populations, then the specific critical habitat requirements of those species should be incorporated into a planting and stewardship plan. For example, to support Southern Flying Squirrels and Blue-spotted Salamanders, a site habitat plan must provide squirrel food (i.e., Bitternut Hickory, Hazelnut, maples) and nesting and shelter resources (i.e., tree cavities), and salamander food and shelter (i.e., forest duff, soil invertebrates) and breeding resources (i.e., an embedded ephemeral wetland with a suitable hydroperiod). The specific biological constraints for individual species are summarized in the AOC Species Checklists, discussed in more detail with references in the AOC species chapters, and species experts can be engaged to review and finalize planting and stewardship plans to ensure that all intended species' requirements are met.

Restoring Wildlife Species: While providing critical habitat components will result in many wildlife species colonizing new sites and increasing their populations, a number of repatriations are also recommended for consideration in many project areas. The restoration of many species'

populations however will be dependent upon the success of physical habitat improvements (i.e., water quality, ephemeral ponds).

Repatriation is the establishment of new fish and wildlife populations by translocating individuals from other populations, sometimes including captive breeding to supply animals. Repatriation is an especially important tool for recovery of mussel, crayfish, fish, and herptile populations in the Greenway, due to limited opportunities for natural colonization in this urban environment. Repatriation, often with captive propagation (i.e., the sturgeon program), is commonly used by Wisconsin DNR to establish and maintain populations of fishes, mammals, and mussels, and used worldwide for many other taxa including herptiles and dragonflies (Bertoleroa et al. 2018, Dolný et al. 2018). Successful repatriation, however, is predicated upon a number of factors. First, the species under consideration should be shown to be truly absent from the site under consideration, with no nearby extant populations likely to colonize the site unassisted. Second, all critical habitat components for the species entire life cycle must be physically restored, including feeding, denning, nursery, and over-wintering sites – all spatially connected on the landscape – and a habitat management plan should be in place in perpetuity. Second, disease and parasite conditions should be evaluated; both at the source populations (to ensure healthy transplants) and at the receiving site, to ensure no reservoirs of important pathogens are present to infect newly arrived species (diseases may persist in non-affected organisms after affected species are extirpated). In particular, for herptiles, source and receiving sites should be evaluated for chytrid fungi for amphibians (Pasmans et al. 2018), and snake fungal disease (Lorch et al. 2016). Finally, transplants of egg, larvae, or juvenile life stages are generally more successful than attempts to transplant adults, and harvest of these life stages should be designed to have no affect on source populations (these life stages have harvestable surpluses). Finally, translocations should utilize multiple sources from populations as near to the receiving site as possible, in order to provide genetic diversity adapted to local conditions. In receiving sites which will remain isolated, periodic infusion of additional individuals from outside sources can be considered as a safeguard against genetic drift if warranted. While not all repatriations will succeed, monitoring can identify unforeseen problems that can often be rectified, and many successful examples illustrate the cost effectiveness of this conservation tool. In developing repatriation proposals experienced zoologists should always be consulted.

4.1 Light Pollution

Focus Areas: Lincoln Park, Estabrook Park, and Pleasant Valley Park

Light pollution has a variety of negative effects on wildlife and human health, often altering circadian rhythms, changing species behaviors, and contributing to sleep disorders and associated health problems. Many nocturnal animals can have their activities compromised and stress levels raised by excessive night lighting, particularly lighting in the blue spectrum. Migrants and insects are often attracted to lighting, leading to heightened mortality. Many communities are replacing street lighting with blue-spectrum LEDs, which while more energy efficient are brighter than traditional lights and in the worrisome blue spectrum. This will have predictably negative impacts on human health and wildlife populations, and is easily avoided with the wide variety of warm spectrum LEDs now available. Recent research on humans has resulted in a "night shift" setting available on some smart phones, which

reduces the harmful effects of screen light by changing the light spectrum and intensity after sunset. Similar research on street and security lighting is available, with best practice remedies available such as shielding light emissions (to direct light only where it is needed), changing emission spectrums, effective placement, and utilizing motion sensors to avoid constant emission. Many of these innovations save energy costs and reduce carbon emissions as well. For example, the Dutch company Signify has developed bat friendly street lighting (Spoelstra et al. 2017).

Light pollution is by any reasonable measure a major issue within the Greenway, and one that is readily mitigated through actions such as adding appropriate shielding to lighting fixtures, adjusting light color temperature, and utilizing automated switch-offs and motion detectors. The American Medical Association has adopted guidance to reduce harm from high intensity street lights (https://www.ama-assn.org/ama-adopts-guidance-reduce-harm-high-intensity-street-lights). The Urban Wildlands Group has made available a bibliography of night lighting literature (http://www.urbanwildlands.org/nightlightbiblio.html). Additional information is available from the International Dark-Sky Association (http://darksky.org/). The following references also provide some background on this topic: Arble et al. 2010, Baker and Richardson 2006, Blackwell et al. 2015, Cabrera-Cruz et al. 2018, Cloyed and Eason 2015, Delhey and Peters 2017; Gaston et al. 2013, 2014; Hale et al. 2015, Hölker et al. 2010, Kyba et al. 2011, Longcore 2006, Schoeman 2016, Spoelstra et al. 2015, and Wright et al. 2013.

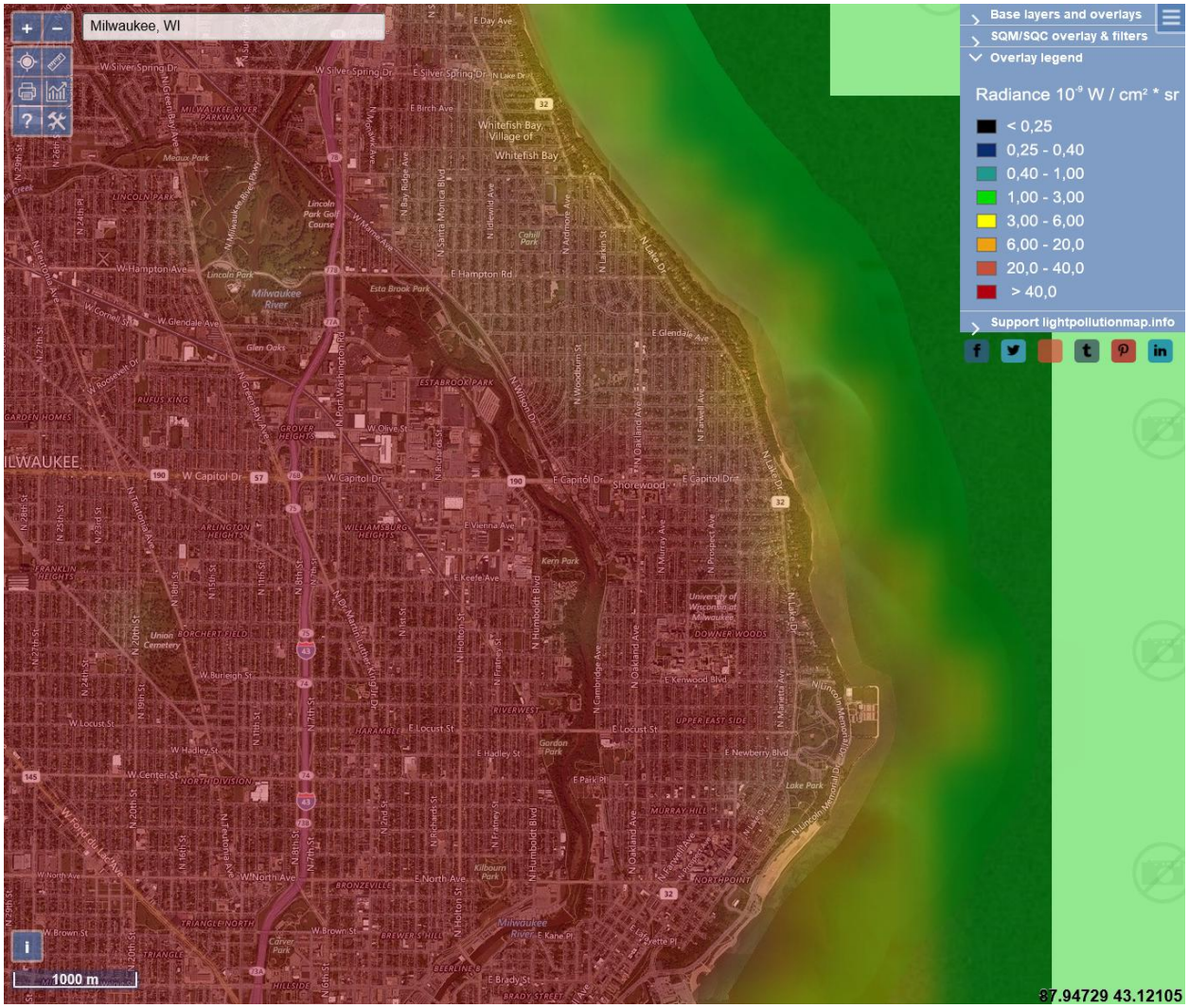
Screech Owl hunting success is affected by light levels

There is no clear scientific evidence that increased outdoor lighting deters crime (Sherman et al. 1997, Morrow and Hutton 2000, Steinbach et al. 2015). It may make us feel safer, but has not been shown to make us safer. In fact, outdoor lighting can decrease safety by making victims and property easier to see. In practice, security lighting may be more effective when only triggered by motion sensors, as the sudden turning on of lights alerts home owners or security personnel that something has entered the area, while lighting that is constantly on may lull observers into a false sense of security.

Project: A lighting project for the Greenway will survey for lighting and map areas where improvements can be considered, develop guidelines for both public and private wildlife friendly lighting, and designate areas as refuges from light pollution. A light pollution monitoring program can be

considered through an array of sensors. Current satellite based mapping of light pollution (see figure) suggests that Lincoln Park, Estabrook Park, and Pleasant Valley Park are currently the least impacted areas and are recommended as candidate light pollution remediation areas. Project actions may include outreach to residents and municipalities to properly shield lighting, replace blue spectrum bulbs with warm spectrum bulbs, and employ automated switch-offs and motion detectors wherever possible, using model outreach resources available from the International Dark-Sky Association (including sample lighting ordinances). Substantial reductions in light pollution are possible in the Greenway.

Goals: 1) Complete a light pollution survey. 2) Establish at least one municipal ordinance on light pollution modeled after International Dark-Sky Association guidelines (http://www.darksky.org/). 3) Remediate existing light pollution at one project area (i.e., Lincoln Park). 4) Establish a light pollution landowner outreach program.



2018 map of light pollution in the Greenway (source www.lightpollutionmap.info).

4.2 Soundscape

Focus Areas: To be determined pending a noise pollution study. Areas away from the I-43 freeway are likely to offer the best opportunities for noise remediation, such as the region from Estabrook Park to Riverside Park.

Excessive noise has well-documented detrimental effects on wildlife and humans, yet remediation of, and planning for, reduced noise is an often neglected conservation and public health issue. By any reasonable measure excessive noise is a major existing issue within the Greenway, as in most urban areas. Noise effects on human health have been addressed by the World Health Organization (http://www.euro.who.int/en/health-topics/environment-and-health/noise). Research on how noise impairs and alters animal behavior is fairly sparse, however the following references provide a good background: Bee and Swanson 2007, Cardoso 2014, Cunnington 2015, Francis et al. 2011, Hanna et al. 2014, McClure et al. 2016, Troïanowski et al. 2017, and Vargas-Salinas et al. 2014.

In sum, animals communicating acoustically often alter their behaviors in ways that reduce their fitness when subjected to excessive noise, such as changing the timing of vocalizations to quieter periods (so they can be heard above the background din), and changing the frequencies utilized for communications to bandwidths less crowded. Noise pollution is probably more damaging to wildlife during the breeding season than during migration, but effects on human health apply year-round. Mitigation measures for noise pollution would benefit many SLCI, including all birds, frogs, and bats, perhaps some insects, and fishes (aquatic noise pollution is also well documented and affects fishes and other aquatic life communicating acoustically; Haver et al. 2018).

Project: A soundscape project for the Greenway is feasible through an array of digital recorders, modeled on National Park Service soundscape projects (Burson 2005, Burivalova et al. 2017). The soundscape project will map noise pollution in the Greenway and identify areas where improvements can be achieved. Guidelines will then be developed for both public and private noise sources with the objective of reducing noise levels, and appropriate areas will be designated as quiet zones. Areas away from the I-43 freeway are likely to have the most potential for noise remediation, such as the region from Estabrook Park to Riverside Park.

Goals: 1) Complete a noise pollution survey. 2) Conduct a feasibility study for mitigating noise pollution with recommendations for further actions.

4.3 Habitat Connectivity

Focus Areas: Shorelines under bridges at North Ave., Locust St., Capitol Dr., Port Washington Rd., I-43, Hampton Ave., Milwaukee River Pkwy in Lincoln Park, and Silver Spring Ave.

Habitat connectivity is often an important constraint for wildlife species (Andrews et al. 2015, Brady and Richardson 2017), especially in urban environments where movement among habitat patches is often impeded by hostile terrain (i.e., pavement and manicured areas where animals are exposed to predators) or physical barriers (i.e., roads, fences, elevated culverts impeding fish passage, etc.). Lack of connectivity can impede gene flow and lower genetic diversity, and isolate populations to suboptimal

conditions where they are more susceptible to disappearing due to chance events such as extreme weather or disease. Maintaining habitat connectivity is especially important for less mobile groups such as amphibians and reptiles, and less so for highly mobile groups such as birds, bats, and dragonflies.

Fortunately, the Greenway is a riparian corridor that has “built in” connectivity represented by the river and its shorelines. The last physical barriers to fish passage were removed in 1990 (North Avenue dam) and 2018 (Estabrook Park dam). Remaining “pinch points” where shoreline passage is somewhat constrained are the shorelines under bridges at North Ave., Locust St., Capitol Dr., Port Washington Rd., I-43, Hampton Ave., and Milwaukee River Pkwy. in Lincoln Park. The Silver Spring Ave. bridge representing the northern limit of the Greenway also represents a “pinch point” between the Greenway and habitat and wildlife populations to the north. While none of these narrower green areas represent physical barriers to wildlife movement, several are uninviting as described below, and many animals may choose instead to dash across roadways, creating traffic mortality hazards.

Wildlife crossings at roadways are often referred to as “ecopassages”, and these can designed be as a higher drier shelf along a stream, or as a dedicated tunnel under a roadway, as shown in these examples. Many design examples are available throughout the world, each specially designed for the local terrain and target wildlife species. In general, design features should incorporate natural substrates attractive to animals (such as soil, avoid rip rap and hard surfaces), be as short and straight as possible (so animals can see the other end), and be tall enough to allow passage of the largest target species (in the Greenway consider deer and coyote).

Example dry passages

Example shoreline passage

Projects: Priority should be given to improvements for wildlife passage under Silver Spring Dr., Hampton Ave., and Port Washington Rd., as follows.

- Silver Spring Dr. bridge: Wildlife crossing here requires passing a rip rapped apron, or passing in the water. Improvements should be considered on the west bank where the habitat corridor is present. Given the narrow passageway and occasional inundation, improvements are likely limited to a pathway through the rip rap (as was recently completely for the trail under Port Washington Road). However, when the bridge is next scheduled for replacement, a higher dry ecopassage is recommended on the west bank.
- Two Milwaukee River Pkwy. bridges in Lincoln Park: Wildlife here must cross rip rapped aprons, or pass in the water. Riverbeds under both bridges have dry elevations most of the time, but are inundated during flood stages. Replacement of rip rap with natural shoreline is recommended. Alternatively, creating flatter unobstructed pathways through the rip rap could be considered to improve ease of movement for wildlife. The south bridge already has a reasonably passable area on the south bank.
- Hampton Ave. bridge: Wildlife here must cross a rip rapped apron on the east side, rip rap shoreline or a paved bike trail on the west side, or pass in the water. On the west bank a dirt or grassed strip between the paved bike trail and rip rap would improve wildlife crossing. On the east side a pathway would need to be created through the rip rap, or the rip replaced with a natural shoreline. When the bridge is next scheduled for replacement, designing better

ecopassage terrain is recommended on both banks. Also, removing the old stone retaining wall on the southwest side is recommended, as this forces wildlife either into the water, or through hazardous park amenity areas and over the roadway.

- Port Washington Rd. and I-43: Wildlife crossing here is fairly easy under the I-43 bridges which have wide setbacks from the normal high water mark and are not completely rip rapped. Wildlife moving under the Port Washington Rd. bridge however must cross rip rapped aprons on both sides. On the north bank a foot path has been created through the rip rap which helps. On the south bank a similar solution is needed. When this bridge is next scheduled for replacement, designing better ecopassage terrain is recommended on both banks, consider removing the old stone retaining wall on the northeast side.
- Capitol Dr., Locust St., and North Ave. bridges are all currently passable and no ecopassage improvements are needed.

Goals: 1) Improve crossings as recommended at the Milwaukee River Parkway and Hampton Avenue bridge crossings in Lincoln Park.

Crossing roads is dangerous for Red Fox and many other animals. (photo wildlife.ohiodnr.gov)

Silver Spring Dr. east bank.

Silver Spring Dr. west bank.

Milwaukee River Pkwy. north bridge, north bank.

Hampton Rd. east bank.

Hampton Rd. west bank.

Port Washington Rd. north bank.

Port Washington Rd. south bank.

4.4 Lincoln Park Projects

Species of Local Conservation Interest

Candidate SLCI Focal Species to be preserved or enhanced.
Mussels: Elktoe. Fishes: various. Amphibians: Green Frog, Northern Leopard Frog. Reptiles: Butler's Gartersnake, Common Gartersnake, Eastern Spiny Softshell, Northern Map Turtle. Breeding Birds: Brown Thrasher, Chimney Swift, Great Blue Heron, Great Egret, Peregrine Falcon, Wood Thrush, Yellow-billed Cuckoo. Mammals (non-bat): American Mink, Common Muskrat, Coyote, North American River Otter, weasel spp. Bats: Big Brown Bat, Little Brown Bat, Silver-haired Bat, Eastern Red Bat, Tricolored Bat, Northern Long-eared Myotis.

Candidate SLCI Focal Species to be considered for establishment.
Mussels: Ellipse, Spike. Crayfish: Digger Crayfish, Prairie Crayfish. Fishes: various. Amphibians: Blue-spotted Salamander, Common Mudpuppy, Boreal Chorus Frog, Gray Treefrog. Reptiles: Eastern Milksnake, Northern Brownsnake, Northern Watersnake. Breeding Birds: American Kestrel, American Redstart, American Woodcock, Black-billed Cuckoo, Black-crowned Night Heron, Common

Nighthawk, Field Sparrow, Least Flycatcher, Merlin, Peregrine Falcon, Red-headed Woodpecker, Willow Flycatcher. Mammals (non-bat): Southern Flying Squirrel, Gray Fox, Eastern Fox Squirrel.

Lincoln Park is a mixed use public park, including natural areas, picnic and other park activity areas, and a golf course. Areas designated for recreation such as golf and pool facilities are not expected to become available as natural areas. The park includes three small and two large islands. One large island is mostly manicured for mixed use; the other large island (Mott Island) is a natural area and includes some older hardwood forest, shrub, wetland, and grassland habitat. The northwestern forest area plant community was surveyed by Barloga and Lane (2011) and scored moderate for floristic quality (FQI score 21.0). Notable were three species with Coefficients of Conservatism at 7 and 8: Wild Ginger, False Rue Anemone, and Wild Black Currant. The forest also contains many mature trees important as wildlife food and shelter resources, and some ephemeral ponds with hydroperiods currently too short to support many amphibian SLCI. Lengthening these hydroperiods and repatriating amphibians is a priority project recommendation.

Important constraints on habitat improvements to support fish and wildlife populations at Lincoln Park are the recreational areas, low to moderate plant community quality, small habitat patch size, abundant urban predators, noise levels, and water quality issues. The communication towers also pose hazards to migrating birds and bats.

Priority existing resources at Lincoln Park are:

- The mussel community is one of the richest in the Greenway.
- The stream channels around the islands, including the east oxbow, provide complex aquatic habitats of differing flow velocities and substrate types; this diversity is important for mussels and fish and rare within the Greenway. This habitat complexity should be preserved and enhanced if possible by improving water quality, improving aquatic vegetation, and considering construction of some deep pools.
- The east oxbow backwater and emergent wetland habitat area is important for fishes, mussels, insects, frogs, turtles, birds, and mammals (including bats). This habitat area should be preserved and enhanced if possible through invasive species control and native plantings.
- The northwest woods area is an important block of mature hardwood forest that can support some forest dependent birds, mammals, and amphibians. This habitat area should be preserved and enhanced if possible by expanding its area, lengthening the ephemeral pond hydroperiod, and improving plant diversity; also consider repatriations of amphibians and crayfish.
- Surrogate savanna habitat exists throughout the park where mature trees are interspersed with sparse ground and shrub layer vegetation (lawns and golf course). A small area of unmowed grassland is present just south of Mott Island. This surrogate habitat should be preserved and enhanced if possible by expanding unmowed areas, and improving mast bearing trees and shrubs, while maintaining the savanna structure. Eastern Fox Squirrel, Gray Fox, and Red-headed Woodpecker are appropriate Focal Species for this habitat.
- This park is recommended as a light pollution refuge.

- Mott Island has potential as an *urban wilderness area*, where human disturbance is minimized. Designation and signage may be considered, and possibly banning dogs or enforcing on leash ordinances to minimize disturbance to wildlife.

Project Recommendations

1) *Habitat Enhancements*

a) *General:* Provide or preserve mature trees as roosting habitat on Mott Island and the northwestern forested area. Enhance the semi-permanent wetland habitat within the old Lincoln Creek east oxbow channel by improving the plant community, where soil contamination liability constraints do not occur. Create an ephemeral wetland scrape on Mott Island. Extend the hydroperiod of ephemeral wetlands in the northwestern forested area (by appropriate berming or deepening of basins) and repatriate crayfish and amphibians.

b) *Trails:* Establish a designated trail system designed to limit disturbance to two existing sensitive natural areas: Mott Island and the northwest forest.

c) *Plant Communities:* Enhance existing habitat through invasive species removal and creation or enhancement of additional wetlands and grasslands where feasible to improve forage species (insects). Plant native hardwood trees and understory trees/shrubs, as well as herbaceous ground cover, to improve forest structure along the riparian shoreline and critical upland terrestrial habitat for SLCI (provide protection from deer for planted trees). Expand forest patch size and reduce edge effect and mitigate canopy loss where feasible. A percentage of dead snags should be left in order to provide nesting micro-habitat. Establish more mast bearing trees such as Bitternut Hickory and shrubs such as Hazelnut as wildlife food resources. Maintain naturalized shorelines and enhance existing shoreline plant communities; upland natural habitat buffering the river shoreline should exceed 150 feet wherever possible. Consider creating additional naturalized shoreline and semi-permanent wetland backwater areas. Mitigate Emerald Ash Borer impacts to enhance potential maternity roosting sites for bats through reforestation of hardwood tree species. Control invasive species to improve habitat quality and mitigate threats to species viability.

d) *Movement Corridors:* Maintain and enhance wildlife movement corridors along shorelines and railroads by maintaining natural native vegetation. Address wildlife crossings under Silver Spring Rd. and Hampton Ave. as noted above.

e) *Stopover Habitat*: Enhance migratory stopover habitat by planting fruit, nut, and seed bearing plants (woody/herbaceous), with a particular focus on transitional habitat zones where migrants tend to concentrate. Important areas include Mott Island and the surrogate savanna directly south of it; and all shorelines. Evaluate and mitigate potential migrant impacts from large utility towers and buildings. Inventory and mitigate light pollution.

f) *Wildlife Shelters*: Maintain and expand bird and bat houses. Consider artificial roosting sites for bats under bridges.

g) *Aquatic Habitats*: Consider creating in-stream cool deep pools for enhancing fish, turtle, and potential mudpuppy habitat. Enhance backwater east oxbow area for native aquatic plants and substrates to support fish spawning and habitat for adult and larval frogs.

h) *Surrogate Savanna*: Enhance habitat to benefit Gray Fox, Red-headed Woodpecker, and Eastern Fox Squirrel through protection and expansion of surrogate savanna habitat, including by maintaining appropriate mast bearing trees and shrubs on the golf course and other suitable open canopy areas.

i) *Turtles*: Create protected turtle nesting areas by establishing a mixed sand-gravel substrate protected from meso-predators by fencing (DNR designs available), with a volunteer citizen adoption program to monitor nest success and predation. Additional nesting surveys are recommended to identify current nesting areas, by visual searches and/or radio telemetry. Mott Island or the golf course shoreline due south of it are potential sites.

2) **Inventory and Monitoring**

a) *Plants:* Establish long term plant community monitoring in the northwest woods area to compare to the Barloga and Lane (2011) baseline data (their Site 1, Lincoln Creek Hackberry Site), sufficient to track change in the FQI and persistence of any desirable rare species. Incorporate monitoring of plantings and invasive species control into any planting and stewardship proposals to provide measures of success.

b) *Mussels*: Recent in-stream contaminant work at Lincoln Park undoubtedly affected the mussel beds here, which were the most diverse in the Greenway. Conduct mussel monitoring to compare to baseline data (Casper and Dare 2013), and to assess mussel survival and possible additional conservation actions.

c) *Dragonflies and Damselflies*: Conduct monitoring of dragonflies and damselflies. Lincoln Park has suitable habitat for various dragonflies and damselflies.

d) *Breeding Birds*: Establish point count stations and conduct monitoring with sufficient replicates.

e) *Mammals*: Conduct weasel surveys. Confirm acoustic-only bat detections with mist netting.

f) *Turtles*: Identify nesting areas with visual searches. Consider a radio telemetry study with geolocations of turtle movement and nesting patterns to evaluate critical habitat and survivorship of Eastern Spiny Softshell and Northern Map Turtle.

g) *Acoustic Monitoring*: Fund and establish permanent acoustic stations to monitor breeding frogs, breeding birds, and bats (maternal and migratory). Equipment costs are ca. $1,000/station. Annual data analysis costs are ca. $350/station/taxa/year.

3) **Light Pollution**

a) Map and mitigate light pollution with Lincoln Park designated as a light pollution refuge area.

4) Noise Pollution

a) Assess soundscape and identify quiet zones with consideration of noise abatement actions.

5) Biodiversity Enhancements

a) *Crayfish*: Establish Digger and/or Prairie crayfish in Lincoln Park. Prairie Crayfish can be considered for introduction on Mott Island and the back channel area, and Digger Crayfish in the ephemeral forested wetlands in the northwest corner.

b) *Mammals*: Reintroduce Eastern Fox Squirrel on golf course with habitat enhancements (forage trees and shrubs, snags). Enhance habitat to benefit Southern Flying Squirrel and consider reintroduction in mature hardwood forest patches.

c) *Amphibians*: Repatriate Blue-spotted Salamander, Boreal Chorus Frog, Northern Leopard Frog, and/or Gray Treefrog into restored ephemeral wetlands with suitable surrounding terrestrial habitat on Mott Island and/or the forested wetlands in the northwest corner.
d) *Reptiles*: Repatriate Eastern Milksnake, Northern Brownsnake, and/or Northern Watersnake through repatriation. Candidate areas are Mott Island and the surrogate savanna immediately to the south, with both having connection to the railroad corridor.
e) *Fishes*: Consider possible repatriations of fish SLCI if appropriate suitable water quality and habitat conditions are met.
f) *Mussels*: Consider possible repatriations of Ellipse and/or Elktoe if appropriate suitable water quality and habitat conditions are met.

4.5 Estabrook Park Projects

Species of Local Conservation Interest

Candidate SLCI Focal Species to be preserved or enhanced.

Mussels: Elktoe. Fishes: various. Amphibians: Green Frog, Northern Leopard Frog. Reptiles: Butler's Gartersnake, Common Gartersnake, Northern Brownsnake, Eastern Spiny Softshell, Northern Map Turtle. Breeding Birds: American Redstart, Chimney Swift, Great Blue Heron, Great Egret, Peregrine Falcon. Mammals (non-bat): American Mink, North American River Otter, weasel spp. Bats: Big Brown Bat, Little Brown Bat, Silver-haired Bat, Eastern Red Bat, Tricolored Bat, Northern Long-eared Myotis.

Candidate SLCI Focal Species to be considered for establishment.

Mussels: Ellipse, Spike. Crayfish: Prairie Crayfish. Fishes: various. Amphibians: Gray Treefrog. Reptiles: Eastern Milksnake, Northern Watersnake. Breeding Birds: Black-billed Cuckoo, Black-crowned Night Heron, Brown Thrasher, Common Nighthawk, Merlin, Red-headed Woodpecker, Willow Flycatcher, Yellow-billed Cuckoo. Mammals (non-bat): Southern Flying Squirrel, Gray Fox, Eastern Fox Squirrel.

Estabrook Park is a mixed use public park, including natural areas, one island, and picnic and other park activity areas. The plant communities were surveyed by Barloga and Lane (2011) and scored moderate for floristic quality (FQI scores 26.5 and 33.5). Notable were 15 species with Coefficients of Conservatism at 7 to 10; mostly west of the parkway road (Site 7): Bellwort, Canada May Flower, Early Meadow Rue, Juneberry, Large-flowered Trillium, Largeleaf Aster, Musclewood, Red Oak, White Birch, Wild Black Currant, Wild Sarsaparilla, Witch Hazel, Wood Anemone, Yellow Pimpernel, and Yellowbud Hickory. The forested areas contain many mature trees important as wildlife food and shelter resources. A permanent pond is stocked with fish and supports some turtles and frogs, draining through a culvert and intermittent stream through a lowland hardwood ravine to the river. An old oxbow and newly constructed shoreline areas are near the island following the 2018 removal of the dam.

Important constraints on habitat improvements to support fish and wildlife populations at Estabrook Park are the recreational areas, moderate plant community quality, habitat fragmentation into small patches, noise levels, and water quality issues.

Priority existing resources at Estabrook Park are:

- This reach of the Milwaukee River provides some riffle areas which are uncommon within the Greenway. This aquatic habitat would be enhanced by actions improving water quality, and adding supplemental habitat for fish spawning and turtles such as vegetated backwater areas (the old oxbow just north of the island is a potential wetland enhancement area). Also consider construction of some deep pools as fish and turtle refuges.
- This park is recommended as a light pollution refuge.
- A fair number of desirable native plant species were present in 2011 within the lowland hardwood forest, which resource should be protected and enhanced.

Project Recommendations

1) **Habitat Enhancements**
   a) *General*: Enhance ephemeral and semi-permanent wetland habitats along river backwater areas and the lagoon watershed system by improving plant communities. Consider extending hydroperiods to support more SLCI. Maintain and enhance existing naturalized riparian shoreline buffer zones, and extend naturalized shoreline where feasible. Upland shoreline buffer habitat should exceed 150 feet wherever possible.
   b) *Trails*: Maintain designated trails and address erosion issues. Conduct detailed plant surveys prior to additional trail construction.
   c) *Plant Communities:* Identify areas supporting native plant species with a CC of 8 or above, and establish management zones with a stewardship plan including invasive species control, plantings, and deer fencing if necessary. Protect or create mature trees as roosting habitat. Enhance existing habitat through invasive species control, and create or enhance additional wetlands and grasslands where feasible to improve forage species (insects). Expand forest patch size to reduce edge effect and mitigate canopy loss where feasible. A percentage of dead snags should be left in order to provide nesting micro-habitat. Establish additional mast bearing trees such as Bitternut Hickory and shrubs such as Hazelnut as wildlife food resources. Plant additional native hardwood trees and understory trees/shrubs, as well as herbaceous ground cover, to improve forest structure along the riparian shoreline and critical upland terrestrial habitat for SLCI. Mitigate Emerald Ash Borer impacts through reforestation of native hardwood tree species. Invasive species control will improve habitat quality and mitigate threats to species viability.
   d) *Movement Corridors:* Maintain and enhance wildlife movement corridors along shorelines and the bike trail. Consider new ecopassage designs under the Port Washington Rd. bridge when feasible as noted above.
   e) *Stopover Habitat*: Enhance migratory stopover habitat by planting fruit, nut, and seed bearing plants (woody/herbaceous), with a particular focus on transitional habitat zones

where migrants tend to concentrate. Evaluate and mitigate potential migrant impacts from large utility towers and buildings, and light pollution.

f) *Wildlife Shelters*: Establish bird and bat houses. Consider artificial roosting sites for bats under bridges.

g) *Surrogate Savanna*: Enhance habitat to benefit Gray Fox, Red-headed Woodpecker, and Eastern Fox Squirrel through provision of surrogate savanna habitat in picnic and recreation areas, including by maintaining appropriate mast bearing trees and shrubs in suitable open canopy areas.

h) *Aquatic Habitats*: Consider in-stream cool deep pools for enhancing fish, turtle, and mudpuppy habitat.

2) **Inventory and Monitoring**

a) *Mussels*: Monitor mussels to evaluate success of the dam removal, and to assess possible additional conservation actions such as repatriation of mussel beds.

b) *Dragonflies and Damselflies*: Conduct monitoring of dragonflies and damselflies.

c) *Acoustic Monitoring*: Consider establishing permanent acoustic stations to monitor maternal and migratory bats.

3) Light Pollution

a) Map and mitigate light pollution with Estabrook Park designated as a light pollution refuge area.

4) **Noise Pollution**

a) Assess the soundscape and identify quiet zones with consideration of noise abatement actions.

5) Biodiversity Enhancements

a) *Mammals*: Conduct habitat enhancements to benefit Southern Flying Squirrel and reintroduce into mature hardwood forest patches. Reintroduce Eastern Fox Squirrel with habitat enhancements (forage trees and shrubs, snags).

b) *Crayfish*: Establish Prairie Crayfish in the ephemeral wetland area north of the lagoon. The ravine draining from the lagoon, and the oxbow area north of the island, may also provide suitable habitat.

c) *Amphibians*: Repatriate Gray Treefrog into the ephemeral wetland area north of the lagoon with surrounding terrestrial habitat enhancements (remove Common Buckthorn). Monitor frogs in the lagoon to determine if Green Frog persists, or is pushed out by American Bullfrogs.

d) *Fishes*: Consider possible repatriations of fish SLCI in the Milwaukee River if appropriate water quality and habitat conditions are met.

e) *Mussels*: Consider possible repatriations of Ellipse and/or Elktoe in the Milwaukee River if appropriate water quality and habitat conditions are met.

f) *Reptiles*: Consider a program to establish Northern Watersnake through repatriation with an education program for fishermen. This project should include the old quarry across the river, where a denning site might be established.

4.6 Glendale Industrial Park (and west bank south to Capitol Dr.)

Species of Local Conservation Interest

Candidate SLCI Focal Species to be preserved or enhanced.

Mussels: Elktoe. Fishes: various. Amphibians: Green Frog, Northern Leopard Frog. Reptiles: Butler's Gartersnake, Common Gartersnake, Eastern Spiny Softshell, Northern Map Turtle. Breeding Birds: Black-crowned Night Heron, Chimney Swift, Great Blue Heron, Great Egret, Peregrine Falcon. Mammals (non-bat): American Mink, Coyote, North American River Otter, weasel spp. Bats: Big Brown Bat, Little Brown Bat, Silver-haired Bat, Eastern Red Bat, Tricolored Bat, Northern Long-eared Myotis.

Candidate SLCI Focal Species to be considered for establishment.

Mussels: Ellipse, Spike. Crayfish: Prairie Crayfish. Fishes: various. Amphibians: Common Mudpuppy, Gray Treefrog. Reptiles: Eastern Milksnake, Northern Watersnake. Breeding Birds: American Kestrel, American Redstart, Black-billed Cuckoo, Brown Thrasher, Common Nighthawk, Merlin, Willow Flycatcher, Yellow-billed Cuckoo. Mammals (non-bat): Gray Fox.

The Glendale Industrial Park area includes some existing natural area, mainly along the shoreline of the river but also in currently undeveloped vacant lots. Plant communities have not been surveyed. An old quarry is a notable habitat feature.

Important constraints on habitat improvements to support fish and wildlife populations here are the commercial zoning, ongoing development, likely low plant community quality, limited habitat area, noise and lighting levels, and water quality issues.

Priority existing resources at the Glendale Industrial Park area are:

- This reach of the Milwaukee River provides some riffle areas which are uncommon within the Greenway and fish SLCI repatriations may be possible.
- A snake population here is valuable as few areas within the Greenway currently support snakes. This population is however becoming increasingly isolated as development continues. This area is therefore recommended as a priority for establishing managed surrogate grassland habitat.
- Undeveloped lots could be considered for acquisition as green space to provide and enhance habitat for wildlife SLCI.
- The old quarry is a unique aquatic habitat that could be enhanced by improving both aquatic and surrounding terrestrial plant communities, and creating critical habitat features specific to wildlife SLCI. It offers a unique opportunity in the Greenway to establish a population of Northern Watersnake. Its overflow to the river is currently a fish barrier except at flood stages, typically allowing fish entry in spring after snow melt. Alterations here to isolate the quarry from the river could be considered if an isolated pond habitat supporting more dragonfly, amphibian, reptile, and bird SLCI is desired. Alternatively, more permanent connection to the river may be considered to place more emphasis on fish spawning and turtle habitat.

Project Recommendations

1) Habitat Enhancements

a) *General*: Preserve and enhance habitats in and around the old quarry specific to supporting SLCI. Maintain and enhance existing naturalized riparian shoreline through plant community management, and establishment of protected naturalized shoreline buffer zones. Upland shoreline buffer habitat should exceed 150 feet wherever possible.

b) *Trails*: Establish a designated trail system. There are currently no known sensitive areas but trails should avoid steep grades and any future established snake dens.

c) *Plant Communities*: Enhance existing habitat through invasive species control to improve habitat quality and mitigate threats to species viability. Preserve, enhance, and expand grassland habitats where feasible as critical habitat for snake SLCI. This area is one of the few in the Greenway where managed grassland habitat is recommended as a priority, wrapping around the industrial park and extending past the quarry south into the UWM Park and Ride area. This managed grassland could benefit a number of frog, snake, breeding bird, bat, mammal, and migratory SLCI. Maintain and enhance existing riparian forest south of the UWM Park and Ride detention pond, and around the Wheaton Fransiscan Healthcare Center. Establish additional mast bearing trees such as Bitternut Hickory and shrubs such as Hazelnut as wildlife food resources. Provide or preserve mature trees in these patches as roosting habitat. A percentage of dead snags should be left in order to provide nesting micro-habitat. Plant additional native hardwood trees and understory trees/shrubs, as well as herbaceous ground cover, to improve forest structure in these patches. Mitigate Emerald Ash Borer impacts through reforestation of hardwood tree species.

d) *Movement Corridors:* Maintain and enhance the wildlife movement corridor along the Milwaukee River shoreline and consider a new ecopassage design under the Port Washington Rd. bridge when feasible as noted above.

e) *Stopover Habitat*: Enhance migratory stopover habitat by planting fruit, nut, and seed bearing plants (woody/herbaceous). The best opportunity for enhancement is around the UWM parking lot where mowed areas can be converted to stopover habitat. Evaluate and mitigate potential migrant impacts from buildings and light pollution.

f) *Wildlife Shelters*: Establish bird and bats houses. Consider Common Nighthawk and/or Chimney Swift nesting structures placed atop commercial buildings.

2) Light Pollution

a) Mitigate light pollution, especially lighting for the UWM parking lot.

3) Noise Pollution

a) Assess the soundscape and consider noise abatement actions.

4) Biodiversity Enhancements

a) *Old quarry area*: Consider habitat enhancement and repatriation options for the quarry pond and surrounding terrestrial habitat. If the overflow is changed to allow fish passage this may become an important fish spawning area. If the overflow prevents fish passage the habitat is more valuable for frogs, turtles, snakes, and dragonflies. Consider repatriating Northern Watersnake here with provision of a denning site.

b) UWM parking lot and surround including detention ponds: Where feasible enhance and restore habitat with native plantings for stopover habitat, and to better support snake, breeding bird, dragonfly, and mammal SLCI. Focus actions on grassland or savanna habitat to better preserve the snake population.

c) *Fishes*: Consider possible repatriations of fish SLCI in the Milwaukee River if appropriate water quality and habitat conditions are met.

d) Mussels: Consider possible repatriations of Ellipse and/or Elktoe in the Milwaukee River if appropriate water quality and habitat conditions are met.

4.7 Hubbard Park

Species of Local Conservation Interest

Candidate SLCI Focal Species to be preserved or enhanced.

Mussels: Elktoe. Fishes: various. Breeding Birds: American Redstart, Great Blue Heron, Great Egret. Mammals (non-bat): American Mink. Bats: Big Brown Bat, Little Brown Bat, Silver-haired Bat, Eastern Red Bat, Tricolored Bat, Northern Long-eared Myotis.

Candidate SLCI Focal Species to be considered for establishment.

Mussels: Ellipse, Spike. Fishes: various.

Hubbard Park is a mostly wooded slope with public facilities and trails embedded. The plant communities were surveyed by Barloga and Lane (2011; Sites 10 and 11) and scored high for floristic quality (FQI scores 47.9 and 38.4, respectively). Species lists from these surveys are not available, but see adjacent Cambridge Woods list. The forested areas contain many mature trees important as wildlife food and shelter resources.

Important constraints on habitat improvements to support fish and wildlife populations here are the recreational areas, limited habitat area (forest is all edge), noise and lighting levels, and water quality issues.

Priority existing resources at Hubbard Park are:

- Mature upland hardwood forest with rare plants.
- Movement corridor.
- Stopover habitat.

Project Recommendations

1) Habitat Enhancements

a) *General*: Maintain and extend where feasible naturalized aquatic buffer zones. Upland shoreline buffer habitat should exceed 150 feet wherever possible.

b) *Trails*: Establish designated trails and address erosion issues. Trails should be designed to limit disturbance to sensitive existing plant communities.
c) *Plant Communities*: Enhance existing habitat through invasive species control to improve habitat quality and mitigate threats to species viability. Maintain and enhance existing high quality forest habitat, including by replacing dying ash, planting native hardwoods and forbs, and retaining snags. Expand forest patch size where feasible to reduce edge effect and mitigate canopy loss. Establish additional mast bearing trees such as Bitternut Hickory and shrubs such as Hazelnut as wildlife food resources.
d) *Movement Corridor:* Maintain and enhance the wildlife movement corridors along the shoreline and bike trail.
e) *Stopover Habitat*: Enhance migratory stopover habitat by planting fruit, nut, and seed bearing plants (woody and herbaceous), and maintenance of large mature shelter trees.
f) *Wildlife Shelters*: Establish bird and bat houses.

2) Inventory and Monitoring
a) *Mussels*: Continue monitoring mussels to compare to available baseline data (Casper and Dare 2013; WDNR).

3) Light Pollution
a) Mitigate light pollution.

4) Biodiversity Enhancements
a) *Fishes*: Consider possible repatriations of fish SLCI if appropriate water quality and habitat conditions are met.
b) *Mussels*: Consider possible repatriations of Ellipse and/or Elktoe in the Milwaukee River if appropriate water quality and habitat conditions are met.

5) Flora
a) *Flora*: Maintain and enhance the high quality floral assemblage (Barloga and Lane, 2011) north of the Hubbard Park lodge, consider deer exclosures and native plantings.

4.8 Pleasant Valley Park

Species of Local Conservation Interest

Candidate SLCI Focal Species to be preserved or enhanced.

Mussels: Elktoe. Fishes: various. Amphibians: Green Frog. Reptiles: Butler's Gartersnake, Common Gartersnake, Dekay's Brownsnake, Eastern Spiny Softshell. Breeding Birds: American Redstart, Chimney Swift, Great Blue Heron, Great Egret, Peregrine Falcon. Mammals (non-bat): American Mink, North American River Otter, weasel spp. Bats: Big Brown Bat, Little Brown Bat, Silver-haired Bat, Eastern Red Bat, Tricolored Bat, Northern Long-eared Myotis.

Candidate SLCI Focal Species to be considered for establishment.

Mussels: Ellipse, Spike. Fishes: various. Amphibians: Gray Treefrog, Northern Leopard Frog. Reptiles: Northern Map Turtle. Breeding Birds: Black-billed Cuckoo, Black-crowned Night Heron, Brown Thrasher, Common Nighthawk, Least Flycatcher, Merlin, Wood Thrush, Yellow-billed Cuckoo. Mammals (non-bat): Southern Flying Squirrel.

Pleasant Valley Park is a mixed use public park with limited access, consisting primarily of wooded riparian and bluff forested natural areas with trails. The plant communities were surveyed by Barloga and Lane (2011) and scored moderate (Site 2) for floristic quality (FQI score 33.6). Notable were four species with Coefficients of Conservatism at 8 to 10: False Rue Anemone, Long-beaked Sedge, Ninebark, and White Birch. The forested areas contain many mature trees important as wildlife food and shelter resources.

Important constraints on habitat improvements to support fish and wildlife populations at Pleasant Valley Park are the recreational areas, moderate plant community quality, ongoing trail erosion, linear habitat with continuous edge effects, noise and light pollution, and water quality issues.

Priority existing resources at Pleasant Valley Park are:

- Mature upland and lowland hardwood forest with rare plants.
- Movement corridor.
- Stopover habitat.

Project Recommendations:

1) Habitat Enhancements

a) *General*: Preserve and expand where feasible a naturalized shoreline buffer zone. Upland shoreline buffer habitat should exceed 150 feet wherever possible. Consider creating an ephemeral pond in the valley.

b) *Trails*: Establish designated trails and address erosion issues. Trails should be designed to limit disturbance to sensitive existing plant communities.

c) *Plant Communities*: Enhance existing habitat through invasive species control to improve habitat quality and mitigate threats to species viability. Maintain and enhance high quality forest habitat, including replacing dying ash, planting native hardwoods and forbs, and retaining snags. Consider deer exclusion zones to establish and protect high quality ground vegetation. Expand forest patch size if feasible to reduce edge effect and mitigate canopy loss. Establish more mast bearing trees such as Bitternut Hickory and shrubs such as Hazelnut as wildlife food resources.

d) *Movement Corridor:* Maintain and enhance the wildlife movement corridor along shoreline.

e) *Stopover Habitat*: Enhance migratory stopover habitat by planting fruit, nut, and seed bearing plants (woody and herbaceous), and maintenance of large mature shelter trees.

f) *Wildlife Shelters*: Establish bird, bat, and flying squirrel houses.

g) *Reptiles and amphibians*: Preserve and enhance grassland area at end of E. Concordia Ave. supporting three SLCI snakes, and consider ephemeral wetland feasibility there.

2) **Inventory and Monitoring**

a) *Acoustic Monitoring*: Pleasant Valley Park may be considered for permanent acoustic stations to monitor breeding birds and bats (and frogs if repatriated in a created wetland).

3) Light Pollution

a) Mitigate light pollution.

4) **Noise Pollution**
   a) Assess the soundscape and consider noise abatement actions.
5) **Biodiversity Enhancements**
   a) *Fishes*: Consider possible repatriations of fish SLCI in the Milwaukee River if appropriate water quality and habitat conditions are met.
   b) *Mussels*: Consider possible repatriations of Ellipse and/or Elktoe in the Milwaukee River if appropriate water quality and habitat conditions are met.
   c) *Mammals*: Consider Southern Flying Squirrel repatriation and monitoring with squirrel nest boxes.
6) **Flora**
   a) *Flora*: Maintain and enhance high quality floral assemblages, consider deer exclosures and native plantings.

4.9 Koenen Nature Preserve

Species of Local Conservation Interest

Candidate SLCI Focal Species to be preserved or enhanced.

Breeding Birds: American Redstart. Mammals (non-bat): American Mink, North American River Otter, weasel spp. Bats: Big Brown Bat, Little Brown Bat, Silver-haired Bat, Eastern Red Bat, Tricolored Bat, Northern Long-eared Myotis.

Candidate SLCI Focal Species to be considered for establishment.

Breeding Birds: Wood Thrush. Mammals (non-bat): Southern Flying Squirrel.

The Koenen Nature Preserve area is a preserve with limited access, consisting primarily of upland and lowland mature hardwood forest natural area on a steep bluff with foot trails, and a small surrogate grassland. The plant communities were surveyed by Barloga and Lane (2011) and scored low (Site 3) for floristic quality (FQI score 21.2). Only White Birch had a Coefficient of Conservatism >7 (CC=10). The forested area however contains many mature trees important as wildlife food and shelter resources.

Important constraints on habitat improvements to support fish and wildlife populations at the Koenen Nature Preserve are the recreational areas, ongoing trail erosion, linear habitat with continuous edge effects, noise and light pollution, and water quality issues.

Priority existing resources at the Koenen Nature Preserve are:

- Mature upland and lowland hardwood forest.
- Movement corridor.
- Stopover habitat.

Project Recommendations:

1) **Habitat Enhancements**

a) *General*: Preserve and expand where feasible a naturalized shoreline buffer zone. Upland shoreline buffer habitat should exceed 150 feet wherever possible.
b) *Trails*: Establish designated trails and address erosion issues. Trails should be designed to limit disturbance to sensitive existing plant communities.
c) *Plant Communities*: Enhance existing habitat through invasive species control to improve habitat quality and mitigate threats to species viability. Maintain and enhance mature hardwood forest habitat, including replacing dying ash, planting native hardwoods and forbs, and retaining snags. Consider deer exclusion zones to establish and protect high quality ground vegetation. Where possible expand forest patch size to reduce edge effect and mitigate canopy loss. Establishment of more mast bearing trees such as Bitternut Hickory and shrubs such as Hazelnut should be considered as wildlife food resources.
d) *Movement Corridor:* Maintain and enhance the wildlife movement corridor along the shoreline.
e) *Stopover Habitat*: Enhance migratory stopover habitat by planting fruit, nut, and seed bearing plants (woody/herbaceous), and maintenance of large mature shelter trees.
f) *Wildlife Shelters*: Establish bird, bat, and flying squirrel houses.

2) **Inventory and Monitoring**
   a) *Acoustic Monitoring*: Consider permanent acoustic stations to monitor breeding birds and bats.
3) **Light Pollution**
   a) Assess and mitigate light pollution.
4) **Noise Pollution**
   a) Assess the soundscape and consider noise abatement actions.
5) **Biodiversity Enhancements**
   a) *Mammals*: Consider Southern Flying Squirrel repatriation and monitoring with squirrel nest boxes.
6) **Flora**
   a) *Flora*: Improve floral assemblages with native plantings. Consider deer exclosures to limit grazing.

4.10 Cambridge Woods

Species of Local Conservation Interest

Candidate SLCI Focal Species to be preserved or enhanced.

Mussels: Elktoe. Fishes: various. Amphibians: Green Frog, Northern Leopard Frog. Reptiles: Eastern Spiny Softshell. Breeding Birds: American Redstart, Chimney Swift, Great Blue Heron, Great Egret, Peregrine Falcon. Mammals (non-bat): American Mink, North American River Otter, weasel spp. Bats: Big Brown Bat, Little Brown Bat, Silver-haired Bat, Eastern Red Bat, Tricolored Bat, Northern Long-eared Myotis.

Candidate SLCI Focal Species to be considered for establishment.

Mussels: Ellipse, Spike. Fishes: various. Reptiles: Northern Map Turtle. Breeding Birds: Common Nighthawk, Merlin, Wood Thrush. Mammals (non-bat): Southern Flying Squirrel.

Cambridge Woods is a mixed use public park consisting primarily of wooded riparian lowland and upland bluff forest with trails. The plant communities were surveyed by Barloga and Lane (2011) and scored high (Site 12) for floristic quality (FQI score 55.1). Notable were 23 species with Coefficients of Conservatism at 8 to 10: Alternate-leaved Dogwood, Beech-drops, Black Ash, Canada May Flower, Common Juniper, Dwarf Honeysuckle, Forked Aster, Juneberry, Large-flowered Trillium, Largeleaf Aster, Long-stalked Hummock Sedge, Musclewood, Narrow-leaved Oval Sedge, Pale Leafcup, Pale Vetchling, Poke Milkweed, Round-leaved Dogwood, Snowberry, White Birch, Wild Sarsaparilla, Witch Hazel, Wood Betony, and Yellow Pimpernel. The forested areas contain many mature trees important as wildlife food and shelter resources.

Important constraints on habitat improvements to support fish and wildlife populations at Cambridge Woods are the recreational areas, ongoing trail erosion, linear habitat with continuous edge effects, noise and light pollution, and water quality issues.

Priority existing resources at Cambridge Woods are:

- Mature upland and lowland hardwood forest with rare plants; this is the highest quality existing plant community in the Greenway.
- Movement corridor.
- Stopover habitat.

Project Recommendations:

1) **Habitat Enhancements**
   a) *General*: Preserve and expand where feasible a naturalized shoreline buffer zone. Upland shoreline buffer habitat should exceed 150 feet wherever possible.
   b) *Trails*: Close social trails, maintain existing designated trails and address erosion issues. Trails should be designed to limit disturbance to sensitive existing plant communities.
   c) *Plant Communities*: Maintain and enhance existing high quality forest plant community, with special attention to the ground layer at risk from over-grazing. Consider deer exclusion zones to establish and protect high quality ground vegetation. Replace dying ash by planting native hardwoods, shrubs, and forbs, and retain snags as habitat where feasible. Manage and protect the Threatened Forked Aster and other high quality plant assemblages. Enhance existing habitat through invasive species control to improve habitat quality and mitigate threats to species viability. Where possible expand forest patch size to reduce edge effect and mitigate canopy loss. Establish more mast bearing trees such as Bitternut Hickory and shrubs such as Hazelnut as wildlife food resources.
   d) *Movement Corridor:* Maintain and enhance the wildlife movement corridors along the shoreline and 10 feet mowed area on either side of the bike trail.
   e) *Stopover Habitat*: Enhance migratory stopover habitat by planting fruit, nut, and seed bearing plants (woody/herbaceous), and maintenance of large mature shelter trees.
   f) *Wildlife Shelters*: Establish bat and flying squirrel houses.
2) **Inventory and Monitoring**

a) *Acoustic Monitoring*: Consider establishing permanent acoustic stations to monitor breeding birds and bats.

3) **Light Pollution**
   a) Map and mitigate light pollution.
4) **Noise Pollution**
   a) Assess the soundscape and consider noise abatement actions.
5) **Biodiversity Enhancements**
   a) *Mammals*: Consider Southern Flying Squirrel repatriation and monitoring with squirrel nest boxes.
6) **Flora**
   a) *Flora*: Maintain and possibly enhance the high quality floral assemblages with additional native plantings. Consider deer exclosures for protecting planted trees and native plantings.

4.11 Gordon Park and Milwaukee River Parkway from Locust Street south to Caesar Park

Species of Local Conservation Interest

Candidate SLCI Focal Species to be preserved or enhanced.

Mussels: Elktoe. Fishes: various. Amphibians: Green Frog, Northern Leopard Frog. Reptiles: Butler's Gartersnake, Common Gartersnake, Northern Brownsnake, Eastern Spiny Softshell, Northern Map Turtle. Breeding Birds: American Redstart, Chimney Swift, Great Blue Heron, Great Egret, Peregrine Falcon. Mammals (non-bat): American Mink, weasel spp. Bats: Big Brown Bat, Little Brown Bat, Silver-haired Bat, Eastern Red Bat, Tricolored Bat, Northern Long-eared Myotis.

Candidate SLCI Focal Species to be considered for establishment.

Crayfish: Prairie Crayfish. Fishes: various. Amphibians: Boreal Chorus Frog, Gray Treefrog. Breeding Birds: American Woodcock, Black-billed Cuckoo, Black-crowned Night Heron, Brown Thrasher, Carolina Wren, Chimney Swift, Common Nighthawk, Field Sparrow, Willow Flycatcher, Wood Thrush, Yellow-billed Cuckoo.

This region is a mix of public and private parkland with more habitat variety than the Greenway immediately to the north owing to a wider floodplain valley with some recently created new habitats. The east bank south of Riverside Park is mostly in private ownership and is part of the area designated as the Milwaukee Rotary Centennial Arboretum managed by the Urban Ecology Center. The open floodplain areas resulting from the removal of the North Ave. dam are currently dominated by invasive species (mostly Reed Canary Grass), but many grassed areas on the east bank are under a reforestation plan being implemented by the Urban Ecology Center (Callaghan et al. 2015). Some additional grassland habitat was created in the Arboretum area. The overall loss of grassland habitat is expected to permanently reduce one of the main wildlife resources in this region – a robust snake population. The southern portion of the west bank floodplain is also expected to be impacted sometime in the future for contaminated sediment removal, which will also negatively impact the existing snake population, at least temporarily. This forthcoming contaminant remediation action however may represent an

opportunity to replace Reed Canary Grass with higher quality snake habitat. The floodplain grassland on the west side of the river is designated as snake habitat by Milwaukee County Parks and no activities are underway or planned to close the canopy there. Remaining areas (outside of Riverside Park) consist of a mix of recreational use (i.e., Gordon Park picnic areas), wooded riparian lowland and upland hardwood forest natural areas with trails. On the east bank Riverside Park and the Milwaukee Rotary Centennial Arboretum are managed by the Urban Ecology Center with a focus on outdoor education. The Urban Ecology Center also recently constructed an ephemeral pond habitat on their property just south of Riverside Park. Ephemeral ponds and associated dependent SLCI are rare in the Greenway and this pond may support additional SLCI populations in the future.

The plant communities were surveyed by Barloga and Lane (2011) and scored low (Sites 4, 5, 6, 13) for floristic quality (FQI scores 24.7, 18.7, 8.8, 10.8, respectively). Notable were two species with Coefficients of Conservatism at 7 to 10: Balm of Gilead and Early Meadow Rue. The forested areas contain many mature trees important as wildlife food and shelter resources. The open floodplain areas are comprised mostly of invasive species but provide grassland and shrub habitats that are rare in the Greenway and support several important SLCI. This illustrates an important conclusion from the AOC study – that rare animals are not strongly associated with high quality plant communities.

The River Revitalization Foundation is active in controlling invasive and introducing native plants in the Gordon Park woodland. There are several portions of the bluff in Gordon Park that have large populations of native spring ephemerals. River Revitalization Foundation has been conducting plant surveys in Gordon Park and Caesar Park for several years. The Urban Ecology Center has also conducted plant surveys in the area defined as the Milwaukee Rotary Centennial Arboretum and is addressing restoration of native plant communities there.

Important constraints on habitat improvements to support fish and wildlife populations in this area are the recreational areas, low plant community quality, ongoing educational and recreational activates that often create high disturbance levels, trail erosion (mostly on the west bank), linear habitat with continuous edge effects, noise and light pollution, sediment contamination, and water quality issues.

<u>Priority existing resources in this region are</u>:

- Mature upland and lowland hardwood forest habitat.
- Floodplain grassland and shrubland habitats providing critical habitat for SLCI.
- A created ephemeral pond.
- A robust snake population.
- Movement corridor.
- Stopover habitat.
- The Urban Ecology Center for providing outdoor education and outreach, and local habitat stewardship.

Project Recommendations:

1) **Habitat Enhancements**
   a) *General*: Maintain and enhance a shoreline buffer zone of native vegetation exceeding 150 feet wherever possible. Consider creating or enhancing (by replacing native species with native species) additional wetland, shrubland, and grassland habitat where feasible to improve forage species (insects) and better support SLCI associated with these habitats. Consider creation of additional ephemeral and semi-permanent wetland habitats to support crayfish, dragonfly, amphibian, and bird SLCI.
   b) *Trails*: Establish designated trails and address erosion issues. There are currently no known sensitive plant communities but trails should avoid steep grades and seepage areas to reduce erosion and provide disturbance refuges away from trails, such as placing trails mostly at bluff tops and bluff bottoms, and limiting cross trails penetrating habitat patch centers. Any known areas of high snake use or congregation, or other critical habitat features such as nesting areas that may develop through ongoing management (i.e., if a turtle nesting area is designated) should also evaluate trail access to minimize disturbance to these animals.
   c) *Plant Communities*: Enhance existing habitat through invasive species control to improve habitat quality and mitigate threats to species viability. Plant native hardwood trees and understory trees/shrubs, as well as herbaceous ground cover, to improve both forest and grassland habitat structure along the riparian shoreline. A management plan should establish viable managed forest, shrub, and grassland habitat zones. Preserve and enhance mature trees as roosting habitat. A percentage of dead snags should be left in order to provide nesting micro-habitat. Where possible expand habitat patch sizes to reduce edge effect. Establish additional wildlife food resources through native plantings. Mitigate Emerald Ash Borer impacts through reforestation with hardwood tree species.
   d) *Movement Corridors:* Maintain wildlife movement corridors along shorelines and bike trails.
   e) *Stopover Habitat*: Enhance migratory stopover habitat by planting native fruit, nut, and seed bearing plants (woody/herbaceous), and maintain large mature shelter trees. Evaluate and mitigate potential migrant impacts from buildings and light pollution.
   f) *Wildlife Shelters*: Establish bird, bat, and flying squirrel houses. Consider artificial roosting sites for bats including under the North Ave. and Locust St. bridges. Consider artificial nesting structures for Common Nighthawk and Chimney Swift on area rooftops.
   g) *Turtle Nesting Area*: Create a protected turtle nesting area south of the Urban Ecology Center, by establishing a mixed sand-gravel substrate protected from meso-predators by electric or other fencing (DNR designs available). Establish a volunteer citizen stewardship program for the nesting area.
   h) *Snake SLCI*: Preserve, enhance and maintain Butler's Gartersnake, Common Gartersnake, and Northern Brownsnake populations and their critical habitats. The upcoming contaminant remediation will affect existing snake populations through earth moving activities. Activities should be carefully planned to ensure snakes survive and are recovered by restoring better habitat post-remediation. Consider revising the Callaghan et al. (2015) plan to preserve grassland snake habitat on the east bank as a temporary snake refuge, and delay any further

reforestation until after contaminant remediation is completed and the west bank habitat is restored and again occupied by snakes.

i) *Amphibian, Dragonfly, and Crayfish SLCI*: Repatriate Blue-spotted Salamander, Chorus Frog, Northern Leopard Frog, and/or Gray Treefrog into the Urban Ecology Center ephemeral pond. Consider creating a semi-permanent pond at the base of the west bluff post-remediation to support additional SLCI such as dragonflies, Green Frog, Gray Treefrog, Northern Leopard Frog, and Prairie Crayfish.

2) **Inventory and Monitoring**

a) *Acoustic Monitoring*: Establish permanent acoustic stations to monitor frogs, breeding birds, and bats.

b) *Dragonflies and Damselflies*: Monitor dragonflies and damselflies.

c) *Mussels*: Monitor mussels to compare to baseline data (Jass and Glenn 2002, Casper and Dare 2013), and to assess mussel survival and possible additional conservation actions.

d) *Snakes*: Monitor snake populations for continuing successful reproduction. Population level monitoring of snakes utilizing capture-mark-recapture methods as attempted in the past is not recommended owing to impacts to the snake population in this area with such high human activity.

e) *Turtles*: Consider a radio telemetry study with geolocations of turtle movement and nesting patterns to evaluate critical habitat and survivorship.

f) *Mammals*: Consider weasel surveys and camera surveys for mammals (frequent vandalism may preclude this technique).

3) Light Pollution

a) Map and mitigate light pollution.

4) Noise Pollution

a) Assess the soundscape and consider noise abatement actions.

5) Biodiversity Enhancements

a) *Fishes*: Consider possible repatriations of fish SLCI in the Milwaukee River if appropriate water quality and habitat conditions are met.

b) *Mussels*: Consider possible repatriations of Ellipse and/or Elktoe in the Milwaukee River if appropriate water quality and habitat conditions are met.

c) *Crayfish*: Consider establishing Prairie Crayfish in floodplain and ephemeral wetland areas.

d) *Mammals*: Consider Southern Flying Squirrel repatriation in mature hardwood forest patches and monitoring with squirrel nest boxes.

6) Conservation Easements or Acquisition of Private Properties

a) Contact landowners to explore preservation or restoration of additional green space and natural habitats through acquisition or conservation easement.

4.12 Riverside Park

Species of Local Conservation Interest

Candidate SLCI Focal Species to be preserved or enhanced.

Mussels: Elktoe. Fishes: various. Amphibians: Green Frog, Northern Leopard Frog. Reptiles: Butler's Gartersnake, Common Gartersnake, Northern Brownsnake, Eastern Spiny Softshell, Northern Map Turtle. Breeding Birds: American Redstart, Chimney Swift, Great Blue Heron, Great Egret, Peregrine Falcon. Mammals (non-bat): American Mink, weasel spp. Bats: Big Brown Bat, Little Brown Bat, Silver-haired Bat, Eastern Red Bat, Tricolored Bat, Northern Long-eared Myotis.

Candidate SLCI Focal Species to be considered for establishment.

Crayfish: Prairie Crayfish. Fishes: various. Amphibians: Blue-spotted Salamander, Boreal Chorus Frog, Gray Treefrog. Breeding Birds: Black-billed Cuckoo, Brown Thrasher, Common Nighthawk, Field Sparrow, Willow Flycatcher, Wood Thrush, Yellow-billed Cuckoo. Mammals (non-bat): Southern Flying Squirrel.

Riverside Park is a mixed use public park consisting mostly of upland and lowland hardwood forest natural area with trails. It is part of the area designated as the Milwaukee Rotary Centennial Arboretum and is managed by the Urban Ecology Center. The plant communities were surveyed by the Urban Ecology Center, and a detailed management plan addressing the restoration of native plant communities has been completed (Callaghan et al. 2015). This plan envisions creating a mosaic of small patches of regionally native plant communities that can be maintained both to improve wildlife habitat, and to showcase differing habitat types for educational purposes.

Important constraints on habitat improvements to support fish and wildlife populations in this area are the recreational areas, low to moderate plant community quality, ongoing educational and recreational activates that often create high disturbance levels, small habitat patch size with edge effects, low habitat diversity, noise and light pollution, and water quality issues.

Priority existing resources in this region are:

- Mature upland and lowland hardwood forest habitat.
- A created ephemeral pond abutting the south border.
- Movement corridor.
- Stopover habitat.
- The Urban Ecology Center for providing outdoor education and outreach, and local habitat stewardship.

Project Recommendations:

1) **Habitat Enhancements**
   a) *General*: Maintain and enhance existing naturalized riparian buffer zone exceeding 150 feet wherever possible.

b) *Trails*: Maintain designated trails and address erosion issues. Trails should be designed to limit disturbance to any known sensitive existing plant communities.

c) *Plant Communities*: As one of the larger mature upland hardwood forest patches in the Greenway, this habitat type is a priority for management. Enhance existing habitat through invasive species control to improve habitat quality and mitigate threats to species viability. Preserve mature trees as roosting habitat. A percentage of dead snags should be left in order to provide nesting micro-habitat. Expand forest patch size where feasible to buffer edge effect and mitigate canopy loss. Establish more mast bearing trees such as Bitternut Hickory and shrubs such as Hazelnut as wildlife food resources. Plant additional native hardwood trees and understory shrubs and forbs to improve forest structure and plant community diversity. Mitigate Emerald Ash Borer impacts through reforestation of hardwood tree species.

d) *Movement Corridors:* Maintain the wildlife movement corridor along the shoreline and bike trail.

e) *Stopover Habitat*: Enhance migratory stopover habitat by planting fruit, nut, and seed bearing plants (woody and herbaceous), and maintenance of large mature shelter trees. Evaluate and mitigate potential migrant impacts from buildings and light pollution.

f) *Wildlife Shelters*: Consider bird, bat, and flying squirrel houses.

g) *Reptiles*: Preserve and maintain Butler's Gartersnake and Northern Brownsnake habitat in the savanna area by maintaining grassed ground cover.

2) **Inventory and Monitoring**

a) *Acoustic Monitoring*: Consider establishing permanent acoustic stations to monitor frogs, breeding birds, and bats.

b) *Dragonflies and Damselflies*: Consider monitoring for dragonflies and damselflies.

c) *Mammals*: Weasel surveys are recommended.

3) Light Pollution

a) Map and mitigate light pollution.

4) Noise Pollution

a) Assess the soundscape and consider noise abatement actions.

5) Biodiversity Enhancements

a) *Fishes*: Consider possible repatriations of fish SLCI in the Milwaukee River if appropriate water quality and habitat conditions are met.

b) *Mussels*: Consider possible repatriations of Ellipse and/or Elktoe in the Milwaukee River if appropriate water quality and habitat conditions are met.

c) *Crayfish*: There is potential to establish Prairie Crayfish in the Urban Ecology Center ephemeral wetland bordering Riverside Park.

d) *Mammals*: Consider Southern Flying Squirrel repatriation in Riverside Park and monitoring with squirrel nest boxes or nocturnal feeder/camera stations.

e) *Amphibians*: Consider programs to repatriate Blue-spotted Salamander, Boreal Chorus Frog, Northern Leopard Frog, and/or Gray Treefrog in the Urban Ecology Center ephemeral wetland bordering Riverside Park.

4.13 Turtle Park (River Revitalization Foundation)

Species of Local Conservation Interest

Candidate SLCI Focal Species to be preserved or enhanced.

Mussels: Elktoe. Fishes: various. Amphibians: Green Frog, Northern Leopard Frog. Reptiles: Butler's Gartersnake, Common Gartersnake, Northern Brownsnake, Eastern Spiny Softshell, Northern Map Turtle. Breeding Birds: Chimney Swift, Great Blue Heron, Great Egret, Peregrine Falcon. Mammals (non-bat): American Mink, weasel spp. Bats: Big Brown Bat, Little Brown Bat, Silver-haired Bat, Eastern Red Bat, Tricolored Bat, Northern Long-eared Myotis.

Candidate SLCI Focal Species to be considered for establishment.

Fishes: various. Amphibians: Common Mudpuppy. Breeding Birds: Black-billed Cuckoo, Brown Thrasher, Common Nighthawk, Willow Flycatcher, Yellow-billed Cuckoo.

Turtle Park is located on the west bank at the old North Ave. dam, and has been the subject of extensive habitat restoration in recent years by the River Revitalization Foundation. It has a variety of prairie and pollinator plantings creating a diverse habitat mix with some mature hardwood trees along the shoreline. Offshore is the spillway deep pool and a recently created fish spawning shoal. The plant communities were surveyed by Barloga and Lane (2011) and scored low (Sites 6) for floristic quality (FQI scores 8.8), but the plant community has substantially changed since this survey was undertaken and is probably of moderate to high quality now. It is currently managed by the River Revitalization Foundation for native diverse plant communities with passive walking trails and a canoe launch.

Important constraints on habitat improvements to support fish and wildlife populations in this area are high disturbance levels, linear habitat with continuous edge effects, noise and light pollution, sediment contamination, and water quality issues.

Priority existing resources in this region are:

- The old dam spillway and deep pool are important turtle habitat.
- Diverse pollinator habitat.
- Partial support for an important snake population.
- Stopover habitat.

Project Recommendations:

1) **Habitat Enhancements**
   a) *General*: Maintain and expand if possible the existing naturalized riparian shoreline to enhance water quality. Establish a designated trail system.
   b) *Plant Communities*: Plant community restoration in this area is focused on managed grassland and pollinator habitat. Preserve mature trees as roosting habitat to benefit bats and birds. Provide dead snags as wildlife habitat. Control invasive species and maintain native plant

communities to improve migratory stopover habitat. Establish additional native fruit and nut bearing trees and shrubs to improve wildlife food resources.

c) *Movement Corridor:* Since wildlife movement to the south is not important (no habitat exists) this area is not important as a movement corridor.

d) *Stopover Habitat*: Enhance migratory stopover habitat by planting fruit, nut, and seed bearing plants (woody/herbaceous), and maintenance of large mature shelter trees. Evaluate and mitigate potential migrant impacts from buildings and light pollution.

e) *Wildlife Shelters*: Place bird and bat houses.

f) *Turtles*: Create an in-stream turtle basking site consisting of a tethered or anchored floating log structure.

g) *Snakes*: Maintain grassland habitats to benefit existing snake SLCI.

h) *Turtle Nesting Area*: Create a protected turtle nesting area by establishing a mixed sand-gravel substrate protected from meso-predators by electric or other fencing (DNR designs are available). Establish a volunteer citizen stewardship program for it.

2) **Inventory and Monitoring**

a) *Acoustic Monitoring*: Establish a permanent acoustic station to monitor breeding and migratory bats.

b) *Turtles*: Consider a radio telemetry study with geolocations of turtle movement and nesting patterns to evaluate critical habitat and survivorship.

3) Light Pollution

a) Map and mitigate light pollution where feasible.

4) Noise Pollution

a) Assess the soundscape and consider noise abatement actions.

5) Biodiversity Enhancements

a) *Fishes*: Consider possible repatriations of fish SLCI in the Milwaukee River if appropriate water quality and habitat conditions are met.

b) *Amphibians*: Consider repatriating Common Mudpuppy in the shoal just downstream of the old North Avenue dam.

Painted Turtles basking (photo by G. S. Casper)

Table 5. Summary of Management Actions.

	Lincoln Park	Estabrook Park	Glendale Ind. Park	Hubbard Park	Pleasant Valley Park	Koenen Preserve	Cambridge Woods	Gordon Park, Parkways	Riverside Park	Turtle Park
Natural Areas*	X	X	X	X	X	X	X	X	X	X
Invasive Species	X	X	X	X	X	X	X	X	X	X
Plant Community Enhancement	X	X	X	X	X	X	X	X	X	X
Movement Corridors	X	X	X	X	X	X	X	X	X	
Stopover Habitat	X	X	X	X	X	X	X	X	X	X
Wildlife Shelters	X	X	X	X	X	X	X	X	X	X
Turtle Nesting Areas	X							X		X
Snake Habitat	X		X		X			X	X	X
Mussel Monitoring	X	X	X	X				X	X	
Dragonfly Monitoring	X	X						X	X	
Breeding Bird Monitoring	X	X			X	X	X	X	X	
Snake Monitoring								X		
Acoustic Monitoring	X	X			X	X	X	X	X	X
Turtle Study	X							X		X
Light Pollution	X	X	X	X	X	X	X	X	X	X
Noise Pollution	X	X	X	X	X	X	X	X	X	X
Biodiversity	X	X	X	X	X	X	X	X	X	X
Flora	X	X		X	X	X	X			

* - refers to existing undeveloped green space, of varying floristic quality

5.0 Project Priorities

This report identifies many existing habitat issues and potential habitat projects at both general and specific scales, under a framework that focuses on preserving existing valuable natural resources, and on restoring species richness, in particular of extirpated and locally at risk fish and wildlife species (SLCI), and quality native plant communities. This has provided a menu of project goals to select from. Project implementation however does not materialize solely based on ecological values or the needs of SLCI. Human desires and social priorities play an equal or greater role in determining what habitat projects are feasible, as humans are part of the system and their needs must be integrated into long term planning as well. In an urban community different social groups often have competing visions for land use and recreation, which must be balanced. As noted in Section 2, *Social Constraints* are very flexible based on human desire to prioritize resources, but if they are used to override or compromise the *Biological Constraints*, then projects addressing fish and wildlife or plant community habitat restoration and enhancement may not be feasible. *Social Constraints* are fickle, and frequently change upon changes in land ownership, the economy, or community social attitudes. Therefore *Social Constraints* are unpredictable over time, and must be negotiated as project opportunities arise.

Prioritizing habitat projects requires addressing both *Biological* and *Social* constraints and opportunities, in particular landowner approval (which is often balanced against other desirable land uses) and funding support. Most habitat projects are therefore opportunity driven, scheduled when landowners are willing, and when funding becomes available or projects can be piggybacked on other funded initiatives (such as recreational trails or contaminant remediation). This necessitates the development of broad habitat objectives, with specifics determined in the project design phase. Specific project designs will be addressed when feasibility is in place, and will include details on exact project limits, grading and planting plans, permitting, management plans, and partner responsibilities in perpetuity. This plan provides broad conceptual goals, many site specific project ideas, and a menu of projects that can be developed to a design stage.

The highest global priority is improving native plant communities, to set the stage for more specific projects that address critical habitat needs of the SLCI discussed below, and to enhance the Greenway as migratory stopover habitat. The plant community goals are to control invasive species, and to restore diverse native plant communities to the extent practical. Each project site should select plant community goals appropriate for the site soil types. In most of the Greenway this goal will be Southern Mesic Forest and Floodplain Forest (after Epstein et al. 2017), but several areas have been identified where Shrub-Carr, Ephemeral Pond, Mesic Prairie, Wet Prairie, Southern Sedge Meadow, and Surrogate Savanna communities are desired (see Section 4 and Table 6). To the extent practical, all forest edges should be “feathered” with native shrub transition zones to support shrubland and migratory birds. Plantings supporting pollinators should also be considered to replace mowed grass wherever feasible, such as along trails.

This study identified sixty-one fish and wildlife SLCI from the Greenway including twelve state or federally listed species (Table 2). For habitat planning, priority should be given to any sites supporting SLCI, especially those that are state or federally listed species, and to preserving rare plant communities.

Of the twelve listed species, one is the Northern Leopard Frog. The only records for this species are from Lincoln Park and the Estabrook Park lagoon (Casper et al. 2018b). Vagrants also are occasionally found, believed to be either released or dispersing individuals (i.e., in the Urban Ecology Center entrance pond). The new ephemeral pond at the Urban Ecology Center may also be able to support this species and repatriation is recommended there as a priority project (through egg mass translocation). Monitoring for Northern Leopard Frog at Lincoln Park and the Estabrook Park lagoon is also recommended via acoustic surveys and egg searches, with further enhancement measures considered after monitoring results are analyzed.

Regionally rare frogs in the Greenway are Gray Treefrog and Boreal Chorus Frog, both of which are very rare AOC-wide, and may be supportable within the Greenway. Currently there are no known breeding populations, but there is potential to repatriate these species where ephemeral wetlands exist within natural habitat matrices. Recommended priority sites for repatriation are the Lincoln Park northwest woods ephemeral pond (contingent upon lengthening the hydroperiod), Lincoln Park Mott island (if an ephemeral pond is created), ephemeral wetlands north of the Estabrook Park lagoon, and at Riverside Park in the new Urban Ecology Center ephemeral pond. If a semi-permanent pond can be created as part of the restoration plan for the future contaminant removal in the floodplain north of North Ave., this may also have potential for supporting these species. Likewise any newly created ephemeral ponds elsewhere in the Greenway may be candidates.

There are no state or federally listed salamander species in the Greenway, but all salamanders are severely impaired AOC-wide. No populations currently exist within the Greenway, and repatriation potential is questionable due to small habitat patch sizes, poor duff development, and poor soil conditions. However, the sites identified as potentially supporting Gray Treefrog and Boreal Chorus Frog may also support Blue-spotted Salamander, which could be included in any repatriation projects pursued. Habitat conditions for the wholly aquatic Common Mudpuppy are also questionable (poor water quality, low oxygen levels, high water temperatures), but if cool, well oxygenated, deep pools can be created in-stream repatriation of this species may be worth attempting. The most likely sites are the new shoal below North Ave., any deep pools that could be created in Lincoln or Estabrook parks, and the old quarry in the Glendale Industrial park.

Four listed species are bats – the State Threatened Big Brown Bat and Little Brown Bat, and Special Concern Silver-haired Bat. The Greenway also supplies migratory stopover habitat for these species and the State and Federal Threatened Species Northern Long-eared Myotis. All of these bats may be present within the Greenway during migration, but only Big Brown Bat is likely to breed within the Greenway (Casper and Niemiller 2018). Global habitat measures to benefit all species are incorporated into site project recommendations, including increasing native plant diversity and improving water quality to support more insect food for bats, and retaining and enhancing mature trees with cavities, large leaves,

and loose bark as roosting and shelter sites. Additional global measures to benefit bats are addressing light pollution and providing bat houses. Big Brown Bat is recommended as a Focal Species, and habitat measures for it will also provide potential for Little Brown Bat and Silver-haired Bat to establish. The habitat goal is deciduous woodlands, where bats will forage in forest gaps, along edge habitat, and in riparian habitat. Big Brown Bat forms maternity colonies in buildings, bat houses and rock crevices. It hibernates in buildings, culverts, basements, caves or abandoned mines. A community outreach program might identify existing roosts and areas where socially acceptable roost structures are needed. The priority areas where bat habitat measures are recommended, and where monitoring for bats to demonstrate successful breeding and persistence is needed, are the larger woodland patches in Lincoln Park, Estabrook Park, Pleasant Valley/Kern Park, and Riverside Park. The recommended acoustic survey methods can quantify measures of bat activity and provide putative species lists for both maternal and migratory seasons, mist netting should also be considered to verify species in-hand where high activity levels are found.

Four listed species are breeding birds – Peregrine Falcon (Endangered), Red-headed Woodpecker (Special Concern), Red-shouldered Hawk (Threatened), and Vesper Sparrow (Special Concern). Of these, Red-shouldered Hawk and Vesper Sparrow records are considered to be non-breeding records, and they are unlikely to be supported within the Greenway. Peregrine Falcon populations are managed by the Wisconsin Peregrine Project, with nest structures on buildings, and no actions specific to this species are recommended within the Greenway. Red-headed Woodpecker has potential to breed in surrogate savanna habitats, mainly at Lincoln, Riverside and Estabrook parks. The management action for attracting Red-headed Woodpecker is to retain and enhance dead snags (where there are no public safety concerns) and mature hardwood trees with cavities in the open space picnic and recreation areas. Breeding bird surveys should include these habitats in order to measure success.

Other breeding bird species that are regionally rare and supportable within the Greenway can be best viewed as habitat guilds for habitat management purposes, as described by Casper et al. (2018c). From this perspective, assume that breeding birds will routinely colonize suitable habitats (an assumption supported by monitoring research). In the Greenway, the Urban guild will be the most supportable breeding bird assemblage, followed by Forest, Shrub, Wetland, Airspace, and Grassland guilds. The major constraints on Forest and Grassland guilds are habitat patch size. Only a few Forest guild species are expected to be supported in the larger forest patches (i.e. American Redstart), and no obligate Grassland species. Shrub guild species such as Brown Thrasher and Willow Flycatcher, and Urban and Airspace guild species such as Chimney Swift, are supportable. In sum, for birds the habitat recommendation is mostly to improve plant communities and habitat patch sizes, and forage opportunities (fruits, insects), and birds will then occupy sites. Enhancing tree cavities and establishing bird houses or other nesting structures will also add value (i.e. Chimney Swift, Tree Swallow).

Only one listed fish has been identified in the Greenway (Lake Sturgeon, Special Concern, and likely not breeding). However, many regionally rare species can potentially be supported such as Black Crappie, Bluegill, Channel Catfish, Greater Redhorse, Pumpkinseed, Smallmouth Bass, and Walleye. In the Greenway actions to enhance fish communities are to improve water quality (i.e., addressing road runoff, contaminated sediments, etc.), provide in-stream habitat structure, and regularly monitor.

Where improvements are realized, repatriations may be necessary to establish new populations. Most of these actions will be under the purview of Wisconsin DNR, where the Greenway Coalition can provide a supporting role.

No mammal species (except bats discussed above) are priorities for specific habitat actions in the Greenway except the Eastern Fox Squirrel and Southern Flying Squirrel. All other regionally rare mammal species will benefit from broader habitat improvements. Actions to enhance and repatriate Eastern Fox Squirrel and Southern Flying Squirrel on specific sites are discussed in Section 4, with recommendations for establishing populations in Lincoln Park, Estabrook Park, Riverside Park, Pleasant Valley/Kern Park, and Koenen Nature Preserve. An outreach program to area residents is also recommended for Southern Flying Squirrel as a nighttime feeder watch program, to potentially identify additional populations and garner public support for the species.

An information need is identified for shrews, which possibly are rare in the Greenway. However, more survey work is needed to assess the status of shrews before any management actions can be assessed.

Several social outreach actions regarding mammals are also important for realizing Greenway habitat goals. Education for the public on the role of Coyotes in improving the ecology is needed, especially to dispel safety concerns. Education on pest species, particularly White-tailed Deer for their role in damaging plant communities, and feral cats as predators impacting birds, is also needed with a goal of changing public attitudes and behaviors to support controlling these species.

Two listed mussel species are known from the Greenway, Elktoe (Special Concern) and Ellipse (Threatened), as well as the regionally rare Spike. Restoring mussel communities will be dependent upon water quality improvements. Greenway actions to enhance mussel communities are to improve water quality and regularly monitor. Where improvements are realized, repatriations may be necessary to establish new populations. Most of these actions will be under the purview of Wisconsin DNR, where the Greenway Coalition can provide a supporting role.

Snakes are an exceptionally impaired group AOC-wide, and one species in the Greenway is Special Concern (Butler's Gartersnake). The Greenway currently supports a high priority population of this species in the heart of Milwaukee, which should be preserved and enhanced. This population is concentrated in floodplain and upland grassy areas, especially the North Ave. floodplain, the Glendale Industrial Park, and Lincoln Park. These should be high priority snake habitat areas, to support Butler's Gartersnake, Northern Brownsnake, and Common Gartersnake. An upcoming challenge will be the contaminant remediation to take place sometime in the future in the North Ave. floodplain. It will be important to develop a plan for the snake population to survive the earth moving, and then recover. This plan should preserve snake habitat on the east bank as a refuge, temporarily suspend existing reforestation plans on the east bank, and ensure that the post-construction restoration plan establishes suitable snake habitat and a monitoring plan.

Additionally, repatriations for Eastern Milksnake and Northern Watersnake may be considered at Lincoln Park, Estabrook Park, and the Glendale Industrial Park.

No turtles are state or federally listed in the Greenway, and the Greenway currently supports a robust turtle assemblage of five species: Painted Turtle, Snapping Turtle, Spiny Softshell, Northern Map Turtle, and Red-eared Slider. Populations appear to be stable but monitoring data are needed, and nesting areas need to be identified. Recommendations are made for creating nesting habitat near the old North Ave. dam, and in Lincoln Park. Additionally, radio telemetry studies are recommended to identify important foraging and habitat areas, and basking structures at Turtle Park.

Finally, the Greenway is an important migratory stopover habitat, the maintenance and enhancement of this habitat service is recommended as a global habitat goal. Measures to enhance habitat for providing food and shelter to migrants include providing abundant native food plants, enhancing insect populations by improving plant community quality, and providing shelter habitats such as shrubs and large trees. Mitigating light pollution is also very important to migrants, especially replacing blue spectrum lighting with warm spectrum lighting, shielding lights, and managing on times and intensity. An outreach program to businesses, residents, and municipalities is recommended to promote Dark Sky standards for street, commercial, and residential lighting (http://www.darkskysociety.org/).

5.1 Priority Projects

Nineteen projects were selected as high priorities for this initial Habitat Plan. These are listed in Table 6. Coalition members may select projects from Table 6 and form partnerships to advance project design. Additional projects may be parsed from Section 4 site discussions.

For each project, a team with appropriate expertise will need to be formed to produce a project design, obtain landowner approvals, obtain funding, obtain permits, and implement the project. The project design phase often requires specialized expertise in the particular Focal Species and plant communities to be addressed, and the implementation phase typically requires botanical surveys, planting lists, soil and topography investigations, wildlife surveys, and work crews. Successful project teams will ensure that adequate professional expertise and experience is available to complete the project design and implementation.

Monitoring (addressed in the next section) should be integrated into project design plans. Monitoring study designs should be developed as part of the project design phase, and should include measures of success. For example, if a project intends to create a particular habitat type to support particular Focal Species, metrics such as pond hydroperiod, Focal Species presence and reproductive success, and native plant community FQI scores, should be identified in the project plan. The survey methods should be detailed using detection probability based methods, and/or evidence of successful reproduction metrics. Catch per unit effort, or relative abundance, estimates alone are not acceptable as they often give inaccurate estimates without detection probabilities known. The AOC chapters provide additional detail and recommendations on survey methods and metrics for success that can be adopted for Greenway projects.

Table 6. Priority Projects.

Project	Name	Priority	Location	Actions	Focal Species	Target Plant Communities
1	NW Woods habitat enhancements	1	Lincoln Park, northwest woods	Lengthen hydroperiod of ephemeral pond and establish sedge community. Repatriate Blue-spotted Salamander, Gray Treefrog, and Digger Crayfish. Remove invasive shrubs. Plant appropriate trees, shrubs, and forbs. Perform botanical survey and calculate FQI before work begins; repeat every 3-5 years post-planting for adaptive management feedback. Establish bat and bird houses. Set up a permanent acoustic monitoring stations for breeding birds, and maternal and migratory bats. Monitor for crayfish and amphibians post-repatriation.	Digger Crayfish, Blue-spotted Salamander, Gray Treefrog, American Mink, Coyote, weasels, all bats, American Redstart, American Woodcock, Wood Thrush, Black-billed Cuckoo, Black-crowned Night Heron, Least Flycatcher	Southern Mesic Forest, Floodplain Forest, Shrub-Carr, Ephemeral Pond
2	Mott Is. habitat enhancements	2	Lincoln Park, Mott Island	Scrape an ephemeral pond at south edge of woods. Repatriate Chorus Frog and Prairie Crayfish. Remove invasive shrubs. Plant appropriate trees, shrubs, and forbs (maintain forest in north half, prairie in south half). Perform botanical survey and calculate FQI before work begins; repeat every 3-5 years post-planting for adaptive management feedback. Establish bat and bird houses. Set up permanent acoustic monitoring stations for maternal and migratory bats. Monitor for crayfish and amphibians post-repatriation.	Prairie Crayfish, Boreal Chorus Frog, Northern Leopard Frog, Butler's Gartersnake, Common Gartersnake, American Woodcock, Black-billed Cuckoo, Black-crowned Night Heron, Brown Thrasher, Great Blue Heron, Great Egret, Willow Flycatcher, Wood Thrush, Yellow-billed Cuckoo, American Mink, Coyote, North American River Otter, weasels, all bats	Southern Mesic Forest, Floodplain Forest, Shrub-Carr, Ephemeral Pond Mesic Prairie, Wet Prairie, Southern Sedge Meadow
3	Movement corridor	3	Lincoln Park	Remove rip rap under two bridges, replace with natural shoreline.	NA	NA

Table 6. Priority Projects.

Project	Name	Priority	Location	Actions	Focal Species	Target Plant Communities
4	Turtle nesting site	2	Lincoln Park, Mott Island or the shoreline due south of it	Establish a protected turtle nesting site with predator exclusion fencing. Establish monitoring program.	Eastern Spiny Softshell, Northern Map Turtle	NA
5	Light pollution remediation	2	Lincoln Park	Map and mitigate light pollution through street lighting ordinance and landowner outreach.	All frogs, bats, and nocturnal mammals and birds.	NA
6	Savanna habitat enhancements	3	Lincoln Park golf course or picnic areas	Plant more mast and cavity forming trees and repatriate Eastern Fox Squirrel in golf course or picnic areas.	Eastern Fox Squirrel, Gray Fox, Red-headed Woodpecker	Surrogate Savanna
7	Estabrook Park habitat enhancements	2	Estabrook Park riparian forest (Barloga Site 7)	Remove invasive shrubs. Preserve and plant appropriate trees, shrubs, and forbs (see Barloga plant list for 15 species with high CC values to preserve). Perform botanical survey and calculate FQI before work begins; repeat every 3-5 years post-planting for adaptive management feedback. Establish bird and bat houses, including artificial roosting sites for bats under bridges.	American Redstart, American Mink, North American River Otter, weasels, all bats, Eastern Fox Squirrel, Black-billed Cuckoo, Brown Thrasher, Willow Flycatcher, Yellow-billed Cuckoo	Southern Mesic Forest, Floodplain Forest, Shrub-Carr
8	Light pollution remediation	2	Estabrook Park	Map and mitigate light pollution through street lighting ordinance and landowner outreach.	All frogs, bats, and nocturnal mammals and birds.	NA
9	Movement corridor	3	Estabrook Park	Remove rip rap under Port Washington Rd. bridge, replace with natural shoreline.	NA	NA
10	Wildlife Shelters	2	Glendale Industrial Park	Establish Common Nighthawk and/or Chimney Swift nesting structures atop commercial buildings. Monitor for success.	Common Nighthawk, Chimney Swift	Urban

Table 6. Priority Projects.

Project	Name	Priority	Location	Actions	Focal Species	Target Plant Communities
11	Light pollution remediation	1	Glendale Industrial Park, UWM parking lot	Map and mitigate light pollution through street lighting ordinance and landowner outreach.	All frogs, bats, and nocturnal mammals and birds.	NA
12	Mid-East bank habitat enhancements	1	East bank from Capitol to Locust: Hubbard Park, Cambridge Woods	Remove invasive shrubs. Replace dying ash with native hardwood forest trees. Plant appropriate trees, shrubs, and forbs. Expand forest patch size where feasible. Perform botanical survey and calculate FQI before work begins; repeat every 3-5 years post-planting for adaptive management feedback. Map, preserve, and enhance existing 23 plants with high CC values (from Barloga surveys). Establish bird, bat, and flying squirrel houses. Establish a permanent acoustic monitoring station for breeding birds and maternal and migratory bats. Repatriate Southern Flying Squirrel. Establish Common Nighthawk and/or Chimney Swift nesting structures atop commercial buildings.	American Redstart, Black-billed Cuckoo, Black-crowned Night Heron, Brown Thrasher, Chimney Swift, Common Nighthawk, Great Blue Heron, Great Egret, Least Flycatcher, Wood Thrush, Yellow-billed Cuckoo, American Mink, North American River Otter, Southern Flying Squirrel, weasels, all bats	Southern Dry-mesic Forest, Southern Mesic Forest, Floodplain Forest, Shrub-Carr

Table 6. Priority Projects.

Project	Name	Priority	Location	Actions	Focal Species	Target Plant Communities
13	Mid west bank habitat enhancements	2	West bank from Capitol to Locust: Kern Park, Pleasant Valley Park, Koenen Nature Preserve	Remove invasive shrubs. Replace dying ash with native hardwood forest trees. Plant appropriate trees, shrubs, and forbs. Expand forest patch size where feasible. Perform botanical survey and calculate FQI before work begins; repeat every 3-5 years post-planting for adaptive management feedback. Map, preserve, and enhance existing plants with high CC values (from Barloga surveys: False Rue Anemone, Long-beaked Sedge, Ninebark, and White Birch). Establish bird, bat, and flying squirrel houses. Establish a permanent acoustic monitoring station for breeding birds and maternal and migratory bats. Repatriate Southern Flying Squirrel. Establish Common Nighthawk and/or Chimney Swift nesting structures atop commercial buildings.	American Redstart, Black-billed Cuckoo, Black-crowned Night Heron, Brown Thrasher, Chimney Swift, Common Nighthawk, Great Blue Heron, Great Egret, Least Flycatcher, Wood Thrush, Yellow-billed Cuckoo, American Mink, North American River Otter, Southern Flying Squirrel, weasels, all bats	Southern Dry-mesic Forest, Southern Mesic Forest, Floodplain Forest, Shrub-Carr

Table 6. Priority Projects.

Project	Name	Priority	Location	Actions	Focal Species	Target Plant Communities
14	Snake habitat	1	Grassland habitats between old North Ave. dam and Locust St.: parkway, Arboretum, and Gordon Park	Preserve, maintain, and enhance grassland habitat for snakes. Increase plant diversity and control invasive species. After contaminant remediation, restore habitat including new ephemeral wetland scrape and denning sites (snakes are currently using sink holes). Repatriate Chorus Frog and Prairie Crayfish post-remediation and restoration. Consider revising Callaghan et al. (2015) plan to preserve grassland snake habitat on the east bank as a temporary snake refuge, and delay any further reforestation until after contaminant remediation is completed and west bank habitat is restored and again occupied by snakes. Monitor snakes and repatriated crayfish and amphibians.	Prairie Crayfish, Boreal Chorus Frog, Green Frog, Northern Leopard Frog, Butler's Gartersnake, Common Gartersnake, Northern Brownsnake, American Mink, weasels, all bats, American Woodcock, Field Sparrow, Willow Flycatcher	Wet-mesic Prairie, Wet Prairie, Emergent Marsh, Shrub-Carr
15	Turtle nesting site	2	Milwaukee Rotary Centennial Arboretum	Establish a protected turtle nesting site with predator exclusion fencing. Establish monitoring program.	Eastern Spiny Softshell, Northern Map Turtle	NA
16	Turtle Park habitat enhancements	2	Turtle Park	Establish a protected turtle nesting site with predator exclusion fencing and a monitoring program. Place turtle basking structures in-stream. Establish bat and bird houses.	Eastern Spiny Softshell, Northern Map Turtle, bats	NA

Table 6. Priority Projects.

Project	Name	Priority	Location	Actions	Focal Species	Target Plant Communities
17	Arboretum habitat enhancements	2	East bank from Locust St. to Caesar Park: Riverside Park, Milwaukee Rotary Centennial Arboretum	Implement the Urban Ecology Center Urban Forestry Strategic and Management Plan (with revision as noted for snake habitat above). Repatriate Blue-spotted Salamander, Gray Treefrog, Northern Leopard Frog, and Boreal Chorus Frog into the new ephemeral pond. Establish permanent acoustic monitoring stations for bats, frogs, and breeding birds at the ephemeral pond. Establish Common Nighthawk and/or Chimney Swift nesting structures atop commercial buildings. Establish bat, bird, and flying squirrel houses. Establish monitoring programs, including acoustic stations, meeting Greenway standards.	Blue-spotted Salamander, Boreal Chorus Frog, Gray Treefrog, Green Frog, Northern Leopard Frog, Butler's Gartersnake, Common Gartersnake, Northern Brownsnake, Eastern Spiny Softshell, Northern Map Turtle, American Redstart, American Woodcock, Black-billed Cuckoo, Black-crowned Night Heron, Brown Thrasher, Carolina Wren, Chimney Swift, Common Nighthawk, Field Sparrow, Great Blue Heron, Great Egret, Peregrine Falcon, Willow Flycatcher, Wood Thrush, Yellow-billed Cuckoo, American Mink, Southern Flying Squirrel, weasels, all bats	see Callaghan et al. 2015 plan

Table 6. Priority Projects.

Project	Name	Priority	Location	Actions	Focal Species	Target Plant Communities
18	South west bank habitat enhancements	2	West bank from Locust to Turtle Park: Gordan Park, parkway	Remove invasive shrubs. Replace dying ash with native hardwood forest trees. Plant appropriate trees, shrubs, and forbs. Expand forest patch size where feasible. Perform botanical survey and calculate FQI before work begins; repeat every 3-5 years post-planting for adaptive management feedback. Map, preserve, and enhance 3 existing plants with high CC values (from Barloga surveys: Balm of Gilead, Red Oak, and Early Meadow Rue). Establish bird, bat, and flying squirrel houses. Establish a permanent acoustic monitoring station for breeding birds and maternal and migratory bats. Repatriate Southern Flying Squirrel. Establish Common Nighthawk and/or Chimney Swift nesting structures atop commercial buildings. Coordinate with snake habitat and Turtle Park habitat projects above. Establish monitoring programs.	Northern Leopard Frog, Butler's Gartersnake, Common Gartersnake, Northern Brownsnake, Eastern Spiny Softshell, Northern Map Turtle, American Redstart, American Woodcock, Black-billed Cuckoo, Black-crowned Night Heron, Brown Thrasher, Carolina Wren, Chimney Swift, Common Nighthawk, Field Sparrow, Great Blue Heron, Great Egret, Peregrine Falcon, Willow Flycatcher, Wood Thrush, Yellow-billed Cuckoo, American Mink, Southern Flying Squirrel, weasels, all bats	Southern Dry-mesic Forest, Southern Mesic Forest, Floodplain Forest, Shrub-Carr, Wet-mesic Prairie, Wet Prairie, Emergent Marsh, Shrub-Carr
19	Trails	1	Entire Greenway	Establish a designated trail system avoiding sensitive plant communities.	NA	NA

6. Long-term Monitoring

This section addresses Objective 4 in the Master Plan – Create and implements a framework for *long-term monitoring and adaptive management* of plant and animal communities.

Long-term monitoring will measure the success of habitat projects and long-term health of the Greenway ecosystem, by collecting meaningful metrics on species occupancy and population status, reproduction, and trends in these metrics over time. Such monitoring differs from surveys with the objective of outdoor education and outreach (Objective 5 in the Master Plan – see section 5.12). Monitoring programs should employ rigorous study designs to track metrics of success, produce data having statistical significance, and provide a documented record of empirical evidence that can be independently examined. Recommendations are made here on metrics and methods for each taxonomic group (summarized in Table 5), and where feasible on monitoring locations. Program proposals should address initial selection of sampling sites and refine methods as appropriate to meet monitoring objectives. A central data repository is recommended that standardizes methods and data management so that Greenway-wide data can be aggregated, kept current, and periodically analyzed.

It is important to differentiate *inventory* from *monitoring* activities, as both use identical survey methods. The purpose of *inventory* surveys is to catalog the species or populations present – this is the discovery phase to understand the community sampled. The purpose of *monitoring* surveys is to track changes (trends) in the species or populations present – this is the stewardship phase to understand how the community is changing in response to management actions and other factors (i.e., climate change). Inventory data assist with developing project and stewardship plans, monitoring data are used in feedback loops to determine if stewardship actions are working and change them if warranted (i.e., adaptive management). *Note that some survey methods, such as minnow traps in ponds and mussel sampling in stream beds, are not meant to be conducted annually as they can damage sensitive habitats with repeated use.*

6.1 Mussels

Monitoring of mussels can track measures of species richness (site occupancy), and population size (counts), as well as the success of repatriation attempts. Measures of physical and chemical habitat quality parameters may also be useful, such as dissolved oxygen and temperature levels. Temperature constraint assessments may be a fairly efficient initial filter from which to select potential habitat enhancement goals (for assessment methodology see Seuront et al. 2018). Assessing the presence of host fishes should also be a prerequisite to any repatriation proposals (without host availability repatriations cannot succeed). Information on predator levels (especially Raccoon) may also be useful, which can be obtained through tracking or camera trap surveys. Surveys that document absence or low abundance in species may justify proposed recovery efforts to benefit species. Post-restoration surveys can then document recovery by demonstrating occupancy and increasing numbers and/or species richness over several years.

Casper and Dare (2013) provide baseline mussel count data for four sites within the Greenway. These were selected as areas with existing high mussel habitat suitability, so are well suited to monitor for detecting mussel declines, and the appearance of new species. Continued periodic monitoring of these beds is advised to track species occupancy and abundance trends. A fifth site near the North Avenue bridge may also be considered, where Jass and Glenn (2002) reported on species present after the dam was removed in 1990. Additionally, monitoring for potential re-establishment of mussels at the Estabrook Dam removal site may be considered. Study design should include at least three (better five) replicates of the Piette (2005) quantitative survey methodology at each site in each sampling year to allow for detection probability based population estimates. This would collect valuable data on abundance, age class structure, and recruitment, for tracking change. Mussel beds should not be disturbed annually, a sampling schedule every 3-5 years is recommended.

Since mussel surveys require specialized skills in identification, snorkeling, and in minimizing damage to mussels and their habitats, only qualified professionals should perform surveys. Mussel survivorship is affected by disturbance such as moving individuals around, or inadvertent trampling. Collection of voucher specimens and photographs to allow for confirmation of any questionable records and documentation of habitat changes is also recommended. Mussel inventory or monitoring should utilize consistent sampling methods and, to the extent possible, consistent experienced personnel. This should maximize data consistency and allow for periodic re-assessment of the conservation status of mussel species in the system.

Attempting to recover mussel populations in an urban environment will be challenging (Gillis et al. 2017). In the Greenway, however, water quality improvements and captive propagation programs can significantly contribute to recovery. Note that water quality, temperature constraints, and contaminated sediment issues will be continuing constraints on success. Goals should be to establish viable reproducing populations that persist at least five years as documented through quantifiable, detection probability based, population monitoring.

6.2 Dragonflies and Damselflies

This group is poorly known and an initial checklist has only recently been developed (Rutherford 2012, Casper and Rutherford 2018). Monitoring should build upon these existing baseline data, and share data with the Wisconsin Odonata Survey (WOS) which contributes additional presence-only records (see Section 5). While Greenway and WOS studies have focused on adult stage surveys, surveys for exuvia (cast exoskeletons left upon transformation of aquatic nymphs to adults) also show great promise (Bried et al. 2015), but require a fair level of expertise to handle and identify the ephemeral and fragile exuvia, and precise timing of surveys for success.

Better use could also be made of existing information in museum collections, much of which remains relatively inaccessible. Surveys should routinely collect specimen vouchers, as photographic vouchers have short life spans (subject to changing digital technology and equipment failures), and often lack details necessary for positive identification (i.e., genitalia). Specimen vouchers provide significantly more information and can last a century or more (Graeter et al. 2013).

It is also important in designing inventory and monitoring programs to collect metrics that represent the local habitat conditions. All Odonata have aquatic nymphs and terrestrial adults. As a consequence, their use as indicators of ecosystem health or as umbrella species in conservation plans may be misleading if data from a particular life stage does not reflect actual residency at a freshwater site. Patten et al. (2015) found that adult Odonata occupy many more sites than those at which the species breeds, and suggest that surveys of adults, which are relatively easy because of organized efforts to encourage observations by community (citizen) scientists, can paint a misleadingly broad picture of a species' ecological niche. They recommend that evidence of breeding, especially presence of tenerals or exuviae, be used to outline ecological requirements when questions of conservation or population monitoring arise. In this regard exuvia surveys, and observations of ovipositing adults, would convey the most useful information for local habitat assessments.

For Greenway objectives, selection of a number of sites for long term monitoring of aquatic Odonata habitat stages (larvae or exuvia) is recommended, representing differing aquatic habitat types (i.e., emergent wetland, several stream sizes and substrates, ponds). Professional surveys can then provide metrics on species richness and abundance to track trends over time. Meanwhile, community (citizen) science surveys of adult stages should continue per WSO program recommendations throughout the Greenway, but with specimen vouchers taken for any new species encountered. Over time, as the Odonata diversity of the Greenway becomes better known, "sensitive" species might be identified whose presence indicates some standard of water or habitat quality, and some percentage of these species presence be used to assess impairment, an approach used by the Index of Biotic Integrity concept (Kutcher and Bried 2014, MPCA 2014, Valente-Neto et al. 2016).

6.3 Primary Burrowing Crayfish

If established, primary burrowing crayfish can be effectively sampled by use of aquatic funnel traps to provide metrics on occupancy trends and reproduction (Casper et al. 2018).

6.4 Fishes

Periodic fish surveys conducted by Wisconsin DNR should be sufficient to monitor overall trends in fish populations in the lower Milwaukee River if detection probability based study designs are developed. However, if fish SLCI repatriations are pursued a monitoring protocol should be developed to measure success with metrics on occupancy and reproduction to track persistence of any reintroduced populations.

6.5 Amphibians and Reptiles

Herptile response to habitat and population projects can be monitored through a variety of methods (for details see Heyer et al. 1994, Graeter et al. 2013, Casper et al. 2018b). Methods for these groups are well developed but feasibility (cost and labor) is often problematic. Surveys should be designed to meet sample size requirements to achieve confidence in detection, with goals being tracking occupancy and reproduction over time. Most survey methods require experienced professional personnel.

Caution! Many herptile monitoring methods have the potential to harm the species they are intended to assist, by damaging habitats, causing stress and mortality in the animals, or through aiding and abetting poaching. This is especially so in urban environments where populations are typically already stressed. It is never a good idea to widely publicize effective methods for capturing animals that have appeal as pets, that have market value, or for which there is low social tolerance. Therefore caution is advised against the widespread adoption of any programs that involve in-hand capture, including community (citizen) science programs. It is more appropriate to utilize experienced and credentialed herpetologists for most field surveys, and refrain from publicizing capture methods.

For salamanders, egg searches are the preferred method (sometimes supplemented with aquatic funnel traps and/or dipnet surveys), and may be used to track occupancy and reproduction if populations become established in any created ephemeral ponds in the Greenway. Common Mudpuppy, if reestablished, can be monitored by winter trapping and dipnet surveys.

For frogs and toads, automated acoustic surveys are recommended following the National Park Service protocol (Casper et al. 2018a), for both inventory and long-term monitoring. The Greenway could become part of an acoustic monitoring hub to track regional trends by establishing permanent monitoring sites. Traditional call surveys may also be utilized by outdoor education programs to provide additional presence-only data at other sites (preferably via HerpMapper.org). Supplemental shoreline searches, aquatic funnel trapping, and larval dipnet searches may also be considered, but potential habitat damage is an issue and these activities should be restricted to professional surveyors. Where sufficient, data collected can be utilized for detection probability based occupancy modeling.

For most snakes in the Greenway monitoring can be accomplished by cover object surveys designed to record reproductive metrics (age classes present). Mark-recapture surveys are not recommended due to the large effort and cost required, potential harm to individual snakes, and expected habitat damage and poaching concerns. Additional genetic analyses may also be considered to assist with settling taxonomic questions and measuring genetic diversity retained. Data from volunteer visual observations may also be utilized if submitted through HerpMapper.org. If Northern Watersnake reintroduction is considered, visual surveys are the appropriate monitoring method.

For turtles, visual surveys and public outreach programs may be used during the nesting season to find nesting areas. Aquatic trapping could be considered for additional inventory or population studies, but security and stream flashiness issues make this technique very uncertain in the Greenway. Radio tracking with geolocating, as well as visual searches, should also be considered to find nesting areas and to better delineate critical habitat areas such as hibernating and foraging sites.

Acoustic data analyses are a powerful monitoring tool.

6.6 Breeding Birds

Monitoring of breeding birds can inform the success of individual habitat and population projects, to assess habitat "trap" affects, and to provide metrics tracking species richness and population change. Metrics should include measures of species richness (site occupancy) and reproductive success. For monitoring two separate methods should be employed, and permanent stations selected to represent Greenway habitat types. Temporary stations may also be established for the purpose of monitoring response to specific habitat projects.

Standard 10-minute point counts will record all breeding birds seen or heard, numbers, and reproductive indicators (i.e., fledglings, nests). The protocol should include 8–9 replicates following all survey conditions for time of year, time of day, weather, and spacing between points. The Wisconsin Breeding Bird Atlas protocol for documenting levels of confidence in breeding should also be incorporated into a Greenway point count protocol (Anich et al. 2015). Surveys should be conducted by trained experts certified in visual and acoustic bird identification. The number of replicates recommended is sufficient to detect most common bird species if present, but detection probability will vary with abundance, therefore all replicates should be completed and data analyses should utilize detection probability based occupancy models.

Secondly, establishing permanent acoustic monitoring stations is recommended using automated acoustic recording systems. These affordable systems obtain large sample sizes and greatly increase detection rates and confidence in results for acoustically detectable species. They detect up to twice as many species as point counts, and are especially good at detecting rare species and night calling species. Equipment at a single location can be dual purposed to acoustically sample for both frogs and breeding birds for added efficiency (as currently practiced by the Mequon Nature Preserve, the Ozaukee Washington Land Trust, and the Mississippi National River and Recreation Area). A methodological protocol is available (GSC unpublished). The Greenway may become part of an acoustic monitoring hub to track regional trends in breeding birds.

6.7 Migrant Birds, Bats, and Insect

Migrant use of stopover habitat is highly weather dependent. Migrant bird numbers and diversity can be monitored with point counts if conducted on a regular basis (several times a week), and bat species richness and activity levels should be monitored with acoustic surveys set for 10 weeks in fall (Robson and Casper 2018, Casper and Niemiller 2018). Selection of monitoring stations should represent Greenway habitat types. Temporary stations may also be established for the purpose of monitoring response to specific habitat projects. Programs for monitoring migrant butterflies and dragonflies may also become available but are not currently developed. A bird banding program may also be considered, with blood or feather analysis for measures of health tied to stopover habitat quality.

6.8 Mammals (excluding bats)

The most feasible methods for monitoring mammals in the Greenway are winter track surveys and camera traps – see Casper et al. (2018e) for discussion. However security issues are a concern for camera surveys in the Greenway.

6.9 Resident Bats

Resident bats are easily monitored by ultrasonic acoustic systems, which return metrics on measures of bat activity and species richness (Casper and Niemiller 2018). Surveys should be run for a minimum of 10 nights (sunset to sunrise) per station per year during the maternity season (June–July). For rare species acoustic detections should be verified by in-hand confirmation through mist netting. Selection of monitoring stations should represent Greenway habitat types. Temporary stations may also be established for the purpose of monitoring response to specific habitat projects. The Greenway may contribute to a regional goal of establishing thirty permanent acoustic stations in the Greater Milwaukee Area to monitor regional trends. A mist netting program may also be considered to provide in-hand verifications of rare species presence, and collect data on bat health and reproduction. Traveling surveys (such as the Wisconsin DNR program) typically under-sample, and may contribute additional data points but cannot be used to monitor trends. Traveling surveys can also contribute to Objective 5 by engaging the public, and results can expand coverage within the Greenway with presence-only data.

6.10 Plants and Other Animals

The development of monitoring programs for plants, and other animals such as insects, should be considered as feasible, affordable, and scientifically sound methods become available. In particular, rigorous and documented rare plant surveys are a need within the Greenway, and existing transect or quadrat plant survey protocols can be utilized for assessing the success of habitat projects to measure species richness and abundance pre- and post- management. The Bernthal et al. (2003) protocol for plant inventories is recommended for calculation of FQI scores. For additional references see Elzinga et al. (1998) for plants, and the North American Butterfly Association (https://naba.org/monitoring.html) for butterflies. A lichen monitoring protocol is also under development for consideration in the Greenway (https://elonpreview.weebly.com/).

6.11 Noise and Light Pollution

Methods for monitoring of noise and light pollution need to be developed, utilizing automated continuous metering of lumens and spectrum (light), and decibels and frequencies (sound). A number of automated loggers are available, and development of a protocol for inventory and monitoring of the soundscape and light levels is recommended.

6.12 Community (Citizen) Science Programs

As noted elsewhere, Objective 5 of the Master Plan addresses increasing the ecological literacy of the public through educational components, which connect people to nature by finding plants and animals. While these programs often lack hypothesis driven study designs, they can be useful for collecting baseline and presence-only data. Community science programs should be viewed as supplementary to, and not a substitute for, professional surveys which will provide the needed statistical rigor to answer important questions about progress towards goals selected for Greenway projects addressing habitat and wildlife population restorations. Volunteers can however contribute species occurrence records which may be followed up on by the research community. The Greenway is fortunate in having as a coalition member the Urban Ecology Center, which has a nationwide reputation for excellence in engaging the public through community science, and has the capacity to pursue these programs within the Greenway. The following guidelines are recommended for how these programs can best contribute to inventory and monitoring goals.

1) *First Do No Harm*. This guideline is to encourage program administrators to pause and ask if sending groups of people into sensitive habitats can be destructive (such as by trampling mussels or vegetation, or eroding shorelines), or if disturbance to sensitive wildlife can harm the animals (such as by leading to nest abandonment, or increased predation). Leave these sensitive environments and animals to professional surveyors.
2) *Use existing programs*. No need to re-invent the wheel, or add to an already unwieldy collection of non-standardized data sources. Instead, research and use existing programs. Highly rated for ease of use and data accessibility are: HerpMapper (www.herpmapper.org), iNaturalist (www.inaturalist.org), and eBird (ebird.org/home). Wisconsin DNR also provides some useful programs such as the Wisconsin Odonata Survey. Make sure that the selected programs adequately address Greenway goals. Volunteers will need training on use of these programs to best inform Greenway goals, especially as regards understanding target species and data quality issues.
3) *Ensure that data collected are useful and accessible to the research and management community*. This normally requires that programs be discoverable (i.e., appear in search engines), and that data are placed in well-known public repositories that allow for independent verification (i.e., public museums), or are published. This goal is best achieved by utilizing existing curated online resources to archive data, and by training volunteers appropriately to contribute complete data, including specific locality details and diagnostic photographs or audio recordings where possible.

Table 7. Monitoring Recommendations.

	Metrics	Methods
Mussels	species richness (site occupancy), population size (counts)	Select permanent monitoring stations. Conduct 3-5 replicates of Piette (2005) quantitative survey per site per sampling year. Monitoring of water quality parameters also important (temperature, dissolved oxygen).
Dragonflies and Damselflies	species richness (site occupancy), population size (exuvia counts)	Select permanent monitoring stations and develop a monitoring study design addressing the survey frequency needed to track metrics. Professionally survey for adults and exuvia at permanent monitoring stations to track metrics. Continue volunteer WOS surveys of adults for building species checklist.
Primary Burrowing Crayfish	species richness (site occupancy) and evidence of reproduction	Funnel traps per Casper et al. (2018). Note this group is currently absent from the Greenway.
Fishes	Rely on DNR surveys unless repatriations pursued	Rely on DNR surveys unless repatriations pursued.
Amphibians and Reptiles	species richness (site occupancy) and evidence of reproduction	Utilize a variety of methods including acoustic, trapping, and visual surveys (for details see Heyer et al. 1994, Graeter et al. 2013, Casper et al. 2018a). Community science programs can contribute some presence-only data (via HerpMapper).
Snakes	species richness (site occupancy) and evidence of reproduction	Professional cover object surveys. Community science programs can contribute some presence-only data (via HerpMapper).
Turtles	species richness (site occupancy) and evidence of reproduction	Professional visual surveys and possibly radio telemetry. Community science programs can contribute some presence-only data (via HerpMapper).
Breeding Birds	species richness (site occupancy) and evidence of reproduction	Point count surveys with 8-9 replicates (Anich et al. 2018, Casper et al. 2018c), and acoustic surveys (Casper unpublished). Community science programs can contribute some presence-only data (via eBird).
Migrant Birds, Bats, and Insect	species richness and numbers (birds), activity levels (bats)	Point count surveys with many replicates (birds), and acoustic surveys (bats). Community science programs can contribute additional presence-only data (via eBird). Insect protocols are not available.
Mammals (non-bat)	species richness (site occupancy) and evidence of reproduction	Camera surveys, winter tracking.

Table 7. Monitoring Recommendations.

	Metrics	Methods
Resident Bats	species richness and activity levels	Acoustic surveys, mist netting.
Lichens	species richness, biomass	Protocol under development (https://elonpreview.weebly.com/)
Plants	species richness and abundance	Quadrat and transect surveys over 3 seasons.
Insects and Spiders	species richness and abundance	To be determined.
Light	lumens and spectrum	Protocol to be developed with automated continuous metering.
Noise	decibels and frequency	Protocol to be developed with automated continuous metering.

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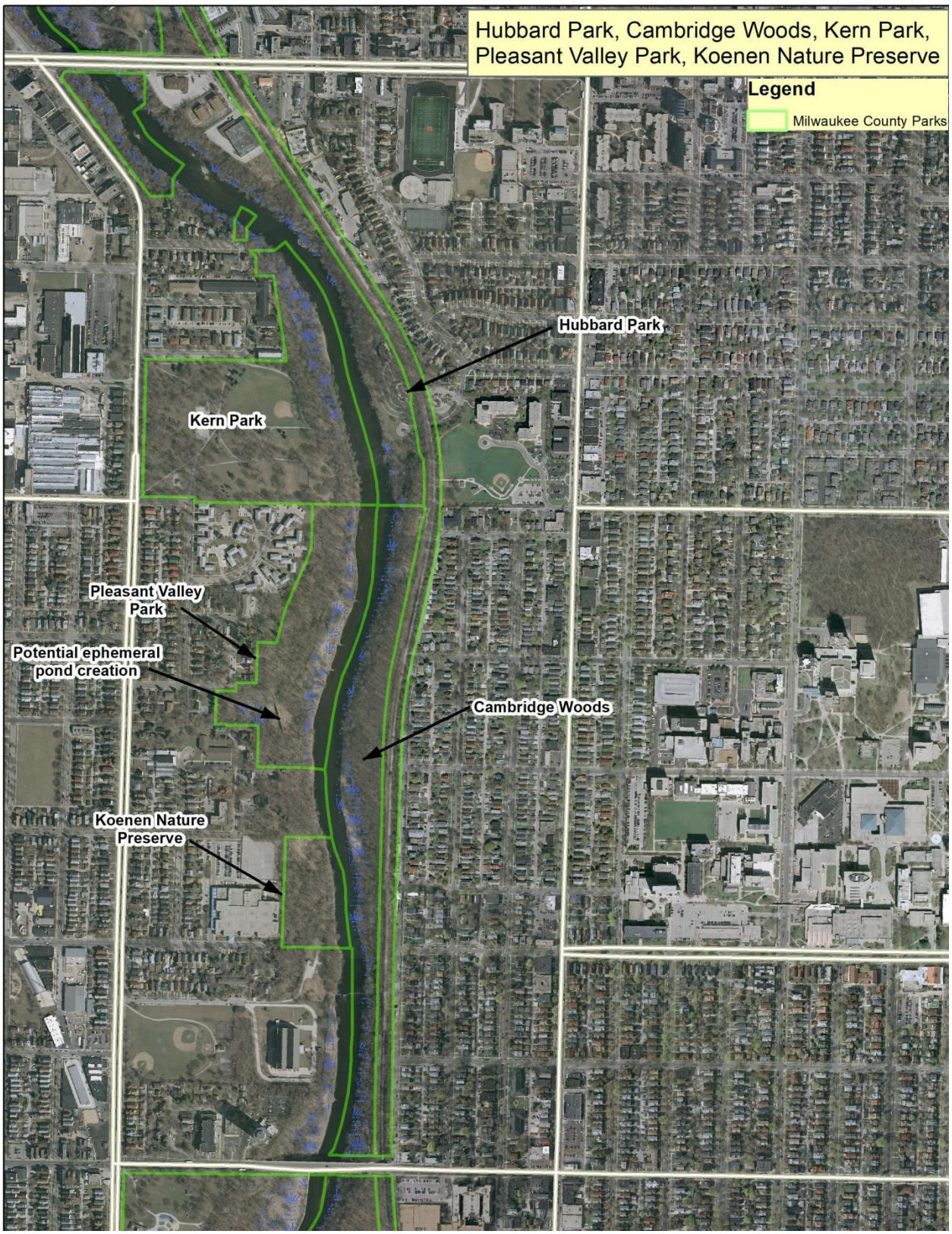
10. Appendices

The SLCI data vetting system, full AOC chapters and methods, and the AOC species checklists, are available at:

https://www.researchgate.net/project/Milwaukee-Estuary-Area-of-Concern-Wildlife-Assessment

11. Project Area Figures


EstabrookPark and
Glendale Industrial Park
Milwaukee County Parks
Existing oxbow wetland
Devonian outcrop at falls
Lagoon pond
Old Quarry
UWM
Park & Ride
190


Hubbard Park, Cambridge Woods, Kern Park,
Pleasant Valley Park, Koenen Nature Preserve
Legend
Milwaukee County Parks
Hubbard Park
Kern Park
Pleasant Valley Park
Potential ephemeral pond creation
Cambridge Woods
Koenen Nature Preserve


Gordon Park, Riverside Park, Turtle Park, Caesars Park
Legend
Milwaukee County Parks
GordonPark
RiversidePark
UEC ephemeral wetland (building removed)
Potential turtle nesting site area
High priority snake habitat consists of all non-forested areas in this section of the Greenway
Potential semi-permanent wetland site
future contaminant removal area
Turtle Park and potential turtle nest and basking sites
Caesars Park
32
32