Ecological Surveys and Assessments to Facilitate Restoration Activities at the Salt River Marsh: Final Report on Field Surveys

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For:
Michigan Department of Environment, Great Lakes, and Energy,
Water Resources Division
February 4, 2020

Report Number 2020-05

EGLE
MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Suggested Citation:
Badra, P.J., T.J. Basset, Y.M. Lee. 2020. Ecological Surveys and Assessments to Facilitate Restoration Activities at the Salt River Marsh: Final Report on Field Surveys. Michigan Natural Features Inventory Report Number 2020-05, Lansing, MI. 97pp.

Cover Photos: Background - Looking northwest at Stand 4, from edge of Stand 5, at cattails and common reed in the Salt River Marsh State Wildlife Area. Photo by Tyler J. Basset; Inset, left - Painted turtle hatchling. Photo by Yu Man Lee; Inset, right - American bluet damselfly larvae. Photo by Peter J. Badra.

Acknowledgments

Financial support for this project was provided by the Great Lakes Restoration Initiative via the Water Resources Division of the Michigan Department of Environment, Great Lakes, and Energy. Daria Hyde and Ashley Cole-Wick provided essential assistance with the field component of this project. Thank you to the landowners who kindly allowed us to access the Salt River and marsh through their properties, especially during difficult times with high water. Mike Monfils, Nancy Toben, Ashley Adkins, and Brian Klatt provided essential administrative support.

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Introduction

The Salt River and associated wetlands in Macomb County have been degraded by sedimentation and nutrient loading from non-point source pollution and encroachment by invasive common reed (*Phragmites australis* subspp. *australis*). The Salt River is connected to Lake St. Clair and riparian wetlands provide a variety of important services, including flood water retention, water quality maintenance, fish and wildlife habitat, and recreational opportunities. The U.S. Army Corps of Engineers along with several other partners, including the U.S. Environmental Protection Agency (U.S. EPA), Michigan Department of Environment Great Lakes and Energy (EGLE), and the Michigan Department of Natural Resources (Wildlife Division), has developed plans to restore portions of the Salt River Marsh within the State Wildlife Area (U.S. Army Corps of Engineers 2013). Restoration is to be accomplished through excavation of sediments deposited within the marsh, as well as mats of common reed. The aim of restoration activities is to improve plant community composition and structure, and fish and wildlife habitat value.

Michigan Natural Features Inventory (MNFI) performed ecological survey work to describe baseline conditions within the project area. An understanding of the current conditions is needed to facilitate the permit application process, which is required for restoration implementation, as well as to allow for future assessments of the success of restoration activities. The three main components of this project were: 1) habitat stand delineation and characterization (terrestrial natural community survey); 2) herpetological survey; and 3) stream assessment and macroinvertebrate survey.

For the habitat delineation, MNFI conducted a floristic survey (including potential rare, threatened, or endangered (RTE) plant species) and characterized natural communities using composition, structure, and edaphic characteristics. Herpetological surveys were conducted to document the presence of target amphibian and reptile, or herpetofaunal, species, including RTE species, and/or suitable habitat for these species within the project area. MNFI assessed the stream habitat and aquatic macroinvertebrate community of the Salt River within the study area following the Michigan Department of Environment, Great Lakes, and Energy's qualitative biological and habitat survey protocols for nonwadable rivers (MDEQ 2013). This report describes the methods and results of these surveys.

Methods

Habitat Stand Delineation and Characterization (Community Survey) - Methods:

Seven habitat stands were delineated (4-6, 7-10 in Figure 1) within which natural community and rare, threatened and endangered (RTE) plant species surveys were conducted. Within each stand, we conducted a floristic survey and characterized natural communities using composition, structure, and edaphic characteristics. Five State-listed plant species were detected in the MNFI Natural Heritage Database (Michigan Natural Features Inventory 2019) within five miles of (*Asclepias sullivantii*, Sullivant's milkweed; *Cardamina maxima*, large toothwort; *Carex lupuliformis*, false hop sedge; *Fraxinus profunda*; pumpkin ash; *Quercus shumardii*, Shumard's oak). With the exception of *A. sullivantii*, for which suitable lakeplain prairie habitat is unlikely to exist within the project area, surveys were timed to detect and identify these species.

Floristic surveys were conducted to document the vascular plant species found in each stand, using a modified timed meander search (TMS) procedure (Goff *et al.* 1982). According to the TMS procedure, plant species were recorded in five-minute increments. Following the surveys, we plotted species accumulation curves for each stand within these five-minute increments, to assess the completeness of surveys.

The plant species observed within each habitat stand were recorded on a field data sheet as they were encountered (Appendix A), using a randomly-patterned meandering route to allow for maximum coverage of variation within each habitat unit. The route at a particular habitat stand was complete when no new species were encountered with additional search efforts, or when the meander had covered all areas of the stand (best professional judgment was exercised in these cases). Unknown species were collected and will be identified at a later time. Nomenclature and nativity of plant species followed Voss and Reznicek (2012) and were cross-checked for updates on the Michigan Flora webpage (Michigan Flora 2019). Finally, we calculated the mean coefficient of conservatism (CoC) and floristic quality index (FQI) for all species recorded in upland stands, and wetland stands, separately (Reznicek *et al.* 2014). Each vascular plant species in Michigan has been assigned a CoC between 0 and 10 indicating fidelity to pre-European settlement habitat (e.g., 'conservatism'). Species assigned a low CoC are typically weed species, found commonly in disturbed conditions, while those assigned a high CoC are conservative species, found only in high-quality habitats. Non-native species are all assigned a 0 value. The FQI is calculated as (mean CoC X $\sqrt{n}$), where n is the number of species recorded. The mean CoC and FQI roughly indicate habitat quality.

Data on the composition and structure of habitat stands were also recorded, including the percent cover (within the following ranges: 0-10%, 10-25%, 25-50%, 50-75%, 75-90%, 90-100%) and dominant species within each vertical strata: Tree canopy (if present), subcanopy (if present), and ground layer vegetation. Finally, we assessed soil texture in the field and measured pH with a field soil pH kit. We used the composition, structure, and edaphic data to assign each stand as natural community, according to the MNFI Natural Community Classification (Cohen *et al.* 2015).

Herpetological Survey - Methods:

Herpetological surveys were conducted to document the presence of target amphibian and reptile, or herpetofaunal, species, including rare, threatened, and endangered (RTE) species, and/or suitable habitat for these species within the project area. Based on the location of the project area, known ranges of herpetofaunal species in Michigan, and description of habitat types within the project area, the following RTE herpetofaunal species had potential to occur within or immediately adjacent to the project area and were targeted for surveys: Blanchard's cricket frog (*Acris blanchardi*, state threatened), pickerel frog (*Rana palustris*, state special concern), spotted turtle (*Clemmys guttata*, state threatened), Blanding's turtle (*Emydoidea blandingii*, state special concern), eastern box turtle (*Terrapene carolina carolina*, state special concern), queen snake (*Regina septemvittata*, state special concern), Butler's garter snake (*Thamnophis butleri*, state special concern), gray ratsnake (*Pantherophis spiloides*, state special concern), and eastern fox snake (*Pantherophis gloydi*, state threatened) (Appendix B). Blanding's turtles, eastern box turtles, Butler's garter snakes, and eastern fox snakes have been documented within 8 km (5 mi) of the project area (Michigan Herp Atlas 2019, Michigan Natural Features Inventory 2019). The common mudpuppy (*Necturus maculosus maculosus*, state special concern) also has been documented within five miles of the project area, mainly in Lake St. Clair (Michigan Herp Atlas 2019). Suitable habitat for mudpuppies may be available within Salt River but this species was not targeted for surveys in 2019. Additional herpetofaunal species that had potential for occurring within or immediately adjacent to the project area included the following species: eastern newt (*Notophthalmus viridescens*), eastern red-backed salamander (*Plethodon cinereus*), eastern American toad (*Bufo [Anaxyrus] americanus americanus*), Midland or western chorus frog (*Pseudacris triseriata triseriata*), northern spring peeper (*Pseudacris crucifer crucifer*), eastern gray treefrog (Hyla versicolor), bullfrog (*Rana catesbeiana*), green frog (*Rana clamitans melanota*), northern leopard frog (*Rana pipiens*), eastern snapping turtle (*Chelydra serpentina serpentina*), eastern musk turtle (*Sternotherus odoratus*), northern map turtle (*Graptemys geographica*), painted turtle (*Chrysemys picta*), red-eared slider (*Trachemys scripta elegans*), eastern spiny softshell turtle (*Apalone spinifera spinifera*), northern water snake (*Nerodia sipedon sipedon*), eastern garter snake (*Thamnophis sirtalis sirtalis*), northern

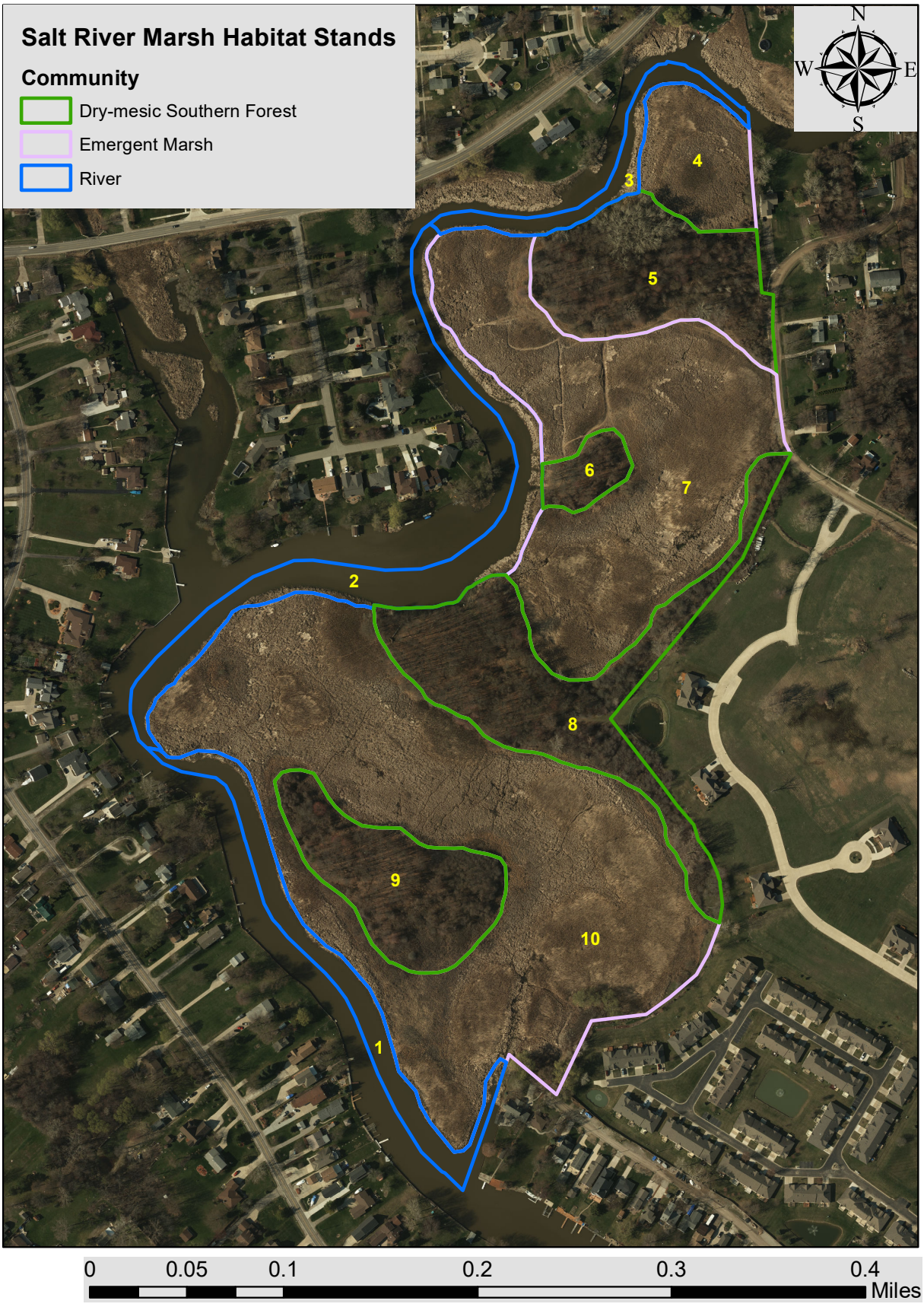

Figure 1. Habitat stands. Both dry-mesic southern forest (Stands 5,8,9) and emergent marsh (4,7,10) stands were targeted during community surveys. Stretches of Salt River (Stands 1-3) were not targeted during community surveys.

ribbon snake (*Thamnophis sauritus septentrionalis*), DeKay's or northern brown snake (*Storeria dekayi dekayi*), northern red-bellied snake (*Storeria occipitomaculata occipitomaculata*), and eastern milk snake (*Lampropeltis triangulum triangulum*) (Harding and Mifsud 2017) (Appendix B).

We utilized area-constrained visual encounter surveys, auditory surveys, basking surveys, aquatic funnel trapping surveys, and limited artificial cover surveys (Figures 2 and 3) (Graeter *et al.* 2013) to survey for target amphibian and reptile species that had potential for occurring within or immediately adjacent to the project area. Surveys were conducted from June 30 to July 14, 2019 with an additional site visit on June 8. Visual encounter, auditory, basking, and aquatic funnel trapping surveys were conducted in all three emergent marsh stands (stands 4, 7, 10) (Figures 1 and 4). Visual encounter, auditory, and artificial cover surveys were conducted in two of the three forested stands (stands 5, 8) (Figures 1 and 4). Sections of the Salt River (stands 1, 2, southern end of 3) also were visually surveyed on July 14. (Figures 1 and 4).

Area-constrained visual encounter surveys (VES) were conducted using a standard method for surveying amphibians and reptiles (Campbell and Christman 1982, Corn and Bury 1990, Crump and Scott 1994, Glaudus 2013). These surveys consisted of one observer walking slowly through pre-defined areas assessing the presence and extent of suitable habitat for survey targets and overturning cover objects (e.g., logs, rocks, etc.), inspecting retreats, and looking for basking, resting, and/or active individuals on the surface or under cover. Visual encounter surveys were conducted in or along the edge of the emergent marsh (stands 4, 7, 10) and through two of the three forested stands (stands 5, 8) in the project area (Figures 1 and 4). Surveys were conducted in several areas proposed for habitat restoration (e.g., parts of the proposed dredge channel in stand 10). Targeted visual encounter surveys were conducted on June 30 and July 8, 10 and 12. Limited or incidental visual surveys also were conducted during the initial field visit on June 8 and during the other herpetological surveys conducted in the project area on July 1-4 and July 14. We visually inspected suitable habitats and documented any amphibian and reptile species encountered during these other surveys (e.g., on the way to checking aquatic funnel traps). Visual encounter surveys were conducted during daylight hours and under appropriate weather conditions when target species were expected to be active and/or visible (i.e., ideally between 60-80°F (16-27°C), wind less than 15 mph, no or light precipitation). Multiple visual encounter surveys were conducted within the various habitat areas or stands.

Basking surveys which involve scanning habitat with binoculars to look for basking reptiles and amphibians (Buhlmann 2013) were conducted along the Salt River and in areas with open water and/or basking structures (e.g., in the emergent marsh stands) within the project area. Basking surveys were conducted within the Salt River (stands 1, 2 and southern end of stand 3) by kayak on July 14 and within the emergent marsh stands (stands 4, 7, 10) from the edge in the adjacent forest stands during visual encounter and aquatic funnel trapping surveys on June 8 and 30 and July 1-4, 8 and 12 (Figures 1 and 4). Basking surveys were conducted during daylight hours and under appropriate weather conditions when target species were expected to be active and/or visible (i.e., ideally between 60-80°F (16-27°C), wind less than 15 mph, no or light precipitation).

Auditory surveys (Luhring 2013) were conducted to document frog and toad species occurring and/or breeding within or immediately adjacent to the project area. Male frogs and toads call to attract mates and warn other nearby males during the breeding season (Mitchell 2000). The auditory survey protocol was based on and modified from standard protocols for auditory surveys utilized by the North American Amphibian Monitoring Program (NAAMP) (Weir and Mossman 2005) and the Michigan Frog and Toad Survey (Sargent 2000). Auditory surveys were conducted on July 1 and July 14 in the evening or at night (from 17:30 – 01:00 EDT) at 10 listening stations distributed throughout the project area so that frog and toad calls in different parts of the project area could be heard (Figure 4). One surveyor visited all listening stations during each auditory survey and listened for frog and toad calls for five minutes at each listening station. Listening stations were located along the edge of the emergent marsh stands so that frog and toad calls emanating from the marsh and in the

adjacent forest could be heard. Listening stations were located using a global positioning system (GPS) so that the same locations were surveyed during multiple visits. Species presence and relative abundance were assessed and recorded using call indices defined in the following manner: 1 = individuals can be counted, space between calls (1-5 individuals); 2 = individual calls can be distinguished but some overlapping calls (6-12 individuals); and 3 = full chorus, calls are constant, continuous and overlapping (unable to count individuals) (Sargent 2000). Calls heard during the day during other herpetological surveys in the project area also were noted.

Artificial cover surveys (Mills *et al.* 2013) were conducted in two of the three forested stands (stands 5 and 8) within the project area to complement visual encounter and basking surveys (Figures 1 and 4). These surveys consisted of placing 20 artificial cover objects (i.e., metal/aluminum/tin boards) on the ground in linear transects within the forested stands and checking them during the other herpetological surveys (i.e., at least 3 times). The cover objects/boards ranged in size from 0.6-1.0 meter (2-3 ft) in width and length. The cover objects/boards were set on July 2 and 3 and checked on July 8, 10, and 12. All species observed underneath or on top of the cover boards were documented and photographed (when possible).

Aquatic funnel trapping for turtles, snakes and amphibians (Willson 2013) were conducted along the edge of the emergent marsh stands in the project area (stands 4, 7 and 10) in areas that were suitable for placement of minnow traps and/or hoop traps (Figures 1 and 4). Aquatic funnel trapping is most effective in shallow water (i.e., <1 m deep) with abundant vegetation, particularly emergent vegetation (Willson 2013). Aquatic funnel trapping was not conducted in the river in the project area because the water was too deep to set minnow and hoop traps. Ten minnow traps were deployed in the emergent marsh stands in the project area at intervals of 60-148 m (200-486 ft) (i.e., ideally at intervals of 100 m (328 ft) or greater and at least 20 m (66 ft) apart) for four consecutive nights from June 30 to July 4 for a total of 40 trap nights. Traps were checked every 24 hours. Traps were set with approximately ¼ of the trap above the water or with floats, allowing captured animals access to air (Willson 2013) (Figure 2). Traps were set along shorelines, submerged wood debris, or other structures that may guide animals into traps, and were tied to stakes, trees, shrubs, or other objects to prevent animals from dragging traps into deep water (Willson 2013). Traps were baited with canned sardines and fish oil. Trap locations were mapped with a global positioning system (GPS) (Figure 4). All amphibian and reptile species and number of individuals captured in traps were recorded. Individuals were aged (i.e., adult, subadult/juvenile, hatchling/yearling), measured, sexed, and/or photographed when possible and released at capture location after processing. This trapping protocol is based on standardized survey and monitoring protocols that have been developed and implemented for Blanding's turtles and spotted turtles in the northeastern U.S. (Willey and Jones 2014, Northeast Spotted Turtle Working Group 2019).

For each survey method, in addition to recording species, number and locations of individuals observed, observer names, dates, times, weather conditions, and habitat and survey conditions were recorded during each survey visit on a field data form (Appendices C-G) and/or on a tablet using mobile applications such as Survey 123 and Backcountry Navigator. Survey locations and routes were mapped and recorded on a GPS unit and/or a tablet using Survey 123 or Backcountry Navigator. All amphibian and reptile species observed were photographed for documentation whenever possible. RTE species encountered in the field were documented using MNFI's Special Animal Survey forms (https://mnfi.anr.msu.edu/pdfs/Special_Animal_Form.pdf) and were entered into the Natural Heritage Database by MNFI staff.

Figure 2. An example of aquatic funnel trap placement used during herpetological surveys. Photo by Yu Man Lee

Figure 3. An example of artificial cover placement used during herpetological surveys. Photo by Yu Man Lee

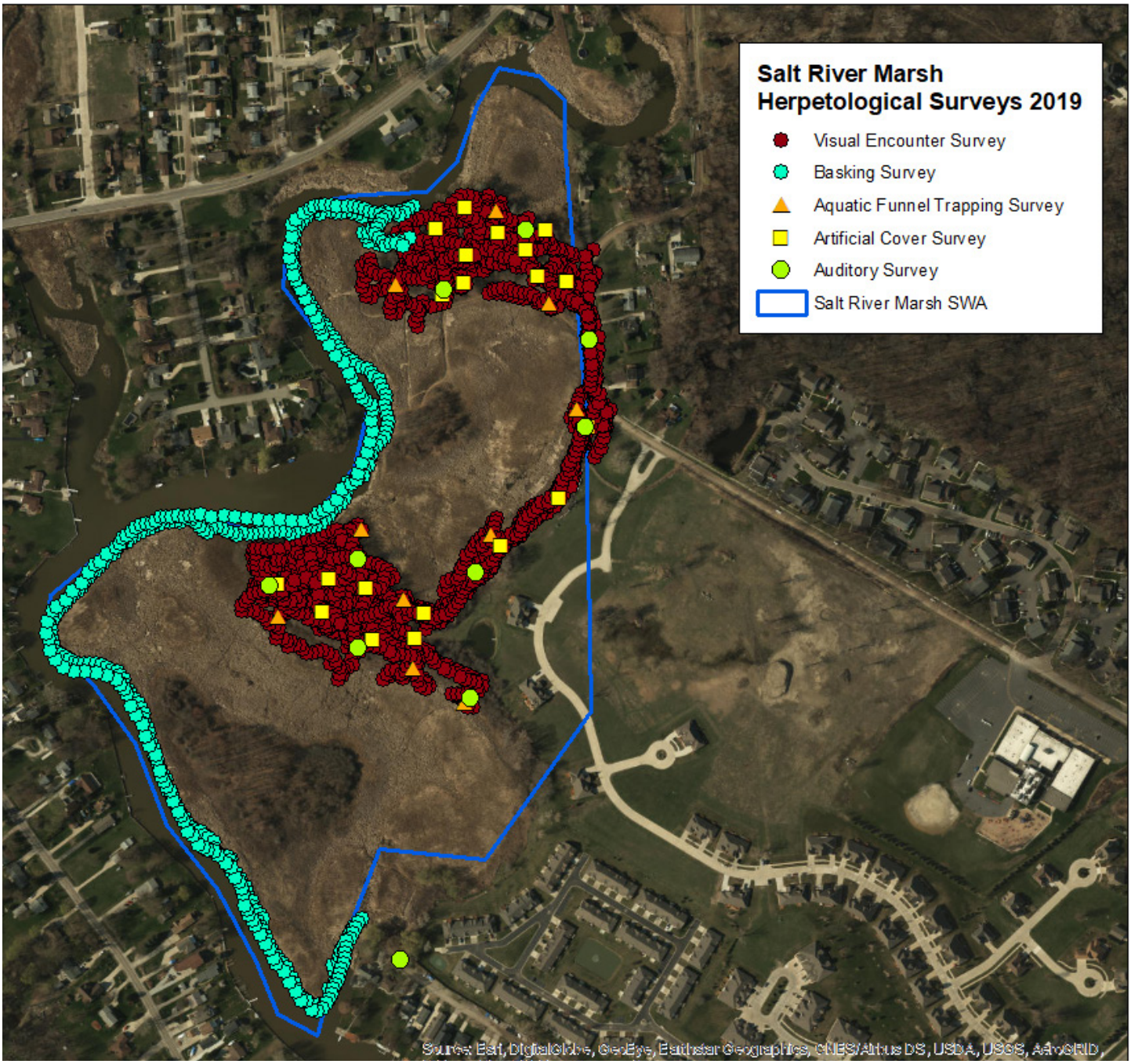

Figure 4. Herpetological survey effort.

Stream Assessment and Macroinvertebrate Survey - Methods:

The primary goal of the stream assessment and macroinvertebrate survey is to provide a rapid habitat and visual-based stream assessment based on physical habitat and macroinvertebrate taxa present. An additional benefit of the survey is the potential detection of RTE and invasive aquatic animal species. Lake St. Clair water levels were at or near record levels the summer of 2019 (NOAA 2019) and water depth in the Salt River necessitated the use of nonwadeable vs. wadeable methods of stream assessment. Survey methodology followed the Michigan Department of Environment, Great Lakes, and Energy (formerly Dept. of Environmental Quality) Qualitative Biological and Habitat Survey Protocols for Nonwadeable Rivers (MDEQ 2013). Refer to this document in Appendix H for a detailed explanation of these protocols.

A pre-planned modification to the MDEQ 2013 protocols was made due to the relatively short river reach within the project area. The protocols call for sampling a standard 2000m length of river reach, with transects performed at 200m intervals and thalweg measurements at 40m intervals for a total of 11 transects. Surveys took place in the Salt River within the boundaries of the Salt River Marsh State Wildlife Area. Since the Salt River reach within the project area was less than 2000m long, transects and thalweg measurements were performed at 50m intervals within three sample reaches to allow for adequate sampling within a shorter river reach. The sample reaches were spaced 50m apart. The large woody debris metric (LWD) was scored for each 500m reach (vs. 2000m), so the number of LWD per reach to determine the LWD score was multiplied by four. Off-channel habitat was scored for each 500m reach (vs. 2000m), so the number of off-channel habitats per reach used to determine the score was also multiplied by four.

Kayaks were used to access the sample reaches during an initial site visit to assess in-stream conditions at the project area and run through sampling methodology before data was collected. Closure of the Salt River to boat traffic at Jefferson Avenue bridge prevented the use of a trailered motorboat during the project. A canoe with an electric trolling motor was used during the collection of habitat data and macroinvertebrate samples. Two landowners along Killewald Street with waterfront property allowed MNFI staff to put-in kayaks and canoes via their property.

During the initial site visit it was discovered that at the downstream (southern) most 140m of the Salt River within the study area, the left riverbank (facing downstream) was inundated so that that there was no discernable edge to the river. The first transect of reach 1 was moved upstream 140m from the downstream edge of the study for this reason. Also, the length of the Salt River reach within the Salt River Marsh study area measured in the field was slightly less than the length estimated from aerial photos. This resulted in seven transects (A-G) fitting in reach 3 before the boundary of the state wildlife area was reached, instead of 11. Reaches 1 and 2 were 500m long with 11 transects each and reach 3 was 300m long with seven transects, for a total of 29 transects spaced 50m apart. Direct comparisons of results between reach 3 and reaches 1 and 2 should not be made for this reason. Distance between transects was measured with a 50m tape and/or a range finder. The habitat assessment and macroinvertebrate surveys were performed in the upstream direction starting with transect A in reach 1.

<u>Qualitative Habitat Assessment Sampling</u>

Qualitative habitat assessments were made at each transect and included visual estimations of vegetative coverage in 10x20m littoral plots centered at each end of the transect, the width of riparian vegetative zone for both banks, an estimate of the width of streambed along the transect covered with fine sediment deposits, and bank stability 20m upstream and downstream of each transect end (modified from 50m due to shorter distances between transects than in original DEQ protocols). Seven habitat metrics were assessed following MDEQ 2013 protocols at each transect, including riparian vegetation width, large woody debris, aquatic vegetation,

thalweg substrate, bottom deposition, bank stability, and off-channel habitat. Data were collected at each of the 11 transects within the two 500m river reaches and seven transects with the 300m river reach, then averaged to obtain a single metric score for each reach.

Transect habitat datasheets and longitudinal profile datasheets were completed for each stream reach (Appendix H). Depth and substrate type were recorded at 50m intervals along the thalweg for each of the three river reaches. A PVC sounding pole marked in 10cm increments was used to measure depth and feel the substrate type. Calculation of habitat metric scores are detailed in the MDEQ 2013 protocols (Appendix H). All data collected in the field via standard datasheets were backed-up the day they were completed by taking a photograph of the datasheet, then saving photographs to an MNFI computer.

Macroinvertebrate Survey

Qualitative macroinvertebrate sampling was performed at a total of 29 transects, 11 within each of the two 500m reaches and seven in the 300m reach. A random number generator was used to determine ahead of time if the left or right bank at each transect would be sampled. All available habitat types (FPOM, sand, coarse substrate, cobble, LWD, and macrophytes) were swept using a long-handled D-frame dip net with 0.8-1.0mm mesh. For each habitat type a 15 second sweep was performed with the D-net. Contents of the net were placed in a labeled whirl-pak sample bag along with 95% ethanol after removing any large pieces of plant material. D-net sweeps were performed from a canoe rather than wading due to relatively deep water (1-2m) throughout the sampling area. Macroinvertebrates were sorted and identified in the lab. Macroinvertebrates from each transect were identified to family level and recorded on the macroinvertebrate data sheet. Bouchard, 2004 and Merritt *et al*., 2008 were used to aid identification of macroinvertebrate taxa. Data from the individual macroinvertebrate samples from each transect were compiled into one composite for the entire reach and scored as detailed in the MDEQ 2013 protocols (see Appendix H).

Results

Habitat Stand Delineation and Characterization (Community Survey) - Results:

No rare, threatened, or endangered plant species were observed during surveys. Suitable conditions for Sullivant's milkweed, which requires intact lakeplain prairie habitat, was not found at the site. Habitat for large toothwort, false hop sedge, Shumard's oak, and pumpkin ash all of which can occur in floodplain forests, may exist at the site. Given the extent of anthropogenic disturbance and invasive species, and the comprehensive coverage of the surveys, the probability of Salt River Marsh SWA supporting RTE species is low.

Early summer surveys were conducted on June 25, 2019 and late summer surveys on September 10 and 16, 2019. Lake levels in the Great Lakes and associated water bodies were at historical highs in 2019, including in Lake St. Clair (National Oceanic and Atmospheric Administration 2019), and high spring precipitation led to extremely high levels in the Salt River and associated wetlands. This resulted in limited access to wetland stands during the early summer surveys, and incomplete or no surveys of habitat stands 4, 6, 7, 9 and 10. Late summer surveys were conducted in part via kayak, permitting access to these stands and facilitating more complete surveys. See Figure 5 for survey tracks. Species accumulation curves can be seen in Figure 6.

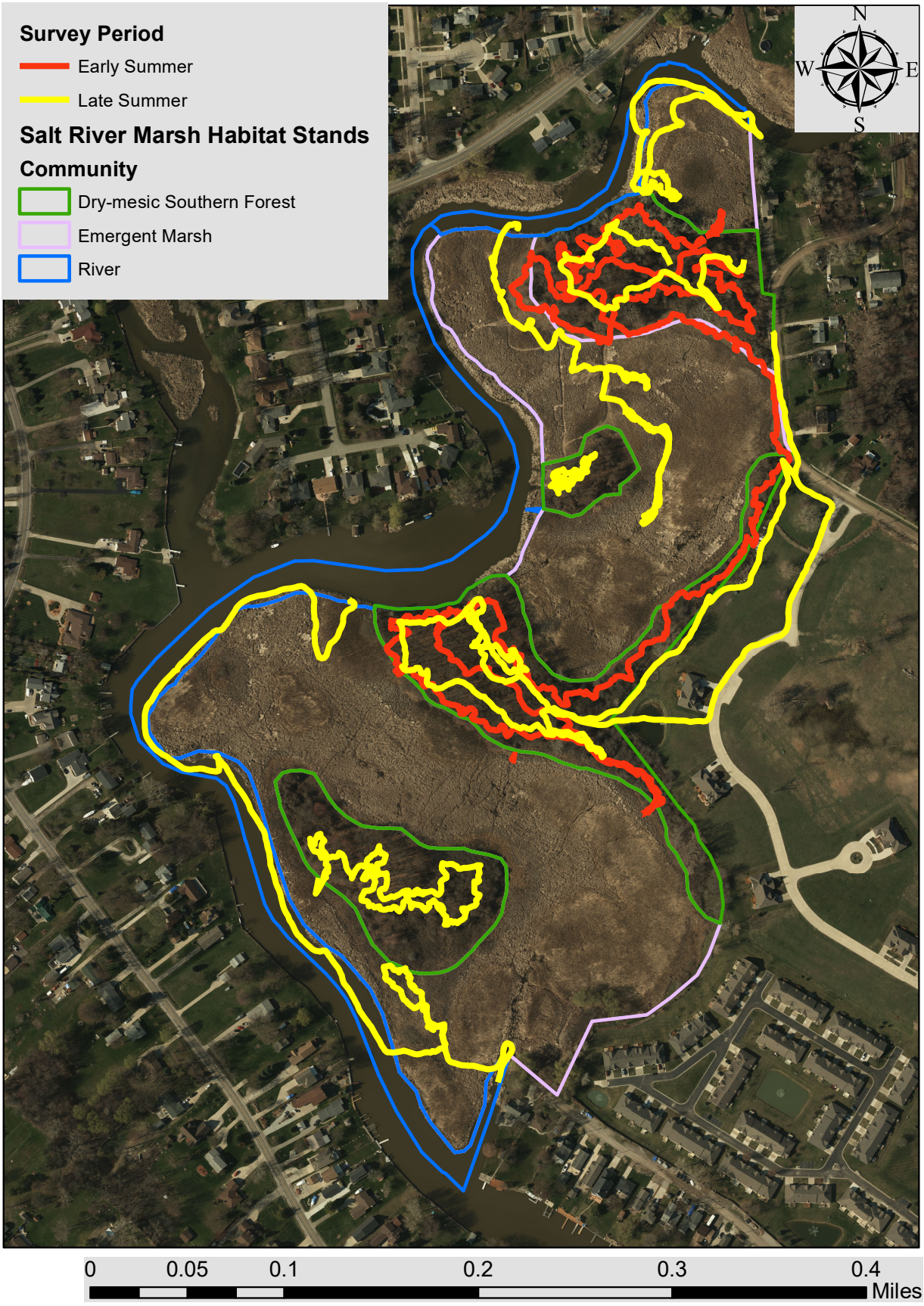

Figure 5. Survey effort (survey tracks) for the habitat stand delineation and characterization.

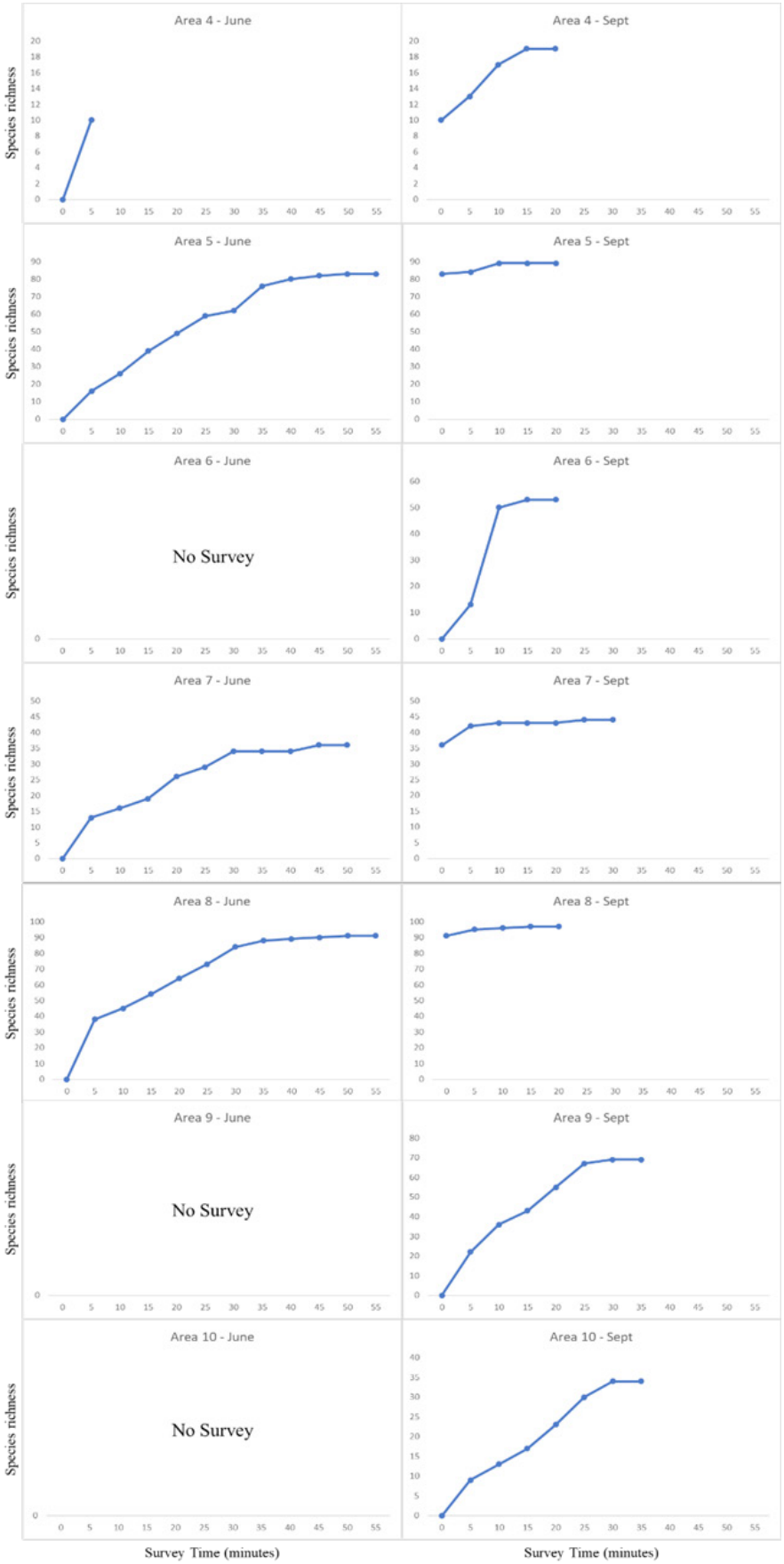

Figure 6. Species accumulation curves for the habitat stand delineation and characterization.

Wetlands (Stands 4, 7, 10)

Overall, 59 (48 or 81% native; 11 or 19% non-native) vascular plant species were documented in the wetland habitats at Salt River Marsh SWA (Appendix I). The mean CoC was 3.3, and FQI was 25.3, suggesting degraded communities supporting only a few species typical of pre-European settlement conditions. The wetland stands at Salt River Marsh SWA were largely dominated by invasive native and non-native emergent species, particularly cattails (*Typha latifolia, T. angustifolia*), reed canary grass (*Phalaris arundinacea*), and invasive common reed (*Phragmites australis* ssp. *australis*) (Table 1). In addition to the density of common reed and cattails, the extremely high water levels resulted in difficulty navigating all three wetland stands. Small portions of two wetland stands were dominated by native species that are likely indicative of historical, pre-European settlement vegetation at this site. Examples of both submergent (e.g., water smartweed, *Persicaria amphibia*; bladderworts, *Utricularia* spp.; Figure 7) and wet meadow (e.g., tussock sedge, *Carex stricta*; lake sedge, *C. lacustris*; blue-joint grass, *Calamagrostis canadensis*; Figures 8 and 9) communities persist in limited areas (Figure 10).

We did not assess canopy or subcanopy in wetland stands. Trees and shrubs in the wetlands were generally limited to the transitional zones with upland stands, and we delineated upland forested stands to include these transitional areas. We also did not assess the pH of wetland soils, due to pervasive flooding and unconsolidated soils.

Stand 4 (2.32 acres)
Nineteen plant species were recorded in Stand 4. This stand was heavily dominated by cattails and the invasive common reed, with most other species occurring at very low abundances (Figure 11; Table 1).

Stand 7 (12.78 acres)
Forty-four plant species were recorded in Stand 7. This stand was characterized by a less-flooded margin of sedge meadow (Figure 10), dominated by native blue-joint grass (*Calamagrostis candensis*) and tussock sedge (*Carex stricta*) (Figure 8), although cattails, common reed, and duckweed were abundant in most of this stand (Figure 12) (Table 1). Recent spraying of common reed has also killed patches of sedge meadow vegetation, including blue-joint grass and sedges (Figure 13).

Stand 10 (21.54 acres)
Thirty-four plant species were recorded in Stand 10. This stand was characterized by a large expansive remnant sedge meadow (Figure 10), dominated by native lake sedge, and to a lesser extent, blue-joint grass (Figure 9). However, cattails were dominant in most of this stand, with small stands of common reed as well (Table 1; Figure 14).

Table 1. Natural community data from the habitat stand delineation and characterization.

			Percent Cover			Dominant Species			Soil		
Area	Community	Surveys	Canopy	Sub-canopy	Ground Layer	Canopy	Subcanopy	Ground Layer	Texture	pH	Photos
4	Emergent/Submergent Marsh	2	0	0	75-90	NA	NA	Cattials (*Typha* spp.) and common reed (*Phragmites australis*)	Loose muck	NA	3
5	Dry-Mesic Southern Forest (Southern Hardwood Swamp)	2	75-90	25-50	25-50	Silver maple (*Acer saccharinum*); Wild black cherry (*Prunus serotina*)	Common privet (*Ligustrum vulgare*), Morrow's honeysuckle (*Lonicera morrowii*)	Japanese honeysuckle (*Lonicera japonica*), Oriental bittersweet (*Celastrus orbiculatus*), swamp agrimony (*Agrimonia parviflora*), path rush (*Juncus tenuis*)	Loamy sand (some silt)	6.5	1
6	Dry-Mesic Southern Forest	1	75-90	25-50	75-90	Black oak (*Quercus velutina*)	Green ash (*Fraxinus pennsylvanica*)	Poverty grass (*Danthonia spicata*), fowl manna grass (*Glyceria striata*), swamp agrimony	Sandy Loam	6.5	1
7	Emergent/Submergent Marsh (Southern Wet Meadow)	2	0	0	75-90	NA	NA	Cattials (*Typha* spp.) and common reed (*Phragmites australis*)	Loose muck	NA	19
8	Dry-Mesic Southern Forest	2	50-75	75-90	25-50	Red oak (*Quercus rubra*); black oak	Cockspur thorn (*Crataegus crus-gallii*), gray dogwood (*Cornus foemina*)	Roseate sedge (*Carex rosea*); green ash	Rich loamy sand over sandy loam	6.5	6
9	Dry-Mesic Southern Forest (Southern Hardwood Swamp)	1	75-90	25-50	25-50	Red oak; shagbark hickory (*Carya ovata*)	Gray dogwood; red oak, box-elder (*Acer negundo*)	Fowl manna grass, brome sedge (*Carex bromoides*)	Loamy sand (some silt)	6.5	4
10	Emergent/Submergent Marsh (Southern Wet Meadow)	1	0	0-10	75-90	NA	Gray dogwood	Cattials (*Typha* spp.) and common reed (*Phragmites australis*); tussock sedge (*Carex stricta*), lake sedge (*C. lacustris*), blue-joint grass (*Calmagrostis canadensis*)	Loose muck	NA	8

Figure 7. Native submergent marsh community in Stand 7 (adjacent to "Remnant patch of sedge meadow" in Figure 10); water smartweed (floating leaves, pink flowers), and bladderwort (forked leaves below surface) pictured. Photo by Tyler Bassett.

Figure 8. Remnant patch of sedge meadow in Stand 7 (see Figure 10), comprised mostly of blue-joint grass, tussock sedge, and lake sedge. Photo by Tyler Bassett.

Figure 9. Looking north over remnant patch of sedge meadow in Stand 10 (see Figure 10), with lake sedge, in foreground, blue-joint grass in the midground, cattails in the background, and upland Stand 9 behind that. Photo by Tyler Bassett.

Figure 10. Salt River Marsh Sate Wildlife Area natural community features.

Figure 11. Looking northwest at Stand 4, from edge of Stand 5, showing cattails in the foreground and common reed in the background. Photo by Tyler Bassett.

Figure 12. Looking west at Stand 7, showing large expanse of duckweeds in the foreground, cattails and common reed in the background, and upland stands 5 and 6 to the right and left, respectively. Photo by Tyler Bassett.

Figure 13. Treated common reed. Much of the lower dead vegetation is native sedges, inadvertently affected by the spraying. Photo by Tyler Bassett.

Figure 14. Looking east at Stand 10 from the Salt River (Stand 1), with dense of wall of cattails in foreground, and upland Stand 9 in background. Photo by Tyler Bassett.

Uplands (Stands 5, 6, 8, 9):

Overall, 163 (121 or 74% native; 42 or 26% non-native) vascular plant species were documented in the upland habitats at Salt River Marsh SWA (Appendix J). The mean CoC was 2.3, and FQI was 29.4, suggesting a community supporting very few species typical of pre-European settlement conditions. The upland stands at Salt River Marsh SWA were variable. Generally, dry-mesic southern forest is the natural community represented at the site, an oak-dominated community on relatively well-drained sandy loam or loamy sand soils. However, each upland stand contained portions of wetter forest community on water-logged soils containing a heavier clay content (Figure 10).

Stand 5 (4.60 acres)
Eighty-nine plant species were recorded in Stand 5. This upland stand had a canopy more typical of hardwood swamp, particularly the dominant, silver maple (*Acer saccharinum*) (Table 2). A typical silver maple tree, measured at 18 inches DBH (diameter at breast height), was aged at 49 years old (Table 2). Oak leaf litter was common, however, no oak species were noted in the canopy. Wild black cherry (*Prunus serotina*) and sassfrass (*Sassfras albidum*), typical of disturbed dry-mesic southern forest, were also present in the canopy, and the soils were silty loamy sand with a pH of 6.5. The understory was dominated by invasive shrubs common privet (*Ligustrum vulgare*) and Asiatic bittersweet (*Celastrus orbiculatus*), but did support patches of native forbs, grasses, and sedges (Figure 15). A small patch of the non-native silver birch (*Betula pendula*) was noted in this stand (Figure 10). Overall, this stand was very disturbed, complicating classification. We classified it as a dry-mesic southern forest with many dominant aspects of southern hardwood swamp. This stand is very accessible from the adjacent neighborhood, and we noted several leaf piles and other signs of recent anthropogenic disturbance.

Stand 6 (0.81 acres)
Fifty-three plant species were recorded in Stand 6. This stand is a small dry-mesic southern forest of moderate quality, surrounded by a narrow ring of southern hardwood swamp. Black oak (*Quercus velutina*), a typical dominant on the dry end of the dry-mesic continuum, was the most common canopy species (Table 1). The soil was characterized as sandy loam, and had a pH of 6.5. A typical black oak tree, measured at 16 inches DBH, was aged at 65 years old (Table 2). The understory was mostly grass-dominated, with a sparse shrub layer (Figure 16). There was a fire pit in middle of island, suggesting use by local residents.

Stand 8 (6.36 acres)
Ninety-seven plant species were recorded in Stand 8. This stand was dominated by red oak (*Quercus rubra*), black oak, and wild black cherry, common dominants of moderate quality dry-mesic southern forest. Soils were rich loamy sand over sandy loam and had a pH of 6.5. The larger western portion supported a more mature forest community (Figure 10). The western portion was characterized by red and black oak, with a subcanopy of gray dogwood (*Cornus foemina*). A typical red oak, at 20 inches DBH, was aged at 48 years old. Two shrubby "wings" extending to the east adjacent to the newly developed neighborhood were dominated by hawthorne (*Cratageus crus-gallii*), with gray dogwood and staghorn sumac (Rhus typhina) also common. Several ground layer species were observed, with common species including roseate sedge (*Carex rosea*) and upland bent (*Agrostis perennans*) (Figure 17). However, the ground-layer was generally sparse and covered in oak leaf litter. The open-canopied portion directly adjacent to the Salt River was dominated by a diversity of grasses and forbs, and boasted a few exceptionally large oak trees, including one ~ 30 inch DBH white oak (*Quercus alba*) (Figure 18).

Stand 9 (3.90 acres)

Sixty-nine plant species were recorded in Stand 9. The canopy was dominated by red oak, with a notable proportion of hickory, particularly shagbark hickory (*Carya ovata*). A typical red oak, at 19 inches DBH, was aged at 128 years old. This stand was similar to stand 5, in that it appeared to be more prone to flooding, with a sparse ground layer and silty loamy sand soil with a pH of 6.5 (Figure 19). This stand was increasingly wet to the southeast, transitioning through a thinly forested shrub swamp with gray dogwood and buttonbush (*Cephalanthus occidentalis*), to remnant sedge meadow in Stand 10 (Figure 10). Brome sedge (*Carex bromoides*) was common in patches where flooding was not prominent (Figure 20). A few pole-size (5-10 inches DBH) green ash (*Fraxinus pensylvanica*) were notable, as most ash trees of that size or larger have succumbed to the invasive beetle, emerald ash borer (*Agrilus planipennis*). We classified this stand as a dry-mesic southern forest with significant southern hardwood swamp components.

Figure 15. An unknown sedge within a patch of poison ivy (*Toxicodendron radicans*) in Stand 5. Photo by Tyler Bassett.

Table 2. Canopy composition from the habitat stand delineation and characterization.

	Area 5			Area 6			Area 8			Area 9		
Species	%	DBH (inches)	Age	%	DBH (inches)	Age	%	DBH (inches)	Age	%	DBH (inches)	Age
Acer negundo							3	12				
Acer saccharinum	**50**	18	**49**				5	15				
Betula pendula	15	21					5	18				
Carya glabra										5	16	
Carya ovata										15	14	
Fraxinus pennsylvanica										5	9	
Pinus sylvestris										5	13	
Populus deltoides	5	25										
Prunus serotina	25	15		15	12		20	13				
Quercus alba				5	23		2	25		5	17	
Quercus rubra							**40**	20	**48**	**60**	19	**128**
Quercus velutina				**80**	16	**65**	20	22				
Salix nigra							5	20				
Sassafras albidum	5	16								5	13	
Total:	100			100			100			100		

Figure 16. Looking east across stand 6, with white oak (*Quercus alba*) in the foreground, dominant black oak (*Quercus velutina*) throughout, open grass-dominated ground-layer, and fire pit in center. Photo by Tyler Bassett.

Figure 17. The southeast corner of Stand 8, with a ground-layer dominated by upland bent (*Agrostis perennans*). Photo by Tyler Bassett.

Figure 18. Looking northeast at the edge of Stand 8, featuring a large open-grown white oak (*Quercus alba*) tree. Photo by Tyler Bassett.

Figure 19. The typically sparse ground-layer of Stand 9. Photo by Tyler Bassett.

Figure 20. A dense ground-layer of brome sedge (*Carex bromoides*) in Stand 9. Photo by Tyler Bassett.

Herpetological Survey - Results:

Herpetological surveys within the Salt River Marsh project area in 2019 documented five common amphibian and reptile species (Table 3). These species were documented during visual encounter, basking, auditory, and aquatic funnel trapping surveys (Table 3). Eastern American toads were observed during visual encounter surveys in forest stands 5 and 8 (Figures 21 and 22). Green frogs were the most common frog species observed in the project area and were documented in all three emergent marsh stands during visual encounter surveys, aquatic funnel trapping, and auditory surveys (heard at all but one listening station with call index of 1 at each station) (Figure 22). Eastern gray treefrogs were only documented during auditory surveys from two locations in stand 10 in the eastern portion of the marsh (Figure 22).

A total of 44 individual painted turtles and 11 eastern snapping turtles were captured during aquatic funnel trapping in emergent stands 7 and 10, with only two recaptures (one painted turtle and one snapping turtle recapture) (Figure 22). This resulted in capture rates of 1.1 painted turtles/trap night and 0.3 snapping turtles/trap night, and a combined turtle capture rate of 1.4 turtles/tap night. The painted turtle captures were comprised of 40 adults (carapace lengths 9.5-16.7 cm/3.7-6.6 in), 3 subadults or juveniles (carapace lengths 8.5-8.9 cm/3.3-3.5 in), and 1 hatchling or yearling (carapace length 4.6 cm/1.8 in) (Figures 23 and 24). These included 20 male turtles and 22 female turtles (2 were unknown or not sexed). The snapping turtle captures were all subadults or juveniles (carapace lengths 9.5-18.6 cm/3.7-7.3 in) (Figure 25). Painted turtles also were observed incidentally on June 8 in the water along the edge of forest stand 8 and emergent marsh stand 7 and basking in emergent marsh stand 7.

No rare, threatened, or endangered amphibian or reptile species were documented in the Salt River Marsh project area during herpetological surveys in 2019. Suitable wetland habitat (i.e., emergent marsh) for eastern

fox snakes and Blanding's turtles appears to be available within the project area but potential for these species to occur in the project area may be fairly low given limited amount of habitat, landscape context (i.e., extensive residential and other development), and lack of available or suitable habitat surrounding the project area. Suitable wetland habitat for Blanchard's cricket frog, pickerel frog, spotted turtle, and Butler's garter snake did not appear to be currently available or were so limited that these species likely have low potential for occurring within the project area. Similarly, the small amount and condition of the forested habitat (i.e., dense canopy/ limited access to sunlight for thermoregulation and lack of ground vegetation/cover) within the project area provide limited habitat and likely result in low potential for eastern box turtles and gray ratsnakes to occur in the project area. Suitable habitat for mudpuppies may be available in the Salt River but this species was not targeted for surveys in 2019.

Table 3. Summary of species observed during herpetological surveys conducted within the Salt River Marsh project area in 2019.

Common Name	Scientific Name	Survey Method(s) that Documented Species[1]	Stand(s) in which Species Observed
Eastern American Toad	*Bufo [Anaxyrus] americanus americanus*	V	5, 8
Green Frog	*Rana clamitans melanota*	V, A, T	4, 5, 7, 10
Eastern Gray Treefrog	*Hyla versicolor*	A	10
Painted Turtle	*Chrysemys picta*	T, V	7, 8, 10
Eastern Snapping Turtle	*Chelydra serpentina serpentina*	T	7, 10

[1]Survey methods: V = Visual encounter surveys; A = Auditory surveys; T = Aquatic funnel trapping surveys.

Figure 21. Eastern American toad (*Bufo [Anaxyrus] americanus americanus*). Photo by Yu Man Lee.

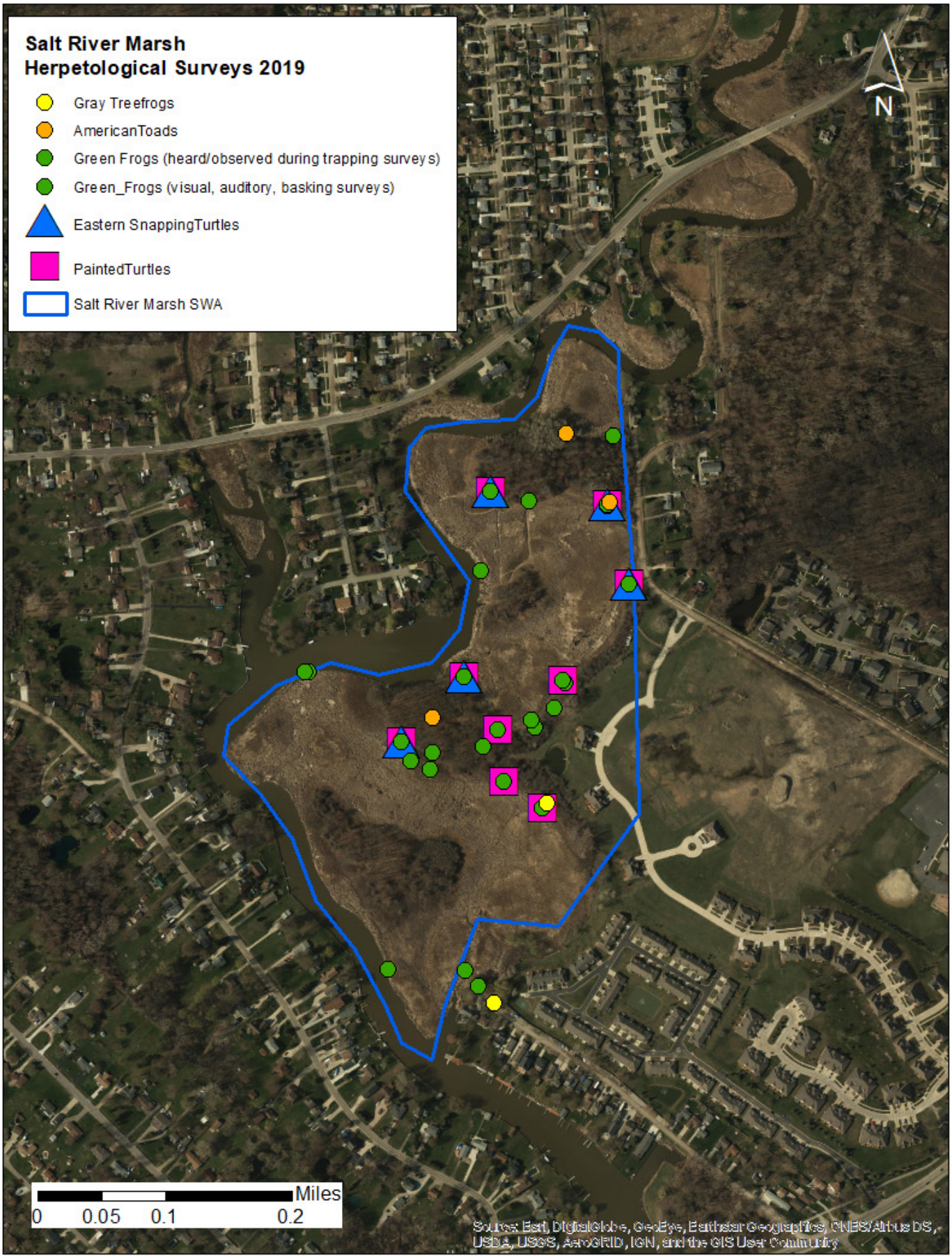

Figure 22. Map of herpitile species found during surveys of the Salt River Marsh State Wildlife Area.

Figure 23. Painted turtle (*Chrysemys picta*) hatchling. Photo by Yu Man Lee.

Figure 24. Painted turtle (*Chrysemys picta*) sub-adult female. Photo by Yu Man Lee.

Figure 25. Eastern snapping turtle (*Chelydra serpentina serpentina*). Photo by Yu Man Lee.

Stream Assessment and Macroinvertebrate Survey - Results:

The start of reach 1 (transect A) was located near the downstream end of the state wildlife area at latitude 42.66187, longitude -82.78065. Transect K, the most upstream transect in Reach 1, was located at 42.66521, -82.78139. The beginning of reach 2 (transect A) was located 50m upstream of reach 1 at 42.66566, -82.78082 and the end (transect K) at 42.66780, -82.77924. The beginning of reach 3 (transect A) was located 50m upstream of reach 2 at 42.66815, -82.77864 and the end (transect G) at 42.66872, -82.77632. Transects were spaced 50m apart within each transect. Water depth at the thalweg ranged from 2.0-2.4m in reach 1, and 1.8-2.1m in reach 2 and in reach 3. The habitat assessment and macroinvertebrate survey took place September 24-26th, 2019.

A steel sea wall and residential lawns were present along the right riverbank (facing downstream) for nearly the entire length of reach 1 and parts of reaches 2 and 3. Riparian vegetation width and aquatic vegetation scores for the right riverbank were low because of this heavy habitat modification (Tables 4-6). The left riverbank scored higher for riparian vegetation width and aquatic vegetation due to its more natural state and function, even with the presence of invasive common reed. LWD scores were especially low in reach 1 due to minimal sources for large woody debris input into the river.

The river bottom at the thalweg consisted mostly of fine silty substrates throughout reaches 1-3 and scored low for this reason. A high proportion of the river bottom was covered in fine sediments and bottom deposition scores were accordingly low. Following MDEQ 2013 protocols, stability of the riverbank with a sea wall was scored on an assessment of its condition absent of the artificially provided stability of the riverbank protection. Areas of the right bank with a sea wall were scored low. The number of off channel habitats was greatest in reach 1 and lowest in reach 3. The total habitat score was highest for reach 2 (41 out of a possible 100) but all three reaches were within the "marginal" rating (Table 7).

A total of 29 macroinvertebrate taxa representing 11 orders and at least 29 different families were identified in samples from the Salt River within the State Wildlife Area (Table 8). The most abundant macroinvertebrate taxa was the narrow-winged damselfly family (Odonata: Zygoptera: Coenagrionidae: *Enallagma* sp.)(Figure 26). In contrast, no Plecoptera (stoneflies) or Trichoptera (caddisflies) were present in the samples. Only two individuals of the order Coleoptera (beetles) were found including one riffle beetle (Elmidae) and one crawling water beetle (Haliplidae: *Peltodytes* sp.)(Figure 27). All five functional feeding groups (collector filterer, collector gatherer, predator, scraper, and shredder) were generally well represented in each reach and the "excellent" ratings all three reaches received reflect this. Only 2 families from the orders Ephemeroptera, Trichoptera, and Plecoptera were represented in each reach and this is reflected in the "poor" ratings the three reaches received in the % Trichoptera, EPT richness, and Plecoptera taxa richness metrics.

Macroinvertebrate metric ratings were the same for all three reaches except for total taxa richness, which rated lower in reach 3, Diptera taxa richness, which rated higher in reach 2, and % dominant taxa, which rated highest in reach 1 and lowest in reach 2. The total macroinvertebrate score was highest for reach 1, followed by reach 2, then reach 3 (Table 8).

Table 4. Stream habitat metric data from the Salt River within the Salt River Marsh State Wildlife Area - Reach 1. For a detailed explanation of habitat metrics see Appendix H (MDEQ 2013).

Transect	Bank	Riparian vegetation width	LWD	Aquatic vegetation	Thalweg substrate	Depostion	Bank stability	Bank stability	Off-channel habitat
A	L	13	5	57.5	no coarse	90	5		1
	R	0		25		90		0	
B	L	13		57.5		90	5		
	R	0		25		90		0	
C	L	13		57.5		90	5		
	R	0		25		90		0	
D	L	21		57.5		100	5		
	R	0		25		90		0	
E	L	20		25		90	5		
	R	0		25		90		0	
F	L	17		57.5		100	5		
	R	5		5		90		0	
G	L	15		87.5		100	5		
	R	15		25		90		3	
H	L	13		87.5		100	5		
	R	5		5		90		3	
I	L	13		25		100	5		
	R	0		25		90		0	
J	L	13		87.5		100	5		1
	R	0		25		100		0	
K	L	13		25		100	5		
	R	1		5		100		0	

Table 5. Stream habitat metric data from the Salt River within the Salt River Marsh State Wildlife Area - Reach 2. For a detailed explanation of habitat metrics see Appendix H (MDEQ 2013).

Transect	Bank	Riparian vegetation width	LWD	Aquatic vegetation	Thalweg substrate	Depostion	Bank stability	Bank stability	Off-channel habitat
A	L	22	13	57.5	no coarse	100	4		1
	R	1		57.5		100		1	
B	L	23		5		90	4		
	R	0		87.5		100		1	
C	L	23		57.5		80	4		
	R	2		87.5		100		1	
D	L	12		57.5		100	5		
	R	0		25		80		1	
E	L	23		57.5		100	5		
	R	0		5		90		1	
F	L	13		57.5		100	5		
	R	5		25		90		1	
G	L	13		25		90	5		
	R	2		25		90		5	
H	L	13		25		100	5		
	R	4		57.5		100		4	
I	L	13		57.5		100	5		
	R	9		25		90		4	
J	L	13		25		90	5		
	R	3		25		80		2	
K	L	20		87.5		100	5		
	R	0		57.5		90		2	

Table 6. Stream habitat metric data from the Salt River within the Salt River Marsh State Wildlife Area - Reach 3. For a detailed explanation of habitat metrics see Appendix H (MDEQ 2013).

Transect	Bank	Riparian vegetation width	LWD	Aquatic vegetation	Thalweg substrate	Depostion	Bank stability	Bank stability	Off-channel habitat
A	L	23	12	5	no coarse	90	5		
	R	0		57.5		100		0	
B	L	23		57.5		90	4		
	R	4		25		90		1	
C	L	13		87.5		100	5		
	R	0		57.5		90		1	
D	L	21		57.5		100	5		
	R	12		25		90		1	
E	L	21		57.5		100	5		
	R	4		57.5		100		4	
F	L	13		57.5		100	5		
	R	2		57.5		100		4	
G	L	13		25		90	5		
	R	12		87.5		100		5	

Table 7. Habitat metric scores and ratings for Salt River reaches 1-3. For a detailed explanation of scores calculations see Appendix H (MDEQ 2013). Total habitat ratings are "excellent" (100-84), "good" (83-56), "marginal" (55-28), and "poor" (27-0).

	Reach 1		Reach 2		Reach 3	
	Value	Score	Value	Score	Value	Score
Riparian width	8.64	9	9.73	10	11.50	10
LWD	20	2	52	6	80	9
Aquatic vegetation	38.18	10	45.00	15	54.38	15
Thalweg substrate	no coarse	0	no coarse	0	no coarse	0
Depostion	94.09	0	93.64	0	95.71	0
Bank stability (Left)	5.000		4.727		4.857	
Bank stability (Right)	0.545		2.091		2.857	
Bank stability combined	5.545	6	6.818	7	7.714	8
Off-channel habitat	8	5	4	3	0	0
Total habitat score		32		41		42
Total habitat rating		Marginal		Marginal		Marginal

Table 8. Number of individuals of each macroinvertebrate taxa collected in 11 samples from Salt River reaches 1 and 2, and seven samples in reach 3. (FFG= functional feeding group: CF-collector filterer; CG-collector gatherer; P-predator; Sc-scraper; Sh-shredder)

Common Name	Order/subclass	Family	Reach 1	Reach 2	Reach 3	FFG
Leeches	Hirudinea		1	1		P
Microdrile worms	Oligochaeta		12	2	8	CG
Sideswimmers	Amphipoda		20	13	12	Sh
	Isopoda		1			Sh
Mayflies	Ephermoptera	Baetidae	1		1	CG
		Caenidae	8	9	19	CG
Dragonflies and damselflies	Odonata	Aeshnidae	1	1		P
		Coenagrionidae	27	158	75	P
		Cordulliidae	1	1	1	P
		Corixidae	1			CG
		Gerridae			2	P
		Libellulidae	5	12	18	P
Butterflies and moths	Lepidoptera	Pyralidae	8	31	11	Sh
Beetles	Coleoptera	Elmidae		1		CG
		Haliplidae		1		Sh
Flies	Diptera	Chaoboridae		1		P
		Chironomidae	13	28	6	CG
		Sciomyzidae		1		P
		Stratiomyidae	2			CG
		Tipulidae		2		CG
Snails and limpets	Gastropoda	Ancylidae	4		1	Sc
		Bithyniidae	8	11	4	Sc
		Hydrobiidae		4	1	Sc
		Lymnaeidae		1		Sc
		Physidae	17	35	23	Sc
		Planorbidae	9	18	28	Sc
		Viviparidae	1			Sc
Mussels and clams	Pelecypoda	Dreissenidae	6	1		CF
		Sphaeriidae	11	4	2	CF

Figure 26. American bluet (*Enallagma* sp.) of the narrow-winged damselfly family (Odonata: Zygoptera: Coenagrionidae) was the most abundant macroinvertebrate found during surveys Photo by Peter Badra.

Figure 27. This crawling water beetle (Haliplidae: *Peltodytes* sp.) was one of only two Coleoptera found during macroivertebrate surveys. Photo by Peter Badra.

Table 9. Macroinvertebrate metric scores and ratings for Salt River reaches 1-3. For a detailed explanation of score calculations see Appendix H (MDEQ 2013). Total macroinvertebrate scores range from a possible 0-100. (FFG= functional feeding group: CF-collector filterer; CG-collector gatherer; P-predator; Sc-scraper; Sh-shredder)

	Reach 1	Reach 2	Reach 3
CF- collector filterer	17	5	2
CG- collector gatherer	37	42	34
P- predator	35	175	96
Sc- scraper	39	69	57
Sh- shredder	31	45	23
-SumPi(log2Pi)	2.272	1.813	1.862
FFG Score	25	25	25
FFG Rating	excellent	excellent	excellent
(Sc+CF)/(CG+Sh)	0.824	0.851	1.035
Habitat surrogate score	8	8	8
Habitat surrogate rating	marginal	marginal	marginal
% Trichoptera	0	0	0
% Trichoptera score	0	0	0
% Trichoptera rating	poor	poor	poor
# of EPT families	2	1	2
EPT richness score	0	0	0
EPT richness rating	poor	poor	poor
# of Taxa	21	22	16
Total taxa richness score	5	5	2
Total taxa richness rating	good	good	marginal
Diptera taxa richness	2	4	1
Diptera taxa richness score	2	4	0
Diptera taxa richness rating	poor	good	poor
Plecoptera taxa richness	0	0	0
Plecoptera taxa richness score	0	0	0
Plecoptera taxa richness rating	poor	poor	poor
% Dominant taxa	16.98	47.02	35.38
% Dominant taxa score	5	2	4
% Dominant taxa rating	excellent	poor	good
Total macroinvertebrate score	45	44	39

Discussion

Habitat Stand Delineation and Characterization (Community Survey) - Discussion:

While most of the habitat was very disturbed relative to historical (pre-European settlement) conditions, portions of some of the stands possessed higher-quality attributes that can serve as initial benchmarks for restoration efforts. In the wetlands, two patches of remnant sedge meadow likely characterize the historical, pre-disturbance conditions (Figure 10). Care should be taken to avoid impacting these areas during both dredging of the stream channel and spraying of invasive species. Certain portions of the upland stands also better represent historical conditions (Figure 10). These portions are broadly characterized by dominance by large-diameter oak species. With the exception of stand 9, which is more strongly influenced by ponding or flooding which limits the establishment of a ground-layer, moderate quality oak stands are also characterized by a ground-layer that is more diverse and densely vegetated.

Herpetological Survey - Discussion:

Herpetological surveys in the Salt River Marsh project area in 2019 documented five common amphibian and reptile species. These included eastern American toads, eastern gray treefrogs, green frogs, painted turtles, and eastern snapping turtles. These species utilize a wide variety of habitat types, can tolerate a variety of habitat conditions, and can persist in urban and suburban landscapes (Harding and Mifsud 2017). Potential exists for additional common amphibian and reptile species to occur in the project area, particularly the eastern red-backed salamander, Midland or western chorus frog, northern spring peeper, eastern musk turtle, northern map turtle, eastern spiny softshell turtle, northern water snake, eastern garter snake, northern ribbon snake, DeKay's or northern brown snake, northern red-bellied snake, and eastern milk snake. These species may not have been documented in 2019 due to timing and limited nature or extent of the herpetological surveys. For example, auditory surveys were conducted a little later than originally proposed (i.e., in late June/early July instead of May/June) due to contracting delays and likely missed the breeding periods for a few frog species that breed and call earlier in the spring. Visual encounter and aquatic funnel trapping surveys were primarily conducted along the shoreline or edge of the emergent marsh due to high water levels in the marsh and may have missed detecting species that occur in other parts of the marsh.

Some species may not occur within the project area due to limited extent and/or condition of available habitat within the project area, landscape context surrounding the project area, and other potential threats or limiting factors such as pollution (e.g. chemical contamination from surrounding homes and roads or invasive species treatment). Collection or persecution by humans also may have impacted presence or abundance of some herpitile species within the project area. One of the landowners across the road from the project area indicated garter snakes were regularly removed from the project area by adjacent landowners.

Potential exists for several RTE amphibian and reptile species to occur within or adjacent to the project area although the potential may be low. These species include the eastern fox snake, Blanding's turtle, Butler's garter snake, eastern box turtle, and common mudpuppy. These species can be cryptic and difficult to detect, especially if they occur in low numbers, and may not have been detected due to the timing and limited extent of the surveys in 2019 (except for the mudpuppy which was not targeted for surveys in 2019). However, it is more likely that the potential for these species to currently occur within the project area is low due to limited habitat extent and condition and surrounding landscape context. Eastern fox snakes are closely associated with marsh and open dry upland habitats (e.g., old fields, prairies) and can occur in landscapes with small habitat patches as long as snakes can move between habitat patches and populations (Ernst and Barbour 1989, Row *et al.* 2012). Eastern fox snakes also can be locally common in areas where extensive habitat is still available (Harding and Mifsud 2017). Blanding's turtles often utilize and move between different wetland types, travel extensive distances within aquatic habitats and/or over land for nesting, foraging and overwintering, and require

large areas of habitat (Congdon *et al.* 1983, Ross and Anderson 1990, Joyal *et al.* 2002, U.S. Fish and Wildlife Service (USFWS) 2011 and 2019). The wetland and upland habitats within and around the project area may not provide sufficient habitat to support eastern fox snakes and/or Blanding's turtles currently. Similarly, while Butler's garter snakes and eastern box turtles have been reported fairly close to the project area (within 2-3 km/1-2 mi), current habitats within the project area may not be adequate to support these species. Butler's garter snakes can use emergent marshes, but they generally prefer wet grassy/sedgy habitats such as wet meadows and wet prairies (Environment Canada 2016, Harding and Mifsud 2017). Only small, remnant patches of sedge meadow occur within the project area. Eastern box turtles are associated with forested habitats with sandy soils near a source of water such as a stream, pond, lake, marsh or swamp, and access to unshaded nesting sites in sandy, open areas is critical for successful reproduction (Tinkle *et al.* 1979). The forest habitats within the project area currently may be too closed canopy and shaded and may not have sufficient ground cover in some areas for eastern box turtles to use.

Potential for other target RTE amphibian and reptile species to occur within the project area is also likely low. While Blanchard's cricket frogs, pickerel frogs, spotted turtles can use emergent marshes, they are generally more closely associated wet grassy/sedgy habitats such as wet meadows, wet prairies, fens and bogs (Ernst *et al.* 1994, Lee *et al.* 2000, Harding and Mifsud 2017). Blanchard's cricket frogs, pickerel frogs, and spotted turtles also require or prefer clean, clear water and appear to be sensitive to or intolerant of pollution (Lee 2000, Lee *et al.* 2000, Ernst and Lovich 2009, Harding and Mifsud 2017). Additionally, the auditory surveys conducted in the project area in 2019 overlapped the Blanchard's cricket frog's breeding period and likely would have documented the species if it was breeding there. Queen snakes prefer small to medium-sized, clear, spring-fed streams and rivers that are permanent and relatively shallow with rocky- or gravelly substrates, abundant crayfish, and shoreline vegetation and open areas for basking (Vogt 1981, Phillips *et al.* 1999, COSEWIC 2010, Harding and Mifsud 2017, NatureServe 2019). Queen snakes also occur in marshes, ponds, lakeshores, drainage canals, and ditches (COSEWIC 2010, WI DNR 2012). Queen snakes may have potential to occur along the Salt River but the river may be too deep and information on the crayfish population and river bottom is lacking.

Additional herpetological surveys would provide a more complete understanding of the amphibian and reptile community that could potentially be impacted by and benefit from habitat restoration efforts in the Salt River Marsh project area. Conducting additional surveys earlier in the spring and increasing survey effort (e.g., conducting surveys over a longer period of time or more survey visits, surveying additional areas within the project area, and/or setting more cover boards or traps) may document additional amphibian and reptile species within the project area. Utilizing a combination of survey methods including visual encounter surveys, basking surveys, auditory surveys, aquatic funnel trapping, and artificial cover surveys would increase detectability of different amphibian and reptile species. For example, eastern gray treefrogs were only detected during auditory surveys and snapping turtles were only detected during aquatic funnel trapping surveys. Additionally, aquatic funnel trapping surveys could be used to inform and monitor potential impacts of habitat restoration efforts in the project area given the number of turtles that were captured and the standardized protocol. Monitoring the species, number and demographics of individuals captured over time could be informative.

While proposed habitat restoration efforts for the Salt River Marsh project area have potential to improve habitat for amphibian and reptile species that occur within and adjacent to the project area, they also have potential to adversely impact some of these species particularly during the implementation of these activities. Dredging in the emergent marsh stands has potential for impacting turtles using these habitats, particularly during the winter when turtles may be overwintering in the marsh. Snapping turtles and painted turtles overwinter underwater and buried in muddy substrates along the edge or in the bottom of marshes, ponds, and other wetlands/waterbodies (Meeks and Ultsch 1990, Ernst and Lovich 2009, COSEWIC 2018). These turtles may not be able to successfully avoid equipment or move to other areas if they overwinter in areas that are dredged. Dredging

the marsh during late spring, summer and/or early fall would minimize the potential for adversely impacting overwintering turtles. Reducing chemical pollution and minimizing the use of chemicals (e.g., herbicides) during habitat restoration efforts would benefit amphibian and reptile species occurring within the project area (Mifsud 2014). Creating more open forest conditions and increasing ground vegetation and ground cover (e.g., leaf litter, woody debris) also would enhance habitat for some amphibians and reptiles that occur or have potential to occur within the project area. Finally, education and outreach in the local community to reduce collection and/or persecution of amphibians and reptiles, particularly snakes, would be beneficial for restoring the herp community in the Salt River Marsh project area.

Stream Assessment and Macroinvertebrate Survey - Discussion:

Future stream assessments can allow for a comparison of metric scores over time in the Salt River Marsh assuming the same number of transects within each reach is sampled. However, the fewer number of macroinvertebrate samples collected in reach 3 (seven) compared to reaches 1 and 2 (11) most likely biased reach 3 scores to be lower for two metrics; total number of taxa and Diptera richness. Two additional EPT families would have been needed to change the EPT richness score/rating from 0/poor to 3/marginal, and no Plecoptera were collected in the entire survey, so these two metrics were not likely different by having fewer samples in reach 3. The other four metrics were based on proportional data (i.e. FFG rating, habitat surrogate rating, % Trichoptera, and % dominant taxa) and are not likely biased by the shorter length of reach 3. The shorter length of reach 3 was accounted for in calculating the large woody debris and off-channel habitat scores by multiplying actual counts by 6.66 (2000m/300m) to get the metric value. Other habitat metrics were not likely biased due to the shorter reach 3.

The bank that is part of the Salt River Marsh State Wildlife Area (left bank) tended to score higher in riparian vegetation width, aquatic vegetation, and bank stability than the right bank, which was often dominated by a seawall and residential lawns. River ecosystems and fauna can be affected by local habitat modification and also by impacts upstream. Human activity at the watershed level can influence river ecosystems and the macroinvertebrate fauna that inhabits them. The biological metrics based on macroinvertebrate data and used in the MDEQ 2013 protocols to infer human caused impacts, were developed based on a dissertation by Wessell (2004). The general types of impacts or stressors each metric is thought to respond to is described on page 9 of the MDEQ 2013 protocols and are summarized below.

The "excellent" rating that all three reaches scored in the functional feeding group (FFG) diversity metric is thought to correspond with low levels of human disturbance (i.e. riparian land use, total phosphorus, and turbidity) (Opdyke Wilhelm 2002). Three macroinvertebrate metrics scored "poor" for all three sample reaches: percent Trichoptera; Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa richness; and Plecoptera taxa richness. Percent trichoptera has been shown to have a negative correlation to agricultural riparian land use. EPT taxa richness has a positive correlation with large woody debris at the site scale and a negative correlation to urban land use at the watershed scale. Plecoptera taxa richness is thought to have a positive correlation to percent natural land use in riparian buffers and the presence of large woody debris.

Some portion of fine particulate organic matter (FPOM) deposition is likely part of the natural state of the lower section of the Salt River, due to slow flow/low gradient within the study area. Excessive deposition of FPOM has also likely occurred due to disturbance to the watershed such as increased impermeable surface area leading to increased erosion and flashiness upstream.

Three aquatic invasive animal species were identified in macroinvertebrate samples. Faucet snails (*Bithynia tentaculata*) were found in all three reaches and 11 of the 29 transects sampled (Figure 28). Faucet snail, a native of Eurasia, is now established throughout the Great Lakes including parts of the lower and upper

peninsula of Michigan. The first record of it in Michigan is from 1891 and it was likely first introduced through solid ballast material of Great Lakes timber ships. Faucet snail can carry a parasite that is thought to have caused annual die-offs in the upper Mississippi River of waterfowl that eat them (Hubbuch 2016 and Stachura 2008). The species is known to displace and reduce diversity of native snail fauna as well (Harman 2000). Zebra mussels (*Dreissena polymorpha*) were found in two of the 29 transects sampled (two of the three reaches). No rare, threatened, or endangered aquatic animal species were encountered. It was noted though that conditions within the study area were not conducive to detecting unionid mussels, i.e. water clarity was low and water depth was high. No crayfish were caught during D-net sweeps for macroinvertebrates.

Figure 28. Faucet snail (*Bithynia tentaculata*) is an invasive aquatic species that was present in 11 of 29 transects sampled in the macroinvertebrate survey of the Salt River. The smaller shell on the right is Tadpole physa (Physidae: *Physella gyrina*). Photo by Peter Badra.

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Appendices A-J.

Appendix A. Field data sheet for timed meander plant surveys, page 1.

Timed Meander Search

Observer: Start time:	Date: End time:	Location: Start pt:	Habitat Area: End pt:	Community type:

Time:	Species:	Time:	Species:	% cover canopy:
0-5				% cover subcanopy: % cover groundlayer:
				Dominant vegetation
				Canopy: (DBH in cm, age)
				Subcanopy:
				Groundlayer:
				Soil Texture: pH:
				Photos (#-date-time-subject)

Notes:

Enter time every 5 minutes; Unknowns: *date-area-initials-unique name*

Sheet: ____of____

Appendix A. Field data sheet for timed meander plant surveys, page 2.

Timed Meander Search

Time:	Species:	Time:	Species:	Time:	Species:

Enter time every 5 minutes; Unknowns: *date-area-initials-unique name*

Sheet: ____of____

Appendix B. Summary of amphibian and reptile species that have potential to occur in or adjacent to the Salt River Marsh project area and recommended survey seasons and methods/techniques based on Graeter *et al.* 2013.

Species Common Name	Scientific Name	State Status	Season	Survey Method(s)	
Common Mudpuppy	*Necturus maculosus maculosus*	SC	Y	C [r]	C [r] - Cover - searching under rocks and stones
Eastern Newt	*Notophthalmus viridescens*		SP, SU	V, T [mt]	T [mt] - Trapping with minnow traps
Eastern Red-backed Salamander	*Plethodon cinereus*		SP, SU, AU	C [w]	C [w] - Cover - wooden coverboards
Eastern American Toad	*Bufo [Anaxyrus] americanus americanus*		SP, SU	V, D [pf], A [a]	D [pf] - Drift fence - pitfalls, , A [a] -Auditory surveys - active
Blanchard's Cricket Frog	*Acris blanchardi*	T	SP, SU, AU	A [r], A [a]	A [r] - Auditory surveys recording calls; A [a] - Auditory Surveys - active - listening for calls
Midland or Western Chorus Frog	*Pseudacris triseriata triseriata*		SP	A [a]	A [a] - Auditory Surveys - active - listening for calls
Northern Spring Peeper	*Pseudacris crucifer crucifer*		SP	V, A [r]	A [r] - Auditory surveys recording calls
Eastern Gray Treefrog	*Hyla versicolor*		SP, SU	V, A [a]	A [a] - Auditory Surveys - active - listening for calls
Bullfrog	*Rana catesbeiana*		SP, SU	V, A [a]	A [a] - Auditory Surveys - active - listening for calls
Green Frog	*Rana clamitans melanota*		SP, SU	V, A [a]	A [a] - Auditory Surveys - active - listening for calls
Northern Leopard Frog	*Rana pipiens*		SP, SU	V, A [a]	A [a] - Auditory Surveys - active - listening for calls
Pickerel Frog	*Rana palustris*	SC	SP, SU	V, A [a]	A [a] - Auditory Surveys - active - listening for calls
Eastern Snapping Turtle	*Chelydra serpentina serpentina*		SP, SU, AU	V, T [h]	T [h] - Trapping - hoop nets
Eastern Musk Turtle	*Sternotherus odoratus*		SP, SU, AU	V, T [h], T [cr]	T [h] - Trapping - hoop nets; T [cr] - Trapping - crawfish traps
Spotted Turtle	*Clemmys guttata*	T	SP, SU, AU	V [bk]	V [bk] - Visual Encounter Survey (VES) - Searching for basking individuals
Blanding's Turtle	*Emydoidea blandingii*	SC	SP, SU, AU	T [h], V [bk]	T [h] - Trapping - hoop nets; V [bk] - VES - Searching for basking individuals
Eastern Box Turtle	*Terrapene carolina carolina*	SC	SP, SU, AU	V, V [r]	V -VES - general; V [r] - VES - road cruising
Northern Map Turtle	*Graptemys geographica*		SP, SU, AU	V [bk]	V [bk] - VES - Searching for basking individuals
Painted Turtle	*Chrysemys picta*		SP, SU, AU	V [bk]	V [bk] - VES - Searching for basking individuals
Eastern Spiny Softshell Turtle	*Apalone spinifera spinifera*		SP, SU,AU	V [bk], T [fy]	V [bk] - VES - Searching for basking individuals; T [fy] - Trapping with fyke nets
Red-eared Slider	*Trachemys scripta elegans*		SP, SU, AU	T [h], V [bk]	T [h] - Trapping - hoop nets; V [bk] - VES - Searching for basking individuals
Northern Water Snake	*Nerodia sipedon sipedon*		SP, SU, AU	V [bk], V, T [mt]	V [bk] - VES - Searching for basking individuals; V - VES general; T [mt] - Trapping - minnow traps
Queen Snake	*Regina septemvittata*	SC	SP, SU, AU	C, V [bk]	C - Cover objects - general; V [bk] - VES - Searching for basking individuals
Butler's Garter Snake	*Thamnophis butleri*	SC	SP, SU, AU	C, V	C - Cover objects - general; V - VES - general
Eastern Garter Snake	*Thamnophis sirtalis sirtalis*		SP, SU, AU	V, C, V [r]	V - VES - general; C - Cover objects - general; V [r] - VES - road cruising
Northern Ribbon Snake	*Thamnophis sauritus septentrionalis*		SP, SU, AU	V	V - VES - general
DeKay's/Northern Brown Snake	*Storeria dekayi dekayi*		SP, SU, AU	C, D [pf]	C -Cover objects - general; D [pf] - Drift fence - pitfalls
Northern Red-bellied Snake	*Storeria occipitomaculata occipitomaculata*		SP, SU, AU	C [w]	C [w] - Cover objects - wooden coverboards
Eastern Fox Snake	*Pantherophis gloydi*	T	SP, SU, AU	C, V [r]	C - Cover objects - general; V [r] - VES - road cruising
Gray Ratsnake	*Pantherophis spiloides*	SC	SP, SU, AU	V [r], C	V r - VES - road cruising; C - Cover objects - general
Eastern Milk Snake	*Lampropeltis triangulum triangulum*		SP, SU, AU	V [r], V, D [pf], C	V - VES - general; C - Cover objects - general; V [r] - VES - road cruising; D [pf] - Drift fence - pitfalls

State Status: T - Threatened; SC - Special Concern
Season - Survey Season: SP - Spring; SU - Summer; AU - Autumn; Y - All Year

Appendix C. Field data sheet for herpetological surveys - Visual/basking, page 1.

MNFI AMPHIBIAN AND REPTILE SURVEY FORM

I. SURVEYOR & WEATHER INFORMATION

Observer(s)_____ Date_____ Project: _____

Time Start _____ Time End _____ Weather: Air Temp – Start_____End _____ RH – Start_____ End_____

Sky Code – Start _____ End _____ Wind Code - Start _____ End _____ Precip Code - Start_____ End _____

II. LOCATION INFORMATION

Site/Property Name _____ County_____ Town, Range, Sec_____

Stand Number(s)_____ Stand habitat type(s)/classification(s)_____

Directions/access _____

_____

GPS Unit Type & #: _____ GPS Waypoint(s): _____ GPS Track(s): _____

III. SURVEY INFORMATION

Survey Method(s): _____Target species/group _____

Target/rare species found? Yes No Comments: _____

Habitat for target species/group found? Yes No Comments: _____

Species found (common or rare)	Number	Location (GPS, landmarks)	Notes (habitat, behavior, condition, etc.)

Survey comments (area surveyed, potential for other rare species, revisit warranted, photos taken? etc.)

_____

_____

_____

_____

IV. SITE/HABITAT DESCRIPTION - Describe site/habitat in relation to species surveyed for – presence, quantity, and quality of suitable habitat, crayfish burrows, dominant vegetation, natural communities, habitat structure, etc.

_____

_____

_____

_____

_____

_____

_____

04/24/2019

Appendix C. Field data sheet for herpetological surveys - Visual/basking, page 2.

V. THREATS TO SPECIES/HABITAT AND MANAGEMENT CONSIDERATIONS

Disturbance/threats (e.g., habitat loss/fragmentation, woody encroachment/succession, predation, disease, ORV's, mtn bike use, grazing, structures, past logging, plantations, development, erosion, ag, runoff, hydrologic alteration, chemical pollution, etc.)

_____

Exotic species (plants or animals)_____

_____

Stewardship Comments _____

_____

EO Ranking/Viability Considerations _____

_____

VI. ADDITIONAL ASSOCIATED SPECIES FOUND

Species found (common or rare)	Number	Location (GPS, landmarks)	Notes (habitat, behavior, condition, etc.)

VII. Additional Comments or Map/drawing of general area surveyed and approximate locations of suitable habitat and/or rare species found

Wind Codes (Beaufort wind scale):

0 = Calm (< 1 mph) smoke rises vertically

1 = Light air (1-3 mph) smoke drifts, weather vane inactive

2 = Light breeze (4-7 mph) leaves rustle, can feel wind on face

3 = Gentle breeze (8-12 mph) leaves and twigs move, small flag extends

4 = Moderate breeze (13-18 mph) moves small tree branches, twigs & leaves, raises loose paper

5 = Strong breeze (19-24 mph) small trees sway, branches move, dust blows

6 = Windy (> 24 mph) larger tree branches move, whistling

Precipitation Codes:

0 = None

1 = Mist

2 = Light rain or drizzle

3 = Heavy rain

4 = Snow/hail

Sky Codes:

0 = Sunny/clear to few clouds (0-5%)

1 = Mostly sunny (5-25% cloud cover)

2 = Partly cloudy, mixed variable sky (25-50%)

3 = Mostly cloudy (50-75%)

4 = Overcast (75-100%)

5 = Fog or haze

04/24/2019

Appendix D. Field data sheet for herpetological surveys - Auditory, page 1.

MNFI Amphibian Auditory Survey Form

Survey Date: _____ **Project:** _____ **Surveyors:** _____

Survey Start Time: _____ **Site/Property:** _____ **Stand Number(s) & Habitat:** _____

Survey End Time: _____ **County:** _____ **T, R, S:** _____ **Landowner(s):** _____

Beginning Weather: **Air temp (°F):** _____ **Sky Code:** **Wind Code:** _____ **GPS Unit/Tablet:** _____

Rel. humidity (%): _____ **Precipitation Code:** _____ **Last Rain Event:** _____

Listening Station #	Listening Time	Species Heard	Call Index (0, 1, 2, 3)	Habitat Type/Description	Photos?	GPS Waypoints/ Coordinates	Comments:

Ending Weather: **Air temp (°F):** _____ **Sky Code:** _____ **Wind Code:** _____

Rel. humidity (%): _____ **Precipitation Code:** _____

Appendix D. Field data sheet for herpetological surveys - Auditory, page 2.

Other Species Present: List additional species observed at this site. Note especially listed species and potential predators. :

Species:	Number observed	Notes, observations, etc.

Directions to survey site and location if first time to site/location and how to access survey site/location/ Additional Comments (incl. habitat descriptions):

****Attach map, air photo or drawing indicating survey area, survey routes and locations of massasaugas and/or suitable habitat.**

Sky Codes:

0 = Sunny/clear to few clouds (0-5% cloud cover)
1 = Mostly sunny (5-25% cloud cover)
2 = Partly cloudy, mixed or variable sky (25-50%)
3 = Mostly cloudy (50-75%)
4 = Overcast (75-100%)
5 = Fog or haze

Wind Codes (Beaufort wind scale):

0 = Calm (< 1 mph) smoke rises vertically
1 = Light air (1-3 mph) smoke drifts, weather vane inactive
2 = Light breeze (4-7 mph) leaves rustle, can feel wind on face
3 = Gentle breeze (8-12 mph) leaves and twigs move, small flag extends
4 = Moderate breeze (13-18 mph) moves small tree branches, twigs & leaves, raises loose paper
5 = Strong breeze (19-24 mph) small trees sway, branches move, dust blows
6 = Windy (> 24 mph) larger tree branches move, whistling

Precipitation Codes:

0 = None
1 = Mist
2 = Light rain or drizzle
3 = Heavy rain
4 = Snow/hail

Macrohabitats:

PFO = Palustrine Forested Wetland: standing water at least part of the year, tree canopy cover exceeds 30%.
PSS = Palustrine Scrub-Shrub Wetland: shrub cover exceeds 30%, but tree cover does not.
SDG = Palustrine Emergent Wetland dominated by sedges.
CAT = Palustrine Emergent Wetland dominated by cattails.
UFO = Upland Forest: >30% tree canopy cover, elevated above any potential flooding by sloping topography.
USS = Upland Scrub-Shrub: berry bushes, willows, crab apples and hawthorns, typically mid-succession.
OLD = Oldfield: fallow fields covered with herbaceous or grassy cover, includes CRP lands.

Appendix E. Field data sheet for herpetological surveys - Coverboards, page 1.

Page ______ of ______

MNFI Herp Artificial Cover / Coverboard (CB) Survey Form

Survey Date: ____________ **Project:** ______________________________ **Surveyors:** ______________________________

Survey Start Time: ____________ **Site/Property:** ______________________________ **Stand Number(s) & Habitat:** ______________________________

Survey End Time: ____________ **County:** ______________________ **T, R, S:** ______________ **Landowner(s):** ______________________

Beginning Weather: **Air temp (°F):** __________ **Sky Code:** **Wind Code:** ________ **GPS Unit/Tablet:** ______________________

Rel. humidity (%): __________ **Precipitation Code:** ________ **Last Rain Event:** ______________________

CB #	CB Type	Crayfish Burrows ?	Species & # Individuals Found	Photos?	GPS Waypoints/ Coordinates	Comments:
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				
		Y N				

Ending Weather: **Air temp (°F):** __________ **Sky Code:** __________ **Wind Code:** __________

Rel. humidity (%): __________ **Precipitation Code:** ________ **Crayfish Burrow Density:** High / Medium / Low / Not Observed

Appendix E. Field data sheet for herpetological surveys - Coverboards, page 2.

Page _____ of _____

Other Species Present: List additional species observed at this site. Note especially listed species and potential predators. :

Species:	Number observed	Notes, observations, etc.

Directions to survey site and location if first time to site/location and how to access survey site/location/ Additional Comments (incl. habitat descriptions):

****Attach map, air photo or drawing indicating survey area, survey routes and locations of massasaugas and/or suitable habitat.**

Sky Codes:

0 = Sunny/clear to few clouds (0-5% cloud cover)
1 = Mostly sunny (5-25% cloud cover)
2 = Partly cloudy, mixed or variable sky (25-50%)
3 = Mostly cloudy (50-75%)
4 = Overcast (75-100%)
5 = Fog or haze

Wind Codes (Beaufort wind scale):

0 = Calm (< 1 mph) smoke rises vertically
1 = Light air (1-3 mph) smoke drifts, weather vane inactive
2 = Light breeze (4-7 mph) leaves rustle, can feel wind on face
3 = Gentle breeze (8-12 mph) leaves and twigs move, small flag extends
4 = Moderate breeze (13-18 mph) moves small tree branches, twigs & leaves, raises loose paper
5 = Strong breeze (19-24 mph) small trees sway, branches move, dust blows
6 = Windy (> 24 mph) larger tree branches move, whistling

Precipitation Codes:

0 = None
1 = Mist
2 = Light rain or drizzle
3 = Heavy rain
4 = Snow/hail

Macrohabitats:

PFO = Palustrine Forested Wetland: standing water at least part of the year, tree canopy cover exceeds 30%.
PSS = Palustrine Scrub-Shrub Wetland: shrub cover exceeds 30%, but tree cover does not.
SDG = Palustrine Emergent Wetland dominated by sedges.
CAT = Palustrine Emergent Wetland dominated by cattails.
UFO = Upland Forest: >30% tree canopy cover, elevated above any potential flooding by sloping topography.
USS = Upland Scrub-Shrub: berry bushes, willows, crab apples and hawthorns, typically mid-succession.
OLD = Oldfield: fallow fields covered with herbaceous or grassy cover, includes CRP lands.

Appendix F. Field data sheet for herpetological surveys - Traps, page 1.

Page _____ of _____

MNFI Amphibian and Reptile Trapping Survey Form

Survey Date: _____ **Project:** _____ **Surveyors:** _____

Survey Start Time: _____ **Site/Property:** _____ **Stand Number(s) & Habitat:** _____

Survey End Time: _____ **County:** _____ **T, R, S:** _____ **Landowner(s):** _____

Beginning Weather: **Air temp (°F):** _____ **Sky Code:** **Wind Code:** _____ **GPS Unit/Tablet:** _____

Rel. humidity (%): _____ **Precipitation Code:** _____ **Last Rain Event:** _____

Trap #	Trap Type	Species Captured	Number Captured	Habitat Type/Description	Photos?	GPS Waypoints/ Coordinates	Comments:

Ending Weather: **Air temp (°F):** _____ **Sky Code:** _____ **Wind Code:** _____

Rel. humidity (%): _____ **Precipitation Code:** _____ **Crayfish Burrow Density:** High / Medium / Low / Not Observed

Appendix F. Field data sheet for herpetological surveys - Traps, page 2.

Other Species Present: List additional species observed at this site. Note especially listed species and potential predators. :

Species:	Number observed	Notes, observations, etc.

Directions to survey site and location if first time to site/location and how to access survey site/location/ Additional Comments (incl. habitat descriptions):

****Attach map, air photo or drawing indicating survey area, survey routes and locations of massasaugas and/or suitable habitat.**

Sky Codes:

0 = Sunny/clear to few clouds (0-5% cloud cover)
1 = Mostly sunny (5-25% cloud cover)
2 = Partly cloudy, mixed or variable sky (25-50%)
3 = Mostly cloudy (50-75%)
4 = Overcast (75-100%)
5 = Fog or haze

Wind Codes (Beaufort wind scale):

0 = Calm (< 1 mph) smoke rises vertically
1 = Light air (1-3 mph) smoke drifts, weather vane inactive
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6 = Windy (> 24 mph) larger tree branches move, whistling

Precipitation Codes:

0 = None
1 = Mist
2 = Light rain or drizzle
3 = Heavy rain
4 = Snow/hail

Macrohabitats:

PFO = Palustrine Forested Wetland: standing water at least part of the year, tree canopy cover exceeds 30%.
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UFO = Upland Forest: >30% tree canopy cover, elevated above any potential flooding by sloping topography.
USS = Upland Scrub-Shrub: berry bushes, willows, crab apples and hawthorns, typically mid-succession.
OLD = Oldfield: fallow fields covered with herbaceous or grassy cover, includes CRP lands.

Appendix G. Field data sheet for herpetological surveys - Observation, page 1.

MNFI Amphbian and Reptile Observation Data Sheet (attach to survey form(s) if appropriate)

Processing Start Time: _____
Processing End Time: _____

Date: _____ **Project:** _____ **Surveyors:** _____

Species: _____ **Survey Method:** Visual / Basking | Auditory | Coverboard | Trapping - Type: _____ | Other: _____

Capture Time: _____ **Site/Property Name:** _____ **Stand #'s:** _____ **County:** _____ **T, R, S:** _____

Notch ID #: _____ **Stand/Habitat Description:** _____ **Landowner:** _____

PIT Tag #: _____ **Status:** Initial Capture | Recapture **Measured** Yes / No

Location of PIT tag: _____ **Transmitted?** Yes / No **Marked/Notched** Yes / No

Frequency: _____ **Transmitter?** New | Old / Replaced **Species Photos** Yes / No #'s: _____

GPS Unit: _____ **GPS Waypt.:** _____ **EPE:** _____ **Habitat Photos** Yes / No #'s: _____

Latitude (dd.dddd): _____ **Longitude (dd.dddd):** _____ **Blood Sample:** Yes / No

Weather: **Air temp (°F):** _____ **Sky Code:** _____ **Tissue Sample:** Yes / No

Wind Code: _____ **RH (%):** _____ **Precip. Code:** _____ **Last Precip Event:** _____

Sex: Male | Female | Gravid | Not Gravid | Not Sure Gravid | Unknown **Age class:** Adult | Juvenile | Neonate/Hatchling

Total L (cm/in): _____ **SVL (cm/in):** _____ **Tail L (cm/in):** _____ **If EMR, Rattle Description:** _____ **# Subcaudals:** _____

Carapace L (cm/in): _____ **CPW (cm/in):** _____ **Height (cm/in):** _____ **Age/Visible Annuli:** _____ **Clutch size:** _____

Plastron L (cm/in): _____ **PW (cm/in):** _____ **Mass (g):** _____ with / without transmitter

General Health: Healthy | Scars | Injuries | Markings | Deformities | Sores | Lethargy | URT Distress | Parasites | Other

Injuries: Tail | Eye | Limb | Carapace | Plastron | Body/Torso **Scale/Scute morphology:** Normal | Irregular

Activity/Behavior: Basking | Resting | Traveling (land) | Traveling (water) | Mating | Nesting | Foraging | Other (describe): _____

Observed in: Sun | Partial Sun | Filtered | Shade **Snake Behavior:** Coiled Tightly | Coiled Loosely | Looped - Touching / Not Touch | Straight

Macrohabitat / Microhabitat (natural community type, dominant canopy, understory, shrub and ground cover, species composition, moisture, microhabitat, etc.) :

_____

_____

Substrate: Sedge | Grass | Herb/Moss | Detritus/Leaf litter | Log | Rock | Bare Ground | Sand | Water | Other / Unkn

Cover: None | Shrub | Sedge/Grass | Herb/Forb | Detritus/Litter | Log | Water | Other | Unknown

Other/Unknown: _____

Soil Moisture: Inundated | Saturated | Moist (mesic) | Dry-mesic | Dry (xeric) **Habitat Type:** Active | Nesting/ Gestation | Overwintering

Tree Canopy:
___open
___partial
___filtered
___shade

Position:
___crest
___upper slope
___mid slope
___lower slope
___bottom

Slope:
___flat
___0-10
___10-35
___35+
___vertical

Additional Data/Comments:

_____

_____

_____

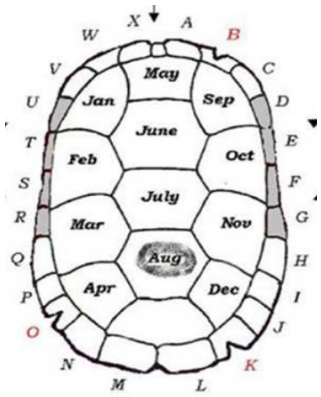
_____

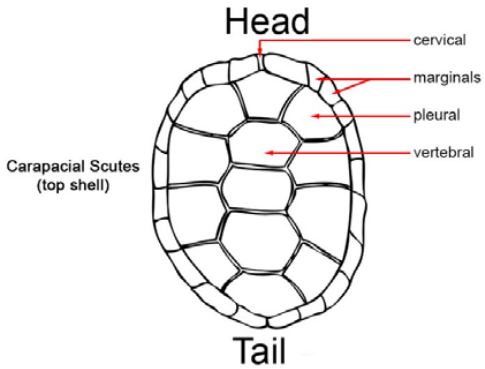
_____

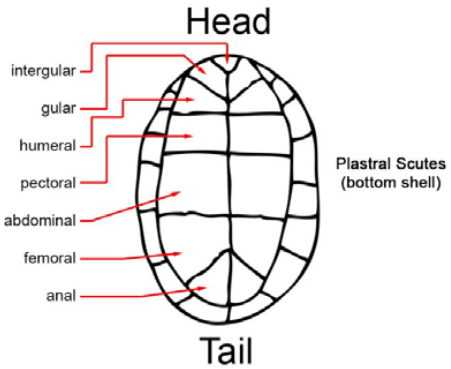
_____

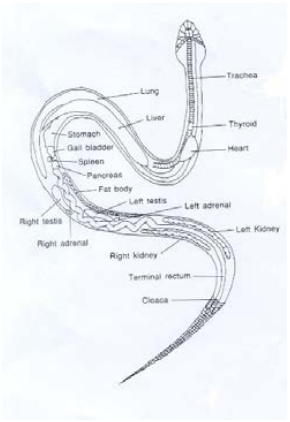
Appendix G. Field data sheet for herpetological surveys - Observation, page 2.

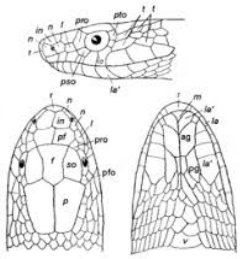
Indicate notches, unique marks or features on shell, and/or injuries (page 2):

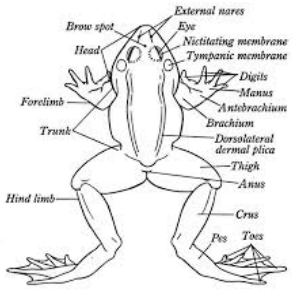


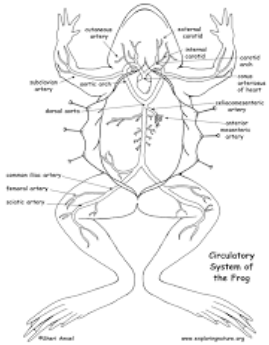


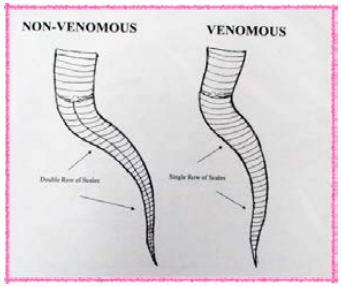












Indicate or draw on map or air photo where turtle was generally found/where signal indicates:

Appendix H. Michigan Department of Environment, Great Lakes, and Energy's Qualitative Biological and Habitat Survey Protocols for Nonwadeable Rivers, including field data sheets.

DEQ	WATER RESOURCES DIVISION POLICY AND PROCEDURE		DEPARTMENT OF ENVIRONMENTAL QUALITY
Original Effective Date: February 6, 2013 Revised Date: Reformatted Date:	Subject: QUALITATIVE BIOLOGICAL AND HABITAT SURVEY PROTOCOLS FOR NONWADEABLE RIVERS		Category: ☒ Internal/Administrative ☐ External/Non-Interpretive ☐ External/Interpretive
	Program: Surface Water Quality Program		
	Number: WRD-SWAS-022	Page: 1 of 30	

A Department of Environmental Quality (DEQ) Policy and Procedure cannot establish regulatory requirements for parties outside of the DEQ. This document provides direction to DEQ staff regarding the implementation of rules and laws administered by the DEQ. It is merely explanatory; does not affect the rights of, or procedures and practices available to, the public; and does not have the force and effect of law.

INTRODUCTION, PURPOSE, OR ISSUE:

This Water Resources Division (WRD) Policy/Procedure establishes the process necessary to qualitatively monitor habitat and biological communities in large, nonwadeable rivers to meet the objectives of the Michigan Water Quality Monitoring Strategy.

AUTHORITY:

Section 3103(1) of Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

PROCEDURES:

The development of these biological and habitat survey protocols resulted from the need for the WRD to more broadly understand the biological and physical habitat condition of Michigan's nonwadeable rivers and to make determinations of designated use support (per R 323.1100 of the Part 4 Water Quality Standards [Part 4 Rules] promulgated under Part 31, of the NREPA). Generally, large rivers are poorly understood due to sampling difficulties related to their size, power, and complexity (Johnson et al., 1995; Sheehan and Rasmussen, 1999; Lyons et al., 2001). This Policy/Procedure is based on research collaboratively conducted by the University of Michigan (habitat survey) and Michigan State University (biological survey), which was funded by a Clean Michigan Initiative grant. For additional and more detailed information regarding the development of these protocols, refer to Wessell, 2004; Opdyke, 2002; and Merritt et al., 2003.

This Policy/Procedure consists of qualitative methods for the assessment of benthic macroinvertebrate communities and physical habitat conditions of nonwadeable rivers. The Policy/Procedure was developed specifically for Michigan's nonwadeable rivers and was tested at 45 locations on 13 of Michigan's nonwadeable rivers in 4 ecoregions across the state (Omernik and Gallant, 1988). Accordingly, they are expected to assess the range of conditions in Michigan's nonwadeable rivers.

The assessment of nonwadeable rivers is conducted by randomly identifying survey reaches that are assumed to be representative of the larger river and catchment so that the information can be extrapolated to other similar areas, or by a targeted approach to answer more specific questions regarding the quality of the habitat and biological community.

Each nonwadeable river survey reach is described by an assessment of the benthic macroinvertebrate community and physical habitat condition. Each assessment is made according to a series of measurements or 'metrics'. The individual metrics for the benthic macroinvertebrate assessment provide information on a variety of biological attributes and, when combined, intend to indicate community response to various river quality conditions. Similarly, the individual metrics for physical habitat, related to both in-stream and riparian conditions, provide information on a variety of physical attributes at varying scales that typify the nonwadeable reach and assist in interpreting biological community data. A river of excellent quality will have substantially different metric values than a river of poor quality, providing a systematic evaluation of each site based on the two suites of metrics. These protocols provide a consistent and accurate method to determine the condition of a nonwadeable river relative to the best condition it might be expected to attain.

This procedure incorporates multiple transect samples taken within a 2 kilometer (km) reach that are composited to obtain a macroinvertebrate and habitat assessment that typifies the reach. Collection of the qualitative habitat and macroinvertebrate assessment at a reach should take approximately one-half day and demands at least two trained field personnel.

I. SAMPLING CONSIDERATIONS

In general, a nonwadeable river or river segment is one where water depths frequently exceed the maximum depth that can be safely and conveniently surveyed in chest waders thus sacrificing the ability to adequately and safely sample all available habitats. The exact boundary between wadeable and nonwadeable will always be indistinct, because water depth varies seasonally and with recent precipitation, with location, and may be influenced by impoundments or other human alterations. The need for this nonwadeable procedure stems from the broad scale of habitat features and the potential difficulties with collecting biological and habitat information representative of the entire river reach.

Stream gauge data provide a convenient dividing line between wadeable and nonwadeable locations. Based on experience, sites on rivers where the mean annual discharge exceeds 530 cubic feet per second are usually nonwadeable during summer flows. In Michigan, locations where the mean annual discharge exceeds 530 cubic feet per second usually are fifth order or higher, have drainage areas greater than 1,600 km^2, and main stem lengths greater than 100 km (Opdyke, 2002). According to these guidelines, there are 22 such rivers in Michigan; 15 of these are in the Lower Peninsula (Saginaw, Grand, St. Joseph, Tittabawassee, Muskegon, Au Sable, Manistee, Kalamazoo, Cheboygan, Flint, Thunder Bay, Raisin, Cass, Huron, and Thornapple) and 7 are in the Upper Peninsula (Menominee, Manistique, Ontonagon, Escanaba, Tahquamenon, Sturgeon, and Michigamme). Additionally, survey locations in the "Very Large" Valley Segment Ecological Classification stratum (Seelbach et al., 1997) will most likely need to be assessed using this procedure.

Ultimately, judgment by professional field personnel must be used to determine whether a river reach can be adequately navigated over a 2,000 meters (m) area by boat, regardless of the aforementioned flow information. This procedure is not to be used if the river reach can be safely and adequately

surveyed following the Qualitative Biological and Habitat Survey Protocols for Wadeable Streams and Rivers, WRD policy number WRD-SWAS-051.

Unless study objectives dictate otherwise, sampling should occur between June 1 and September 30 during periods of stable discharge, preferably under low or moderate flow conditions. This temporal and flow-stabilized target will help decrease some of the sampling variability and ensure proper assessment of potential macrophyte beds that are most abundant during the summer season. In addition, effects of pollutants and other stressful conditions are most often apparent during summer conditions, e.g., dilution is minimal for pollutants during low flow conditions, while elevated temperatures and plant productivity will produce maximum fluctuations in diurnal oxygen conditions. Higher temperatures typically found under baseflow conditions also increase macroinvertebrate metabolic rates, which may amplify pollutant effects. Sampling outside baseflow conditions may represent an increased safety risk due to flow and debris as well as an increased difficulty in conducting the survey due to extremes in turbidity and the potential for sampling terrestrial bank material rather than substrate that is available to macroinvertebrate colonization year-round. Where available, United States Geological Survey stream gauge information should be accessed prior to field sampling to aid in determining flow stability with the recognition that many large rivers will be slower to respond (both in rising and falling water levels) to precipitation in the watershed.

For basin investigations or long-term studies, where necessary, seasonal variability in macroinvertebrates distribution or abundance may be minimized by sampling during a more refined time frame.

Because of the potential hazards encountered on nonwadeable rivers, one of the two field personnel must be an experienced boat operator. Nonwadeable rivers, while generally navigable, will have shallow areas, riffles, boulders, logjams, strong current, etc. that may result in damage to equipment and personal injury if not approached with caution. Personal floatation devices should be worn at all times during this survey work. Personal safety is more important than data collection, and survey locations should be shifted if conditions are not suitable to safely conduct this procedure.

II. SITE SELECTION

Site selection will depend on the intended use for the information to be collected. Targeted reaches may be chosen for specific needs (e.g., investigate potential impacts of specific significant point sources, evaluate the effectiveness of specific water quality protection projects). Locations intended to support probabilistic status sampling should be gathered from reaches chosen randomly following the process described in the Macroinvertebrate Community Status and Trend Monitoring Procedure (DEQ, In Preparation).

Mouths of rivers as they enter the Great Lakes and upstream portions subject to seiche effects and reverse flows as well as sections immediately upstream or downstream of lakes should be avoided; these habitats are often influenced by the larger, lentic water body and are not representative of the lotic system for which these protocols were developed. A station should be 2,000 m in length, as this

distance is considered logistically feasible to sample in a half day and captures much of the natural variation in habitat variables within the reach.

For safety and practicality it is best to use larger versus smaller flat-bottomed boats, which necessitates access to locations with boat ramps. Access sites should be located using various print publications (County map books, Atlas, and Gazetteer) as well as local knowledge (District staff input, particularly Fisheries Division, Department of Natural Resources), and Internet information (e.g., http://www.mcgi.state.mi.us/MRBIS/). Launch locations may be a primary consideration for reach selection or in considering riverine travel time to a selected reach. Access to, and the appropriateness and safety of sampling a reach must be carefully considered prior to sampling.

III. TRANSECT ESTABLISHMENT

Each nonwadeable river sampling site consists of 11 transects spaced 200 m apart for a total reach length of 2,000 m (Figure 1). If selected randomly, the reach should incorporate the randomly chosen point based on valley segment (VSEG) classification (see Macroinvertebrate Community Status and Trend Monitoring Procedure, DEQ, In Preparation). Regardless of the site selection method, the VSEG number for the sample reach should be recorded on the Reach data sheet (Appendix I). The macroinvertebrate community and physical habitat survey components primarily focus on conditions near channel banks. This is both practical and reasonable because many large rivers tend to have a hydraulically efficient main channel with little habitat heterogeneity and their greatest biological and habitat richness is associated with edge or inshore zones (Stalnaker et al., 1989; Schiemer, 2000).

Establish the start of the reach (either upstream or downstream end depending on launch location relative to randomly chosen survey point) and use a GPS unit to set a waypoint. Choose one bank consistently to mark with survey flagging material (on overhanging branches or other visible location) and mark the first transect at this point. Establishing successive upstream/downstream transects is dependent on measured distances from each previous waypoint, all of which should be established along the same bank. Use the GPS unit to track distance from the starting waypoint, when the distance traveled equals 200 m (approx. 0.12 miles) the next transect should be marked on the shoreline with flagging and a second waypoint established. Proceed in this manner until 11 transects are marked, thus defining the reach. Care should be taken to mark and sample transects at the predetermined interval (unless safety issues dictate otherwise) to ensure that their placement is random and guard against bias. Transects are labeled A-K, from downstream to upstream (Figure 1).

While marking transects along the reach, depth and substrate are measured at approximately 40 m intervals along the thalweg for the entire reach for a total of 51 measurements (see Appendix II for Longitudinal Profile data sheet). The thalweg is defined as the deepest part of the channel and care must be taken to periodically verify that the correct path is followed. If an island is encountered along the longitudinal profile, navigate and survey the channel that carries the most flow (Kauffman, 2000). Left bank and right bank are determined by facing downstream.

Depth should be measured using a depth finder or a fiberglass/PVC sounding pole marked in 10 centimeter increments. The sounding pole is also used to determine thalweg substrate materials

based on how the bottom "feels" when dragging the pole along it. The best results are obtained using a fiberglass surveying rod or PVC sounding tube and combining dragging motions with jabs against the bottom. The dominant thalweg substrate is classified as bedrock, boulder, cobble, coarse gravel, fine gravel, sand, or silt. In cases of heterogeneous substrate, up to two size categories may be recorded if each exceeds approximately 40 percent of the total composition of the 40 m interval.

While navigating the thalweg, record the presence of off-channel habitats, such as backwater pools, connected side channels, and other extensive lateral wetted habitat including tributaries at every location that the thalweg depth and substrate are measured. When side channels are present, checkmarks on the Longitudinal Profile data sheet should be used to show the points of convergence/divergence. In cases of tributaries, there will not be a point of divergence. Finally, maintain a tally of all large woody debris (LWD) greater than 0.1 m (approximately 4 inches) in diameter and 3 m in length that is found at least partially within the wetted channel throughout the 2,000 m reach. Branched trees that meet these size requirements are counted once and counts of log-jams should be made quickly to generally reflect how abundant individual pieces of LWD are in the group without needing to spend extra time getting exact counts in those instances.

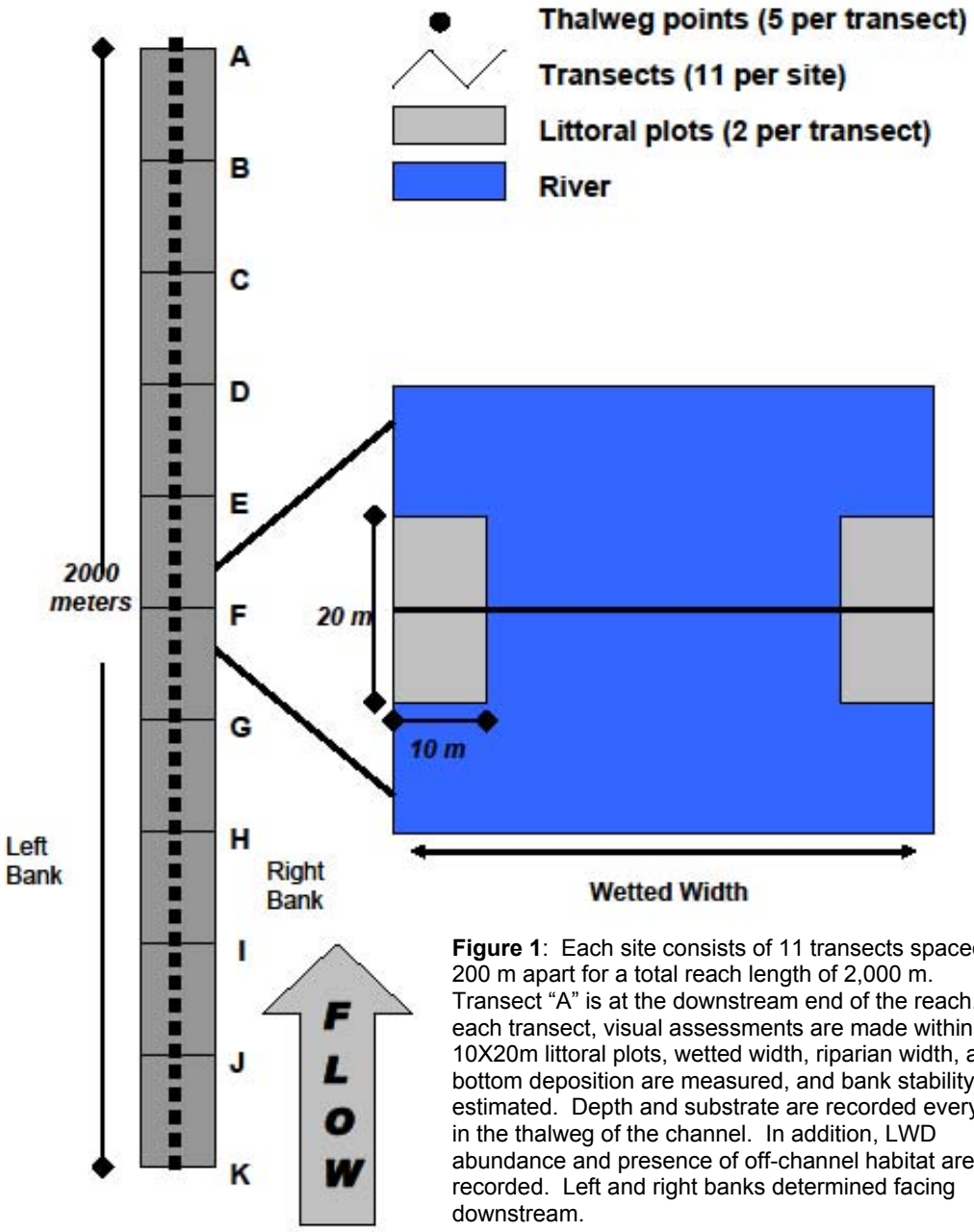


Figure 1: Each site consists of 11 transects spaced 200 m apart for a total reach length of 2,000 m. Transect "A" is at the downstream end of the reach. At each transect, visual assessments are made within 10X20m littoral plots, wetted width, riparian width, and bottom deposition are measured, and bank stability is estimated. Depth and substrate are recorded every 40 m in the thalweg of the channel. In addition, LWD abundance and presence of off-channel habitat are recorded. Left and right banks determined facing downstream.

IV. QUALITATIVE BENTHIC MACROINVERTEBRATE SAMPLING PROCEDURE AND DATA ANALYSIS

The biological portion of the protocol for evaluating the ecological health of nonwadeable rivers in Michigan is based on sampling all transects (A-K) at one randomly chosen bank. Biological assessments are done using a composite sample of all habitats present at each transect (fine particulate organic matter (FPOM), sand, coarse sediments, cobble, LWD, and macrophytes).

Metrics included in the final protocol were chosen after several steps of data reduction, which helped determine which biological attributes provided unique information, described the most variation among sites, and had a linear or otherwise unambiguous response to anthropogenic impacts. For an in-depth discussion of the metric selection process, see the supporting document from Wessell (2004).

OVERVIEW OF BENTHIC MACROINVERTEBRATE PROCEDURES

An equipment checklist is provided (Appendix III) to ensure all necessary equipment is brought along for the benthic macroinvertebrate community assessment. A random method should be used (e.g., coin flip, die roll) to decide which bank to sample for each transect. Sample all available habitats within an area approximately 10 m upstream and downstream of the marked transects (A-K) (Figure 1). Sampling should take place within 10 m from the wetted margin in shoreline areas where safely wadeable (generally <1 m deep). If river depth at the selected bank is too deep to safely and adequately wade, select the opposite bank for that transect. If neither bank is able to be safely sampled, no benthic macroinvertebrate sample is collected. The flagging should be removed as each transect is assessed and completed. See the next section for detailed description of sampling procedures.

By using a composite sample approach, the biological assessment will reflect the broadly available habitat as well as in-stream water quality. This sampling procedure involves sampling all available habitats at each transect and combining the individual samples into one composite for the entire reach. At each transect:

1. Tally the individual habitat types available in the littoral plot (Figure 1). Habitats must be in sufficient abundance to collect 15-second samples in order to be tallied and may include:

    a) FPOM
    b) Sand (gritty up to ladybug sized)
    c) Coarse Substrate (Gravel - ladybug to tennis ball sized)
    d) Cobble (tennis ball to basketball sized)
    e) LWD
    f) Macrophytes

2. For each habitat type, take timed samples (15 seconds each) with a D-frame aquatic dip net with mesh size = 0.8-1.0 millimeters. Habitat-specific considerations are as follows:

    a) FPOM: If there is flow through the sampling area, use kick methods to reduce the amount of detritus in the sample. If there is no flow, sweep the net along the bottom and make sure to wash as much detritus from the net as possible.
    b) Sand: Same as above.
    c) Gravel: If there is flow through the sampling area, use kick methods to stir up gravels, with the net held downstream to capture dislodged benthos. If there is no flow, use kick methods to stir up gravels then sweep the net along the bottom to capture dislodged benthos.
    d) Cobble: It is difficult to take timed sweeps of cobble habitat; therefore, try to choose a piece of cobble at least 15 centimeters in diameter. Place the cobble in a bucket and brush organisms off with a brush.
    e) LWD: Sampling LWD presents challenges, especially when the debris cannot be removed from the river. Use a brush to dislodge organisms from the LWD and follow closely behind the brush with the net. If there is high flow in the area being sampled, make sure the net opens into the current and the brush is upstream of the net. Do this for 15 seconds.
    f) Macrophytes: If there are macrophytes in the study reach, take timed sweeps (15 seconds) of the stems to dislodge attached macroinvertebrates.

3. Empty the net into a sample processing pan or bucket filled with water. This allows one to easily wash out the net (attached organisms may need to be picked from the net with forceps).

4. Remove as much detritus and macrophytes as possible, taking care to scrub or otherwise vigorously shake materials in the collection bucket to retain any benthos. After all transects are sampled, use a sample splitter to divide the composite sample into quarters. All macroinvertebrates present in one of the quarter subsamples must be counted. The quarter sample may have to be processed in portions, based on the density of macroinvertebrates and detritus, to accurately identify and count.

5. Identify and count the macroinvertebrates in the subsample to family level and record on the Macroinvertebrate Data Sheet (Appendix IV).

6. Upon return to the office, the macroinvertebrate data are entered into the appropriate database for storage.

7. Biological data are summarized and metric scores (below) calculated.

BIOLOGICAL METRIC DESCRIPTION AND SCORING

Inferring stressor-response relationships in nonwadeable rivers is difficult due to the different scales of human impacts and should rely heavily on professional judgment. The following list defines the suite

of biological metrics used in this Policy/Procedure and discusses specific stressors to which the metrics may respond; these should only be used as guidelines and are based on analyses conducted by Wessell (2004) for the development of this procedure. This information can be useful in assessing the types of human influences that may affect the river including: influences from water chemistry (e.g., pH, nutrients), in-stream habitat, and riparian and catchment land use.

A. Calculate values and corresponding scores for each metric as follows:

1. **Functional Feeding Group (FFG) Diversity** (calculated based on abundance of FFGs similar to the Shannon Index of Diversity, $-\Sigma[pi(Log_2pi)]$ where p_i is the proportion of individuals represented by each FFG, see Appendix V; scoring out of 25: <0.95 = 0, </=1.41 = 8, </=1.7 = 16, >1.7 = 25): Shows significant negative correlation with measures of human disturbance (Human Disturbance Gradient, see Opdyke, 2002) including riparian land use and a negative correlation with water quality measures like total phosphorus and turbidity.

2. **Habitat Stability FFG Surrogate** [(# Scrapers + # Collectors Filterers)/(#Collectors Gatherers + #Shredders); scoring out of 25: <0.09 = 0, </=1.41 = 8, </=1.7 = 16, >1.7 = 25]: This FFG surrogate responds to overall in-stream habitat quality (LWD) (Merritt et al., 1996), with a negative correlation to urban and agricultural watershed land use, and a positive correlation to natural land use.

3. **Percent Trichoptera** (Relative abundance of Trichoptera; Trichoptera abundance/total abundance; scoring out of 20: </=1.3% = 0, </=3.4% = 7, </=6.8% = 14, >6.8% = 20): This metric shows a negative correlation to agricultural riparian land use.

4. **Ephemeroptera, Plecoptera, and Trichoptera (EPT) Taxa Richness** (Total number of EPT families; scoring out of 8: <4 = 0, </=6 = 3, </=9 = 6, >9 = 8): This metric shows positive correlations with extent of LWD at sites and a negative correlation to urban land use in the watershed.

5. **Total Taxa Richness** (Total number of families in the sample; scoring out of 7: <15 = 0, </=18 = 2, </=24 = 5, >24 = 7): This metric has a negative correlation to percent urban land use in the watershed.

6. **Diptera Taxa Richness** (Total number of Diptera Families; scoring out of 5: <2 = 0, </=3 = 2, </=5 = 4, >5 = 5): This metric shows a negative correlation with water quality measures like total Nitrogen, turbidity, and suspended chlorophyll. Sites with Diptera taxa richness equal to 1 or 2 are usually dominated by Chironomidae.

7. **Plecoptera Taxa Richness** (Total number of Plecoptera families; scoring out of 5: 0 = 0, 1 = 2, 2 = 4, >2 = 5): Plecoptera appear to respond to riparian stressors (positive correlations with percent natural land use in riparian buffers) and LWD presence.

8. **Percent Dominance** (Relative abundance of dominant taxon; scoring out of 5: <35% = 5, </=46% = 4, </=60% = 2, >60% = 0): This metric shows a negative correlation with percent natural riparian land use in the watershed and in the riparian buffer. When percent dominance is extremely high, the sample is usually dominated by Chironomidae.

B. Add the scores for each metric to obtain a composite value with the range of scores used to classify each metric described in the following rating table. The range of total scores for biological metrics (i.e., the sum of metrics 1-8) is 0-100.

METRIC	SCORING RANGE/RATING			
	Excellent	Good	Marginal	Poor
1. FFG Diversity	25	16	8	0
2. Habitat Stability FFG Surrogate	25	16	8	0
3. Percent Trichoptera	20	14	7	0
4. EPT Taxa Richness	8	6	3	0
5. Total Taxa Richness	7	5	2	0
6. Diptera Taxa Richness	5	4	2	0
7. Plecoptera Taxa Richness	5	4	2	0
8. Percent Dominance	5	4	2	0

V. QUALITATIVE HABITAT ASSESSMENT SAMPLING PROCEDURE AND DATA ANALYSIS

The qualitative habitat assessment portion of this Policy/Procedure is based on sampling both banks of all 11 transects as well as reach-wide sampling (e.g., LWD count, thalweg substrate, off-channel habitat). Transect data are recorded on the Transect Habitat data sheet (Appendix VI). At each transect, wetted width (the wetted surface of the river from one bank to the other) is visually estimated or measured. If a large island blocks the view from bank to bank, record the width of the main channel to the edge of the island, flag the observation, and write a comment indicating that the measurement refers only to the main channel (Kaufmann, 2000).

Extent of vegetative coverage in littoral plots is assessed by estimating the percent coverage by aquatic vegetation including filamentous algae and macrophytes within 10x20 m plots centered on the imagined transect line extending from the channel margin towards the middle of the river (Figure 1). These dimensions are estimated, so it is helpful to know the length of the sampling boat or have measurement marks taped onto the side of the boat in order to constantly calibrate visual estimates of distance.

In-stream vegetative coverage is recorded as absent (0%), sparse (<10%), moderate (10-40%), heavy (40-75%), and very heavy (>75%) within the littoral plots of both left and right banks (categories consistent with those used by Kauffman [2000]). These estimates should be made visually unless water clarity precludes this, in which case proportional coverage will be estimated by using the PVC sounding pole. Filamentous algae are long-streaming algae typically found in slow moving waters and aquatic macrophytes include plants found in the water, mosses, and live wetland grasses (Kaufmann, 2000).

The width of the intact riparian vegetative zone is estimated for both banks by visually extending the transect line perpendicular to the river channel. An intact riparian vegetative zone is able to stabilize stream banks, filter runoff, provide shade, and contribute allochthonous input and LWD. Riparian width is recorded for widths from 0 to 25 m and it is noted if the riparian buffer extends beyond this distance. In cases with extremely dense vegetation, reconnaissance on foot may be necessary to observe riparian conditions to 25 m.

Fine sediment deposition is estimated by recording the approximate width of streambed along the transect covered with enough silt sediment to limit habitat available to macroinvertebrate colonization and converting this to a proportion of the wetted width. Sand substrates are not considered in this estimate.

Bank stability is estimated visually for both banks by observing conditions approximately 50 m upstream and downstream of the transect. Stable banks with gradual side slopes and little erosion potential receive higher scores than unstable banks with steep side slopes and well defined erosional areas.

Upon return to the office, data from transect and reach-wide habitat surveys are entered into the appropriate database.

HABITAT METRIC DESCRIPTION AND SCORING

The following list defines the suite of habitat metrics and discusses specific stressors to which they respond. This information will be useful in assessing what types of human influences may affect the river being assessed. Data for these metrics comes from the Habitat Data Sheet (Appendix VI) and are collected at each of the 11 transects, then averaged over the entire reach to obtain a single metric score and a composite metric score for that reach. Metric calculation is described below and scoring information is contained in Appendix VII.

Metric 1. Riparian Vegetation Width

An intact zone of riparian vegetation stabilizes stream banks and reduces erosion, provides storage for flood waters, removes excess nutrients and sediment from runoff and shallow groundwater, and provides shading to maintain optimal temperature regimes for aquatic plants and animals. In large rivers, the ability of the riparian zone to supply woody debris to the stream channel strongly influences biological communities and organic carbon storage in the form of stable particulate deposition.

Factors to Consider: Higher scores for Metric 1 are associated with riparian zones that contain LWD, both standing or downed, in close approximation to the stream channel that can reach the stream channel through natural processes. A more intact riparian zone may have the ability to buffer high-water events through water storage. Lower scores reflect buffer zones that provide little opportunity of LWD recruitment and/or water storage function has been reduced by anthropogenic disturbance.

Metric Calculation: All 22 riparian width estimates (left and right bank at each of 11 transects) are scored following Appendix VII, and then the average of all 22 scores is calculated as the reach score.

Habitat Parameter	**Condition Category** Excellent	Good	Marginal	Poor
1. Riparian vegetation width	Mean riparian width > 24 m. LWD (standing or downed) common and recruitable. Human activities have had little to no impact on the riparian zone resulting in a functioning buffer of wetlands, grasslands, or forest.	Mean riparian width 18-24 m. Human activities have encroached within the buffer, but are still relatively minimal. A buffer exists that still can function in providing woody debris recruitment, bank stabilization, and some water storage function.	Mean riparian width 10-17 m. Human activities have greatly impacted the riparian area frequently leaving only a very narrow riparian buffer with limited LWD recruitment potential.	Mean riparian width < 10 m. Little riparian vegetation remains due to heavy influence of human activities adjacent to the river. Little to no LWD recruitment potential.
Score	25 - 20	19 - 13	12 - 6	5 - 0

Metric 2. LWD

Woody debris is an important component of streams and rivers, providing substrate for invertebrates, cover for fish, and influencing channel structure and habitat complexity. This habitat metric is based on the assumption that more wood results in better physical habitat conditions. Rivers dominated with large pieces of wood that are firmly anchored should score in the higher range of this category than those dominated by less substantial, and therefore more transient, pieces of wood.

Factors to Consider: LWD is defined for these surveys as approximately 4 inches (soft ball size) or larger in diameter and 10 feet long or greater that is mostly in the wetted channel.

Metric Calculation: LWD is counted on the Longitudinal Profile Data Sheet and summed for the entire reach and scored following Appendix VII.

Habitat Parameter	**Condition Category** Excellent	Good	Marginal	Poor
2. LWD	Greater than 200 pieces of LWD in 2,000 m reach.	Between 100 and 200 pieces of LWD in 2,000 m reach. LWD is still plentiful and provides cover and habitat where present.	Between 50 and 100 pieces of LWD in 2,000 m reach. LWD is scattered infrequently throughout the river channel.	Fewer than 50 pieces of LWD in 2,000 m reach. The lack of LWD is obvious, causing the river reach to lack substantive cover, habitat, and substrate.
	20 - 16	15 - 11	10 - 6	5 - 0

Metric 3. Aquatic Vegetation

Macrophytes are important in providing seasonally stable habitat for macroinvertebrates, creating local flow variability for habitat and fish refugia, local sediment deposition, and an autochthonous energy source. The scoring of this metric assumes that, in large rivers, sites with more aquatic vegetation are biologically healthier.

Factors to Consider: There may be circumstances where excessive aquatic vegetation is detrimental and limits flow and habitat variability; if excessive aquatic vegetation is widespread at all transects, the reach's overall scoring should reflect this decrease in condition.

Metric Calculation: For each bank of each transect, determine the highest cover percentage category for either macrophytes or filamentous algae. Use the midpoint of the range from the Habitat Data Sheet (Appendix VI) for each category (0=0%; 1=5%; 2=25%; 3=57.5%; 4=87.5%) and average all values (one for each bank at 11 transects, 22 measurements in total) and score following Appendix VII.

Habitat Parameter	**Condition Category**			
	Excellent	Good	Marginal	Poor
3. Aquatic Vegetation	Greater than 25% of the littoral plots, averaged over all transects for 2,000 m reach, are covered with submerged or emergent aquatic vegetation. Beds of aquatic vegetation are dense and extensive.	15-25% of the littoral plots is covered with submerged or emergent aquatic vegetation. Beds of aquatic vegetation are relatively common throughout the stream reach in the shallow areas.	6-14% of the littoral plots is covered with submerged or emergent aquatic vegetation. Beds of aquatic vegetation are infrequent.	Lack of aquatic vegetation is obvious. 5% or less of the littoral plots is covered with submerged or emergent aquatic vegetation.
	20 - 16	15 - 11	10 - 6	5 - 0

Metric 4. Thalweg Substrate

Substrate particle size, heterogeneity, and embeddedness are important determinants of habitat for aquatic life. Substrate composition determines channel roughness, provides microhabitat for fish species, influences macroinvertebrate and freshwater mussel distribution and abundance, and can be an indicator of significant land use or riparian disturbance. Large, stable substrate is generally accepted to be more favorable for epifaunal colonization and fish cover. However, coarse substrates are inherently rare in low gradient rivers.

Metric Calculation: Thalweg substrate is calculated as the proportion of 51 measurements on the Longitudinal Profile Data Sheet (Appendix II) recording some proportion of fine gravel or larger particle sizes (including woody debris and other, see page 4). Add the number of measurements recording coarse substrate (fine gravel or larger), including those that may have a mix of a coarse and

fine substrate (e.g., both fine gravel and sand circled, indicating a heterogeneous substrate). Divide the resulting number by 51 (or the total count of measurements, if different) to get the proportion containing coarse substrate (e.g., 6 stations recorded only SA (sand) and/or FN (fine) substrates, so 45/51 = 88 percent with coarse substrates). Once the proportion is calculated and multiplied by 100 to convert to percentage, it can be scored following Appendix VII.

Habitat Parameter	**Condition Category**			
	Excellent	Good	Marginal	Poor
4. Thalweg Substrate	More than 60% of the thalweg river bed, averaged over the 2,000 m reach, consists of fine gravel (>2 millimeters) or larger substrate that are relatively stable and suitable for cover and colonization.	35-60% of the thalweg river bed, averaged over the 2,000 m reach, consists of gravel or larger substrate, with less stable sand or fine substrate dominating the remainder of the thalweg river bed.	15-34% of the thalweg river bed, averaged over the 2,000 m reach, consists of gravel or larger substrate. Sand or fine substrate dominates the thalweg river bed contributing to a scarcity of stable substrate or cover.	Less than 15% of the thalweg river bed, averaged over the 2,000 m reach, consists of gravel or larger substrate. The lack of stable substrate is obvious with the thalweg river bed almost exclusively sand or fine sediment.
	10 - 9	8 - 6	5 - 3	2 - 0

Metric 5. Bottom Deposition

Bottom deposition measures the proportion of the entire riverbed that is overlaid with silt, muck, and other fine sediments. Deposition leads to high embeddedness filling interstitial spaces in the riverbed and is typically considered to be detrimental to the quality of stream habitat and negatively affects benthic invertebrates and fish spawning conditions.

Factors to Consider: FPOM may be common in reduced flow areas, and should not be considered as a detriment to habitat quality nor counted in this metric. Professional judgment should be exercised to distinguish between naturally occurring FPOM and excessive, typically inorganic fines from disturbance-related events. Deposition is estimated as a proportion of the entire wetted width and does not consider sand substrates.

Metric Calculation: Sum all depositional area widths for each bank and each transect (22 measurements) and divide by the sum of all wetted widths (11 measurements) to get a proportion of total wetted width covered by depositional area. Multiply by 100 to get percentage of depositional coverage and score following Appendix VII.

Habitat Parameter	Condition Category			
	Excellent	Good	Marginal	Poor
5. Bottom Deposition	Less than 5% of the riverbed, averaged over all transects in the 2,000 m reach, have apparent deposition of fine sediments. Natural substrate may consist of sand, or fine gravel to larger substrate, which is clean of depositional debris. Even shallow areas with slower river velocity and flow are relatively free of fine sediment deposition.	5-24% of the riverbed affected by deposition and sedimentation. Remaining natural substrate may consist of sand, or fine gravel to larger substrate. Limited deposition in the shallow, low flow river bank areas and pools leaving the thalweg substrate relatively clean and free of fine sediments.	25-50% of the riverbed affected by deposition and sedimentation. Riverbed habitat noticeably degraded by embedded sediments covering surfaces and filling interstices. The depositional areas extend beyond the shallows into the main river channel.	More than 50% of the riverbed affected by deposition and sedimentation. Extensive sediment deposits cover most surfaces and fill most interstices. These depositional areas are not confined to shallow and low flow areas and extensively affect habitat availability throughout the river channel. Heavy deposition at sediment bars and islands.
	10 - 9	8 - 6	5 - 3	2 - 0

Metric 6. Bank Stability

Banks are an important transition zone between rivers and adjacent terrestrial areas. Banks in good condition provide cover and reduce pollutant input, while banks in poor condition lead to increased erosion and in-stream sediment deposition. Bank erosion is a natural and continuous process in lotic systems. Certain land use activities, channelization, or disturbance related to frequent high flow events or boat wakes in larger rivers accelerates bank erosion rates altering channel morphology and limiting habitat for organisms.

Factors to Consider: The use of rip-rap to stabilize erosive shorelines may be common in some segments of larger rivers. When scoring a rip-rapped streambank, it should be rated on an assessment of its condition *absent* the rip-rap as much as possible. This will reflect the instability causing the need for protection versus the artificially provided stability of the streambank protection.

Metric Calculation: The composite score results from summing of scores for each specific bank and dividing by 11 to get an average score at each bank, then adding left and right bank (i.e., add up all scores for left and right bank, respectively, divide each by 11 to get overall bank-specific score, then add the overall left and right bank scores to get the composite). Score following Appendix VII.

Habitat Parameter	Condition Category			
	Excellent	Good	Marginal	Poor
6. Bank Stability (score each bank). **Note: determine left or right side facing downstream** SCORE __(LB) SCORE __(RB)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for problems. < 5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; > 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; > 60% of bank has erosional scars.
Left bank	5	4 - 3	2 - 1	0
Right bank	5	4 - 3	2 - 1	0

Metric 7. Off-Channel Habitat

Off-channel and backwater habitats can be biological hotspots in large rivers, containing disproportionately high fish biomass. These areas frequently are nutrient enriched and are used for spawning and nursery purposes, in addition to being places of refugia during disturbance events. They contribute to the habitat complexity found in large rivers and the overall habitat diversity. Similarly, tributary mouths also may be areas of increased species richness, abundance, and density.

Factors to Consider: Off-channel habitats may be wetted or seasonally dry. Look for the presence or evidence of areas of river connection to the floodplain and the confluence of tributaries (including intermittent drainage ways and water storage potential).

Metric Calculation: Sum all off-channel habitat counts and score following the table below or Appendix VII.

Habitat Parameter	Condition Category			
	Excellent	Good	Marginal	Poor
7. Off-channel Habitat.	More than 5 off-channel habitats per 2,000 m reach. Backwaters of large area, with a range of depths and flows.	4-5 off-channel habitats per 2,000 m reach. Backwaters are relatively common and still provide refugia and additional habitat.	2-3 off-channel habitats per 2,000 m reach.	Fewer than 2 off-channel habitats per 2,000 m reach. Backwater habitats are rare to nonexistent.
	5	4 - 3	2 - 1	0

Integration of Habitat Metrics

The seven variables included in the final habitat index are given different weightings as reflected in the maximum score of each metric, based on the analysis described below (see also Opdyke, 2002). Riparian width (up to 25 points), woody debris, and aquatic vegetation (up to 20 points each) are given the highest weight because they were most frequently associated with high quality habitat. Bottom deposition, thalweg substrate, and bank stability are given an intermediate weight and are scored on a ten-point scale. Off channel habitat is given the lowest weight and is scored on a five-point scale. The process by which transect data is converted to an overall site score for individual metrics is described in Appendix VII.

The sum of the scores from each metric give a total score representative of the habitat quality for each reach, with a maximum of 100 points. The individual metric scores may be translated into a qualitative rating as described previously, and the same can be done for the sum of all metrics over the sample reach: "excellent" (84-100), "good" (56-83), "marginal" (28-55), or "poor" (0-27). It is important to communicate that the overall riverine habitat description is a holistic assessment that may be too general in nature to adequately correlate with the biological data or describe anything but broad differences between sites and over time. The ability or inability of a stream to support optimal macroinvertebrate communities is best communicated by scores from individual metrics that provide the specifics of existing conditions that directly affect biological communities or the potential to support biological communities. An individual metric with a poor rating can be isolated and addressed relative to the corresponding biological data. Additionally, impacts from large-scale riparian disturbance may be realized well downstream from the source of the disturbance; therefore, not reflected in the adjacent biological scores.

Other measurements of river condition that may be helpful in interpreting assessments of the river are thalweg depth and width-to-depth ratio. These measurements help define expectations for habitat and biology, but are not associated directly with habitat quality. Thalweg depth (recorded on the Longitudinal Profile Data Sheet) is the mean vertical distance from the riverbed to the water surface for 51 measurements along the 2,000 m reach in the deepest part of the channel. Variation in thalweg depth provides an estimate of heterogeneity in habitat.

Width-to-depth ratio is calculated by dividing the mean width of the 11 transects (found on the Transect Habitat Data Sheet) by the mean thalweg depth (derived from the Longitudinal Profile Data Sheet). This ratio indicates general channel shape and is a correlate of glide/pool and riffle/run variation, typically measured in wadeable streams and rivers.

VI. OVERALL APPLICATION AND INTERPRETATION

While biological and habitat assessments are expected to provide broadly similar site evaluations in most circumstances, substantial discrepancies between biological and habitat scores may occur, and could indicate chemical contamination or some other unidentified pollutant. Each site should be carefully evaluated using both the habitat and biological protocols outlined above and in combination with other relevant field notes.

VII. PROCEDURAL CONSISTENCY AND DATA MANAGEMENT

A. Training of DEQ Personnel

All personnel conducting nonwadeable river assessments should be trained in a consistent manner to ensure procedures are conducted in a standardized fashion. Periodic training of new field biologists and refresher training of experienced biologists should be performed, and techniques should be cross-checked by experienced personnel. Training may be in the classroom, field, or a combination of these. At least one investigator for each site will be a professional biologist trained and skilled in field aquatic sampling methods and organism identification.

B. Standard Procedures

The standard procedures described in this document are followed in the surveys. Field experience and taxonomic expertise requirements must be met by staff involved in surveys. Any deviations from the procedures should be documented as to the reason for the deviation.

C. Documentation

Field data sheets should be filled out completely for each survey. Data collected using this procedure should be stored in an appropriate electronic database in a timely manner for future reference. Field data sheets are filed in the Surface Water Assessment Section raw data files.

D. Benthic Macroinvertebrate Collections

The sampling methodology should be closely followed. Reference collections and voucher specimens should be maintained by the DEQ. With regard to voucher specimens, representatives of macroinvertebrates that cannot be identified in the field should be placed in vials containing preservative and clearly labeled with site information and number of each taxa in the sample. These specimens should be taken back to the laboratory for examination and identification under a microscope using appropriate taxonomic keys.

Who	Does What
Surface Water Assessment Section Staff	Select site, conduct monitoring per the procedure or oversee grantee monitoring per the procedure, calculate habitat and biological community score, determine condition and water quality standard attainment for each site within a watershed, and store and summarize data for use in rotating basin water quality monitoring reports.

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APPENDICES:

Appendix I. Nonwadeable Procedure Reach Data Sheet.
Appendix II. Nonwadeable Procedure Longitudinal Profile Data Sheet, Pages 1 and 2.
Appendix III. Nonwadeable Procedure Field Equipment List.
Appendix IV. Nonwadeable Procedure Macroinvertebrate Data Sheet.
Appendix V. Nonwadeable Procedure Macroinvertebrate FFG Identification.
Appendix VI. Nonwadeable Procedure Transect Habitat Data Sheet.
Appendix VII. Nonwadeable Procedure Habitat Metric Calculation and Scoring Information.

DIVISION/SECTION/UNIT CHIEF APPROVAL:

Diana Klemans, Chief
Surface Water Assessment Section

February 6, 2013
Date

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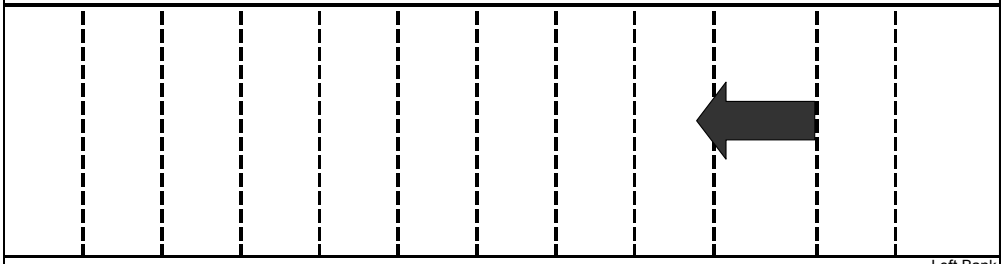
Appendix I. Nonwadeable Procedure Reach Data Sheet.

DATE:	CREW:		
RIVER:	REACH LOCATION		
	GPS or Gazetteer Info	Other information	
		Upstream	Of (City, Dam, etc.)
		Downstream	
Other Notes:			

On the diagram below, mark the locations at which macroinvertebrate samples were taken.



For composite assessments, note which macroinvertebrate habitats were present at each transect.

A	F	Sa	C	Cb	W	M	OU	G	F	Sa	C	Cb	W	M	OU
B	F	Sa	C	Cb	W	M	OU	H	F	Sa	C	Cb	W	M	OU
C	F	Sa	C	Cb	W	M	OU	I	F	Sa	C	Cb	W	M	OU
D	F	Sa	C	Cb	W	M	OU	J	F	Sa	C	Cb	W	M	OU
E	F	Sa	C	Cb	W	M	OU	K	F	Sa	C	Cb	W	M	OU
F	F	Sa	C	Cb	W	M	OU	Total Samples:							

F = FPOM; Sa = Sand; C = Coarse substrates; Cb = Cobble; W = LWD; M = Macrophytes, OU = Overhang/Undercut

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Appendix II. Nonwadeable Procedure Longitudinal Profile Data Sheet, Page 1.

LONGITUDINAL PROFILE

Site Name:

Investigators: **Date:**

GPS for Boat Launch: **GPS file name:**

BH = Bedrock/Hardpan (larger than a car)
BL = Boulder (250 to 4000mm; basketball to car)
CB = Cobble (64 to 250mm; tennis ball to basketball)
GC = Coarse Gravel (16 to 64mm; marble to tennis ball)
GF = Fine Gravel (2 to 16mm; ladybug to marble)
SA = Sand (0.06 to 2mm; gritty - up to ladybug size)
FN = Silt/Clay/Muck (< .06mm, not gritty)
WD = Woody debris
OT = Other (metal, tires, asphalt, concrete, etc.; Comment)

THALWEG SUBSTRATE AND DEPTH PROFILE

Station	Depth meters or feet	Off Channel	Substrate (Circle the dominant type; up to two can be circled in heterogeneous areas)									Comments
A			FN	SA	GF	GC	CB	BL	BH	WD	OT	
A-B 1			FN	SA	GF	GC	CB	BL	BH	WD	OT	
A-B 2			FN	SA	GF	GC	CB	BL	BH	WD	OT	
A-B 3			FN	SA	GF	GC	CB	BL	BH	WD	OT	
A-B 4			FN	SA	GF	GC	CB	BL	BH	WD	OT	
B			FN	SA	GF	GC	CB	BL	BH	WD	OT	
B-C 1			FN	SA	GF	GC	CB	BL	BH	WD	OT	
B-C 2			FN	SA	GF	GC	CB	BL	BH	WD	OT	
B-C 3			FN	SA	GF	GC	CB	BL	BH	WD	OT	
B-C 4			FN	SA	GF	GC	CB	BL	BH	WD	OT	
C			FN	SA	GF	GC	CB	BL	BH	WD	OT	
C-D 1			FN	SA	GF	GC	CB	BL	BH	WD	OT	
C-D 2			FN	SA	GF	GC	CB	BL	BH	WD	OT	
C-D 3			FN	SA	GF	GC	CB	BL	BH	WD	OT	
C-D 4			FN	SA	GF	GC	CB	BL	BH	WD	OT	
D			FN	SA	GF	GC	CB	BL	BH	WD	OT	
D-E 1			FN	SA	GF	GC	CB	BL	BH	WD	OT	
D-E 2			FN	SA	GF	GC	CB	BL	BH	WD	OT	
D-E 3			FN	SA	GF	GC	CB	BL	BH	WD	OT	
D-E 4			FN	SA	GF	GC	CB	BL	BH	WD	OT	
E			FN	SA	GF	GC	CB	BL	BH	WD	OT	
E-F 1			FN	SA	GF	GC	CB	BL	BH	WD	OT	
E-F 2			FN	SA	GF	GC	CB	BL	BH	WD	OT	
E-F 3			FN	SA	GF	GC	CB	BL	BH	WD	OT	
E-F 4			FN	SA	GF	GC	CB	BL	BH	WD	OT	
					# With Larger Substrate (A-E):							

Tally Large Woody Debris > 0.1 m in diameter and 3 m in length in space below & total for A-F
Total A-F:

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Appendix II (cont.). Nonwadeable Procedure Longitudinal Profile Data Sheet, Page 2.

Station	Depth meters or feet	Off Channel	Substrate (Circle the dominant type; up to two can be circled in heterogeneous areas)									Comments
F			FN	SA	GF	GC	CB	BL	BH	WD	OT	
F-G 1			FN	SA	GF	GC	CB	BL	BH	WD	OT	
F-G 2			FN	SA	GF	GC	CB	BL	BH	WD	OT	
F-G 3			FN	SA	GF	GC	CB	BL	BH	WD	OT	
F-G 4			FN	SA	GF	GC	CB	BL	BH	WD	OT	
G			FN	SA	GF	GC	CB	BL	BH	WD	OT	
G-H 1			FN	SA	GF	GC	CB	BL	BH	WD	OT	
G-H 2			FN	SA	GF	GC	CB	BL	BH	WD	OT	
G-H 3			FN	SA	GF	GC	CB	BL	BH	WD	OT	
G-H 4			FN	SA	GF	GC	CB	BL	BH	WD	OT	
H			FN	SA	GF	GC	CB	BL	BH	WD	OT	
H-I 1			FN	SA	GF	GC	CB	BL	BH	WD	OT	
H-I 2			FN	SA	GF	GC	CB	BL	BH	WD	OT	
H-I 3			FN	SA	GF	GC	CB	BL	BH	WD	OT	
H-I 4			FN	SA	GF	GC	CB	BL	BH	WD	OT	
I			FN	SA	GF	GC	CB	BL	BH	WD	OT	
I-J 1			FN	SA	GF	GC	CB	BL	BH	WD	OT	
I-J 2			FN	SA	GF	GC	CB	BL	BH	WD	OT	
I-J 3			FN	SA	GF	GC	CB	BL	BH	WD	OT	
I-J 4			FN	SA	GF	GC	CB	BL	BH	WD	OT	
J			FN	SA	GF	GC	CB	BL	BH	WD	OT	
J-K 1			FN	SA	GF	GC	CB	BL	BH	WD	OT	
J-K 2			FN	SA	GF	GC	CB	BL	BH	WD	OT	
J-K 3			FN	SA	GF	GC	CB	BL	BH	WD	OT	
J-K 4			FN	SA	GF	GC	CB	BL	BH	WD	OT	
K			FN	SA	GF	GC	CB	BL	BH	WD	OT	
					# With Larger Substrate (F-K):							
					Total Count (A-K):							

Tally Large Woody Debris > 0.1 m in diameter and 3 m in length in space below & total
Total F-K:

Total A-K:

Additional comments or notes (including turbidity, color, oil films, floating/suspended/settleable solids, foams, or deposits):

Nuisance aquatic plants or slimes present? (circle one) Yes No
Dominant species/type present?

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Appendix III. Nonwadeable Procedure Field Equipment List.

	ITEM		
Boating	Flat-bottomed boat, motor, trailer, spare propeller		
	Anchor		
	Oar(s)		
	Personal Floatation (one for each person) + throwable cushion		
	Throwable Safety Line		
	First Aid kit		
	Sunscreen, bug spray, drinking water		
Macroinvertebrate	D-frame bug dip net		
	Scrubbing/Toilet brush		
	5-gallon bucket with lid		
	Extra 5 gallon buckets		
	White shallow sorting pans		
	Vials for I.D./Voucher specimens, Ethanol/Isopropyl		
	Sample Splitter		
	Forceps, hand lenses		
Data sheets	Data sheets – Longitudinal Transect		
	Data sheets – Cross-sectional Transects		
	Data sheets – Macroinvertebrate enumeration		
	Data sheets – Biological survey field sheet		
Habitat	PVC/Fiberglass sounding pole (3 m+ long)		
	Depth finder		
	Laser rangefinder		
	Field flagging		
	GPS Unit and batteries		

Appendix IV. Nonwadeable Procedure Macroinvertebrate Data Sheet.

NON-WADEABLE BENTHIC MACROINVERTEBRATES

Site Name: Date:

Comments:

PORIFERA ____
PLATYHELMINTHES
Turbellaria ____
NEMATOMORPHA ____
BRYOZOA ____
ANNELIDA
Hirudinea ____
Oligochaeta ____
ARTHROPODA
Crustacea
Amphipoda ____
Decapoda ____
Isopoda ____
Arachnoidea
Hydracarina ____
Insecta
Ephemeroptera
Ametropodidae ____
Baetiscidae ____
Baetidae ____
Caenidae ____
Ephemerellidae ____
Ephemeridae ____
Heptageniidae ____
Isonychiidae ____
Leptohyphidae (Tricor.) ____
Leptophlebiidae ____
Metretopodidae ____
Polymitarcyidae ____
Potamanthidae ____
Siphlonuridae ____
Odonata
Anisoptera
Aeshnidae ____
Cordulegastridae ____
Corduliidae ____
Gomphidae ____
Libellulidae ____
Macromiidae ____
Zygoptera
Calopterygidae ____
Coenagrionidae ____
Lestidae ____
Plecoptera
Capniidae ____
Chloroperlidae ____
Leuctridae ____
Nemouridae ____
Peltoperlidae ____
Perlidae ____
Perlodidae ____
Pteronarcyidae ____
Taeniopterygidae ____

Hemiptera
Belostomatidae ____
Corixidae ____
Gelastocoridae ____
Gerridae ____
Mesoveliidae ____
Naucoridae ____
Nepidae ____
Notonectidae ____
Pleidae ____
Saldidae ____
Veliidae ____
Megaloptera
Corydalidae ____
Sialidae ____
Neuroptera
Sisyridae ____
Trichoptera
Brachycentridae ____
Glossosomatidae ____
Helicopsychidae ____
Hydropsychidae ____
Hydroptilidae ____
Lepidostomatidae ____
Leptoceridae ____
Limnephilidae ____
Molannidae ____
Odontoceridae ____
Philopotamidae ____
Phryganeidae ____
Polycentropodidae ____
Psychomyiidae ____
Rhyacophilidae ____
Sericostomatidae ____
Uenoidae (*Neophylax*) ____
Lepidoptera
Noctuidae ____
Pyralidae ____
Coleoptera
Chrysomelidae (a/l) ____
Curculionidae (a/l) ____
Dryopidae ____
Dytiscidae ____
Elmidae ____
Gyrinidae (a/l) ____
Haliplidae (a/l) ____
Heteroceridae ____
Hydraenidae ____
Hydrophilidae ____
Lampyridae (a/l) ____
Limnichidae (a/l) ____
Noteridae (a/l) ____
Psephenidae(a/l) ____
Ptilodactylidae (a/l) ____
Scirtidae (a/l) ____

Diptera
Athericidae ____
Ceratopogonidae ____
Chaoboridae ____
Chironomidae ____
Culicidae ____
Dixidae ____
Dolichopodidae ____
Empididae ____
Ephydridae ____
Muscidae ____
Ptychopteridae ____
Psychodidae ____
Sciomyzidae ____
Simuliidae ____
Stratiomyidae ____
Syrphidae ____
Tabanidae ____
Thaumaleidae ____
Tipulidae ____
MOLLUSCA
Gastropoda
Ancylidae ____
Bithyniidae ____
Hydrobiidae ____
Lymnaeidae ____
Physidae ____
Planorbidae ____
Pleuroceridae ____
Pomatiopsidae ____
Valvatidae ____
Viviparidae ____
Pelecypoda
Corbiculidae ____
Dreissenidae ____
Sphaeriidae (Incl. Pisid.) ____
Unionidae ____
_____ ____
_____ ____
_____ ____
_____ ____

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Appendix V. Nonwadeable Procedure Macroinvertebrate FFG Identification.

CF = collector filterer P = predator Sh = shredder

CG = collector gatherer Sc = scraper

TAXA	FFG
PORIFERA (sponges)	CF
PLATYHELMINTHES (flatworms)	
Turbellaria	CG
NEMATOMORPHA (roundworms)	P
BRYOZOA (moss animals)	CG
ANNELIDA (segmented worms)	
Hirudinea (leeches)	P
Oligochaeta (worms)	CG
ARTHROPODA	
Crustacea	
Amphipoda (scuds)	Sh
Decapoda (crayfish)	CG
Isopoda (sowbugs)	Sh
Arachnoidea	
Hydracarina	P
INSECTA	
Ephemeroptera (mayflies)	
Ametropodidae	CF
Baetiscidae	CG
Baetidae	CG
Caenidae	CG
Ephemerellidae	Sc
Ephemeridae	CG
Heptageniidae	Sc
Isonychiidae	CF
Leptophlebiidae	CG
Metretopodidae	CG
Oligoneuriidae	CF
Polymitarcyidae	CG
Potamanthidae	CF
Siphlonuridae	CG
Leptohyphidae (Tricor.)	CG
Odonata	
Anisoptera (dragonflies)	
Aeshnidae	P
Cordulegastridae	P
Corduliidae	P
Gomphidae	P
Libellulidae	P
Macromiidae	P
Zygoptera (damselflies)	
Calopterygidae	P
Coenagrionidae	P
Lestidae	P
Plecoptera (stoneflies)	
Capniidae	Sh
Chloroperlidae	P
Leuctridae	Sh
Nemouridae	Sh
Peltoperlidae	Sh
Perlidae	P
Perlodidae	P
Pteronarcyidae	Sh
Taeniopterygidae	Sh
Hemiptera (true bugs)	
Belostomatidae	P
Corixidae	CG
Gelastocoridae	P
Gerridae	P
Mesoveliidae	P
Naucoridae	P
Nepidae	P
Notonectidae	P
Pleidae	P
Saldidae	P
Veliidae	P
Megaloptera	
Corydalidae (dobson flies)	P
Sialidae (alder flies)	P
Neuroptera (spongilla flies)	
Sisyridae	P
Trichoptera (caddisflies)	
Brachycentridae	CF
Glossosomatidae	Sc
Helicopsychidae	Sc
Hydropsychidae	CF
Hydroptilidae	Sc

TAXA	FFG
Lepidostomatidae	Sh
Leptoceridae	Sh
Limnephilidae	Sh
Trichoptera (caddisflies) cont'd	
Molannidae	Sc
Odontoceridae	Sc
Philopotamidae	CF
Phryganeidae	Sh
Polycentropodidae	P
Psychomyiidae	Sc
Rhyacophilidae	P
Sericostomatidae	Sc
Uenoidae	Sc
Lepidoptera (moths)	
Noctuidae	Sh
Pyralidae	Sh
Coleoptera (beetles)	
Chrysomelidae (adults)	Sh
Curculionidae (adults)	Sh
Dytiscidae (total)	P
Gyrinidae (adults)	P
Haliplidae (adults)	Sh
Heteroceridae (total)	CG
Hydraenidae (total)	Sc
Hydrophilidae (total)	P
Lampyridae (adults)	--
Limnichidae (adults)	CG
Noteridae (adults)	P
Psephenidae (adults)	Sc
Ptilodactylidae (adults)	Sh
Scirtidae (adults)	Sc
Chrysomelidae (larvae)	Sh
Curculionidae (larvae)	Sh
Dryopidae	Sc
Elmidae	CG
Gyrinidae (larvae)	P
Haliplidae (larvae)	Sh
Lampyridae (larvae)	P
Limnichidae (larvae)	CG
Noteridae (larvae)	P

TAXA	FFG
Psephenidae (larvae)	Sc
Ptilodactylidae (larvae)	Sh
Scirtidae (larvae)	Sc
Diptera (flies)	
Athericidae	P
Ceratopogonidae	P
Chaoboridae	P
Chironomidae	CG
Culicidae	CF
Dixidae	CG
Dolichopodidae	P
Empididae	P
Ephydridae	Sh
Muscidae	P
Psychodidae	CG
Ptychopteridae	CG
Sciomyzidae	P
Simuliidae	CF
Stratiomyidae	CG
Syrphidae	CG
Tabanidae	P
Thaumaleidae	Sc
Tipulidae	CG
MOLLUSCA	
Gastropoda (snails)	
Ancylidae (limpets)	Sc
Bithyniidae	Sc
Hydrobiidae	Sc
Lymnaeidae	Sc
Physidae	Sc
Planorbidae	Sc
Pleuroceridae	Sc
Pomatiopsidae	Sc
Valvatidae	Sc
Viviparidae	Sc
Pelecypoda (bivalves)	
Corbiculidae	CF
Dreissenidae	CF
Sphaeriidae (clams)	CF
Unionidae ('mussels')	CF

Appendix VI. Nonwadeable Procedure Transect Habitat Data Sheet.

TRANSECTS				TRANSECTS			
Site Name: **Time:**				**Site Name:** **Time:**			
Investigators: **Date:**				**Investigators:** **Date:**			
Transect: A B C D E F G H I J K (A=Downstream; K=Upstream)				**Transect: A B C D E F G H I J K** (A=Downstream; K=Upstream)			
GPS LB RB Center **Latitude:** **Longitude:**				**GPS LB RB Center** **Latitude:** **Longitude:**			
Wetted Width (m): **Bar/Island Present? If yes, width (m):**				**Wetted Width (m):** **Bar/Island Present? If yes, width (m):**			
Riparian Width Estimate				**Riparian Width Estimate**			
Mean riparian width > 24m. LWD (standing or downed) common and recruitable. Human activities have had little to no impact on the riparian zone resulting in a functioning buffer of wetlands, grasslands, or forest	**Mean riparian width 18 - 24m. Human activities have encroached within the buffer, but are still relatively minimal. A buffer exists that still can function in providing woody debris recruitment, bank stabilization, and some water storage function.**	**Mean riparian width 10 – 17m. Human activities have greatly impacted the riparian area frequently leaving only a very narrow riparian buffer with limited LWD recruitment potential.**	**Mean riparian width < 10m. Little riparian vegetation remains due to heavy influence of human activities adjacent to the river. Little to no LWD recruitment potential.**	**Mean riparian width > 24m. LWD (standing or downed) common and recruitable. Human activities have had little to no impact on the riparian zone resulting in a functioning buffer of wetlands, grasslands, or forest**	**Mean riparian width 18 - 24m. Human activities have encroached within the buffer, but are still relatively minimal. A buffer exists that still can function in providing woody debris recruitment, bank stabilization, and some water storage function.**	**Mean riparian width 10 – 17m. Human activities have greatly impacted the riparian area frequently leaving only a very narrow riparian buffer with limited LWD recruitment potential.**	**Mean riparian width < 10m. Little riparian vegetation remains due to heavy influence of human activities adjacent to the river. Little to no LWD recruitment potential.**
LB: 25 23 21 24 22 20	19 17 15 13 18 16 14	12 10 8 6 11 9 7	5 4 3 2 1 0	**LB:** 25 23 21 24 22 20	19 17 15 13 18 16 14	12 10 8 6 11 9 7	5 4 3 2 1 0
RB: 25 23 21 24 22	19 17 15 13 18 16 14	12 10 8 6 11 9 7	5 4 3 2 1 0	**RB:** 25 23 21 24 22	19 17 15 13 18 16 14	12 10 8 6 11 9 7	5 4 3 2 1 0
Vegetative Cover: (measured within 10x20m plot: 10m up and 10m downstream of transect) 0 = Absent (0%); 1 = Sparse (<10%); 2 = Moderate (10-40%); 3 = Heavy (40-75%); 4 = Very Heavy (>75%)				**Vegetative Cover: (measured within 10x20m plot: 10m up and 10m downstream of transect) 0 = Absent (0%); 1 = Sparse (<10%); 2 = Moderate (10-40%); 3 = Heavy (40-75%); 4 = Very Heavy (>75%)**			
	LEFT BANK	**RIGHT BANK**			**LEFT BANK**	**RIGHT BANK**	
Filamentous Algae	0 1 2 3 4	0 1 2 3 4		**Filamentous Algae**	0 1 2 3 4	0 1 2 3 4	
Macrophytes	0 1 2 3 4	0 1 2 3 4		**Macrophytes**	0 1 2 3 4	0 1 2 3 4	
Bank Stability (circle a score for each bank):				**Bank Stability (circle a score for each bank):**			
Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems; <5% banks affected.	Moderately stable; infrequent, small areas of erosion mostly healed over; 5-30% of bank in reach has areas of erosion.	Moderately unstable; >30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; >60% of bank has erosional scars.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems; <5% banks affected.	Moderately stable; infrequent, small areas of erosion mostly healed over; 5-30% of bank in reach has areas of erosion.	Moderately unstable; >30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; >60% of bank has erosional scars.
LB: 5	4 3	2 1	0	**LB:** 5	4 3	2 1	0
RB: 5	4 3	2 1	0	**RB:** 5	4 3	2 1	0
Bottom deposition: Total width of depositional area near the **LB:** **RB:** **TOTAL:**				**Bottom deposition: Total width of depositional area near the** **LB:** **RB:** **TOTAL:**			
Comments/Sketch of Transect:				**Comments/Sketch of Transect:**			

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Appendix VII. Nonwadeable Procedure habitat Metric Calculation and Scoring Information.

Metric																										
1. Riparian Width (sumX/11)	Metric Value (m)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
(average of all transects, in meters)	Score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

2. Large Woody Debris	Metric Value	0-7	8-15	16-23	24-32	33-40	41-49	50-59	60-69	70-79	80-89	90-99	100-119	120-139	140-159	160-179	180-200	201-225	226-250	251-275	276-300	300+
(total count entire site)	Score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	

3. Vegetative Cover (sumX/22)	Metric Value (%)	0	<10	10-40	40-75	>75
(average of all transect scores LB and RB)	Score	1	5	10	15	20

4. Thalweg Substrate (sumX/61 x 100)	Metric Value (%)	0-4	5-9	10-14	15-21	22-27	28-34	35-42	43-51	52-60	61-80	81-100
(proportion of measurements (x) with fine gravel or larger)	Score	0	1	2	3	4	5	6	7	8	9	10

5. Bottom Deposition	Metric Value (%)	100-85	84-68	67-51	50-43	42-34	33-25	24-19	18-12	11-5	4-2	1-0
[sum(deposition A-K)/sum(wetted width A-K)] x 100	Score	0	1	2	3	4	5	6	7	8	9	10

6. Bank Stability	Metric Value	0	1	2	3	4	5	6	7	8	9	10
(sum each bank X/11; sum LB and RB)	Score	0	1	2	3	4	5	6	7	8	9	10

7. Off-channel Habitat	Metric Value	0-1	2	3	4	5	6+
(total count entire site)	Score	0	1	2	3	4	5

Appendix I. Plant species documented in wetland habitats at Salt River Marsh State Wildlife Area.

Practitioner:	Tyler Bassett	
Latitude:		
Longitude:		
Weather Notes:		
Duration Notes:	6/25/19 and 9/10/19	
Community Type Notes:		
Other Notes:		
Private/Public:	Private	
Conservatism-Based Metrics:		
Total Mean C:	3.3	
Native Mean C:	4	
Total FQI:	25.3	
Native FQI:	27.7	
Adjusted FQI:	36.1	
% C value 0:	20.3	
% C value 1-3:	32.2	
% C value 4-6:	37.3	
% C value 7-10:	10.2	
Native Tree Mean C:	1.7	
Native Shrub Mean C:	3.7	
Native Herbaceous Mean C:	4.3	
Species Richness:		
Total Species:	59	
Native Species:	48	81.40%
Non-native Species:	11	18.60%
Species Wetness:		
Mean Wetness:	-3.2	
Native Mean Wetness:	-3.8	
Physiognomy Metrics:		
Tree:	3	5.10%
Shrub:	11	18.60%
Vine:	5	8.50%
Forb:	28	47.50%
Grass:	3	5.10%
Sedge:	8	13.60%
Rush:	1	1.70%

Appendix I. Continued...

Fern:	0	0%
Bryophyte:	0	0%
Duration Metrics:		
Annual:	3	5.10%
Perennial:	56	94.90%
Biennial:	0	0%
Native Annual:	3	5.10%
Native Perennial:	45	76.30%
Native Biennial:	0	0%

Species:

Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Acer saccharinum	Sapindaceae	ACESAI	native	2	-3	tree	perennial	silver maple
Agrimonia parviflora	Rosaceae	AGRPAR	native	4	0	forb	perennial	swamp agrimony
Apocynum cannabinum; a. sibiricum	Apocynaceae	APOCAN	native	3	0	forb	perennial	indian-hemp
Bidens cernua	Asteraceae	BIDCER	native	3	-5	forb	annual	nodding beggar-ticks
Butomus umbellatus	Butomaceae	BUTUMB	non-native	0	-5	forb	perennial	flowering-rush
Calamagrostis canadensis	Poaceae	CALCAN	native	3	-5	grass	perennial	blue-joint
Carex bebbii	Cyperaceae	CXBEBB	native	4	-5	sedge	perennial	sedge
Carex lacustris	Cyperaceae	CXLACU	native	6	-5	sedge	perennial	sedge
Carex pellita; c. lanuginosa	Cyperaceae	CXPELL	native	2	-5	sedge	perennial	sedge
Carex sartwellii	Cyperaceae	CXSART	native	5	-5	sedge	perennial	sedge
Carex stricta	Cyperaceae	CXSTRI	native	4	-5	sedge	perennial	sedge
Carex vulpinoidea	Cyperaceae	CXVULP	native	1	-5	sedge	perennial	sedge
Cephalanthus occidentalis	Rubiaceae	CEPOCC	native	7	-5	shrub	perennial	buttonbush
Ceratophyllum demersum	Ceratophyllaceae	CERDEM	native	1	-5	forb	perennial	coontail
Cirsium arvense	Asteraceae	CIRARV	non-native	0	3	forb	perennial	canada thistle
Cornus foemina	Cornaceae	CORFOE	native	1	0	shrub	perennial	gray dogwood
Cornus sericea; c. stolonifera	Cornaceae	CORSER	native	2	-3	shrub	perennial	red-osier
Elaeagnus umbellata	Elaeagnaceae	ELAUMB	non-native	0	3	shrub	perennial	autumn-olive
Fraxinus pennsylvanica	Oleaceae	FRAPEN	native	2	-3	tree	perennial	red ash
Galium asprellum	Rubiaceae	GALASP	native	5	-5	vine	perennial	rough bedstraw
Hypericum kalmianum	Hypericaceae	HYPKAL	native	10	-3	shrub	perennial	kalms st. johns-wort
Impatiens capensis	Balsaminaceae	IMPCAP	native	2	-3	forb	annual	spotted touch-me-not
Iris virginica	Iridaceae	IRIVIR	native	5	-5	forb	perennial	southern blue flag
Juncus effusus	Juncaceae	JUNEFF	native	3	-5	rush	perennial	soft-stemmed rush
Lathyrus palustris	Fabaceae	LATPAL	native	7	-3	vine	perennial	marsh pea
Lemna trisulca	Araceae	LEMTRI	native	6	-5	forb	perennial	star duckweed
Ligustrum vulgare	Oleaceae	LIGVUL	non-native	0	3	shrub	perennial	common privet
Lonicera morrowii	Caprifoliaceae	LONMOR	non-native	0	3	shrub	perennial	morrow honeysuckle

Appendix I. Continued...

Lythrum salicaria	Lythraceae	LYTSAL	non-native	0	-5	forb	perennial	purple loosestrife
Myriophyllum heterophyllum	Haloragaceae	MYRHET	native	6	-5	forb	perennial	various-leaved water-milfoil
Nymphaea odorata	Nymphaeaceae	NYMODO	native	6	-5	forb	perennial	sweet-scented waterlily
Persicaria amphibia; polygonum a.	Polygonaceae	PERAMP	native	6	-5	forb	perennial	water smartweed
Phalaris arundinacea	Poaceae	PHAARU	native	0	-3	grass	perennial	reed canary grass
Phragmites australis var. australis	Poaceae	PHRAUU	non-native	0	-3	grass	perennial	reed
Potamogeton natans	Potamogetonaceae	POTNAT	native	5	-5	forb	perennial	pondweed
Pycnanthemum virginianum	Lamiaceae	PYCVIR	native	5	-3	forb	perennial	common mountain mint
Ranunculus sceleratus	Ranunculaceae	RANSCE	native	1	-5	forb	annual	cursed crowfoot
Rumex verticillatus	Polygonaceae	RUMVER	native	7	-5	forb	perennial	water dock
Salix discolor	Salicaceae	SALDIS	native	1	-3	shrub	perennial	pussy willow
Salix exigua	Salicaceae	SALEXI	native	1	-3	shrub	perennial	sandbar willow
Schoenoplectus tabernaemontani; scirpus validus	Cyperaceae	SCHTAB	native	4	-5	sedge	perennial	softstem bulrush
Scirpus cyperinus	Cyperaceae	SCICYP	native	5	-5	sedge	perennial	wool-grass
Scutellaria lateriflora	Lamiaceae	SCULAT	native	5	-5	forb	perennial	mad-dog skullcap
Solanum dulcamara	Solanaceae	SOLDUL	non-native	0	0	vine	perennial	bittersweet nightshade
Sparganium eurycarpum	Typhaceae	SPAEUR	native	5	-5	forb	perennial	common bur-reed
Spirodela polyrhiza	Araceae	SPIPOL	native	6	-5	forb	perennial	greater duckweed
Symphyotrichum firmum; aster puniceus	Asteraceae	SYMFIR	native	4	-3	forb	perennial	smooth swamp aster
Symphytum officinale	Boraginaceae	SYMOFF	non-native	0	5	forb	perennial	common comfrey
Teucrium canadense	Lamiaceae	TEUCAN	native	4	-3	forb	perennial	wood-sage
Toxicodendron radicans	Anacardiaceae	TOXRAD	native	2	0	vine	perennial	poison-ivy
Typha angustifolia	Typhaceae	TYPANG	non-native	0	-5	forb	perennial	narrow-leaved cat-tail
Typha latifolia	Typhaceae	TYPLAT	native	1	-5	forb	perennial	broad-leaved cat-tail
Ulmus americana	Ulmaceae	ULMAME	native	1	-3	tree	perennial	american elm
Utricularia cornuta	Lentibulariaceae	UTRCOR	native	10	-5	forb	perennial	horned bladderwort
Utricularia gibba	Lentibulariaceae	UTRGIB	native	8	-5	forb	perennial	humped bladderwort
Viburnum lentago	Adoxaceae	VIBLEN	native	4	0	shrub	perennial	nannyberry
Viburnum opulus	Adoxaceae	VIBOPU	non-native	0	-3	shrub	perennial	european highbush-cranberry
Vitis riparia	Vitaceae	VITRIP	native	3	0	vine	perennial	river-bank grape
Wolffia columbiana	Araceae	WOLCOL	native	5	-5	forb	perennial	common water meal

Appendix J. Plant species documented in upland habitats at Salt River Marsh State Wildlife Area.

Practitioner:	Tyler Bassett	
Latitude:		
Longitude:		
Weather Notes:		
Duration Notes:	6/25/19 and 9/10/19 and 9/16/19	
Community Type Notes:		
Other Notes:		
Private/Public:	Private	
Conservatism-Based Metrics:		
Total Mean C:	2.3	
Native Mean C:	3.1	
Total FQI:	29.4	
Native FQI:	34.1	
Adjusted FQI:	26.7	
% C value 0:	31.9	
% C value 1-3:	35.6	
% C value 4-6:	30.1	
% C value 7-10:	2.5	
Native Tree Mean C:	3.5	
Native Shrub Mean C:	3.5	
Native Herbaceous Mean C:	3	
Species Richness:		
Total Species:	163	
Native Species:	121	74.20%
Non-native Species:	42	25.80%
Species Wetness:		
Mean Wetness:	0.9	
Native Mean Wetness:	0.3	
Physiognomy Metrics:		
Tree:	26	16%
Shrub:	23	14.10%
Vine:	7	4.30%
Forb:	76	46.60%
Grass:	13	8%
Sedge:	12	7.40%
Rush:	3	1.80%

Appendix J. Continued...

Fern:	3	1.80%
Bryophyte:	0	0%
Duration Metrics:		
Annual:	14	8.60%
Perennial:	144	88.30%
Biennial:	5	3.10%
Native Annual:	11	6.70%
Native Perennial:	109	66.90%
Native Biennial:	1	0.60%

Species:

Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Acalypha rhomboidea	Euphorbiaceae	ACARHO	native	0	3	forb	annual	three-seeded mercury
Acer negundo	Sapindaceae	ACENEG	native	0	0	tree	perennial	box-elder
Acer rubrum	Sapindaceae	ACERUB	native	1	0	tree	perennial	red maple
Acer saccharinum	Sapindaceae	ACESAI	native	2	-3	tree	perennial	silver maple
Achillea millefolium	Asteraceae	ACHMIL	native	1	3	forb	perennial	yarrow
Agrimonia gryposepala	Rosaceae	AGRGRY	native	2	3	forb	perennial	tall agrimony
Agrimonia parviflora	Rosaceae	AGRPAR	native	4	0	forb	perennial	swamp agrimony
Agrostis perennans	Poaceae	AGRPER	native	5	3	grass	perennial	autumn bent
Alliaria petiolata	Brassicaceae	ALLPET	non-native	0	3	forb	biennial	garlic mustard
Ambrosia artemisiifolia	Asteraceae	AMBART	native	0	3	forb	annual	common ragweed
Amphicarpaea bracteata	Fabaceae	AMPBRA	native	5	0	vine	annual	hog-peanut
Antennaria parlinii	Asteraceae	ANTPAL	native	2	5	forb	perennial	smooth pussytoes
Apocynum androsaemifolium	Apocynaceae	APOAND	native	3	5	forb	perennial	spreading dogbane
Apocynum cannabinum; a. sibiricum	Apocynaceae	APOCAN	native	3	0	forb	perennial	indian-hemp
Arctium minus	Asteraceae	ARCMIN	non-native	0	3	forb	biennial	common burdock
Arisaema triphyllum	Araceae	ARITRI	native	5	0	forb	perennial	jack-in-the-pulpit
Berberis thunbergii	Berberidaceae	BERTHU	non-native	0	3	shrub	perennial	japanese barberry
Betula papyrifera	Betulaceae	BETPAP	native	2	3	tree	perennial	paper birch
Betula populifolia	Betulaceae	BETPOP	native	4	0	tree	perennial	gray birch
Bidens frondosa	Asteraceae	BIDFRO	native	1	-3	forb	annual	common beggar-ticks
Calamagrostis canadensis	Poaceae	CALCAN	native	3	-5	grass	perennial	blue-joint
Carex blanda	Cyperaceae	CXBLAN	native	1	0	sedge	perennial	sedge
Carex bromoides	Cyperaceae	CXBROM	native	6	-3	sedge	perennial	sedge
Carex cephalophora	Cyperaceae	CXCEPP	native	3	3	sedge	perennial	sedge
Carex echinodes; c. tenera	Cyperaceae	CXECHO	native	5	-3	sedge	perennial	sedge
Carex gracillima	Cyperaceae	CXGRAA	native	4	3	sedge	perennial	sedge
Carex hirtifolia	Cyperaceae	CXHIRI	native	5	3	sedge	perennial	sedge
Carex lacustris	Cyperaceae	CXLACU	native	6	-5	sedge	perennial	sedge

Appendix J. Continued...

Carex pellita; c. lanuginosa	Cyperaceae	CXPELL	native	2	-5	sedge	perennial	sedge
Carex pensylvanica	Cyperaceae	CXPENS	native	4	5	sedge	perennial	sedge
Carex rosea; c. convoluta	Cyperaceae	CXROSE	native	2	5	sedge	perennial	curly-styled wood sedge
Carex stricta	Cyperaceae	CXSTRI	native	4	-5	sedge	perennial	sedge
Carex swanii	Cyperaceae	CXSWAN	native	4	3	sedge	perennial	sedge
Carpinus caroliniana	Betulaceae	CARCAO	native	6	0	tree	perennial	blue-beech
Carya cordiformis	Juglandaceae	CARCOR	native	5	0	tree	perennial	bitternut hickory
Carya glabra	Juglandaceae	CARGLA	native	5	3	tree	perennial	pignut hickory
Celastrus orbiculatus	Celastraceae	CELORB	non-native	0	5	vine	perennial	oriental bittersweet
Cephalanthus occidentalis	Rubiaceae	CEPOCC	native	7	-5	shrub	perennial	buttonbush
Cerastium fontanum	Caryophyllaceae	CERFON	non-native	0	3	forb	perennial	mouse-ear chickweed
Cinna arundinacea	Poaceae	CINARU	native	7	-3	grass	perennial	wood reedgrass
Circaea canadensis; c. lutetiana	Onagraceae	CIRCAN	native	2	3	forb	perennial	enchanters-nightshade
Cirsium arvense	Asteraceae	CIRARV	non-native	0	3	forb	perennial	canada thistle
Convallaria majalis	Convallariaceae	CONMAJ	non-native	0	5	forb	perennial	lily-of-the-valley
Conyza canadensis	Asteraceae	CONCAN	native	0	3	forb	annual	horseweed
Cornus foemina	Cornaceae	CORFOE	native	1	0	shrub	perennial	gray dogwood
Crataegus crus-galli; c. fontanesiana	Rosaceae	CRACRU	native	5	0	tree	perennial	cockspur thorn
Cypripedium parviflorum; c. calceolus	Orchidaceae	CYPPAR	native	5	0	forb	perennial	yellow lady-slipper
Danthonia spicata	Poaceae	DANSPI	native	4	5	grass	perennial	poverty grass; oatgrass
Daucus carota	Apiaceae	DAUCAR	non-native	0	5	forb	biennial	queen-annes-lace
Desmodium glabellum; d. paniculatum	Fabaceae	DESGLA	native	5	5	forb	perennial	tick-trefoil
Dichanthelium implicatum; panicum i.	Poaceae	DICIMP	native	3	0	grass	perennial	panic grass
Dichanthelium sphaerocarpon; panicum s.	Poaceae	DICSPH	native	5	3	grass	perennial	round-fruited panic grass
Doellingeria umbellata; aster u.	Asteraceae	DOEUMB	native	5	-3	forb	perennial	flat-topped white aster
Elaeagnus umbellata	Elaeagnaceae	ELAUMB	non-native	0	3	shrub	perennial	autumn-olive
Epipactis helleborine	Orchidaceae	EPIHEL	non-native	0	0	forb	perennial	helleborine
Equisetum arvense	Equisetaceae	EQUARV	native	0	0	fern	perennial	common horsetail
Erechtites hieraciifolius	Asteraceae	EREHIE	native	2	3	forb	annual	fireweed
Erigeron philadelphicus	Asteraceae	ERIPHI	native	2	0	forb	perennial	philadelphia fleabane
Euonymus obovatus	Celastraceae	EUOOBO	native	5	3	shrub	perennial	running strawberry-bush
Fragaria virginiana	Rosaceae	FRAVIR	native	2	3	forb	perennial	wild strawberry
Frangula alnus; rhamnus frangula	Rhamnaceae	FRAALN	non-native	0	0	shrub	perennial	glossy buckthorn
Fraxinus americana	Oleaceae	FRAAME	native	5	3	tree	perennial	white ash
Fraxinus pennsylvanica	Oleaceae	FRAPEN	native	2	-3	tree	perennial	red ash
Galium triflorum	Rubiaceae	GALTRR	native	4	3	forb	perennial	fragrant bedstraw
Geum canadense	Rosaceae	GEUCAN	native	1	0	forb	perennial	white avens
Geum fragarioides; waldsteinia f.	Rosaceae	GEUFRA	native	6	5	forb	perennial	barren-strawberry
Geum laciniatum	Rosaceae	GEULAC	native	2	-3	forb	perennial	rough avens
Glechoma hederacea	Lamiaceae	GLEHED	non-native	0	3	forb	perennial	ground-ivy
Glyceria striata	Poaceae	GLYSTR	native	4	-5	grass	perennial	fowl manna grass

Appendix J. Continued...

Hackelia virginiana	Boraginaceae	HACVIR	native	1	3	forb	biennial	beggars lice
Hemerocallis fulva	Hemerocallidaceae	HEMFUL	non-native	0	5	forb	perennial	orange day-lily
Hieracium aurantiacum	Asteraceae	HIEAUR	non-native	0	5	forb	perennial	orange hawkweed
Hypericum kalmianum	Hypericaceae	HYPKAL	native	10	-3	shrub	perennial	kalms st. johns-wort
Hypericum perforatum	Hypericaceae	HYPPER	non-native	0	5	forb	perennial	common st. johns-wort
Hypericum punctatum	Hypericaceae	HYPPUN	native	4	0	forb	perennial	spotted st. johns-wort
Impatiens capensis	Balsaminaceae	IMPCAP	native	2	-3	forb	annual	spotted touch-me-not
Juglans nigra	Juglandaceae	JUGNIG	native	5	3	tree	perennial	black walnut
Juncus effusus	Juncaceae	JUNEFF	native	3	-5	rush	perennial	soft-stemmed rush
Juncus tenuis	Juncaceae	JUNTEN	native	1	0	rush	perennial	path rush
Leersia virginica	Poaceae	LEEVIR	native	5	-3	grass	perennial	white grass
Ligustrum vulgare	Oleaceae	LIGVUL	non-native	0	3	shrub	perennial	common privet
Lobelia siphilitica	Campanulaceae	LOBSIP	native	4	-3	forb	perennial	great blue lobelia
Lonicera japonica	Caprifoliaceae	LONJAP	non-native	0	3	vine	perennial	japanese honeysuckle
Lonicera morrowii	Caprifoliaceae	LONMOR	non-native	0	3	shrub	perennial	morrow honeysuckle
Luzula multiflora	Juncaceae	LUZMUL	native	5	3	rush	perennial	common wood rush
Lycopus americanus	Lamiaceae	LYCAME	native	2	-5	forb	perennial	common water horehound
Lycopus uniflorus	Lamiaceae	LYCUNI	native	2	-5	forb	perennial	northern bugle weed
Lysimachia nummularia	Myrsinaceae	LYSNUM	non-native	0	-3	forb	perennial	moneywort
Lythrum salicaria	Lythraceae	LYTSAL	non-native	0	-5	forb	perennial	purple loosestrife
Malus pumila	Rosaceae	MALPUM	non-native	0	5	tree	perennial	apple
Matteuccia struthiopteris	Onocleaceae	MATSTR	native	3	0	fern	perennial	ostrich fern
Melilotus albus	Fabaceae	MELALB	non-native	0	3	forb	biennial	white sweet-clover
Morus alba	Moraceae	MORALB	non-native	0	3	tree	perennial	white mulberry
Onoclea sensibilis	Onocleaceae	ONOSEN	native	2	-3	fern	perennial	sensitive fern
Oxalis stricta; o. fontana	Oxalidaceae	OXASTR	native	0	3	forb	perennial	yellow wood-sorrel
Panicum capillare	Poaceae	PANCAP	native	0	0	grass	annual	witch grass
Parthenocissus quinquefolia	Vitaceae	PARQUI	native	5	3	vine	perennial	virginia creeper
Persicaria hydropiper; polygonum h.	Polygonaceae	PERHYR	native	1	-5	forb	annual	water-pepper
Persicaria maculosa; polygonum persicaria	Polygonaceae	PERMAC	non-native	0	0	forb	annual	ladys-thumb
Persicaria punctata; polygonum p.	Polygonaceae	PERPUN	native	5	-5	forb	annual	smartweed
Persicaria virginiana; polygonum v.	Polygonaceae	PERVIR	native	4	0	forb	perennial	jumpseed
Phalaris arundinacea	Poaceae	PHAARU	native	0	-3	grass	perennial	reed canary grass
Phragmites australis var. australis	Poaceae	PHRAUU	non-native	0	-3	grass	perennial	reed
Pinus sylvestris	Pinaceae	PINSYL	non-native	0	3	tree	perennial	scotch pine
Poa compressa	Poaceae	POACOM	non-native	0	3	grass	perennial	canada bluegrass
Poa pratensis	Poaceae	POAPRA	non-native	0	3	grass	perennial	kentucky bluegrass
Podophyllum peltatum	Berberidaceae	PODPEL	native	3	3	forb	perennial	may-apple
Populus deltoides	Salicaceae	POPDEL	native	1	0	tree	perennial	cottonwood
Populus tremuloides	Salicaceae	POPTRE	native	1	0	tree	perennial	quaking aspen
Potentilla anserina	Rosaceae	POTANS	native	5	-3	forb	perennial	silverweed

Appendix J. Continued...

Potentilla recta	Rosaceae	POTREC	non-native	0	5	forb	perennial	rough-fruited cinquefoil
Potentilla simplex	Rosaceae	POTSIM	native	2	3	forb	perennial	old-field cinquefoil
Prunella vulgaris	Lamiaceae	PRUVUL	native	0	0	forb	perennial	self-heal
Prunus serotina	Rosaceae	PRUSER	native	2	3	tree	perennial	wild black cherry
Prunus virginiana	Rosaceae	PRUVIR	native	2	3	shrub	perennial	choke cherry
Quercus alba	Fagaceae	QUEALB	native	5	3	tree	perennial	white oak
Quercus rubra	Fagaceae	QUERUB	native	5	3	tree	perennial	red oak
Quercus velutina	Fagaceae	QUEVEL	native	6	5	tree	perennial	black oak
Ranunculus abortivus	Ranunculaceae	RANABO	native	0	0	forb	perennial	small-flowered buttercup
Ranunculus recurvatus	Ranunculaceae	RANREC	native	5	-3	forb	perennial	hooked crowfoot
Ranunculus sceleratus	Ranunculaceae	RANSCE	native	1	-5	forb	annual	cursed crowfoot
Rhamnus cathartica	Rhamnaceae	RHACAT	non-native	0	0	tree	perennial	common buckthorn
Rhus typhina	Anacardiaceae	RHUTYP	native	2	3	shrub	perennial	staghorn sumac
Ribes cynosbati	Grossulariaceae	RIBCYN	native	4	3	shrub	perennial	prickly or wild gooseberry
Robinia pseudoacacia	Fabaceae	ROBPSE	non-native	0	3	tree	perennial	black locust
Rosa multiflora	Rosaceae	ROSMUL	non-native	0	3	shrub	perennial	multiflora rose
Rubus flagellaris	Rosaceae	RUBFLA	native	1	3	shrub	perennial	northern dewberry
Rubus occidentalis	Rosaceae	RUBOCC	native	1	5	shrub	perennial	black raspberry
Rubus setosus	Rosaceae	RUBSET	native	3	-3	shrub	perennial	bristly blackberry
Rubus strigosus	Rosaceae	RUBSTR	native	2	0	shrub	perennial	wild red raspberry
Rumex acetosella	Polygonaceae	RUMACL	non-native	0	3	forb	perennial	sheep sorrel
Rumex triangulivalvis	Polygonaceae	RUMTRI	native	1	0	forb	perennial	dock
Sambucus canadensis	Adoxaceae	SAMCAN	native	3	-3	shrub	perennial	elderberry
Sanicula odorata; s. gregaria	Apiaceae	SANODO	native	2	0	forb	perennial	black snakeroot
Sassafras albidum	Lauraceae	SASALB	native	5	3	tree	perennial	sassafras
Scutellaria lateriflora	Lamiaceae	SCULAT	native	5	-5	forb	perennial	mad-dog skullcap
Sisyrinchium albidum; s. hastile	Iridaceae	SISALB	native	7	3	forb	perennial	common blue-eyed-grass
Smilax ecirrata	Smilacaceae	SMIECI	native	6	5	forb	perennial	upright carrion-flower
Solanum dulcamara	Solanaceae	SOLDUL	non-native	0	0	vine	perennial	bittersweet nightshade
Solidago altissima	Asteraceae	SOLALT	native	1	3	forb	perennial	tall goldenrod
Solidago rugosa	Asteraceae	SOLRUG	native	3	0	forb	perennial	rough-leaved goldenrod
Stellaria media	Caryophyllaceae	STEMED	non-native	0	3	forb	annual	common chickweed
Symphyotrichum lateriflorum; aster l.	Asteraceae	SYMLAT	native	2	0	forb	perennial	calico aster
Symphyotrichum novae-angliae; aster n.	Asteraceae	SYMNOV	native	3	-3	forb	perennial	new england aster
Symphyotrichum pilosum; aster p.	Asteraceae	SYMPIL	native	1	3	forb	perennial	hairy aster
Symphytum officinale	Boraginaceae	SYMOFF	non-native	0	5	forb	perennial	common comfrey
Syringa vulgaris	Oleaceae	SYRVUL	non-native	0	5	shrub	perennial	common lilac
Taraxacum officinale	Asteraceae	TAROFF	non-native	0	3	forb	perennial	common dandelion
Teucrium canadense	Lamiaceae	TEUCAN	native	4	-3	forb	perennial	wood-sage
Thalictrum dasycarpum	Ranunculaceae	THADAS	native	3	-3	forb	perennial	purple meadow-rue
Tilia americana	Malvaceae	TILAME	native	5	3	tree	perennial	basswood

Appendix J. Continued...

Toxicodendron radicans	Anacardiaceae	TOXRAD	native	2	0	vine	perennial	poison-ivy
Trifolium dubium	Fabaceae	TRIDUB	non-native	0	3	forb	annual	little hop clover
Trifolium repens	Fabaceae	TRIREP	non-native	0	3	forb	perennial	white clover
Ulmus americana	Ulmaceae	ULMAME	native	1	-3	tree	perennial	american elm
Urtica dioica	Urticaceae	URTDIO	native	1	0	forb	perennial	stinging nettle
Verbena urticifolia	Verbenaceae	VERURT	native	4	0	forb	perennial	white vervain
Veronica serpyllifolia	Plantaginaceae	VERSER	non-native	0	0	forb	perennial	thyme-leaved speedwell
Viburnum lentago	Adoxaceae	VIBLEN	native	4	0	shrub	perennial	nannyberry
Viburnum opulus	Adoxaceae	VIBOPU	non-native	0	-3	shrub	perennial	european highbush-cranberry
Viburnum rafinesquianum	Adoxaceae	VIBRAF	native	5	5	shrub	perennial	downy arrow-wood
Vitis riparia	Vitaceae	VITRIP	native	3	0	vine	perennial	river-bank grape
Zanthoxylum americanum	Rutaceae	ZANAME	native	3	3	shrub	perennial	prickly-ash