Planning for Ecological Surveys and Assessments to Facilitate Restoration Activities at the Salt River Marsh

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For:
Michigan Department of Environment, Great Lakes, and Energy,
Water Resources Division
June 28, 2019

Report Number 2019-15

EGLE
MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Suggested Citation:
Badra, P.J., T. Bassett, and Y.M. Lee. 2019. Planning for Ecological Surveys and Assessments to Facilitate Restoration Activities at the Salt River Marsh. Michigan Natural Features Inventory Report Number 2019-15, Lansing, MI 124pp.

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. Mike Monfils played a vital role in securing funding for this effort. Nancy Toben, Ashley Adkins, and Brian Klatt provided essential administrative support.

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 the invasive common reed (Phragmites australis). The Salt River is connected to Lake St. Clair and riparian wetlands and provides 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 (EPA) the Michigan Department of Natural Resources (Wildlife Division), and the Michigan Department of Environment, Great Lakes, and Energy (Water Resources Division, Great Lakes Management Unit) have developed plans to restore portions of the Salt River Marsh occurring on State lands (U.S. Army Corps of Engineers 2013). Restoration will be accomplished through the excavation of sediments and mats of common reed, to improve plant community composition and structure and fish and wildlife habitat value. The project area is circumscribed by the boundaries of the approximately 60 acre (25 ha) Salt River Marsh State especially the extent of invasive species.

Ecological survey work is needed to help describe the baseline conditions. An understanding of the current conditions is needed to prepare permit applications required for restoration implementation, as well as assess the success of restoration activities after project completion. In 2019, MNFI personnel plan to complete the following three field components: 1) habitat area delineation and characterization; 2) herpetological survey; and 3) stream assessment and macroinvertebrate survey. To prepare for carrying out this field work and support restoration work at Salt River Marsh Michigan Natural Features Inventory (MNFI) performed in-office planning. Subsequent funding in 2019 is expected to provide funding to complete field work and report results.

This report provides is a draft habitat type map (page 11, Appendix I. Habitat Area Delineation and Characterization QAPP), a list of target species for herpetological and macroinvertebrate surveys, and a description of the methods and sample designs to be used. Draft Quality Assurance Project Plans (QAPPs) were written for each of the three survey components and are included in this report. The methods and sample design for each of the three components of the fieldwork are given within each of the respective draft QAPP below.

Timeline for Fieldwork

Early season fieldwork will be completed in late June/early July. This will include all herpetological fieldwork and the early season terrestrial habitat survey.

Late season fieldwork will be completed in mid-August to the end of September, depending on amount of precipitation and water levels during that time. Late season fieldwork includes the late season terrestrial habitat survey and all fieldwork for the stream assessment and macroinvertebrate sampling. The stream assessment fieldwork will be performed when water levels are near their seasonal low in order to facilitate macroinvertebrate sampling.

List of Target Species

Based on the presence of habitat types, location of the project area, and known ranges of species in Michigan, the following herpetofauna species or suitable habitat for these species have potential to occur in or immediately adjacent to the project area:

Common Mudpuppy (*Necturus maculosus maculosus*, state special concern)
Eastern Newt (*Notophthalmus viridescens*)
Eastern Red-backed Salamander (*Plethodon cinereus*)

Blanchard's Cricket Frog (*Acris blanchardi*, state threatened)
Bullfrog (*Rana catesbeiana*)
Eastern American Toad (*Bufo [Anaxyrus] americanus americanus*)
Eastern Gray Treefrog (*Hyla versicolor*)
Green Frog (*Rana clamitans melanota*)

Midland or Western Chorus Frog (*Pseudacris triseriata triseriata*)
Northern Leopard Frog (*Rana pipiens*)
Northern Spring Peeper (*Pseudacris crucifer crucifer*)
Pickerel Frog (*Rana palustris*, state special concern)

Blanding's Turtle (*Emydoidea blandingii*, state special concern)
Eastern Musk Turtle (*Sternotherus odoratus*)
Eastern Snapping Turtle (*Chelydra serpentina serpentina*)
Northern Map Turtle (*Graptemys geographica*)
Painted Turtle (*Chrysemys picta*)
Red-eared Slider (*Trachemys scripta elegans*)
Spotted Turtle (*Clemmys guttata*, state threatened)

DeKay's Brown Snake (*Storeria dekayi dekayi*)
Eastern Fox Snake (*Pantherophis gloydi*, state threatened)
Eastern Garter Snake (*Thamnophis sirtalis sirtalis*)
Eastern Milk Snake (*Lampropeltis triangulum triangulum*)
Northern Red-bellied Snake (*Storeria occipitomaculata occipitomaculata*)
Northern Ribbon Snake (*Thamnophis sauritus septentrionalis*)
Northern Water Snake (*Nerodia sipedon sipedon*)
Queen Snake (*Regina septemvittata*, state special concern)

A wide range of macroinvertebrate taxa will be targeted during the in-stream macroivertebrate survey as detailed in Appendix III. Stream Assessment and Macroinvertebrate Survey QAPP. The following state endangered and threatened aquatic macroinvertebrate species, and species of special concern have potential to occur within the project area:

Black sandshell (*Ligumia recta*, state endangered)
Deertoe (*Truncilla truncata*, special concern)
Eastern pondmussel (*Ligumia nasuta*, state endangered)
Fluted-shell (*Lasmigona costata*, special concern)
Kidney-shell (*Ptychobranchus fasciolaris*, special concern)
Pink heelsplitter (*Potamilus alatus*, special concern)
Rainbow (*Villosa iris*, special concern)
Round hickorynut (*Obovaria subrotunda*, state endangered)
Round pigtoe (*Pleurobema sintoxia*, special concern)
Slippershell (*Alasmidonta viridis*, state threatened)

Big water crayfish (*Cambarus robustus*, special concern)
Calico crayfish (*Orconectes immunis*, special concern)

Appendix I. Quality Assurance Project Plan - Ecological Surveys and Assessments to Facilitate Restoration Activities at the Salt River Marsh: **Habitat Area Delineation and Characterization.**

QUALITY ASSURANCE PROJECT PLAN

Ecological surveys and assessments to facilitate restoration activities at the Salt River Marsh: **Habitat Area Delineation and Characterization**

Prepared for:

Michelle Selzer

Water Resources Division

Great Lakes Management Unit

Michigan Department of Environment, Great Lakes, & Energy

Doc ID: 190000006457

Prepared by:

Tyler Bassett

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June 7, 2019

SECTION A – PROJECT MANAGEMENT

A.1 Title of Plan and Approval

Quality Assurance Project Plan
Ecological surveys and assessments to facilitate restoration activities at the Salt River Marsh:

Habitat Area Delineation and Characterization

Prepared by:
Michigan Natural Features Inventory,
Michigan State University Extension

_____ Date: _____
Tyler Bassett, Project Manager, MNFI

_____ Date: _____
Peter Badra, QA Manager / Principal Investigator, MNFI

_____ Date: _____
Stephanie Swart, QAPP Reviewer, Great Lakes Management Unit, EGLE

_____ Date: _____
Michelle Selzer, Great Lakes Management Unit, EGLE

_____ Date: _____
Richard Hobrla, Great Lakes Management Unit, EGLE

_____ Date: _____
Louis Blume, Quality Assurance Officer, EPA

A.2 Table of Contents

List of Tables

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A.3 Distribution List

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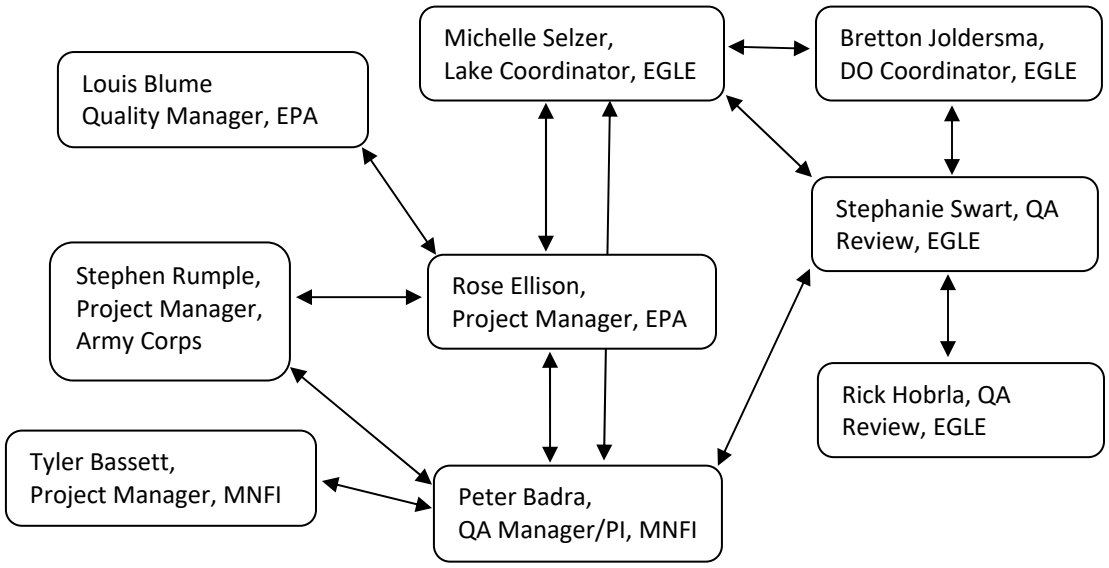
A.4 Project/Task Organization

Table 1. Roles & Responsibilities

Individual(s) Assigned	Responsible for:	Authorized to:
Tyler Bassett	• Project management • Writing QAPP • Sampling design • Data collection, processing, and storage • Sample collection and storage • Report writing	• Design sampling methods • Coordinate and carry-out field work • Collect, process, and store data and samples • Author final report
Peter Badra	• QA manager • Point of contact between MNFI, EPA, Army Corps, and OGL	• Ensure QAPP is followed • Review QAPP, sampling design, data collection, and report writing • Coordinate communication between project partners
Rose Ellison	• Project oversight	•
Louis Blume	• Quality Manager	•
Stephen Rumple	• Project oversight	•
Michelle Selzer	• Project oversight	•
Stephanie Swart	• QA Review	•
Richard Hobrla	• QA Review	•
Bretton Joldersma	• Coordination of DO	•

Figure 1. Organization Chart



A.5 Problem Definition/Background

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 the invasive common reed (*Phragmites australis*). The Salt River is connected to Lake St. Clair and riparian wetlands and provides 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 (EPA) and the Michigan Department of Natural Resources (Office of the Great Lakes [OGL] and Wildlife Division [WLD]), have developed plans to restore portions of the Salt River Marsh occurring on State lands (U.S. Army Corps of Engineers 2013). Restoration will be accomplished through the excavation of sediments and mats of common reed, to improve plant community composition and structure and fish and wildlife habitat value. The project area is circumscribed by the boundaries of the approximately 60 acre (25 ha) Salt River Marsh State Wildlife Area (SWA) (Figure 2).

Prior to restoration, ecological survey work is needed to document the baseline *condition* of the project area - describing the plant species composition, vegetative structure, and Rare, Threatened, and Endangered (RTE) species; and, summarizing *threats* to ecological integrity – especially the extent of invasive species. The results of surveys will also reduce or eliminate negative impacts on any RTE species and the overall ecological integrity of the project area. An understanding of the current conditions is needed to prepare permit applications (MDEQ Parts 31, 91, 301, and 303 of NREPA 1994 PA 451, as amended) required for restoration implementation, as well as assess the success of restoration activities after project completion. The Michigan Natural Features Inventory (MNFI) will work with the agency partners to gather the necessary ecological information to move the project forward. MNFI has performed a desktop habitat delineation of the project site (Figure 3), in order to characterize the expected natural communities. Using historical and current aerial imagery and spatial land cover data, and existing survey data, MNFI has identified 37.5 acres of emergent marsh (comprising three habitat stands) and 14.9 acres of dry-mesic southern forest (comprising three habitat stands) (in addition to 7.5 acres of aquatic stream channel invaded by common reed) within the project area. In addition, a query of the MNFI Natural Heritage Database (Michigan Natural Features Inventory 2019), which contains records of all RTE species known to occur in Michigan, noted one species within one kilometer of the project area (*Cardamine maxima*, large toothwort), two within two miles (*Asclepias sullivantii*, Sullivant's milkweed; *Fraxinus profunda*; pumpkin ash), and two within five miles (*Carex lupuliformis*, false hop sedge; *Quercus shumardii*, Shumard's oak). Surveys will be focused during time periods intended to maximize detectability of characteristic species of emergent marsh and dry-mesic southern forest, RTE species associated with those communities, and RTE species documented within five miles of the project area.

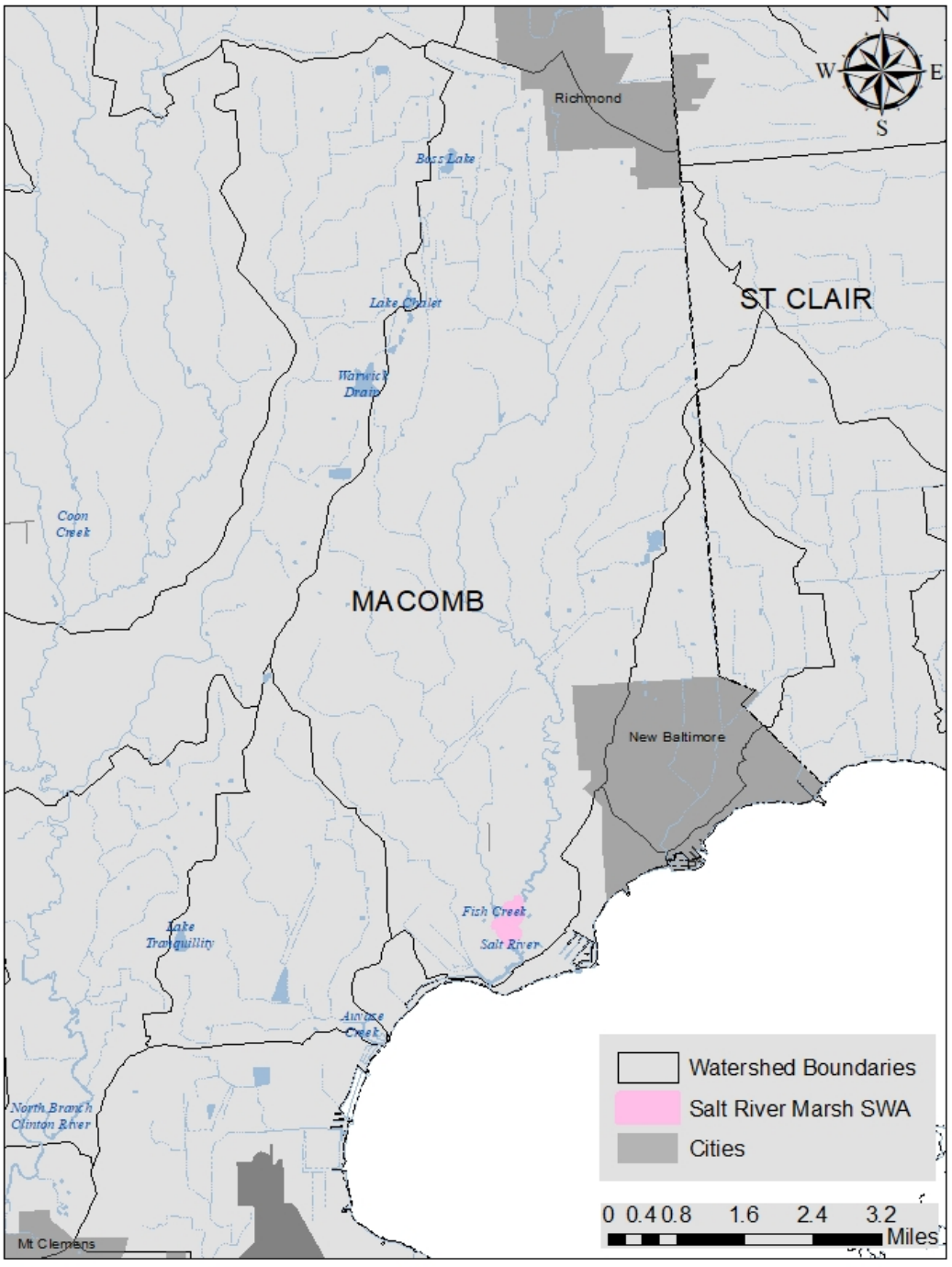


Figure 2. Location of project site, Salt River Marsh SWA, in southeastern Macomb County

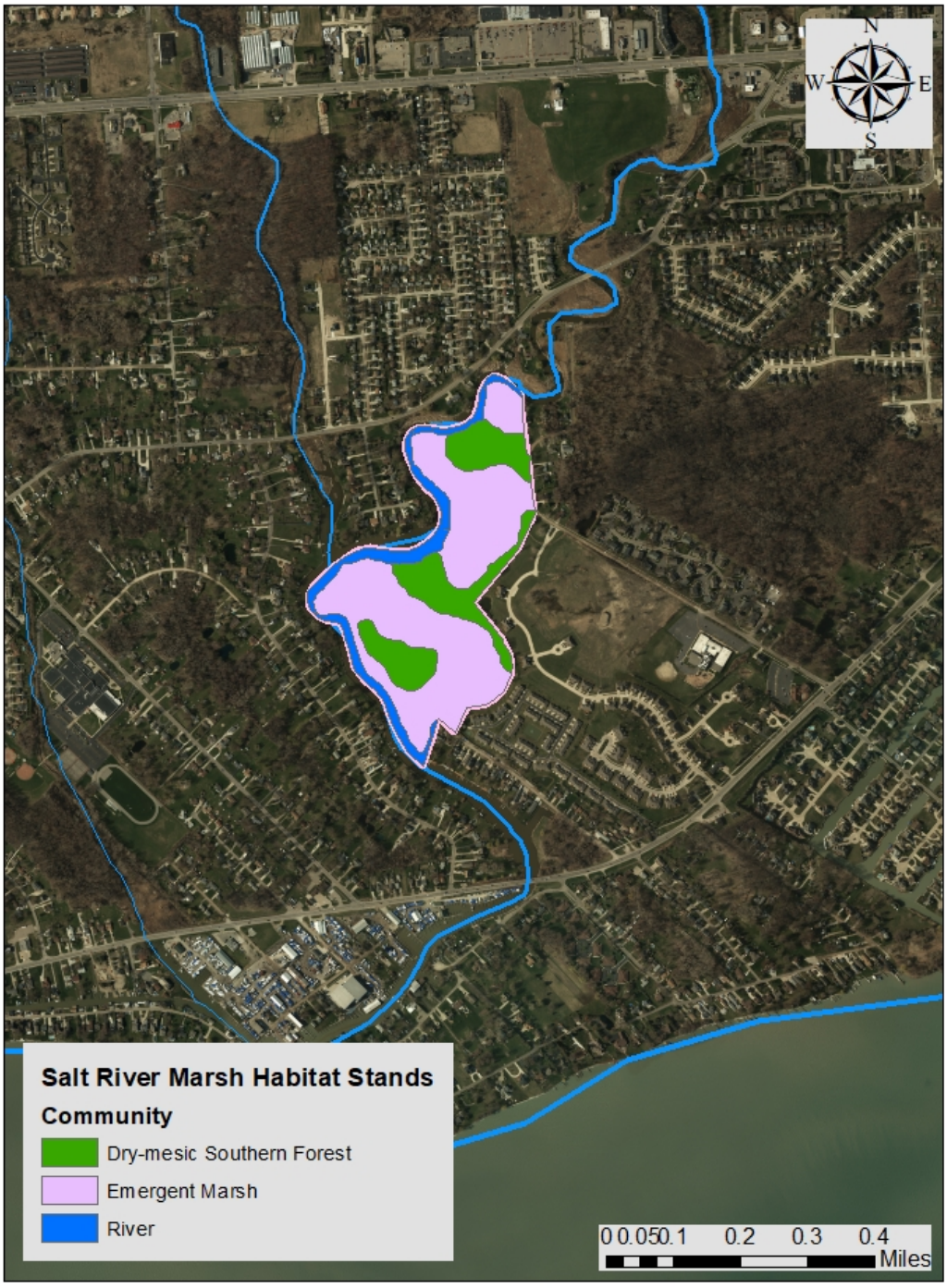


Figure 3. Habitat Stands

A.6 Project/Task Description

Survey Methodology

Ecological surveys will have two broad goals: 1) record the plant species composition within each habitat area, and document in more detail the occurrence and extent of any RTE species and invasive species; and 2) characterize the vegetative structure of each habitat area by describing the dominant species within and percent cover of each vertical stratum: canopy, subcanopy, and ground layers. Five State-listed plant species were detected 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 will be timed to detect and identify these species. Nine habitat stands were delineated into expected natural communities prior to field surveys: three stands of emergent marsh, and three stands of dry-mesic southern forest (Figure 3). In addition, three stands representing the upper, middle, and lower reaches of the Salt River were delineated, but these will not be the focus of plant surveys.

We will use a modified timed meander search (TMS) procedure (Goff et al. 1982) to conduct a plant survey within each habitat stand. Surveys will occur within the boundaries of various habitat areas at the site that were delineated in the office based on aerial imagery and land cover data (Figure 3). These habitat areas were characterized based on anticipated plant species composition and diversity, topography, unique features such as wetlands and streams, disturbances and development, and other distinct characteristics. Each TMS procedure will begin on the boundary of each successive habitat area (which location will be recorded with a GPS point) and be conducted for a minimum of 30 minutes within each area. The clock will be paused when a notable feature is encountered that requires attention, for example an RTE species, an invasive species, or a plant species requiring field identification.

TMS procedure will also be used to generate a plant species list and to determine the potential presence of RTE plant species. The plant species observed within each habitat area will be recorded on a field data sheet as they are encountered (Appendix A). The sampling route will meander throughout the project area to ensure a constant search for new and unique plant species within the mapped habitat unit. A randomly-patterned meandering route allows for maximum coverage of variation within each habitat unit. The route at a particular habitat unit is complete when no new species are encountered with additional search efforts (best professional judgment is exercised in this case). All observed plant species will be recorded on field data sheets (Appendix A) using 6-letter acronyms (see Reznicek et al. 2014) that will also contain entries for habitat type, location within project area, date, name of investigator(s), observed wildlife species, observation times, photographs, and other notes. Nomenclature will follow Voss and Reznicek (2012) and be cross-checked for updates on the Michigan Flora webpage (Michigan Flora 2019). Unknown species will be GPSd, collected in individual Ziploc bags, and noted with the same unique identifiers on bags and data sheets and when recording GPS point, that include the date, habitat area, collector initials, and a unique name (e.g., "2019-

06-24, Area 1, TJB, Carex sp. #1"). Photographs will be documented on field sheets using the following form: photo number-date-time-subject. During field surveys, the location of RTE species observed will be mapped using a global positioning system (GPS) capable of one to two meter accuracy, as well as other key features that may characterize the habitat area such as stands of invasive species, signs of recreational use by community members, significantly disturbed or degraded areas, or unique natural features such as wetlands and streams, using the back of the sheet if required for additional notations. Incidental wildlife species observed during the plant surveys will also be recorded. All RTE species will be documented on Special Plant Survey forms (https://mnfi.anr.msu.edu/pdfs/Special_Plant_Form.pdf), with data entered into the Natural Heritage Database by MNFI staff.

At the conclusion of each survey, we will assess and record general habitat conditions by noting the percent cover and dominant species within each vertical strata: Tree canopy (if present), subcanopy (if present), and ground layer vegetation. We will measure diameter-at-breast-height (DBH) and age (with an increment borer) for representative canopy trees. At a representative location within each habitat area, and while the survey timing is paused, a soil core will be extracted to assess soil texture and pH with a field pH kit.

Following the field activities, species effort curves will be constructed to document the cumulative number of species observed at a particular habitat unit versus the elapsed time spent during the examination. The curves will present the level of effort expended within a specific habitat stand, provide a visual means of interpreting floristic variations within the field unit, and give an indication of species richness.

No special equipment will be required to accomplish these tasks. All surveys will be conducted by T. Bassett, MNFI Botanist.

Survey Timeline
Surveys will be focused during time periods intended to maximize detectability of characteristic species of emergent marsh and dry-mesic southern forest, RTE species associated with those communities, and RTE species known to detected within five miles of the project area. Additional RTE species that occur within these community types may be detected by these surveys, although surveys will not be timed specifically to detect these species. Two surveys will occur to insure detection of both early- and late-maturing plant species.

A.7 Data Quality Objectives & Criteria

The aim of this study is to characterize plant communities within the project area prior to the implementation of restoration efforts, in order to minimize negative impacts to native plant and animal species, particularly any RTE species, and to provide baseline information against which to gauge the effects of restoration efforts. Quality objectives are appropriate for ensuring

that the plant species composition of each habitat stand has been accurately documented and that any RTE plant species that occur on site have been observed and properly documented.

Data quality objectives will ensure the *accuracy*, *precision*, *completeness*, *representativeness* and *comparability* of the data. These components of data quality are addressed, followed by some description of specific practices that integrate these components.

Precision and Accuracy: Accuracy is how close measurements are to a true value, and precision is the degree of agreement between two or more measurements. The accuracy and precision of describing the plant community are dependent on expert judgement in identifying plant species in the field or lab. Hard-to-identify species will be checked with standard dichotomous keys (Voss and Reznicek 2012), and if necessary, verified by comparison with herbarium specimens and consulting an additional trained botanist. Species identification should be 100% accurate 95% of the time. Assigning percent cover classes is also subject to expert judgement, but should be accurate to within one cover at least 90% of the time, when compared to cover class assignment done by another independent expert observer.

Completeness: Completeness is a measure of the amount of data obtained from the monitoring program compared to the amount of data that was expected. There is no standard for number of species or particular species that can be expected during a survey, so a quantitative assessment of completeness is not useful. However, species lists and habitat descriptions will be compared to similar habitats (e.g., descriptions of other emergent marsh and dry-mesic southern forest).

Representativeness: Representativeness refers to how well the measurements reflect environmental conditions being measured, which will depend upon expert judgement in identifying plant species in the field or lab. Hard-to-identify species will be checked with standard dichotomous keys (Voss and Reznicek 2012).

Comparability: Comparability is a measure of the confidence with which one data set can be compared with another. Species lists and habitat descriptions will be compared to similar habitats (e.g., descriptions of other emergent marsh and dry-mesic southern forest).

The TMS method provides safeguards that the plant species composition of each stand is adequately documented in two ways, by allowing for thorough spatial coverage of each habitat, and by temporally quantifying survey effort. The observer crisscrosses the habitat, using expert knowledge to explore variation within each habitat type that may reveal additional species. By documenting each five-minute interval and terminating surveys once a reasonable number of five minute intervals have passed with no or few new species observed, the observer is able to quantitatively demonstrate the thoroughness of surveys. GPS tracks will be recorded during surveys in order to document thorough coverage of each habitat stand.

The spatial and temporal thoroughness of the TMS method also increases the likelihood of encountering target species. Location of RTE species will also be recorded with GPS units capable of one to two meter accuracy. To further verify the accuracy of recorded GPS points, a benchmark GPS point will be taken at the beginning of each survey period at a known location visible from current aerial imagery (e.g., a road intersection).

After the implementation of restoration efforts, the following records will facilitate resurvey of habitat stands to document changes to species composition: habitat stand delineation in GIS format, GPS tracks of surveys, GPS points of any RTE species observed during surveys.

A.8 Special Training/Certification

The plant surveys will be conducted by T. Bassett of MNFI, a skilled botanist with 18 years of professional experience conducting botanical and ecological surveys in the Upper Midwest, and particularly southern Michigan.

A.9 Documents and Records

All parties on the QAPP distribution list will be sent a final version of the document and will be sent a new version when the document is revised. This correspondence will occur via a project email list. If email contact is not possible, other methods of contact will be attempted. QAPP distribution is the project manager's responsibility.

Data management and entry is the responsibility of MNFI. Data across all assessment areas will be reviewed for quality (completeness, format, species). The following general guidelines will be adhered to: All data will be collected in the field via standard project datasheets. Prior to completing surveys, completed field sheets will be reviewed for verification (complete data, correct format, no unexpected species) and prior to data entry, will be reviewed to confirm that all unknown specimens have been identified. Data collected on paper datasheets will be entered by MNFI employees into electronic format, checked by a third party to ensure accurate transcription, stored via digital database, and made available to the entire project team. Hard copy datasheets will be retained for the life of the grant period. All GPS point and track data will be stored on MNFI computers.

SECTION B – DATA GENERATION & AQCUISITION

B.1 Sampling Process Design (Experimental Design)

The aim of this study is to characterize the plant communities within the project area, and document RTE species, prior to the implementation of restoration efforts. Surveys will occur in appropriate seasons in order to detect: 1) the majority species that are expected to occur in the expected habitats on site, especially typical dominant species, and 2) potential list of RTE species within the project area.

Natural community condition and threat assessments do not take the form of a traditional experimental design but rather are designed to maximize the land area surveyed, characterized, and assessed per site. Surveys will occur twice, once during early summer to correspond with detectability of sedges (*Carex* spp.) that may be prevalent within the wetland habitats, and once during late summer to correspond with detectability of composites (e.g., plants in the family *Asteraceae*). Individual surveys will occur in each habitat stand, so each stand will be surveyed one time per sampling period.

B.2 Sampling Methods

All data will be recorded on data sheets in the field. Plant species that are not known by the observer on sight will be either identified in the field using standard keys to Michigan Flora (Voss and Reznicek 2012), or in the lab with the aid of a dissecting microscope. The estimation of percent cover will be made based on expert judgement and reported within the following ranges: 0-10%, 10-25%, 25-50%, 50-75%, 75-90%, 90-100%. Soil pH will be assessed using a Hellige-Truog soil reaction (pH) tester. Tree age will be assessed using a standard increment borer.

To reduce the spread of invasive species into and out of the project area, surveyors will clean all equipment (e.g., soil auger) and boot treads, prior to entering the project area, and at the conclusion of each survey.

No physical samples will be collected for this project, with the exception of unknown plant specimens. Unknown species will be collected in an individual Ziploc bag, labelled with a unique descriptive identifier and given the same label on the data sheet. Once identified, only collected plant material that represents a new collection within Macomb County will be deposited in an herbarium. Other specimens will be retained by MNFI for the grant period.

Surveys will also be guided by standard natural heritage methodology (http://www.natureserve.org/conservation-tools/standards-methods), which employs meander surveys with the following components:

a) Compiling comprehensive plant species lists and noting dominant and representative species
b) Describing site-specific structural attributes and ecological processes
c) Measuring tree diameter at breast height (DBH) of representative canopy trees and aging canopy dominants (where appropriate)
d) Analyzing soils and hydrology using soil augers and pH kits
e) Noting current and historical anthropogenic disturbances
f) Evaluating potential threats
g) Ground-truthing aerial photographic interpretation using GPS
h) Taking digital photos and GPS points at significant locations
i) Evaluating the natural community classification and mapped ecological boundaries
j) Noting management needs and restoration opportunities or evaluating past and current restoration activities and noting additional management needs and restoration opportunities

B.3 Sampling Handling & Custody

Unknown species will be collected in an individual Ziploc bag, labelled with a unique descriptive identifier and given the same label on the data sheet. Once identified, only collected plant material that represents a new collection within Macomb County will be deposited in an herbarium. Specimens that are not new to Macomb County will be stored at MNFI for the duration of the grant.

B.4 Analytical Methods

No samples requiring post-sampling analysis will be collected during this project. Unknown plant specimens that are collected during surveys will be identified using a dissecting microscope and standard dichotomous keys.

B.5 Quality Control

All data collected for this project will be based on expert judgement in the field or lab. However, Quality Control (QC) is advisable and practicable for the TMS method, to ensure that surveys covered a sufficient temporal and spatial extent, as well as in data on RTE species entered in the Natural Heritage Database (NHD). Review of GPS tracks and plotting of survey effort (number species observed per five minutes elapsed) will provide QC for TMS surveys. For all data on RTE species entered into NHD, MNFI follows a standard QA/QC protocol, including maintaining paper or electronic documentation and a QC process following data entry.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

GPS units are calibrated prior to data collection using unit-specific methods. For the condition and quality assessments, precise GPS locations will not typically be necessary, nor are there

likely to be equipment failures that result in corrective actions other than replacement of defective units (for example, diameter tapes, soil augers, or GPS units) from the MNFI in-house supply or via web orders. No additional instruments or equipment directly or indirectly involved in collecting samples will be used for this project.

B.7 Instrument/Equipment Calibration and Frequency

The coarse, site- or landscape-scale assessment of condition does not require a strict level of precision from relevant equipment, including GPS units. No additional instruments or equipment directly or indirectly involved in collecting samples will be used for this project.

B.8 Inspection/Acceptance of Supplies & Consumables

No supplies or consumables requiring inspection will be used for this project. Data will be collected on paper data sheets, GPS units, and stored in Ziploc bags. The project manager will be responsible for maintaining and examining field equipment to ensure units are not defective or damaged. Defective equipment will be replaced prior to collection of field data.

B.9 Data Acquisition Requirements for Non-Direct Measurements

The Natural Heritage Database (Michigan Natural Features Inventory 2019) maintained by MNFI was used to investigate the presence of documented occurrences of RTE species in within 5 miles of the project site. This type of use closely aligns with the intended use of the database. The database contains historical and recent data occurrences, but it possible that undocumented populations of RTE species exist in the project area. MNFI staff will exercise their professional judgement for acceptance of the data.

B.10 Data Management

Data collected in the field during all surveys will be written onto data sheets printed on water resistant paper (Rite-in-the-Rain). Collected specimens and photographs of unknown plants will allow for later verification of species recorded during surveys. Each datasheet will be photographed to provide a backup if the original datasheet is lost. These digital photographs will be stored on an MNFI computer, along with other project photos, according to the following photo protocols. All photos will be stored in one folder on an MNFI computer. Project photos will be named with sequential identifiers following the convention: photo number-date-time-subject; datasheet photos will be named with sequential identifiers using the convention: habitat area-date-sheet number-location of hard copy. Original data sheets will also be stored at MNFI. As soon as possible after data collection, but no later than the fall after each field season, data will be entered into Microsoft Excel spreadsheets and made into tables that will be distributed to project partners and used to report results. Data related to all occurrences of RTE species observed during the surveys will be documented in MNFI's Natural Heritage Database.

SECTION C – ASSESSMENT AND OVERSIGHT

C.1 Assessments and Response Actions

As surveys will be conducted by a single, expert individual, assessments will be limited. A cursory review of survey methods will be conducted after the initial, early summer survey. This will include a check that all data is stored and labelled properly, including all GPS points and tracks uploaded, paper files photographed and filed appropriately, and notes taken of the efficacy of survey methods.

C.2 Reports to Management

Per the grant agreement, a preliminary report will be prepared by MNFI and provided to OGL upon 50% completion of the project, as well as a final report once the project is complete. The final report will also be distributed to project partners listed in section A.3.

SECTION D – DATA VALIDATION AND USABILITY

D.1 Data Review, Verification, and Validation

Qualitative assessments will be reviewed by the QA manager to ensure the consistency and accuracy of assessments. The field data collection is based upon expert judgement, so validation will happen at the discretion of the observer at the time of collection. After field data is transcribed into electronic forms, MNFI will apply standard data review processes to the electronic data. If the data is rejected at any level, the hard copy version will be retrieved, and data will be corrected.

D.2 Verification and Validation Methods

The QA manager will independently review habitat assessments and calibrate assessments with others conducted for previous projects in similar natural communities, to ensure the consistency of application. A summary of the condition and threats of each habitat stand will be provided in a table in the final report.

D.3 Reconciliation with Data Quality Objectives

Qualitative data will be reviewed independently by the QA manager to ensure consistency of application of metrics, utilizing in part results from previous projects that assessed conditions and threats. If data quality issues arise, the QA manager will seek additional expert opinion from ecologists at MNFI. If need be, another MNFI ecologist could be brought into the project to verified or reassessed qualitative data. The scope, utility, and limitations of the data will be specified in the final report to the sponsor.

References

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Appendix A. Timed Meander Search datasheet

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____

Timed Meander Search

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

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

Sheet: ____of____

Appendix II. Quality Assurance Project Plan - Ecological Surveys and Assessments to Facilitate Restoration Activities at the Salt River Marsh: **Herpetological Surveys.**

QUALITY ASSURANCE PROJECT PLAN

Ecological surveys and assessments to facilitate restoration activities at the Salt River Marsh: **Herpetological Surveys**

Prepared for:

Michelle Selzer

Water Resources Division, Department of Environment Great Lakes and Energy

Doc ID: 190000006457

Prepared by:

Yu Man Lee

Michigan Natural Features Inventory

Michigan State University Extension

1st Floor Constitution Hall

525 W. Allegan St.

Lansing, MI 48933

April 30, 2019

SECTION A – PROJECT MANAGEMENT

A.1 Title of Plan and Approval

Quality Assurance Project Plan
Ecological surveys and assessments to facilitate restoration activities at the Salt River Marsh:

Herpetological Surveys

Prepared by:
Michigan Natural Features Inventory,
Michigan State University Extension

_____ Date: _____
Yu Man Lee, Project Manager, MNFI

_____ Date: _____
Peter Badra, QA Manager / Principal Investigator, MNFI

_____ Date: _____
Stephanie Swart, QAPP Reviewer, Office of the Great Lakes, EGLE

_____ Date: _____
Michelle Selzer, Office of the Great Lakes, EGLE

_____ Date: _____
Rick Hobrla, Office of the Great Lakes, EGLE

_____ Date: _____
Louis Blume, Quality Assurance Officer, EPA

A.2 Table of Contents

List of Tables

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A.3 Distribution List

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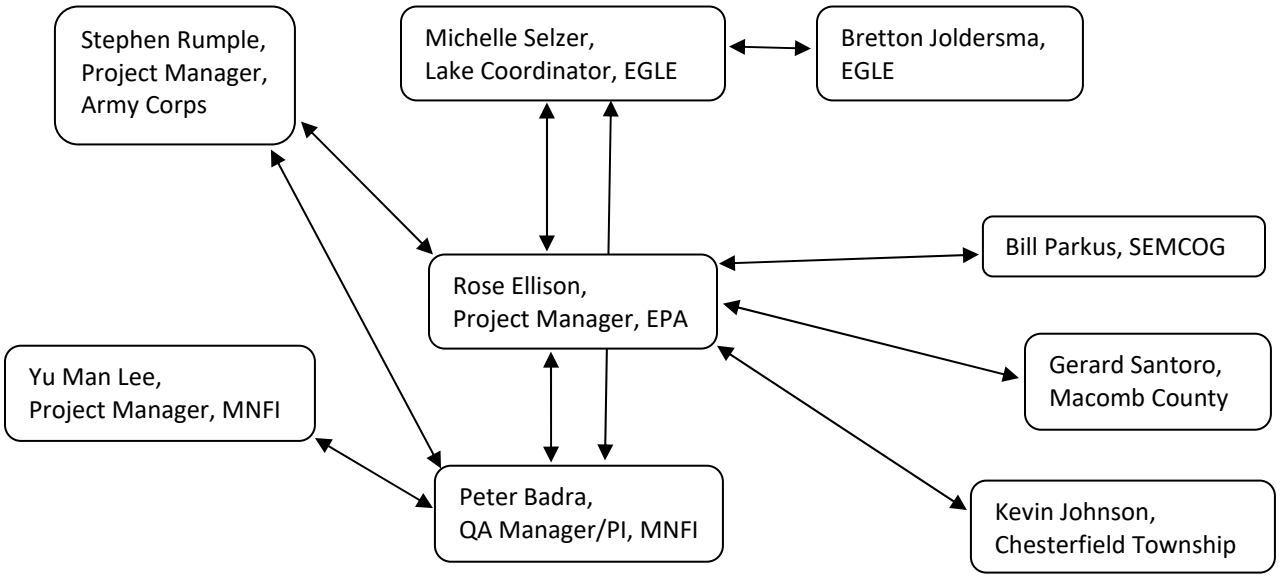
A.4 Project/Task Organization

Table 1. Roles & Responsibilities

Individual(s) Assigned	Responsible for:	Authorized to:
Yu Man Lee	• Project management • Writing QAPP • Sampling design • Data collection, processing, and storage • Sample collection and storage • Report writing	• Design sampling methods • Coordinate and carry-out field work • Collect, process, and store data and samples • Author final report
Peter Badra	• QA manager • Point of contact between MNFI, EPA, Army Corps, and EGLE	• Ensure QAPP is followed • Review QAPP, sampling design, data collection, and report writing • Coordinate communication between project partners
Rose Ellison	• Project oversight	•
Stephen Rumple	• Project oversight	•
Michelle Selzer	• Project oversight	•

Figure 1. Organization Chart



A.5 Problem Definition/Background

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 the invasive common reed (*Phragmites australis*). The Salt River is connected to Lake St. Clair and riparian wetlands and provides 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 (EPA) and the Michigan Department of Environment, Great Lakes, and Energy (EGLE), Water Resources Division and Michigan Department of Natural Resources (MDNR), Wildlife Division (WLD), have developed plans to restore portions of the Salt River Marsh occurring on State lands (U.S. Army Corps of Engineers 2013). Restoration will be accomplished through the excavation of sediments and mats of common reed, to improve plant community composition and structure and fish and wildlife habitat value. The project area is circumscribed by the boundaries of the approximately 60 acre (25 hectare) Salt River Marsh State Wildlife Area (SWA) (Figure 2).

Prior to restoration, a reconnaissance-level survey, coupled with a review of existing literature and data, will be conducted to examine existing habitat within the project area to determine the potential presence of amphibian and reptile or herpetofaunal species and help guide the restoration activities. Areas of quality habitat will be identified from existing data resources and targeted for field inspections. Field reconnaissance will focus on areas within and immediately adjacent to the project boundary that may be directly affected by potential restoration design and will examine the likelihood that the available habitat could support one or more species. Evidence of herpetofaunal species presence or direct observations, particularly of Rare, Threatened, and Endangered (RTE) species, will be documented during the surveys along with documenting the existing habitat present. The results of these surveys will provide information needed to reduce or eliminate negative impacts on any RTE herpetofaunal species and the overall ecological integrity of the project area. An understanding of the current conditions is needed to prepare permit applications (EGLE Parts 31, 91, 301, and 303 of NREPA 1994 PA 451, as amended) required for restoration implementation, as well as assess the success of restoration activities after project completion.

The Michigan Natural Features Inventory (MNFI) will work with the agency partners to gather the necessary ecological and herpetological information to move the project forward. MNFI has performed a desktop habitat delineation of the project site (Figure 3), in order to characterize the expected natural communities and potential habitats for herpetofaunal species. Using historical and current aerial imagery and spatial land cover data, and existing survey data, MNFI has identified 37.5 acres of emergent marsh (comprising three habitat stands) and 14.9 acres of dry-mesic southern forest (comprising three habitat stands) (in addition to 7.5 acres of aquatic stream channel invaded by common reed) within the project area. Based on the presence of these habitat types, location of the project area, and known ranges of herpetofaunal species in Michigan, the following species or suitable habitat for these species have potential to occur in

or immediately adjacent to the project area: Common Mudpuppy (*Necturus maculosus maculosus,* state special concern), Eastern Newt (*Notophthalmus viridescens*), Eastern Red-backed Salamander (*Plethodon cinereus*), Eastern American Toad (*Bufo [Anaxyrus] americanus americanus*), Blanchard's Cricket Frog (*Acris blanchardi*, state threatened), 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*), Pickerel Frog (*Rana palustris,* state special concern), Eastern Snapping Turtle (*Chelydra serpentina serpentina*), Eastern Musk Turtle (*Sternotherus odoratus*), Spotted Turtle (*Clemmys guttata*, state threatened), Blanding's Turtle (*Emydoidea blandingii*, state special concern), Northern Map Turtle (*Graptemys geographica*), Painted Turtle (*Chrysemys picta*), Red-eared Slider (*Trachemys scripta elegans*), Northern Water Snake (*Nerodia sipedon sipedon*), Queen Snake (*Regina septemvittata*, state special concern), Eastern Garter Snake (*Thamnophis sirtalis sirtalis*), Northern Ribbon Snake (*Thamnophis sauritus septentrionalis*), DeKay's Brown Snake (*Storeria dekayi dekayi*), Northern Red-bellied Snake (*Storeria occipitomaculata occipitomaculata*), Eastern Fox Snake (*Pantherophis gloydi*, state threatened), and Eastern Milk Snake (*Lampropeltis triangulum triangulum*) (Harding and Mifsud 2017). A query of the MNFI Natural Heritage Database (Michigan Natural Features Inventory 2019), which contains records of all RTE species known to occur in Michigan, noted one occurrence of a state threatened herpetofaunal species within five miles of the project area (*Pantherophis gloydi*, Eastern Fox Snake, last documented in this area in 1980). Additionally, the habitat restoration activities proposed for this project have potential to create or enhance suitable habitat for these species if it currently does not occur or is limited within the project area.

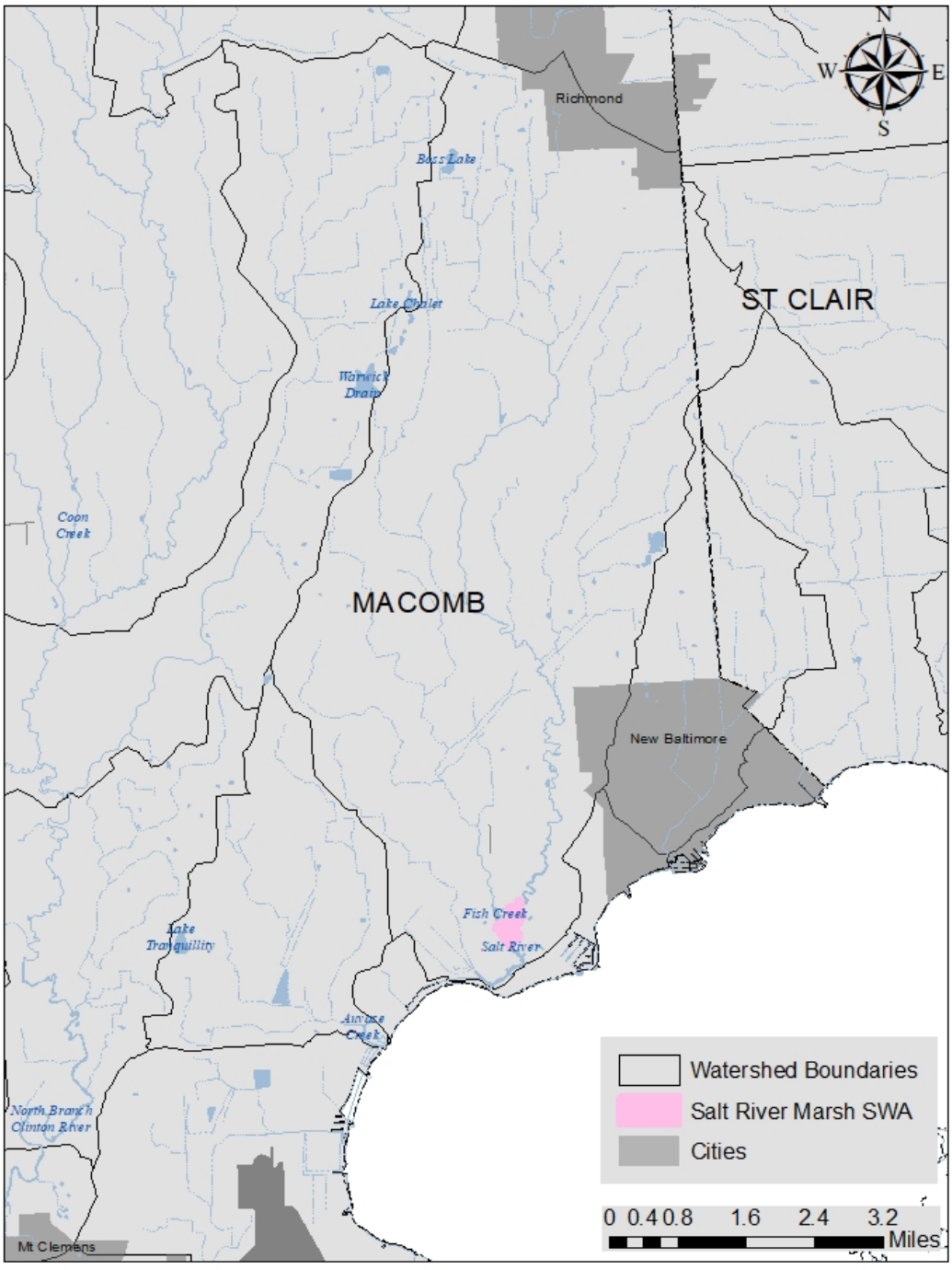


Figure 2. Location of project site, Salt River Marsh SWA, in southeastern Macomb County

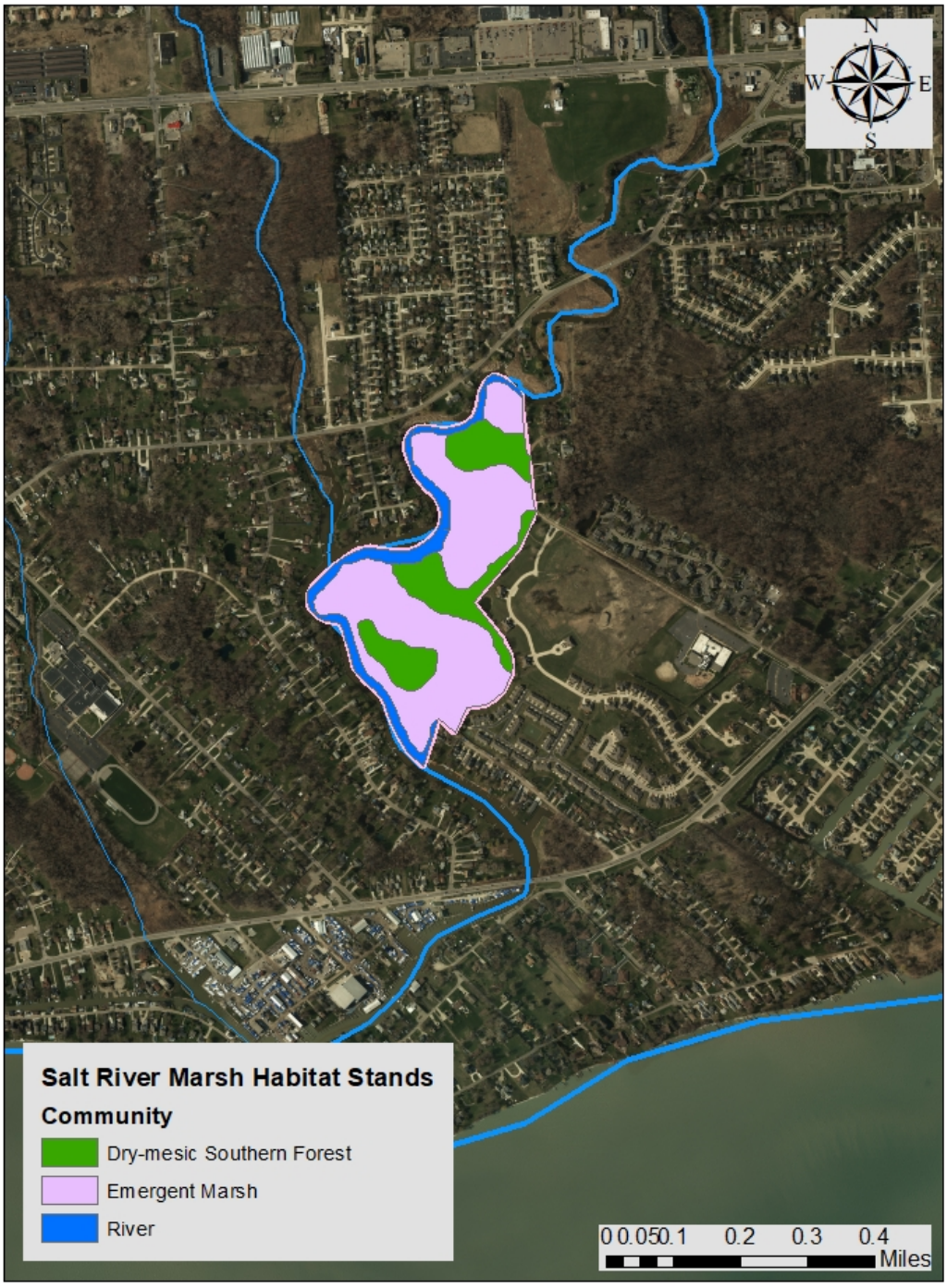


Figure 3. Habitat Stands

A.6 Project/Task Description

Survey Methodology

Herpetological surveys will have two broad goals: 1) conduct a reconnaissance-level survey, coupled with a review of existing literature and data, to examine existing habitat within and immediately adjacent to the project area to identify areas of suitable or quality habitat and potential amphibian and reptile species that could occur in these areas; and, 2) conduct field surveys to document evidence of presence or direct observations of target herpetofaunal species, including RTE species, and/or suitable habitat for these species within the project area. Review of existing literature, known species ranges in Michigan, and habitat types present in the project area (i.e., emergent marsh, dry-mesic southern forest, and Salt River) resulted in the identification of 27 species of amphibians and reptiles that have potential to occur within or immediately adjacent to the project area, listed in Section A.5 of this QAPP. These include a state-listed snake species (i.e., *Pantherophis gloydi*, Eastern Fox Snake) that has been documented historically within five miles of the project area (MNFI 2019), and six additional RTE species (i.e., *Necturus maculosus*, Mudpuppy; *Acris blanchardi*, Blanchard's Cricket Frog; *Rana palustris*, Pickerel Frog; *Clemmys guttata*, Spotted Turtle; *Emydoidea blandingii*, Blanding's Turtle; and *Regina septemvittata*, Queen Snake).

We will primarily utilize area-constrained visual encounter surveys, auditory surveys, and basking surveys to survey for target amphibian and reptile species that have potential to occur within or immediately adjacent to the project area (Graeter et al. 2013, Appendix A). We also will conduct limited artificial cover surveys and trapping surveys (Graeter et al. 2013). We will visually assess and document habitat availability and quality for amphibian and reptile species during these surveys. Surveys will occur within the various habitat areas at the project site that were delineated in the office based on aerial imagery and land cover data (Figure 3). These habitat areas were characterized based on anticipated plant species composition and diversity, topography, unique features such as wetlands and streams, disturbances and development, and other distinct characteristics.

Area-constrained visual encounter surveys (VES) will be 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 will consist of observers 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 will be conducted in or along the edge of the emergent marsh and in the forested stands in the project area. Surveys will be conducted in areas proposed for habitat restoration if possible. Visual encounter surveys will be conducted during daylight hours and under appropriate weather conditions when target species are expected to be active and/or visible [i.e., between 60-80°F (16-27°C), wind less than 15 mph, no or light precipitation]. Multiple visual encounter surveys (i.e., three survey visits) will be conducted within the various habitat areas or stands.

Auditory surveys (Luhring 2013) will be 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 will be 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 will be conducted in the evening or at night (17:30 – 01:00 EDT) at 8-10 listening stations located along roads surrounding the project area and within the project area. Listening stations will be distributed throughout the project area so that frog and toad calls in different parts of the project area will be heard. Surveyors will visit all listening stations in one night during each auditory survey and will listen for frog/toad calls emanating from the project area for five minutes at each station. Two auditory surveys will be conducted within the project area (i.e., one in May, one in June). Listening stations will be located using a global positioning system (GPS) so that the same stations can be surveyed during multiple visits. Species presence and relative abundance will be 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). Sample calls of each species heard during surveys will be recorded for documentation. Calls heard during the day during other herpetological surveys in the project area also will be noted.

Basking surveys which involve scanning habitat with binoculars to look for basking reptiles and amphibians (Buhlmann 2013) will be conducted along Salt River and in areas with open water within or adjacent to the project area (e.g., in the emergent marsh if possible). Basking surveys will be conducted during daylight hours and under appropriate weather conditions when target species will be expected to be active and/or visible [i.e., between 60-80°F (16-27°C), wind less than 15 mph, no or light precipitation]. Two basking surveys will be conducted within or adjacent to the project area. These surveys may be conducted in conjunction with trapping surveys.

Artificial cover surveys (Mills et al. 2013) will be conducted in the forested stands within the project area to complement visual encounter and basking surveys. These surveys will consist of placing twenty artificial cover objects (i.e., metal/aluminum/tin or wooden coverboards) on the ground in linear transects within the forested stands and checking them during the other herpetological surveys (i.e., at least three times). All species observed underneath or on top of the coverboards will be documented and photographed when possible.

Aquatic funnel trapping for turtles, snakes and amphibians (Willson 2013) will be conducted along Salt River and/or in emergent marsh habitats in the project area if conditions are suitable for placement of minnow traps and/or hoop traps. Aquatic funnel trapping is most effective in shallow water bodies with abundant vegetation (Willson 2013). Ten traps will be deployed in the project area ideally at intervals of 100 meters or greater (at least 20 meters apart) for two consecutive nights during the survey period. Traps will be checked every 24 hours, primarily in

the morning during the summer when the water is warmer and can heat up faster. Traps will be set with approximately ¼ of the trap above the water or with floats, allowing captured animals access to air (Willson 2013). Traps will be set along shorelines, submerged wood debris, or other structures that may guide animals into traps, and will be tied to stakes, trees, shrubs, or other objects to prevent animals from dragging traps into deep water (Willson 2013). Traps will be baited with dead fish (e.g., canned sardines). Trap locations will be mapped with a global positioning system (GPS).

For each survey method, species presence, number and locations of individuals observed, observer names, dates, times, weather conditions, and habitat and survey conditions will be recorded during each survey visit on a field data form (Appendices B-E). Survey locations and routes will be mapped and recorded using a GPS unit. All amphibian and reptile species observed will be recorded on field data sheets (Appendices B-F) and photographed for documentation whenever possible. The Amphibian and Reptile Observation Data Form will be completed primarily for species encountered during the visual encounter, artificial cover, and trapping surveys, and may be completed for basking surveys when possible. Only pertinent parts of the Amphibian and Reptile Observation Data Form will be completed for this project. Other wildlife species observed incidentally during herpetological surveys also will be recorded. All RTE species will be documented on Special Animal Survey forms (https://mnfi.anr.msu.edu/pdfs/Special_Animal_Form.pdf), with data entered into the Natural Heritage Database by MNFI staff. Survey data and locations also may be recorded on a tablet in the field using mobile applications such as Survey 123 and Backcountry Navigator.

All surveys will be conducted by Yu Man Lee, MNFI Zoologist/Herpetologist. Seasonal field technicians working under Ms. Lee's supervision may assist with field surveys. Special equipment or supplies needed to accomplish these herpetological surveys include binoculars, artificial cover objects (e.g., sheets of metal/aluminum/tin or plywood), minnow traps, hoop traps, a GPS unit, and a tablet for navigating, recording data, and taking photographs.

Survey Timeline

Surveys will be focused during time periods intended to maximize detectability of target amphibian and reptile species associated with emergent marshes and dry-mesic southern forests, RTE species associated with those communities, and RTE species that have been detected within five miles of the project area. Surveys will be conducted primarily in May and June, with additional visits later in the summer or fall as needed. Additional herpetofaunal species may be detected by these surveys, although surveys will not be timed specifically to detect these species. Multiple survey visits will occur to increase detection of target species.

A.7 Data Quality Objectives & Criteria

The aim of this study is to document amphibian and reptile species and/or suitable habitat for these species that occur within the project area prior to implementation of restoration efforts, in order to minimize negative impacts to native animal species, particularly RTE species, and to

provide baseline information against which to gauge the effects of restoration efforts. Quality objectives are appropriate for ensuring that amphibian and reptile species that occur in each habitat stand has been accurately documented and that any RTE herpetofaunal species that occurs on site have been observed and properly documented.

Data quality objectives will ensure the *accuracy*, *precision*, *completeness*, *representativeness* and *comparability* of the data. These components of data quality are addressed, followed by some description of specific practices that integrate these components.

Precision and Accuracy: Accuracy is how close measurements are to a true value, and precision is the degree of agreement between two or more measurements. The accuracy and precision of describing the amphibian and reptile community and suitable habitat within the project area are dependent on expert knowledge or judgement in identifying amphibian and reptile species and suitable habitat for these species in the field. Each species observed during visual encounter, basking, artificial cover, and trapping surveys and habitat conditions will be photographed and species heard during auditory surveys will be recorded for documentation and verification. Species identifications and habitat descriptions can be checked with information in standard amphibian and reptile field guides (e.g., Harding and Mifsud 2017) and other literature.

Completeness: Completeness is a measure of the amount of data obtained from the monitoring program compared to the amount of data that was expected. Completeness will be assessed based on the type and number or extent of surveys that are conducted compared to the type and number of surveys that are proposed or stated in this plan. For example, survey data will be considered complete if auditory surveys are conducted at 8-10 listening stations under appropriate weather/survey conditions as stated in this plan. Visual survey data will be considered complete if three visual surveys are conducted in the project area under appropriate weather/survey conditions, within or along two of the three forested habitat stands and two of the three emergent marsh stands (if accessible), and through at least half of each of these stands. Basking survey data will be considered complete if two basking surveys are conducted within at least half of the section of Salt River that runs along the project area and through any open water areas in the emergent marsh stands if accessible. Artificial cover survey data will be considered complete if twenty artificial cover objects or cover boards are placed across two of the three forested stands within the project area and checked at least three times during the project. Aquatic funnel trapping data will be considered complete if 10 traps, or as many as possible based on available site conditions up to 10 traps, are deployed ideally 100 meters apart or greater and at least 20 meters apart for two consecutive nights through at least half of the section of Salt River adjacent to the project area and within at least one of the emergent marsh stands in the project area if conditions are suitable for trapping. Survey data also will be considered complete if the following data are recorded for each survey conducted as stated in this plan: species presence, number and locations of individuals observed, observer names, dates, times, weather conditions, habitat and survey conditions,

and survey locations and routes. Survey data will be recorded on field data sheets (Appendix B-F) and on a GPS unit.

Representativeness: Representativeness refers to how well the measurements reflect environmental conditions being measured. To ensure the data collected are representative of actual conditions, a variety of survey methods will be utilized. Performing five different methods of data collection (visual, auditory, basking, artificial cover, and traps) will maximize the chances herpetofaunal species that are actually present in the study area will be detected. Use of a variety of survey methods also allows coverage of all habitat types to further ensure the data are representative. There is no standard for number of species or particular species that can be expected during a survey. However, species lists and habitat descriptions will be compared to those of similar habitats (e.g., descriptions of species found in other emergent marsh and dry-mesic southern forest) documented in standard amphibian and reptile field guides (Harding and Mifsud 2017) and other literature or references on amphibians and reptiles found in similar habitats.

Comparability: Comparability is a measure of the confidence with which one data set can be compared with another. The amphibian and reptile species list and habitat descriptions will be compared to those for similar habitats (e.g., descriptions of amphibians and reptiles and habitat conditions in other amphibian and reptile surveys of emergent marsh and dry-mesic southern forest habitats in Michigan or the Midwest).

The survey methods and approach used for this study will help ensure that the amphibian and reptile species composition of the project area is adequately documented in several ways, by utilizing a combination of survey methods, by allowing for spatial coverage of each habitat, and by conducting multiple visits and temporally spreading survey effort. Some amphibian and reptile species are more likely to be detected by certain survey methods and during certain times of the year or under certain conditions. Utilizing multiple survey methods and conducting multiple survey visits during different times of the year increases the likelihood of detecting all the amphibian and reptile species that occur in the project area under current conditions. Surveying different habitat types and different parts of the stands within the project area, using expert knowledge to explore variation within each habitat type, also increases the likelihood of encountering target species.

GPS locations and tracks will be recorded during surveys in order to document coverage of each habitat stand. Location of RTE species will be recorded with GPS units capable of one- to two-meter accuracy. To further verify the accuracy of recorded GPS points, a benchmark GPS point will be taken at the beginning of each survey period at a known location visible from current aerial imagery (e.g., a road intersection).

After the implementation of restoration efforts, the following information collected during these surveys will facilitate resurvey of habitat stands to document changes to species composition: habitat stand delineation in GIS format, documentation of survey methods and

effort, GPS tracks and locations of surveys, and the type, number, and GPS points of common and RTE amphibian and reptile species observed during surveys.

A.8 Special Training/Certification

Herpetological surveys will be conducted by Yu Man Lee of MNFI. Ms. Lee is a skilled herpetologist with 21 years of professional experience conducting herpetological surveys across Michigan. Seasonal field technicians may assist Ms. Lee with herpetological surveys. They will be trained by and work under the supervision of Ms. Lee. Ms. Lee and MNFI have been permitted by the State of Michigan to conduct these types of herpetological surveys.

A.9 Documents and Records

All parties on the QAPP distribution list will be sent a final version of the document and will be sent a new version when the document is revised. This correspondence will occur via a project email list. If email contact is not possible, other methods of contact will be attempted. QAPP distribution is the project manager's responsibility.

Data management and entry is the responsibility of MNFI. The following general guidelines will be adhered to: All data will be collected in the field via standard project datasheets. Data collected on paper datasheets will be entered by MNFI employees into electronic format, stored via digital database, and made available to the entire project team. Hard copy datasheets will be retained for the life of the grant period. All GPS point and track data will be stored on MNFI computers.

SECTION B – DATA GENERATION & AQCUISITION

B.1 Sampling Process Design (Experimental Design)

The aim of this study is to characterize the amphibian and reptile community and available habitat for these species within the project area, and document RTE species, prior to the implementation of restoration efforts. Surveys will occur in appropriate seasons in order to detect: 1) the majority species that are expected to occur in the expected habitats on site, especially typical dominant species, and 2) potential list of RTE species within the project area.

Amphibian and reptile sampling and habitat assessment will be designed to maximize the number of species observed and land area and habitats surveyed, characterized, and assessed within and adjacent to the project area. Multiple survey methods (i.e., visual encounter, auditory, basking, artificial cover, and trapping surveys) will be utilized and conducted over multiple survey visits (i.e., 2-3 visits/survey method) in spring and summer (except trapping surveys which will only occur in the summer). Each habitat type and stand within and adjacent to the project area will be surveyed with multiple survey methods, assuming habitat conditions are suitable for survey methods. Emergent marsh stands will be surveyed utilizing auditory, visual encounter, and/or trapping surveys. Dry-mesic southern forest stands will be surveyed using visual encounter, auditory, and artificial cover surveys. Salt River along the project area will be surveyed with auditory, basking and/or trapping surveys. Survey locations and routes will be distributed throughout each habitat stand as much as possible to maximize area surveyed and assessed. Habitat conditions will be assessed, documented, and photographed at survey locations. Survey locations and routes will be recorded with GPS to document areas surveyed. These areas can be surveyed in the future after restoration efforts are completed to assess changes in the amphibian and reptile community and habitat over time.

B.2 Sampling Methods

All data will be recorded on data sheets in the field (Appendices B-F). Amphibians and reptiles detected in the field will be identified and recorded on data sheets (Appendices B-F). Amphibians and reptiles encountered during visual surveys, basking surveys, artificial cover surveys, and trapping surveys will be temporarily held (i.e., for 15-20 minutes), visually inspected for general health and condition, sexed and aged (i.e., adult, juvenile/subadult, and neonate/hatchling) when possible, photographed, and released at capture site after required data are collected. Individuals will not be measured or marked. Amphibian and reptile species that are not identified by observers on sight in the field will be photographed and released and later identified in the lab using standard amphibian and reptile field guides and keys (e.g., Harding and Mifsud 2017) or sent to other species experts to verify.

To reduce the spread of invasive species and amphibian and/or reptile diseases (e.g., snake fungal disease) into and out of the project area, surveyors will clean and disinfect all sampling equipment and boot treads prior to entering the project area and at the conclusion of each

survey. Equipment and boots will be disinfected using a disinfection protocol recommended by the Michigan DNR - https://www.michigan.gov/dnr/0,4570,7-350-79136_79236_86126-321786--,00.html.

No biological samples will be collected for this project, with the exception of dead amphibians and reptiles encountered during surveys in the field. Dead amphibian and reptile specimens will be collected in an individual Ziploc bag, labelled with a unique descriptive identifier and given the same label on the data sheet. Dead amphibian and reptile specimens will be deposited in a museum collection (e.g., University of Michigan Museum of Zoology).

Surveys will also be guided by standard natural heritage methodology (http://www.natureserve.org/conservation-tools/standards-methods) and information provided in the Partners in Amphibian and Reptile Conservation's (PARC's) recommended techniques for inventory and monitoring of reptiles and amphibians (Graeter et al. 2013).

B.3 Sampling Handling & Custody

Dead amphibians and reptiles encountered during field surveys in the project area and unknown plant species of interest will be collected incidentally in an individual Ziploc bag, labelled with a unique descriptive identifier and given the same label on the data sheet. Dead amphibian and reptile specimens will be deposited into a museum (e.g., University of Michigan Museum of Zoology). Unknown plant species will be given to MNFI botanists for identification. Once identified, only collected plant material that represents a new collection within Macomb County will be deposited in an herbarium. Specimens that are not new to Macomb County will be stored at MNFI for the duration of the grant.

B.4 Analytical Methods

No samples requiring post-sampling analysis will be collected during this project. Survey effort and amphibian and reptile species encountered in the field will be reviewed, entered into Excel worksheets, and summarized.

B.5 Quality Control

All data collected for this project will be based on expert judgement in the field. However, Quality Control (QC) is advisable and practicable for the herpetological surveys to ensure that surveys covered a sufficient temporal and spatial extent, and also for ensuring data on RTE species are entered in the Natural Heritage Database (NHD) accurately. *Accuracy*, *precision*, *completeness*, *representativeness* and *comparability* of the data will be reviewed by the QA manager. Review of GPS tracks and survey effort will provide QC for herpetological surveys. For all data on RTE species entered into NHD, MNFI follows a standard QA/QC protocol, including maintaining paper or electronic documentation and a QC process following data entry. Amphibian and reptile species encountered in the field will be photographed whenever

possible or recorded (i.e., frog and toad calls during auditory surveys) for documentation. Review of photographs and recordings will provide QC for amphibian and reptile identifications and results.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

GPS units are calibrated prior to data collection using unit-specific methods. For documenting survey effort and species observations and assessing habitat suitability and quality, precise GPS locations with one to two-meter accuracy will be used. There will likely not be equipment failures that result in corrective actions other than replacement of defective units from the MNFI in-house supply or via web orders. Minnow traps and hoop traps for the aquatic funnel trapping surveys will be inspected by MNFI staff prior to deployment to make sure they are in good shape and functioning correctly. Any defective traps will not be deployed or will be replaced with a functioning trap. A computer tablet may be used for navigation, data collection, and/or taking photographs. It will be inspected prior to use during surveys to ensure it is working properly. Computer tablets will be stored in a waterproof case. Survey data and photographs from computer tablets will be downloaded after surveys to a MNFI computer and backed up on MNFI's computer network. Kestrel units will be used to collect air temperature, wind, and relative humidity data during surveys. These units will be inspected and calibrated following manufacturer and unit-specific recommendations prior to data collection. Kestrel units that are not working properly will be replaced.

B.7 Instrument/Equipment Calibration and Frequency

GPS units will be calibrated prior to data collection using unit-specific methods. Kestrel units will be used to collect air temperature, wind, and relative humidity data during surveys. These units will be inspected and calibrated following manufacturer and unit-specific recommendations prior to data collection. MNFI project manager will calibrate these instruments and will record when they are calibrated in a spreadsheet.

B.8 Inspection/Acceptance of Supplies & Consumables

Data will be collected on paper data sheets, GPS units, and potentially a computer tablet as well. The paper data sheets will be stored in metal clipboards. GPS units will be stored in Ziploc bags to protect from moisture/getting wet in the field. The computer tablet will be stored in a waterproof case. Minnow traps and/or hoop traps will be used for the aquatic funnel trapping surveys if habitat conditions are appropriate for trapping. Wooden or metal coverboards made of plywood, corrugated tin or other materials will be used for the artificial cover surveys. These types of traps and artificial cover objects are typically utilized for herpetological surveys and recommended in PARC's "Inventory and Monitoring: Recommended Techniques for Amphibians and Reptiles" by Graeter et al. (2013). Minnow and hoop traps may be baited with fish (i.e., canned sardines) to try to increase capture rates. Floats or plastic bottles may be placed in traps to keep the top portion of the traps above water to provide animals with access

to air. The MNFI project manager will be responsible for maintaining and examining field equipment to ensure units are not defective or damaged. Defective equipment will be repaired or replaced prior to collection of field data.

B.9 Data Acquisition Requirements for Non-Direct Measurements

The Natural Heritage Database (Michigan Natural Features Inventory 2019) maintained by MNFI was used to investigate the presence of documented occurrences of RTE species in within five miles of the project site. This type of use closely aligns with the intended use of the database. The database contains historical and recent data occurrences, but it is possible that undocumented populations of RTE species exist in the project area. MNFI staff will exercise their professional judgement for acceptance of the data. MNFI staff also will consult with the Michigan Herp Atlas (https://www.miherpatlas.org/) to obtain data on any amphibian and reptile species that have been documented in or adjacent to the project area.

B.10 Data Management

Data collected in the field during all surveys will be written onto data sheets printed on water resistant paper (Rite-in-the-Rain). Amphibians and reptiles encountered during visual encounter, basking, artificial cover, and trapping surveys will be photographed and frog/toad calls heard during auditory surveys will be recorded for species verification and documentation after the surveys. Each datasheet will be photographed to provide a backup if the original datasheet is lost. These digital photographs will be stored on an MNFI computer, along with other project photos, and will follow other photo protocols outlined below. Original data sheets will also be stored at MNFI. After the field season, typically in the fall, data will be entered into Microsoft Excel spreadsheets and made into tables that will be distributed to project partners and used to report results. Data related to all occurrences of RTE species observed during the surveys will be entered into MNFI's Natural Heritage Database. Data, photographs, and GPS locations also may be recorded in the field using a computer tablet and mobile applications such as Survey 123 and Backcountry Navigator. These data and photographs will be downloaded after each field survey to a MNFI computer and saved onto MNFI's computer network.

SECTION C – ASSESSMENT AND OVERSIGHT

C.1 Assessments and Response Actions

As surveys will be conducted primarily by a single, expert individual, assessments will be limited. A cursory review of available habitat and survey methods will be conducted after an initial reconnaissance during the first field survey. This review will help identify areas with suitable habitat that may be priority areas for herpetological surveys and determine if target species and survey methods and approach are appropriate for the project area. Survey methods and approach will be reviewed and revised accordingly based on initial field assessments. This review also will include a check that all data are stored and labelled properly, including all GPS points and tracks uploaded, paper files photographed and filed appropriately, and notes taken of the efficacy of survey methods. If seasonal field technicians assist with surveys, they will be trained by and work under the supervision of the MNFI project manager (Yu Man Lee) to ensure surveys are conducted appropriately and data are collected accurately.

C.2 Reports to Management

Per the grant agreement, a preliminary report will be prepared by MNFI and provided to EGLE upon 50% completion of the project, as well as a final report once the project is complete. The final report will also be distributed to project partners listed in section A.3.

SECTION D – DATA VALIDATION AND USABILITY

D.1 Data Review, Verification, and Validation

Qualitative assessments will be reviewed by the QA manager to ensure the consistency and accuracy of assessments. Identification of species in the field is based upon expert judgement, so validation will happen at the discretion of the observer at the time of the observation. After field data are transcribed electronically, MNFI will apply standard data review processes to the electronic data. If the data are rejected at any level, the hard copy version will be retrieved, and data will be corrected.

D.2 Verification and Validation Methods

The QA manager will independently review amphibian and reptile species lists and habitat assessments. Species lists and habitat assessments can be compared with results from previous similar projects or surveys in similar habitats or natural communities to verify results are reasonable. Photographs of species and recordings of frog and toad calls will be reviewed to validate species identifications. A summary of survey effort and results including amphibian and reptile species documented during the field surveys and the locations, extent and condition of suitable habitat for these species within the project area will be provided in the final report.

D.3 Reconciliation with Data Quality Objectives

Qualitative data will be reviewed independently by the QA manager to ensure consistency of application of metrics, utilizing in part results from previous projects that assessed amphibian and reptile communities and habitat. If data quality issues arise, the QA manager will seek additional expert opinion from MNFI staff. If need be, another MNFI zoologist could be brought into the project to verify or reassess qualitative data. The scope, utility, and limitations of the data will be specified in the final report to the sponsor.

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Appendix A. 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] - 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
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
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
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 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]	Cover - wooden coverboards
Eastern Fox Snake	*Pantherophis gloydi*	T	SP, SU, AU	C, V [r]	C - Cover objects - general; V r - VES - road cruising
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

From: Graeter, G.J., K.A. Buhlmann, L.R. Wilkinson, and J.W. Gibbons (Eds.). 2013. Inventory and Monitoring: Recommended Techniques for Reptiles and Amphibians. Partners in Amphibian and Reptile Conservation Technical Publication IM-1, Birmingham, Alabama.

Appendix B. MNFI Amphibian and Reptile Survey Data Form/Sheet for Visual Encounter and Basking Surveys

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.

_____

_____

_____

_____

_____

_____

_____

Appendix B. MNFI Amphibian and Reptile Survey Data Form/Sheet for Visual Encounter and Basking Surveys (continued)

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):	Precipitation Codes:	Sky Codes:
0 = Calm (< 1 mph) smoke rises vertically	0 = None	0 = Sunny/clear to few clouds (0-5%)
1 = Light air (1-3 mph) smoke drifts, weather vane inactive	1 = Mist	1 = Mostly sunny (5-25% cloud cover)
2 = Light breeze (4-7 mph) leaves rustle, can feel wind on face	2 = Light rain or drizzle	2 = Partly cloudy, mixed variable sky (25-50%)
3 = Gentle breeze (8-12 mph) leaves and twigs move, small flag extends	3 = Heavy rain	3 = Mostly cloudy (50-75%)
4 = Moderate breeze (13-18 mph) moves small tree branches, twigs & leaves, raises loose paper	4 = Snow/hail	4 = Overcast (75-100%)
5 = Strong breeze (19-24 mph) small trees sway, branches move, dust blows		5 = Fog or haze
6 = Windy (> 24 mph) larger tree branches move, whistling		

Appendix C. MNFI Amphibian and Reptile Survey Data Form/Sheet for Auditory Surveys

Page _____ of _____

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 C. MNFI Amphibian and Reptile Survey Data Form/Sheet for Auditory Surveys (Continued).

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 D. MNFI Amphibian and Reptile Survey Data Form/Sheet for Artificial Cover Surveys

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				
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		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

MNFI, 04/24/2019

Appendix D. MNFI Amphibian and Reptile Survey Data Form/Sheet for Artificial Cover Surveys (Continued).

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 E. MNFI Amphibian and Reptile Survey Data Form/Sheet for Aquatic Funnel Trapping Surveys.

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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 E. MNFI Amphibian and Reptile Survey Data Form/Sheet for Aquatic Funnel Trapping Surveys (Continued).

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. MNFI Amphibian and Reptile Observation Data Form/Sheet.

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: _____ **Transmittered?** 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:

_____

_____

_____

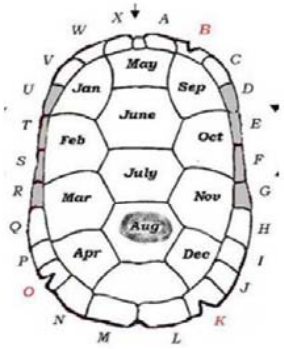
_____

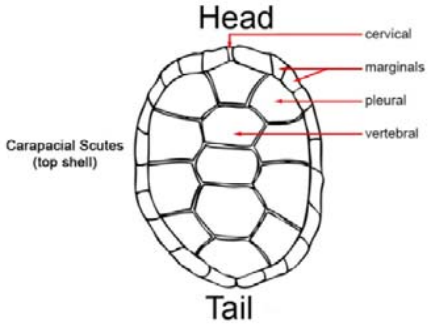
_____

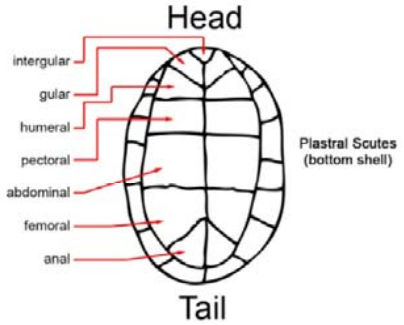
_____

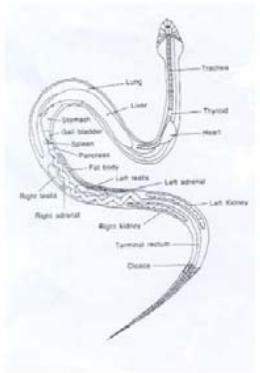
Appendix F. MNFI Amphibian and Reptile Observation Data Form/Sheet (Continued).

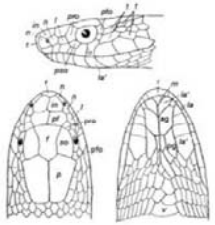
Indicate notches, unique marks or features on shell, and/or injuries (page 2):

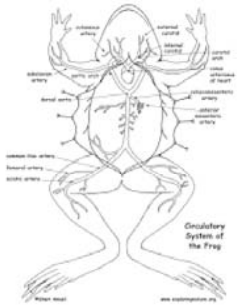


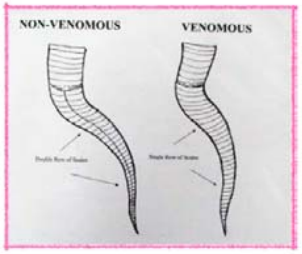












Indicate or draw on map or air photo where turtle was generally found/where signal indicates:

Appendix III. Quality Assurance Project Plan - Ecological Surveys and Assessments to Facilitate Restoration Activities at the Salt River Marsh: **Stream Assessment and Macroinvertebrate Survey.**

DRAFT - QUALITY ASSURANCE PROJECT PLAN

Ecological surveys and assessments to facilitate restoration activities at the Salt River Marsh: **Stream Assessment and Macroinvertebrate Survey**

Prepared for:

Michelle Selzer

Water Resources Division

Great Lakes Management Unit

Michigan Department of Environment, Great Lakes, & Energy

Doc ID:

Prepared by:

Peter Badra

Michigan Natural Features Inventory

Michigan State University Extension

1st Floor Constitution Hall

525 W. Allegan St.

Lansing, MI 48933

June 28, 2019

SECTION A – PROJECT MANAGEMENT

A.1 Title of Plan and Approval

Quality Assurance Project Plan
Ecological surveys and assessments to facilitate restoration activities at the Salt River Marsh:

Stream Assessment and Macroinvertebrate Survey

Prepared by:
Michigan Natural Features Inventory,
Michigan State University Extension

_____ Date: _____
Peter Badra, Project Manager / Principal Investigator, MNFI

_____ Date: _____
Tyler Bassett, QA Manager, MNFI

_____ Date: _____
Stephanie Swart, QAPP Reviewer, Great Lakes Management Unit, EGLE

_____ Date: _____
Michelle Selzer, Great Lakes Management Unit, EGLE

_____ Date: _____
Richard Hobrla, Great Lakes Management Unit, EGLE

_____ Date: _____
Louis Blume, Quality Assurance Officer, EPA

A.2 Table of Contents

List of Tables

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A.3 Distribution List

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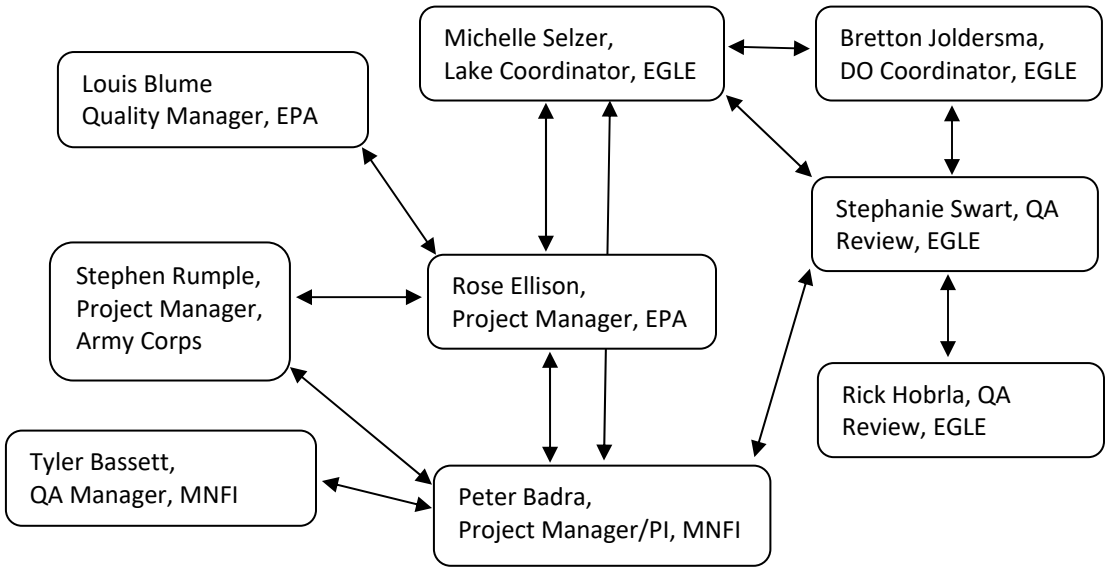
A.4 Project/Task Organization

Table 1. Roles & Responsibilities

Individual(s) Assigned	Responsible for:	Authorized to:
Peter Badra	• Project management • Writing QAPP • Sampling design • Data collection, processing, and storage • Sample collection and storage • Report writing • Point of contact between MNFI, EPA, Army Corps, and OGL	• Design sampling methods • Coordinate and carry-out field work • Collect, process, and store data and samples • Author final report • Coordinate communication between project partners
Tyler Bassett	• QA manager	• Ensure QAPP is followed • Review QAPP, sampling design, data collection, and report writing
Rose Ellison	• Project oversight	•
Louis Blume	• Quality Manager	•
Stephen Rumple	• Project oversight	•
Michelle Selzer	• Project oversight	•
Stephanie Swart	• QA Review	•
Richard Hobrla	• QA Review	•
Bretton Joldersma	• Coordination of DO	•

Figure 1. Organization Chart



A.5 Problem Definition/Background

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 the invasive common reed (*Phragmites australis*). The Salt River is connected to Lake St. Clair and riparian wetlands and provides 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 (EPA) and the Michigan Department of Natural Resources (Office of the Great Lakes [OGL] and Wildlife Division [WLD]), have developed plans to restore portions of the Salt River Marsh occurring on State lands (U.S. Army Corps of Engineers 2013). Restoration will be accomplished through the excavation of sediments and mats of common reed, to improve plant community composition and structure and fish and wildlife habitat value. The project area is circumscribed by the boundaries of the approximately 60 acre (25 ha) Salt River Marsh State especially the extent of invasive species.

An assessment of stream habitat and survey of macroinvertebrate communities is needed to document the baseline condition of the project area. Results of the survey will facilitate future efforts to identify changes in stream habitat and macroinvertebrate community within the area, as well as help identify potential for rare, threatened, or endangered mussel species to occur within the area. The presence of invasive aquatic animal species may also be detected during surveys. An understanding of the current conditions is needed to prepare permit applications (MDEQ Parts 31, 91, 301, and 303 of NREPA 1994 PA 451, as amended) required for restoration implementation, as well as assess the success of restoration activities after project completion. The Michigan Natural Features Inventory (MNFI) will work with the agency partners to gather the necessary ecological information to move the project forward. MNFI has performed a desktop habitat delineation of the project site (Figure 3), in order to characterize the expected natural communities. Using historical and current aerial imagery and spatial land cover data, and existing survey data, MNFI has identified 37.5 acres of emergent marsh (comprising three habitat stands) and 14.9 acres of dry-mesic southern forest (comprising three habitat stands) (in addition to 7.5 acres of aquatic stream channel invaded by common reed) within the project area. In addition, a query of the MNFI Natural Heritage Database (Michigan Natural Features Inventory 2019), which contains records of RTE species known to occur in Michigan, revealed no RTE mussel species occurrences documented in the Salt River. Occurrences for eleven RTE mussel species have been recorded within 5km of the project area, near New Baltimore, MI.

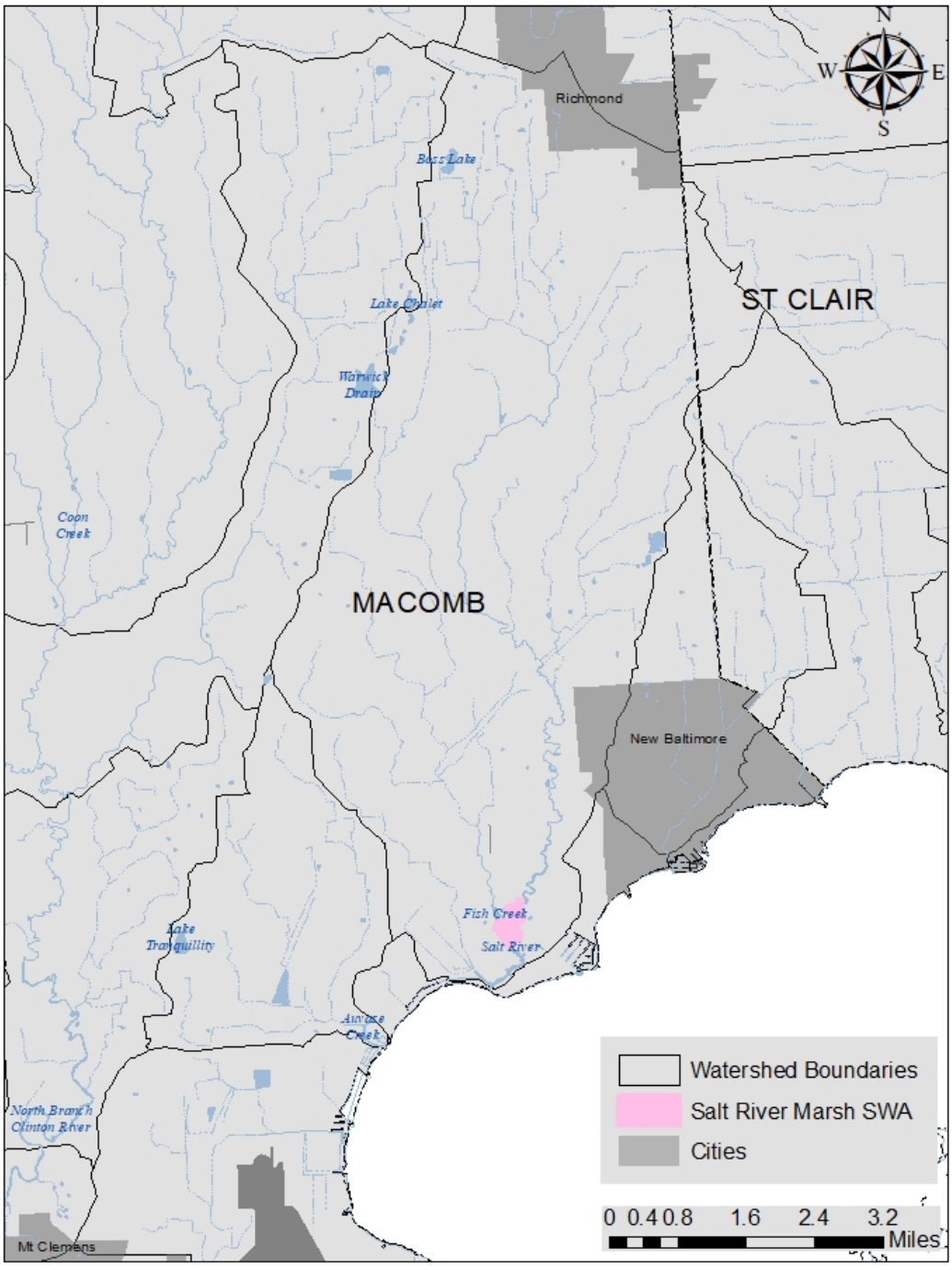


Figure 2. Location of project site, Salt River Marsh SWA, in southeastern Macomb County

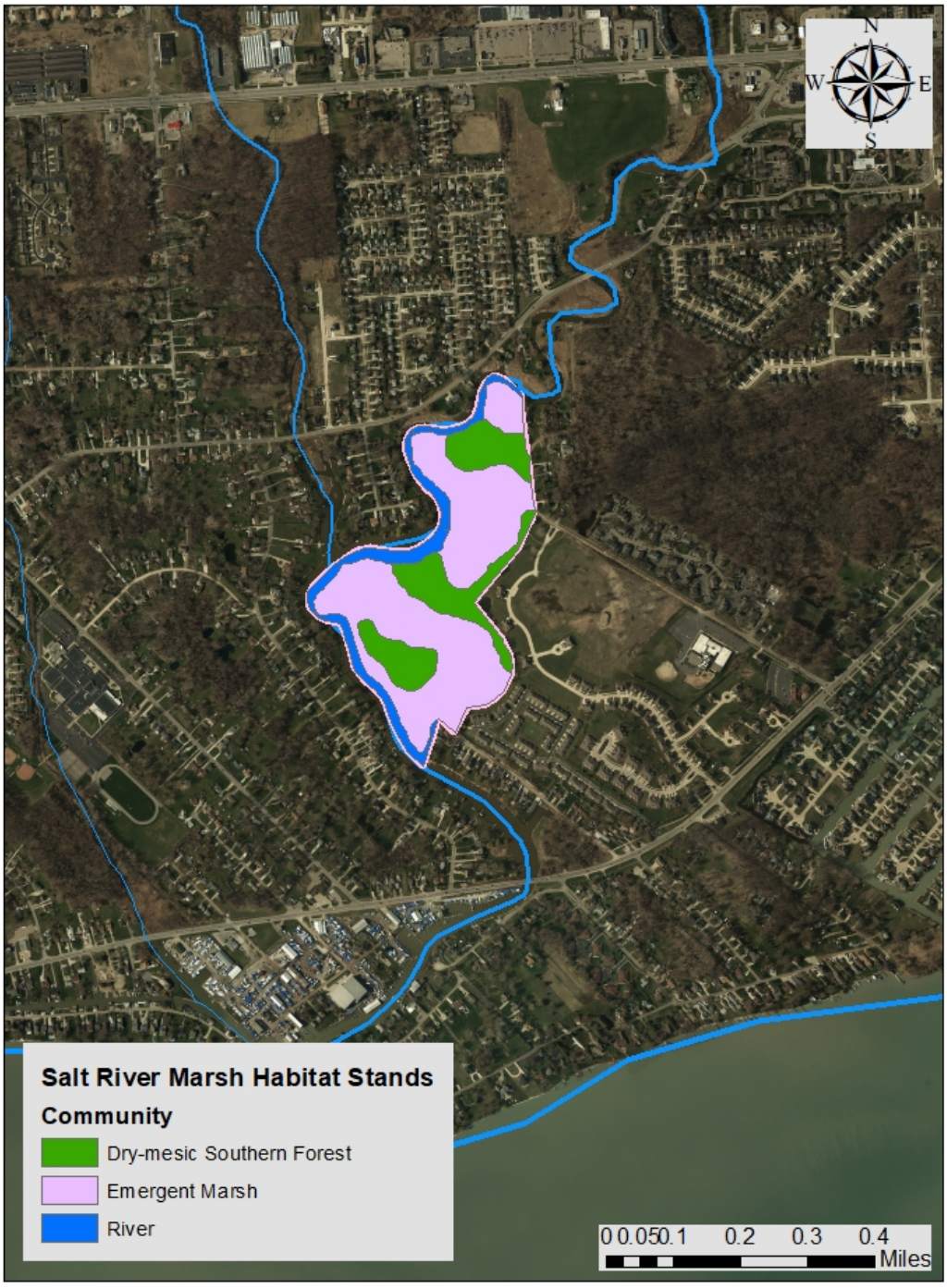


Figure 3. Habitat Stands

A.6 Project/Task Description

Survey Methodology

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.

Survey methodology will follow the Michigan Department of Environmental Quality's Qualitative Biological and Habitat Survey Protocols for Nonwadeable Rivers (MDEQ 2013). Lake St. Clair water levels are currently at record levels (NOAA 2019) and water depth in the Salt River is expected to necessitate the use of nonwadeable vs. wadeable methods. One modification to these protocols will be made. The protocols call for sampling a standard 2000m length of river reach, with transects performed at 200m intervals and thalweg measurements at 40m intervals. Surveys will take place in the Salt River within the boundaries of the project area. Since the Salt River reach within the project area is only approximately 1600m long, transects and thalweg measurements will be performed at 50m intervals within three 500m long reaches to allow for adequate sampling within a shorter river reach. The 500m river reaches will be placed 50m apart.

A 17foot flat bottom aluminum boat with small outboard motor is available to use for field sampling. If access to the project site is not possible by boat (e.g. high water preventing passage under bridges), canoes will be used.

Handheld GPS units will be used to locate the start and end points of each 500m stream reach. Transect Habitat Datasheets and Longitudinal Profile Datasheets will be completed for each 500m stream reach. Depth and substrate type will be recorded at 50m intervals along the thalweg for each of the three 500m river reaches. A PVC sounding pole marked in 10cm increments will be used to measure depth and feel the substrate type.

Qualitative macroinvertebrate sampling will be performed at 11 transects within each 500m reach, spaced 50m apart. Available habitat will be sampled using a D-frame dip net with 0.8-1.0mm mesh and by hand picking when possible to allow for the detection of large invertebrates such as unionid mussels. The contents of the net will be rinsed into a pan or bucket and large detritus and macrophytes will be removed. Macroinvertebrates will be sorted and identified on the spot when possible or preserved for later sorting and identification. All samples not preserved for later sorting and identification will be returned near the location they were found.

Qualitative habitat assessments will be made at each transect and include 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 will be assessed at each transect, including riparian vegetation width, large woody debris, aquatic vegetation, thalweg substrate, bottom deposition, bank stability, and off-channel habitat. Data will be collected at each of the 11 transects within a given 500m river reach and averaged to obtain a single metric score for that reach.

Survey Timeline

Surveys are planned to take place in August or early September when water levels are at their seasonal low. This time frame is within the June 1 to September 30 window stated in MDEQ 2013.

A.7 Data Quality Objectives & Criteria

Quality objectives aim to ensure that MDEQ 2013 protocols are followed, and that habitat and macroinvertebrate data is collected and documented appropriately.

Data quality objectives will ensure the *accuracy*, *precision*, *completeness*, *representativeness* and *comparability* of the data. These components of data quality are addressed, followed by some description of specific practices that integrate these components.

Precision and Accuracy: Accuracy is how close measurements are to a true value, and precision is the degree of agreement between two or more measurements. The accuracy and precision of describing stream habitat measures are dependent on the appropriateness and accuracy of equipment used (e.g. PVC sounding pole and GPS unit) and skill in using equipment correctly (e.g. feeling substrate type with the PVC sounding pole and recording locations with GPS unit). The precision and accuracy of qualitative habitat estimations and scores (e.g. percent coverage of in-stream vegetation coverage) is dependent upon expert judgement of the field biologist. The accuracy and precision of macroinvertebrate sampling is largely dependent on the appropriateness of equipment used (e.g. ensuring that a D-net with 0.8-1.0mm mesh is used for sweeps) and somewhat dependent on the skill of the field biologist

Ensure proper equipment is used, is in good working order, and field staff are trained to be skilled in using equipment. Qualitative habitat estimates will be made more consistent by having each field staff score qualitative habitat factors independently during initial data collection. Additional training will be provided if scores of the different field staff are not reasonably consistent. Staff will be trained to perform macroinvertebrate dip net sweeps and collection before sampling begins. Identification of difficult to identify macroinvertebrate taxa will be checked with identification keys such as Merritt and Cummins “Introduction to The Aquatic Insects of North America” and Thorp and Covich’s “Ecology and Classification of North American Freshwater Invertebrates”.

Identification of macroinvertebrate taxa should be accurate at least 95% of the time. Assigning percent cover classes (e.g. of in-stream vegetation cover) is subject to expert judgement, but should be accurate to within one cover at least 90% of the time, when compared to cover class assignment done by another independent field staff.

Completeness: Completeness is a measure of the amount of data obtained from the stream habitat assessment and macroinvertebrate survey compared to the amount of data that was expected. There is no standard for number of taxa or particular species that can be expected during a survey. However, the number of macroinvertebrate samples taken and recorded can be compared to the number of samples expected. These should match. If there is not the same number of samples collected as expected the survey will be paused and all field staff involved will discuss and investigate potential causes for the discrepancy. For example, a macroinvertebrate sample from one location could potentially be duplicated resulting in a greater number of samples collected than expected. Completeness will be verified by reviewing the number of datasheets completed at the end of each field day vs. the number of data sheets expected at the end of each day before leaving the project site. The completeness of each data sheet will also be assessed at the end of sampling each 500m river reach.

Representativeness: Representativeness refers to how well the measurements reflect environmental conditions being measured, which will depend upon expert judgement in identifying macroinvertebrate taxa in the field or lab. Hard-to-identify species will be checked with identification keys such as Merritt and Cummins “Introduction to The Aquatic Insects of North America” and Thorp and Covich’s “Ecology and Classification of North American Freshwater Invertebrates”. Representativeness of stream habitat scores will be ensured by having each field staff score qualitative habitat factors independently during initial data collection. Additional training will be provided if scores of the different field staff are not reasonably consistent with each other.

Comparability: Comparability is a measure of the confidence with which one data set can be compared with another. Species lists and habitat descriptions will be compared to similar habitats (e.g., descriptions of other Great Lakes tributary rivers).

A.8 Special Training/Certification

Two trained staff will carry out field sampling. At least one of the two field staff will be experienced with operating and trailering power boats. P. Badra (MNFI) will conduct all field work with the help of at least one other trained staff. P. Badra has over 15 years of experience using power boats and paddle watercraft on Michigan’s rivers and lakes during biological field research.

A.9 Documents and Records

All parties on the QAPP distribution list will be sent a final version of the document and will be sent a new version when the document is revised. This correspondence will occur via a project email list. If email contact is not possible, other methods of contact will be attempted. QAPP distribution is the project manager's responsibility.

Data management and entry is the responsibility of MNFI. Data across all assessment areas will be reviewed for quality (completeness, format, species). The following general guidelines will be adhered to: All data will be collected in the field via standard project datasheets. Prior to completing surveys, completed field sheets will be reviewed for verification (complete data, correct format, no unexpected species) and prior to data entry, will be reviewed to confirm that all unknown specimens have been identified. Data sheets will be backed-up the day they are completed by taking a photograph of the datasheet. Data collected on paper datasheets will be entered by MNFI employees into electronic format and made available to the entire project team. Hard copy datasheets will be retained for the life of the grant period or longer.

SECTION B – DATA GENERATION & AQCUISITION

B.1 Sampling Process Design (Experimental Design)

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 the invasive common reed (*Phragmites australis*). Plans have been developed to restore portions of the Salt River Marsh occurring on State lands (U.S. Army Corps of Engineers 2013). Restoration will be accomplished through the excavation of sediments and mats of common reed, to improve plant community composition and structure and fish and wildlife habitat value.

An assessment of stream habitat and survey of macroinvertebrate communities is needed to document the baseline condition of the project area. Results of the survey will facilitate future efforts to identify changes in stream habitat and macroinvertebrate community within the area, as well as help identify potential for rare, threatened, or endangered mussel species to occur within the area.

This project is descriptive in nature in order to fulfill the need at hand. Formal hypotheses will not be tested. MDEQ's Qualitative Biological and Habitat Survey Protocols for Nonwadeable Rivers (MDEQ 2013) will be used in order to provide a baseline for monitoring stream habitat quality and the status of the macroinvertebrate community into the future. These protocols have been widely used throughout Michigan and provide a standard data collection methodology to allow comparisons over time.

An understanding of the current conditions is also needed to prepare permit applications (MDEQ Parts 31, 91, 301, and 303 of NREPA 1994 PA 451, as amended) required for restoration implementation, and to assess the success of restoration activities after project completion. The presence of invasive aquatic animal species may also be detected during surveys. The presence of such species can have dramatic effects on biological communities and habitat quality over time.

B.2 Sampling Methods

The following section was excerpted and modified from MDEQ's Qualitative Biological and Habitat Survey Protocols for Nonwadeable Rivers…

<u>Transect Establishment</u>
Each nonwadeable river sampling site consists of 11 transects spaced 50m apart for a total reach length of 500m. 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. The start of the reach will be established at the downstream end and handheld GPS unit used to set a waypoint. The left (or right) river bank (facing downstream) will be used to mark with survey flagging material (on overhanging branches or other visible location) and mark the first transect at this point. Successive upstream transects are dependent on measured distances from each previous waypoint, all of which will be established along the same bank. A GPS unit or 50m tape measure will be used to track distance from the starting waypoint. When the distance traveled equals 50m the next transect will be marked on the shoreline with flagging and a second waypoint established. Eleven transects will be marked, thus defining the 500m reach. Transects are labeled A-K, from downstream to upstream (Figure 1).

While marking transects along the reach, depth and substrate are measured at approximately 50m intervals along the thalweg for the entire reach for a total of 11 measurements per 500m reach (see Appendix II for Longitudinal Profile data sheet). The thalweg is defined as the deepest part of the channel and care will be taken to periodically verify that the correct path is followed. If an island is encountered along the longitudinal profile, the channel that carries the most flow will be surveyed. Left bank and right bank will be determined by facing downstream. Depth will be measured using a PVC sounding pole marked in 10cm increments. The sounding pole is also used to determine thalweg substrate materials based on how the bottom "feels" when dragging the pole along it. A combination of dragging motions with jabs against the bottom will be used.

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, the presence of off-channel habitats, such as backwater pools, connected side channels, and other extensive lateral wetted habitat including tributaries are recorded at every location that the thalweg depth and substrate are measured. When side channels are present, checkmarks on the Longitudinal Profile data sheet will be used to show the points of convergence/divergence. In cases of tributaries, there will not be a point of divergence.

A tally of all large woody debris (LWD) greater than 0.1m (approximately 4 inches) in diameter and 3m in length that is found at least partially within the wetted channel throughout the 500 m reach will be kept. Branched trees that meet these size requirements are counted once and counts of log-jams will be made quickly to reflect how abundant individual pieces of LWD are in the group without needing to spend extra time getting exact counts in those instances.

Macroinvertebrate Sampling

An equipment checklist will be used (Appendix III) to ensure all necessary equipment is brought along for the benthic macroinvertebrate community assessment. A random method will be used (e.g., coin flip, die roll) to decide which bank to sample for each transect. All available habitats within an area approximately ±10 m upstream and downstream of the marked transects (A-K) will be sampled (Figure 1). Sampling will 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, the opposite bank for that transect will be used. If neither bank is able to be safely sampled, no benthic macroinvertebrate sample is collected. Flagging will be removed as each transect is assessed and completed.

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 the following will be done:
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 electronic form for storage.

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

(See Appendix for detailed biological metric descriptions and scoring methods)

Qualitative Habitat Assessment Sampling Procedure

Qualitative habitat assessment 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. 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 the length of the sampling boat (17ft.) will be used 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. These estimates will be made visually unless water clarity precludes this, in which case proportional coverage will be estimated by using the PVC sounding pole.

The width of the intact riparian vegetative zone is estimated for both banks by visually extending the transect line perpendicular to the river channel. Riparian width is recorded for widths from 0 to 25m 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 25m.

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 50m 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 electronic form.

(See Appendix for detailed habitat metric descriptions and scoring methods)

To reduce the spread of invasive species into and out of the project area, surveyors will clean all equipment (e.g., waders, D-net) and boot treads, prior to entering the project area, and at the conclusion of each survey. The boat and boat trailer will be thoroughly washed and dried before going to or from a different water body.

No physical samples will be collected for this project, with the exception of unknown plant specimens. Unknown species will be collected in an individual Ziploc bag, labelled with a unique descriptive identifier and given the same label on the data sheet. Once identified, only collected plant material that represents a new collection within Macomb County will be deposited in an herbarium. Other specimens will be retained by MNFI for the grant period.

B.3 Sampling Handling & Custody

Any macroinvertebrate samples that are not identified on the spot will be placed in whirl-paks, labeled with date, collector, transect number, and reach number. 95% ethanol will be used in whirl-paks to preserve samples. Once identified, samples will be stored at MNFI for the duration of the grant.

B.4 Analytical Methods

See Appendix for detailed biological and habitat metric descriptions and scoring methods.

B.5 Quality Control

A sub-set of macroinvertebrate taxa identifications will be verified by a second trained field staff. If discrepancies arise standard identification resources will be used to confirm identifications (e.g. Merritt and Cummins “Introduction to The Aquatic Insects of North

America" and Thorp and Covich's "Ecology and Classification of North American Freshwater Invertebrates"). Identification of macroinvertebrate taxa should be accurate at least 95% of the time. Qualitative habitat scores are subject to expert judgement, but should be consistent between field staff at least 90% of the time, when compared independently.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

A boat, boat trailer, and field truck will be used to perform field surveys. Stereoscopes may be used in the lab to help identify macroinvertebrate taxa. Field trucks are MSU owned and receive annual safety inspections and have a regular maintenance schedule. The boat trailer tires, signal/brake wires, and safety chains will be inspected each day before towing the boat. A boat equipment list including safety and maintenance gear will be used to minimize the chances that any needed gear is left behind. Boat battery voltage will be checked and battery charged if needed at the beginning and end of each field day. Boat gas, oil, lower unit grease will be maintained at appropriate levels to complete surveys. All staff entering the boat will be briefed on potential hazards of boating. GPS units are calibrated prior to data collection using unit-specific methods. For the condition and quality assessments, precise GPS locations will not typically be necessary, nor are there likely to be equipment failures that result in corrective actions other than replacement of defective units (for example, diameter tapes, soil augers, or GPS units) from the MNFI in-house supply or via web orders.

B.7 Instrument/Equipment Calibration and Frequency

None needed.

B.8 Inspection/Acceptance of Supplies & Consumables

Supplies for this project will be inspected upon receiving them to confirm they are in working order and of the correct specifications. Supplies include: rite-in-the-rain paper, whirl-paks, ethanol, D-net, sample pan, bucket, and waders. The project manager will be responsible for maintaining and examining field equipment to ensure units are not defective or damaged. Defective equipment will be replaced prior to collection of field data.

B.9 Data Acquisition Requirements for Non-Direct Measurements

The Natural Heritage Database (Michigan Natural Features Inventory 2019) maintained by MNFI was used to investigate the presence of documented occurrences of RTE species in within 5 miles of the project site. This type of use closely aligns with the intended use of the database. The database contains historical and recent data occurrences, but it possible that undocumented populations of RTE species exist in the project area. MNFI staff will exercise their professional judgement for acceptance of the data.

B.10 Data Management

Data collected in the field during all surveys will be written onto data sheets printed on water resistant paper (Rite-in-the-Rain). Collected specimens will allow for later verification of species recorded during surveys. Each datasheet will be photographed to provide a backup if the original datasheet is lost. These digital photographs will be stored on an MNFI computer, along with other project photos, according to the following photo protocols. All photos will be stored in one folder on an MNFI computer. Project photos will be named with sequential identifiers following the convention: photo number-date-time-subject; datasheet photos will be named with sequential identifiers using the convention: habitat area-date-sheet number-location of hard copy. Original data sheets will also be stored at MNFI. As soon as possible after data collection, but no later than the fall after each field season, data will be entered into Microsoft Excel spreadsheets and made into tables that will be distributed to project partners and used to report results. Data related to all occurrences of RTE species observed during the surveys will be documented in MNFI's Natural Heritage Database.

SECTION C – ASSESSMENT AND OVERSIGHT

C.1 Assessments and Response Actions

As surveys are conducted each of the two field staff will periodically verify the other's habitat scores and macroinvertebrate taxa identifications. Discrepancies will be discussed and references checked to resolve. A cursory review of survey methods will be conducted before each field day to minimize any misunderstandings with field staff. This will include a check that all data is stored and labelled properly, including all GPS points, and paper files photographed and filed appropriately.

C.2 Reports to Management

Per the grant agreement, a preliminary report will be prepared by MNFI and provided to OGL upon 50% completion of the project, as well as a final report once the project is complete. The final report will also be distributed to project partners listed in section A.3.

SECTION D – DATA VALIDATION AND USABILITY

D.1 Data Review, Verification, and Validation

Qualitative assessments will be reviewed by the QA manager to ensure the consistency and accuracy of assessments. The field data collection is based upon expert judgement, so validation will happen at the discretion of the observer at the time of collection. After field data is transcribed into electronic forms, MNFI will apply standard data review processes to the electronic data. If the data is rejected at any level, the hard copy version will be retrieved, and data will be corrected.

D.2 Verification and Validation Methods

The QA manager will independently review habitat assessments and calibrate assessments with others conducted for previous projects in similar natural communities, to ensure the consistency of application. A summary of the condition and threats of each habitat stand will be provided in a table in the final report.

D.3 Reconciliation with Data Quality Objectives

Qualitative data will be reviewed independently by the QA manager to ensure consistency of application of metrics, utilizing in part results from previous projects that assessed conditions and threats. If data quality issues arise, the QA manager will seek additional expert opinion from biologists at MNFI. If need be, another MNFI biologist could be brought into the project to verified or reassessed qualitative data. The scope, utility, and limitations of the data will be specified in the final report to the sponsor.

References

Merritt, R.W., K.W. Cummins, and M.B. Berg, eds. An Introduction to The Aquatic Insects of North America. 2008. Kendall Hunt Publishing.

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Appendix A. Michigan Department of Environmental Quality, Water Resources Division Policy and Proceedure, number WRD-SWAS-022. Qualitative Biological and Habitat Survey Protocols for Nonwadeable Rivers.

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.

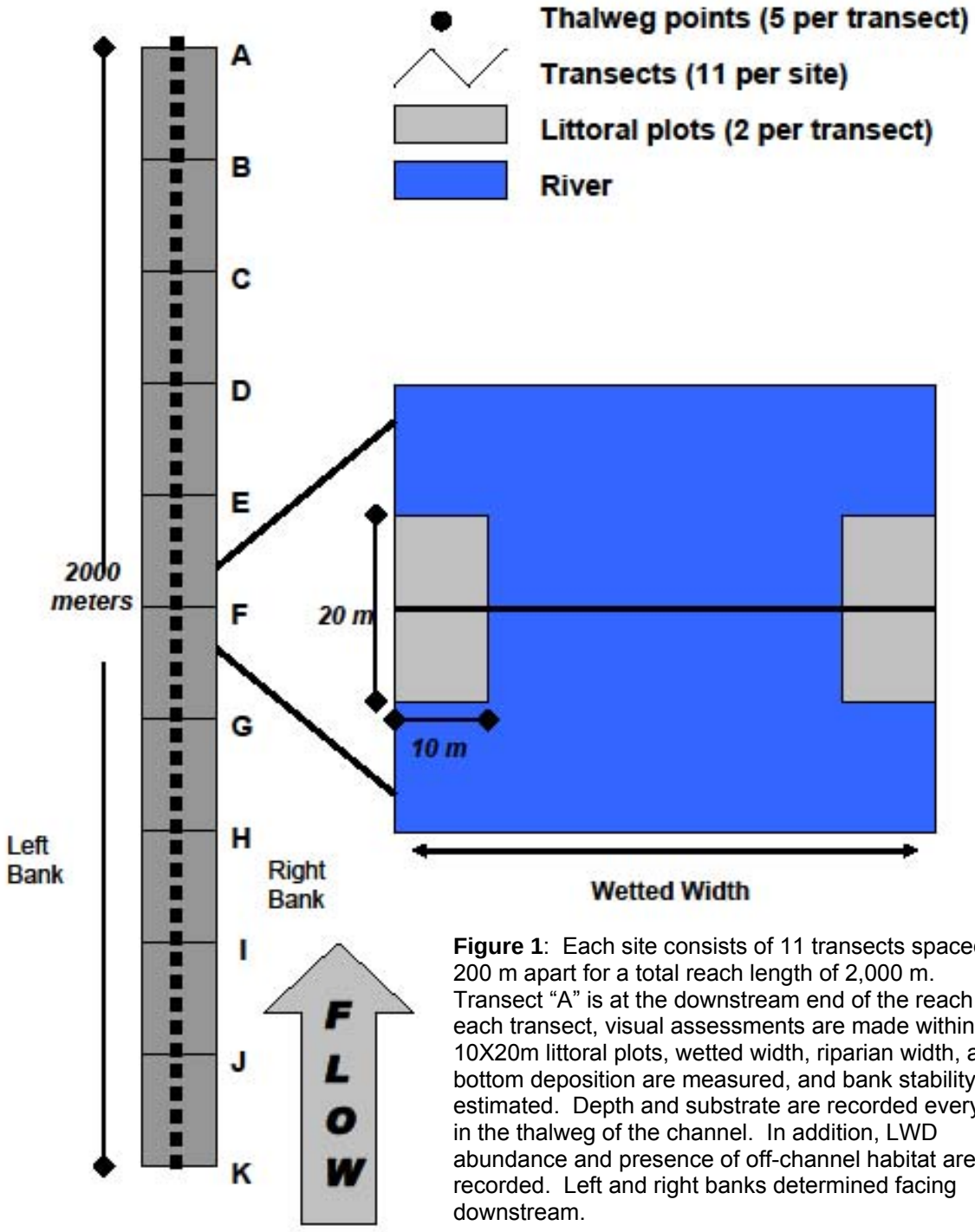

Figure 1: Each site consists of 11 transects spaced 200 m apart for a total reach length of 2,000 m. Transect "A" is at the downstream end of the reach. At each transect, visual assessments are made within 10X20m littoral plots, wetted width, riparian width, and bottom deposition are measured, and bank 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

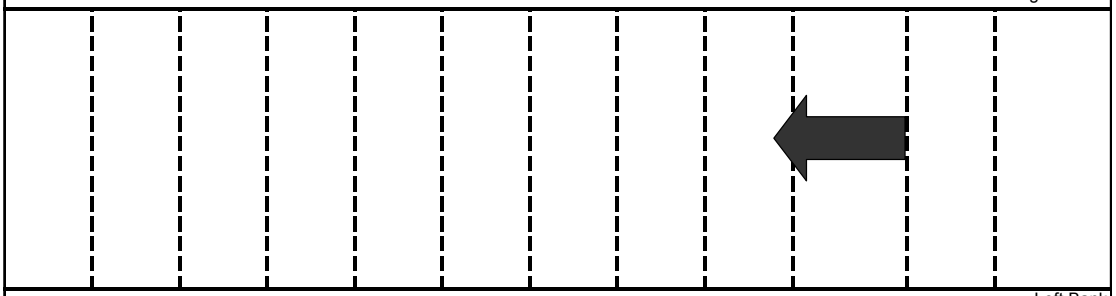
February 6, 2013
Date

Appendix I. Nonwadeable Procedure Reach Data Sheet.

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

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

Right Bank



Left Bank

A B C D E F G H I J K

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

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; labybug 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:

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?

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 ____
_____ ____
_____ ____
_____ ____
_____ ____

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

TAXA	FFG
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:** **Investigators:** **Date:** **Transect: A B C D E F G H I J K** (A=Downstream; K=Upstream)				**Site Name:** **Time:** **Investigators:** **Date:** **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:**			

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