Final 2012 Vegetation Assessment Survey Work Plan

1. Introduction

On July 25 or 26, 2010, a transmission pipeline owned by Enbridge Energy Partners, L.P. (Enbridge) ruptured, causing heavy crude oil to flow from this pipeline near the Town of Marshall in Calhoun County, Michigan. The oil discharged into Talmadge Creek, a tributary of the Kalamazoo River. It is estimated that approximately one million gallons of crude oil were released into Talmadge Creek and the Kalamazoo River. The spill occurred during a high-flow event, and oil was distributed both in the river and in the inundated floodplain for approximately 40 river miles downstream of the point of discharge (two miles of Talmadge Creek and 38 miles of the Kalamazoo River) to the dam on Morrow Lake. The area adjacent to these two watercourses contains a mixture of emergent, scrub-shrub, and forested wetland vegetation communities, as well as agricultural land, residential properties, and commercial properties.

Response and natural resource damage assessment (NRDA) activities began in the river and floodplain shortly after the discovery of the spill. As part of the Michigan Department of Environmental Quality's (MDEQ's or the Agency's) response efforts, geographic information system specialists for both the Agency and Enbridge compiled all datasets detailing the extent of oiling in areas adjacent to the waterways, as observed by various survey crews, and response activities conducted post-spill. Those response activities have since been categorized by the MDEQ as:

- Vegetation removal (soils left intact)
- Soils excavated, dredged, or scraped
- Debris removal
- Filling of wetlands for staging areas, boat launches, or roads
- Other wetland impacts (e.g., from absorbent mats, high- and low-pressure washing, vacutron use, and manual attenuation).

The Natural Resource Trustees[1] (the Trustees) have had ongoing concerns regarding the potential impacts to the vegetative community as a result of response actions. Therefore, as a part of NRDA activities, in August 2010 the Trustees conducted a rapid vegetative assessment (RVA) cooperatively with Enbridge. The purpose of this survey was to gather baseline data to

1. The Trustees for this incident include the U.S. Fish and Wildlife Service (USFWS), the Bureau of Indian Affairs, the MDEQ, the Michigan Department of Natural Resources, the Michigan Attorney General, the National Oceanic and Atmospheric Administration (NOAA), the Nottawaseppi Huron Band of the Potawatomi, and the Match E Be Nash She Wish Band of Pottawatomi.

characterize plant communities present in the floodplain that were potentially affected by the discharged oil and were at risk of further adverse effects associated with response activities. The RVA was repeated in September 2011 by the Trustees cooperatively with Enbridge. The 2011 survey was an expanded effort compared to the 2010 survey. It included a more intensive characterization of the plant communities present, using multiple assessment methods (described below), and included study sites that were selected to span the different types of response activities that had occurred in the floodplain over the preceding year, as detailed above. The fall 2012 survey described in this work plan will use the same survey methods implemented in 2011, and will revisit the same study and reference sites.

2. Objective

The purpose of the 2012 RVA study is to assess floodplain plant communities that were adversely affected by oiling and response activities. The study will acquire a third year of data to evaluate the recovery status of floodplain plant communities. Monitoring the effects of oil and response activities on plant communities in the floodplain and their potential recovery is important because these plant communities provide a variety of important ecological services. Potential effects from oiling and/or response actions may reduce the ecological services that these resources provide, decrease biodiversity, and/or increase the risk of colonization by less desirable or non-native species.

Specifically, the objective of the proposed study is to evaluate potential effects of oiling and response actions on the following plant communities present in the Kalamazoo River and Talmadge Creek floodplain:

- Emergent and scrub-shrub wetland
- Forested wetland
- Forested upland.

The categories of response actions to be assessed include:

- No action (i.e., areas that may have been oiled but were not subject to response actions)
- Vegetation removal (i.e., raking and/or cutting of woody vegetation)
- Disturbance (i.e., trampling, compacting, or scraping and/or removing < 6” of soil and organic matter)
- Excavation (i.e., removing > 6” of soil and organic matter).

Recovery rates may vary across these different types of response actions (including oiled areas where no action occurred), and across plant community types. Recovery is likely to be greater than two years for vegetation at many of the response areas, particularly if woody vegetation (including shrubs) was cut or if additional response actions were completed in 2011 or 2012. The data generated by this field study will provide insight into injury levels within the plant communities affected by response activities and oiling, and assist in documenting the recovery of riparian and floodplain plant communities. Furthermore, the data generated will also assist the Trustees in their overall understanding of the potential impacts on vegetative communities along the Kalamazoo River and Talmadge Creek as a result of this incident, including:

- Identifying areas potentially in need of further management actions, including primary restoration
- Informing the type and scale of compensatory restoration actions
- Informing future monitoring plans.

3. Survey Sites

As noted above, the study and reference sites surveyed in 2011 will be re-surveyed in the 2012 study. The 2011 sites were selected using a matrix of the above-listed response actions (including oiled areas with "no action") and plant communities (see Table 1 and Appendix A). Survey sites were selected so that each of the possible combinations of plant communities and response actions were included in the survey. Reference sites were located in "unaffected areas" adjacent to the study sites, and in locations upstream and downstream of the spill in wetland and upland community types similar to communities located within the area affected by the spill. The locations of study and reference sites are shown in Figure 1.

Table 1. Number of study sites within the different plant communities and response actions

Response action	Emergent and scrub-shrub wetland	Forested wetland	Forested upland
No action	9	10	n/a
Vegetation removal	13	4	2
Disturbance	5	2	2
Excavation	2	3	n/a
Reference	2	4	2

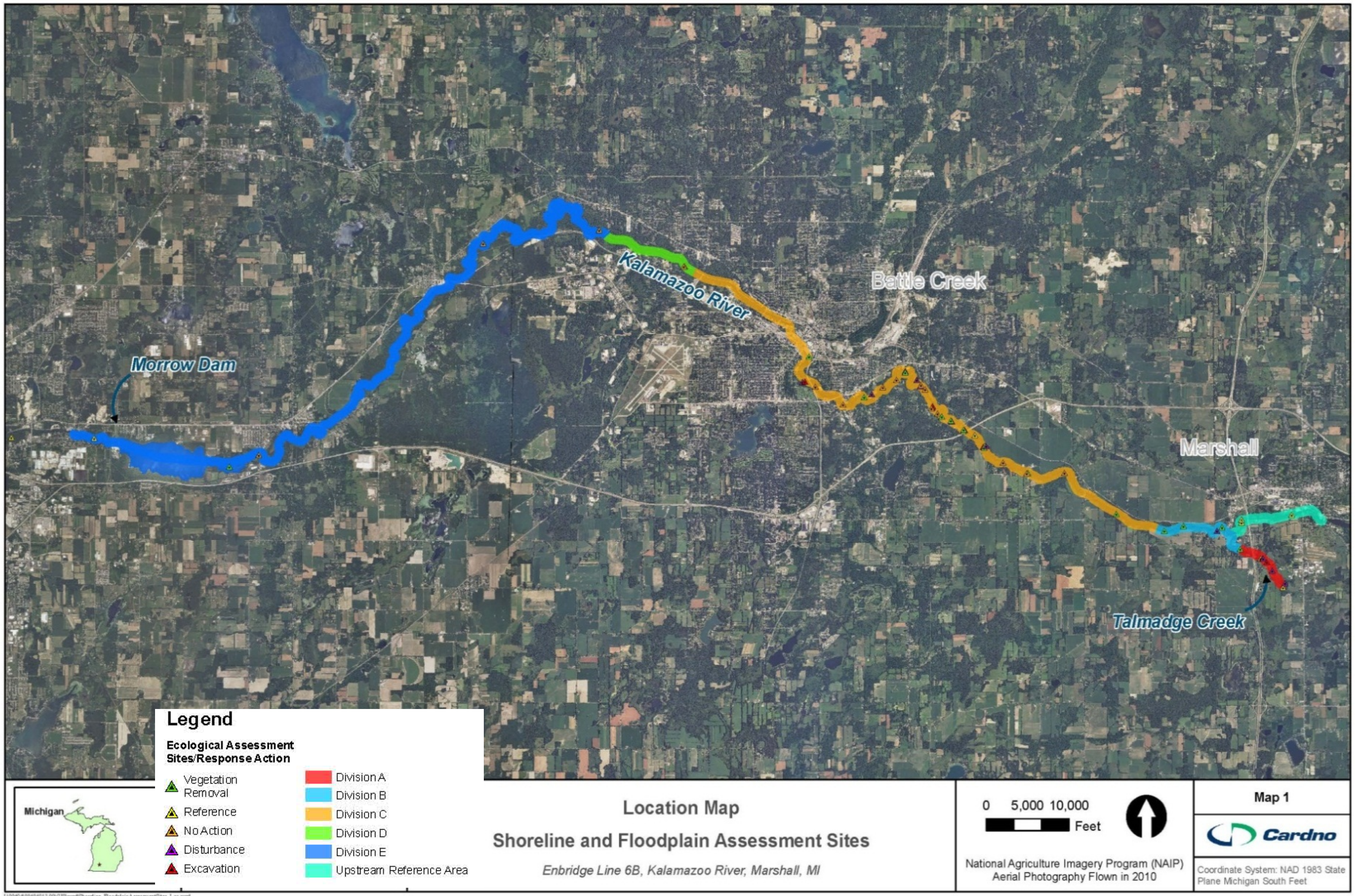


Figure 1. Map showing the 2011 survey sites to be re-surveyed in the 2012 study.

Source: Cardno-Entrix, 2011.

4. Survey Methods

Consistent with the 2011 survey, four vegetation assessment methodologies will be employed at each study and reference site and include:

1. Quantitative direct measurements
2. Wetland quality/services assessment
3. Modified floristic quality assessment (FQA)
4. Dominant species list (repeat of 2010 RVA protocol).

The rest of this section provides more detail on each of the assessment methodologies.

4.1 Quantitative Direct Measurements

Measurements of percent cover, stem height, and stem density will be collected for both native and invasive species at a minimum of three sampling points within each study and reference site. The sampling points identified at each site in the 2011 survey will be revisited in the current survey. Each sampling point will be temporarily marked using a small stake with flagging and a global positioning system (GPS) point will be recorded. The site identification (ID) will be written on each stake (see Section 7 for site ID naming convention). At each sampling point, the herbaceous stratum will be assessed within a 1-m radius plot, the shrub stratum will be assessed within a 3-m radius plot, and the tree stratum will be assessed within a 5-m radius plot. The plots will be measured to the appropriate diameter by holding a measuring tape at the desired length and walking in a circle around the center stake. All data will be recorded on provided datasheets (Appendix B). All calculations will be completed during the data analysis after the field work is completed.

In the 1-m herbaceous plots, the following measurements will be collected:

- Absolute percent cover of every species present (by canopy cover)
- Vegetative stem height of every species present (average height range).

In the 3-m shrub plots, the following measurements will be collected:

- Absolute percent cover of every species present (by canopy cover)
- Vegetative stem height of every species present (average height range)
- Stem density of every species present (number of stems of each species in plot).

In the 5-m tree stratum plots, the following measurements will be collected:

- Absolute percent cover of every species present (by canopy cover)
- Stem density of every species present (number of stems of each species in plot).

Using the absolute percent cover data, the relative percent cover (Rcov) will be calculated for each study site for each of the three strata (i.e., herbaceous, shrub, and tree). Rcov is calculated by summing the absolute percent cover values for an individual species for the plots of each stratum within a study or reference site, and then dividing that number by the total absolute percent cover value for all species by stratum.

$$Rcov = \frac{\sum_{i=0}^{n} percent\ cover\ of\ species\ A}{total\ percent\ cover\ of\ all\ plots\ in\ that\ sample\ site}$$

where: *i* = number of plots within the sample area
n = number of plots within the sample site
species A = one species in one plot.

The stem height will be recorded by species in the herbaceous and shrub stratum. Stem height will not be collected in the tree stratum. The height of each stem will be measured for each species, and the average will be calculated and recorded on the datasheet under the appropriate stem height range (e.g., < 1 m, 1–2 m, 2 + m). The values recorded for each of the three sample points within the study site, per stratum, can be used to obtain the average vegetation height ranges for that study site by stratum.

Stem density by species will be measured and recorded at each study site within the shrub and tree strata. Stem density will be measured by counting the number of stems by species within the plot. Stem density will not be measured in the herbaceous stratum, as the Rcov metric will provide sufficient data. Stem densities for the three sample points within the study site, per stratum, will be averaged to obtain the average stem density values for each species in the shrub and tree strata.

4.2 Wetland Quality/Services Assessment

The Wetland Quality/Services Assessment was developed for the 2011 RVA survey and is based on the Michigan Rapid Assessment Method (MiRAM). MiRAM is a wetland assessment method to assess quantitatively the functional value of a wetland by assessing its hydrologic conditions, surrounding land use, presence of invasive species, and habitat and soil alterations (MDNRE, 2010). At each study and reference site, the following information will be recorded for the Wetland Quality/Services Assessment in the provided datasheets (Appendix C):

- Percentage of the survey site that is bordered (i.e., "buffer zone") by a wetland or river

- Description of the survey site wetland, including if:

    - There is a buffer between the river and other human development (e.g., residential lawn or other human development)
    - It contains vernal pools, is an upland/wetland mosaic, or has a mixture of upland/wetland community types or land features

- Identification of wetland community types within the site:

    - Old growth/mature forest
    - Submergent/floating leaf
    - Emergent below ordinary high water mark (OHWM)
    - Forested
    - Scrub/shrub
    - Emergent above OHWM

- Description of the wetland's hydrologic regime:

    - Permanent inundation
    - Seasonal/intermittent inundation
    - Saturated

- Information on the habitat structure development:

    - Excellent (site appears to represent the best of its type)
    - Good (site appears to represent a good example of its type)
    - Fair (site appears to represent a moderately good example of its type)
    - Poor (site is not a fair example of its type)

- Tally of habitat features (insert number of habitat features observed):

    - Hummocks/tussocks/tree mounds (per acre)
    - Coarse woody debris (per acre)
    - Large standing per acre, living or dead, trees [> 12 in. diameter at breast height (DBH)]
    - Vernal pools where water may reside for a few weeks each season (per acre)

- Characterization of highly invasive species:
  - < 1% aerial coverage of highly invasive species
  - 1 to < 5% aerial coverage of highly invasive species
  - 5 to < 25% aerial coverage of highly invasive species
  - 25 to < 75% aerial coverage of highly invasive species
  - > 75% aerial coverage of highly invasive species
- Other information:
  - Wildlife observations or evidence of wildlife observed during the survey
  - Approximate percent cover by stratum throughout the study site
  - Confirmation that oiling conditions observed with information provided by response personnel
- Additional comments (e.g., additional notes regarding services assessed with this checklist).

4.3 Modified FQA

The vegetation within each study and reference site will also be characterized using the Modified FQA method (Losee and Jones, 2008; Appendix D of the 2011 survey plan, first document). The FQA is a measure of the quality of the habitat with respect to its vegetative composition relative to undisturbed habitats of the same type (MDNR, 2001). The Modified FQA follows the same procedures as the FQA, with two modifications made for the purpose of applying the method to rapid assessment: (1) the assessment time is curtailed to a one-hour walk-through at each site, and (2) at each site, if no new species are recorded after 10 minutes of searching, the assessment ends (Losee and Jones, 2008).

Accordingly, for the current study, a maximum of one hour will be spent on a walk-through of each site. During this hour, all plant species will be recorded on Site Inventory Datasheets (Appendix E). If no new species are recorded for any 10 consecutive minutes of the 1-hour site search, the walk-through will end. Plant names will be recorded as listed in Herman et al. (2001). Any species not immediately identified in the field will be photographed and identified later.

A Floristic Quality Index (FQI) value, which can serve as a measure of vegetative diversity, can be calculated for each study site using the species list compiled during the walk-through; this calculation will be completed during the data analysis after the field work is completed. The FQI is calculated using a coefficient of conservatism (C) and the total number of species found on the site (n), as follows:

$$FQI = \bar{C}\sqrt{n}$$

where: $\bar{C} = (\sum C)/n$.

C is a number ranging from 0 to 10 that indicates the fidelity of a plant species to a particular natural community type. Appendix D provides C values for Michigan plants. Plants that occur in almost any kind of habitat have a C of 0, and plants that only occur in rare communities have a C of 10.

4.4 Dominant Species List (2010 RVA protocol)

The protocol developed for the 2010 RVA survey (Appendix F) was repeated at each study and reference site in the 2011 survey and will be repeated in the 2012 survey to facilitate comparison across different study years. During the 2010 survey, dominant plant species for the tree, shrub/sapling, and herbaceous strata were recorded, where dominant was defined as 10% or greater relative abundance at a survey site. Notable non-dominant species for each of the strata, as well as an estimate of absolute abundance for non-native invasive species, were also recorded. Notable non-dominant species included federal or state threatened or endangered species, as well as those typically found in high-quality wetlands (e.g., with a coefficient of conservatism > 6 as indicated in the Michigan FQA).

Accordingly, for this field study, the site-wide relative abundance of each native species will be recorded by stratum (i.e., herbaceous, shrub/sapling, tree) if the relative abundance is greater than 10%. The absolute abundance of invasives will also be recorded on the provided datasheet (Appendix G). Notable non-dominant species (as defined above) will also be recorded on the datasheet.

The 50/20 Rule will also be used to determine plant dominance within each stratum by plot (1-m, 3-m, and 5-m radii) and site-wide. The 50/20 Rule states that the absolute percent cover of each species by stratum will first be determined and then the species will be ranked in order of descending absolute percent cover values. Starting with the species with the highest absolute percent cover value, the dominant plants are those for which the sum of the absolute percent cover value is 50% or greater. Species will also be considered dominant if their absolute percent cover values are 20% or greater individually. A list of the dominant species, both native and invasive, within each plot by stratum and each species' absolute percent cover will be determined at each study site.

5. Schedule

The field effort will be conducted over 10 working days (two weeks) during September 2012. Three teams consisting of three members each will conduct the field study. Field crews will include personnel who are knowledgeable on local plants and vegetative communities.

6. Equipment and Supplies

The following equipment is required to complete the RVA survey and will be provided for each field team:

- 2” × 2” × 48” wooden stakes
- Blue flagging tape
- Measuring tape (up to 5 m)
- Camera and memory card
- GPS unit
- Clipboard
- Water-resistant field logbook
- Indelible ink pens
- Aerial photographs/imagery and site maps
- Wetland Quality/Services Checklist
- Floodplain and Shoreline Habitat Assessment Datasheets
- Study Site Inventory Datasheets
- Site-specific Health and Safety Plan
- Personal protective equipment
- Water.

7. Field Study Coordination, Documentation, and Data Management

7.1 Field Study Coordination

Stratus Consulting will provide a field study manager (Allison Ebbets) who will be responsible for preparing the study, coordinating field teams, scheduling site visits, and managing data each day. The study manager will be onsite in Michigan for a minimum of three days, starting with the first day of field work. If needed, the study manager will remain in the field; however, it is anticipated that the study manager's duties can be completed offsite after the field study has been initiated.

7.2 Field Documentation

Each team member will document field activities in a water-resistant field logbook with an indelible ink pen. Each site will be named using the following nomenclature: Date (yy.mm.dd) – FSA (for Floodplain and Shoreline Assessment) – Milepost – Bank [right descending bank (RDB), left descending bank (LDB), or ISL (Island)], – three-digit sequential number. Additional sample sites near the same milepost marker will be numbered using the next consecutive number (002, 003, etc.). For example, a site will be named 12.09.01-FSA-9.5-LDB-001 if the survey is conducted September 1, 2012 at milepost marker 9.5 on the LDB and is the first site to be assessed near that milepost marker.

The site ID, time, and date of assessment will be recorded on each datasheet and in field logbooks. At each site location, GPS coordinates will be collected and recorded in decimal degrees (dd.ddddd°) in the logbook and on the datasheets. In addition, photographs will be taken to document each site, the surrounding habitat, and any other notable features. The GPS track log function will be turned on and the camera operator will photograph the GPS unit once daily.

A site sketch will be completed on the back of the Site Inventory Datasheet (Appendix E). The only remaining evidence of surveying at each site will be the wooden stake with its appropriate label and the blue flagging tape to help identify the site location as the wooden stake ages. Care will be taken to minimize trampling of the sites. No vegetation samples will be collected. If positive field identification is impossible, plants will be photographed at close range to facilitate identification at a later time but no sample will be collected.

7.3 Data Management

At the end of each field day, field crews will scan datasheets and field logbooks and upload the scanned files to the Stratus Consulting FTP site. Crew members will also post electronic copies of GPS files (i.e., track logs and waypoints) and photographs to the Stratus Consulting FTP site. Stratus Consulting will geo-reference photographs and translate field data from the datasheets to an electronic format (e.g., Excel spreadsheet). Email notice of the availability of newly posted information on the FTP site will be provided to the following individuals:

- Allison Ebbets, Stratus Consulting, aebbets@stratusconsulting.com
- Stephanie Millsap, USFWS, Stephanie_Millsap@fws.gov
- Todd Losee, MDEQ, loseet@michigan.gov
- Terry Heatlie, NOAA, Terry.Heatlie@noaa.gov.

The field logbooks and original datasheets will be turned in to the study manager at the end of the field study.

8. Health and Safety Precautions

Areas where response actions occurred or are ongoing may contain potentially hazardous materials and should be treated with caution to minimize exposure to field personnel. Additional hazards include slips, trips, and falls; heat stress; insects; poison ivy and sumac; sunburn; and boating hazards. Attire will comply with the site-specific Health and Safety Plan and may include waterproof clothing (e.g., waders/heavy rubber boots), safety glasses, and a personal flotation device as appropriate. In addition, all field staff are required to be in compliance with the 2012 Enbridge safety course requirements.

The site-specific Health and Safety Plan must be reviewed to identify further hazards, precautions, and safety procedures. A daily tailgate safety meeting will be held prior to beginning any field work. A written record of the daily tailgate safety meeting, including signatures of all personnel present, will be maintained and provided to the study manager at the close of each field day when data are transferred.

9. Data Compilation and Synthesis, Report Generation

After the 2012 RVA study is completed, Stratus Consulting will compile and perform preliminary analyses on the collected data, including completing all calculations described in Section 4, Survey Methods. Stratus Consulting will also summarize the data collection efforts and results in a Data Report. This report will summarize the field activities that occurred, summarize the data that were collected, and present data results.

10. Estimated Cost

Below we provide our estimated cost for the Trustees to complete the vegetation assessment. The work is divided into two primary tasks: (1) field work and oversight, and (2) data compilation and Summary Report.

Task 1: This task includes field work and oversight activities, including preparing for the field work, developing datasheets and maps, and traveling to the site. Field work includes conducting the RVA and data management and project oversight. The estimated cost for Task 1 is $134,067, which includes:

- Stratus Consulting estimated total cost: $103,807
  - *Labor*: preparing for the field work, producing materials required for the survey, providing oversight of the field work; staff include 6 field personnel (2 experts, 3 intermediate experts, 1 field technician) and 1 field study manager: 833 labor hours, $80,063
    - *Expert:* someone with a PhD in botany or ecology who is an expert at identifying native Michigan plants and designing and conducting field survey work in Great Lakes wetland and riparian ecosystems or has over 12 years of experience identifying native Michigan plants and designing and conducting field survey work in Great Lakes wetland and riparian ecosystems
    - *Intermediate*: someone with a MS in botany or ecology who has experience identifying native plants in Michigan riparian and wetland ecosystems or has over five years of experience identifying native Michigan plants
    - *Field technician*: someone with a bachelor's degree and experience conducting field work
  - *Supplies*: $600
  - *Travel (airfare, ground transportation, and per-diem):* $23,144

- NOAA estimated total cost: $10,360
  - *Labor* (one expert field crew member): $8,910
  - *Travel* (ground transportation and per-diem): $1,450

- USFWS estimated total cost: $19,900
  - *Labor* (two field technicians): $13,520
  - *Travel* (airfare, ground transportation, and per-diem): $6,380.

Task 2: The estimated cost for Stratus Consulting to complete this task, which includes compiling and summarizing the field data and preparing a summary report, is $33,000 (328 labor hours).

The total cost of implementing the survey and producing the final report is $167,067.

References

Cardno-Entrix. 2011. Sampling Location Map. Cardno-Entrix, Houston, TX.

Herman, K.D., L.A. Masters, M.R. Penskar, A.A. Reznicek, G.S. Wilhelm, W.W. Brodovich, and K.P. Gardiner. 2001. *Floristic Quality Assessment with Wetland Categories and Examples of Computer Applications for the State of Michigan – Revised, 2nd Edition.* Michigan Department of Natural Resources, Wildlife, Natural Heritage Program, Lansing.

Losee, T. and S. Jones. 2008. Michigan Rapid Assessment Method for Wetlands (MiRAM) Field Testing. Michigan Department of Environmental Quality Report.

MDNR. 2001. *Floristic Quality Assessment with Wetland Categories and Examples of Computer Applications for the State of Michigan*. Revised, 2nd Edition, October. Michigan Department of Natural Resources, Wildlife Division, Natural Heritage Program.

MDNRE. 2010. Michigan Rapid Assessment Method for Wetlands (MiRAM), Version 2.1. Michigan Department of Natural Resources and Environment, Lansing.

A. Proposed Survey Sites

Line 6B Proposed Study Sites for 2011 NRDA Shoreline and Floodplain Habitat Assessment

Site ID	Inundation	Site Description	Habitat Type	Site Type	Response Action	Lat	Long	Response Action Notes
1	Outside	New	Upland Forest	Reference	N/A	42.24069977	-84.97250366	
2	Outside	New	Upland Forest	Study	Disturbance	42.24219894	-84.97160339	foot traffic, gravel road, road removed, soil decompacted, site seeded
3	Outside	New	Emergent/Scrub-shrub Wet	Study	Vegetation Removal	42.24599838	-84.97740173	
4	Outside	RVA	Emergent/Scrub-shrub Wet	Study	Excavation	42.24850082	-84.98020172	mat road, excavation, backfill
5	Outside	RVA	Forested Wet	Study	No Action	42.24980164	-84.98169708	
6	Outside	RVA	Forested Wet	Study	Excavation	42.24980164	-84.9815979	excavation, backfill, site seeded
7	Outside	RVA	Forested Wet	Study	Vegetation Removal	42.24990082	-84.9815979	site seeded
8	Outside	New	Emergent/Scrub-shrub Wet	Study	Vegetation Removal	42.25279999	-84.99160004	site seeded
9	Outside	New	Forested Wet	Reference	N/A	42.26380157	-84.96890259	
10	Outside	New	Emergent/Scrub-shrub Wet	Reference	N/A	42.2621994	-84.99130249	
11	Inside	New	Emergent/Scrub-shrub Wet	Reference	N/A	42.26119995	-84.99130249	
12	Inside	RVA	Emergent/Scrub-shrub Wet	Study	Vegetation Removal	42.25960159	-84.99990082	
13	Inside	RVA	Emergent/Scrub-shrub Wet	Study	Disturbance	42.258531	-85.002176	road to RVA site
14	Inside	RVA	Emergent/Scrub-shrub Wet	Study	Vegetation Removal	42.25970078	-85.01719666	
15	Inside	RVA	Emergent/Scrub-shrub Wet	Study	Vegetation Removal	42.25859833	-85.02559662	
16	Inside	RVA	Forested Wet	Study	Vegetation Removal	42.26369858	-85.04699707	
17	Inside	RVA	Forested Wet	Study	No Action	42.27659988	-85.07029724	
18	Inside	RVA	Forested Wet	Study	No Action	42.27619934	-85.08650208	
19	Inside	RVA	Emergent/Scrub-shrub Wet	Study	Vegetation Removal	42.27640152	-85.08650208	
20	Inside	RVA	Emergent/Scrub-shrub Wet	Study	No Action	42.27629852	-85.08679962	
21	Inside	RVA	Forested Wet	Study	No Action	42.27959824	-85.09760284	
22	Inside	O&M	Forested Wet	Study	Excavation	42.28440094	-85.10649872	excavation, backfill
23	Inside	O&M	Forested Wet	Study	Vegetation Removal	42.2845993	-85.10649872	
24	Inside	O&M	Upland Forest	Study	Vegetation Removal	42.2845993	-85.1065979	high quality wetland
25	Outside	New	Forested Wet	Reference	N/A	42.28829956	-85.11029816	
26	Outside	New	Upland Forest	Reference	N/A	42.28939819	-85.1155014	
27	Inside	O&M	Forested Wet	Study	Excavation	42.289929	-85.11541	excavation, backfill
28	Inside	O&M	Upland Forest	Study	Disturbance	42.284622	-85.106634	road
29	Inside	RVA	Emergent/Scrub-shrub Wet	Study	Vegetation Removal	42.289933	-85.115411	
30	Inside	RVA	Emergent/Scrub-shrub Wet	Study	No Action	42.29259872	-85.1207962	
31	Inside	RVA	Upland Forest	Study	Vegetation Removal	42.29270172	-85.1210022	
32	Inside	RVA	Emergent/Scrub-shrub Wet	Study	Vegetation Removal	42.2928009	-85.12120056	Yard 5
33	Inside	RVA	Forested Wet	Study	Vegetation Removal	42.29410172	-85.12509918	
34	Inside	RVA	Emergent/Scrub-shrub Wet	Study	No Action	42.29499817	-85.1269989	
35	Inside	RVA	Emergent/Scrub-shrub Wet	Study	Disturbance	42.29589844	-85.12840271	compaction, shallow disturbance
36	Inside	RVA	Emergent/Scrub-shrub Wet	Study	Vegetation Removal	42.29710007	-85.12909698	
37	Inside	RVA	Emergent/Scrub-shrub Wet	Study	No Action	42.29710007	-85.12909698	
38	Inside	RVA	Forested Wet	Study	No Action	42.30270004	-85.13269806	
39	Inside	O&M	Emergent/Scrub-shrub Wet	Study	Disturbance	42.303532	-85.134943	shallow scraping just dowstream 11.0, O&M calls it 11.00L1
40	Outside	RVA	Emergent/Scrub-shrub Wet	Study	No Action	42.30410004	-85.1344986	
41	Inside	RVA	Forested Wet	Study	Disturbance	42.305622	-85.136481	road
42	Inside	O&M	Forested Wet	Study	Disturbance	42.30830002	-85.14160156	scraping, ice road
43	Inside	RVA	Emergent/Scrub-shrub Wet	Study	Vegetation Removal	42.30799866	-85.14160156	
44	Inside	RVA	Forested Wet	Study	No Action	42.30559921	-85.14550018	
45	Inside	RVA	Forested Wet	Study	No Action	42.30319977	-85.1516037	
46	Inside	RVA	Emergent/Scrub-shrub Wet	Study	Vegetation Removal	42.3003006	-85.15720367	
47	Inside	RVA	Emergent/Scrub-shrub Wet	Study	Disturbance	42.3003006	-85.15720367	scraping
48		RVA	Forested Wet	Study	No Action	42.297553	-85.169298	
49	Inside	RVA	Forested Wet	Study	No Action	42.30310059	-85.18160248	
50	Inside	O&M	Emergent/Scrub-shrub Wet	Study	Disturbance	42.30469894	-85.186203	timber mat road
51	Inside	O&M	Emergent/Scrub-shrub Wet	Study	Excavation	42.30469894	-85.186203	
52	Outside	RVA	Emergent/Scrub-shrub Wet	Study	Vegetation Removal	42.31280136	-85.18460083	
53	Inside	RVA	Emergent/Scrub-shrub Wet	Study	No Action	42.34090042	-85.24030304	
54	Inside	New	Forested Wet	Study	No Action	42.340838	-85.240815	moved site to LDB from island due to homeless man
55	Inside	New	Emergent/Scrub-shrub Wet	Study	No Action	42.352124	-85.278641	
56	Inside	New	Emergent/Scrub-shrub Wet	Study	No Action	42.34730148	-85.33049774	campground
57	Inside	New	Emergent/Scrub-shrub Wet	Study	No Action	42.27939987	-85.4292984	survey in backwater areas closer to road
58	Inside	New	Emergent/Scrub-shrub Wet	Study	Vegetation Removal	42.27550125	-85.44249725	
59	Outside	New	Forested Wet	Reference	N/A	42.284033	-85.50285	moved to 40.5 RDB
60	Outside	New	Forested Wet	Reference	N/A	42.283983	-85.539755	moved to just downstream of 42.5 LDB

B. Datasheets for Quantitative Direct Measurements

Date:______________

Site ID:________________
Sample Point: A B C

Line 6B NRDA Shoreline and Floodplain Assessment Data Sheet

Centroid Latitude: _____________________

Centroid Longitude: _____________________

Total % cover: _______

Team Members: ____
____
____

Fill out one data sheet per sample point (3 sample points per study site).
Percent cover is measured by species in each stratum
For stem height, estimate the approximate average stem height by species .
Stem height is measured in herbaceous and shrub stratum plots only.
Stem density is measured by the number of stems that are rooted within the plot.
Record relevant information regarding plant health of individual species in the Notes column
If positive field ID is not possible, plants will be photographed at close range, but no sample will be collected.

Herbaceous Stratum (woody or herbaceous plants <1 m in height)

Species	*% cover*	*Approximate Stem Height*			*Notes*
		<0.5 m	*0.5-1 m*	*1+ m*	

Site ID:________________
Sample Point: A B C

Line 6B NRDA Shoreline and Floodplain Assessment Data Sheet

Shrub Stratum (woody species <20 feet in height OR >20 feet in height, but <3 inches in diameter)

Species	*% cover*	*Approximate Stem Height*			*Stem Density*	*Notes*
		<1 m	*1-2 m*	*2+ m*		

Tree Stratum (woody species >3 inches in diameter and >20 feet in height)

Species	*% cover*	*Stem Density*	*Notes*

Notes (e.g., observations of oiling, herbivory, other general information about the vegetation and conditions in the plot):

C. Wetland Quality/Services Assessment Datasheets

Study Site ID:__________________________

Line 6B NRDA Wetland Quality/Services Checklist

Date:________________________ Team Members:_________________________
____
____

Complete one data sheet for each study site, which is defined as the specified vegetation community within the NWI, O&M, or otherwise specified polygon, up to a maximum of 10 acres in size.

If area is upland, check here: ☐ and skip to item E.

(A) The Surrounding Buffer Zone (check one)

_____ <25% of surrounding 100 feet is Wetland or River
_____ 25-75% of surrounding 100 feet is Wetland or River
_____ 75-100% of surrounding 100 feet is Wetland or River

(B) Buffers/Habitat Types (check only those that apply)

_____ Wetland serves as buffer between River and other Human Development (e.g., residential lawn or other development within 500 feet of the Study Area)
_____ Wetland contains vernal pools, is an upland/wetland mosaic, or has a mixture of upland/wetland community types or land features

(C) Wetland Community Types (check all that apply for areas with site)

_____ Old Growth/Mature Forest (mean overstory DBH >20 inches, with at least two trees exceeding 28 inches)
_____ Submergent/Floating Leaf
_____ Emergent below OHWM
_____ Forested
_____ Scrub/Shrub
_____ Emergent above OHWM

(D) What term best describes the wetland's hydrologic regime? (check one)

_____ Permanent Inundation
_____ Seasonal/Intermittent Inundation
_____ Saturated

(E) Habitat Structure Development (check one)

_____ Excellent (site appears to represent the best of its type)
_____ Good (site appears to represent a good example of its type)
_____ Fair (site appears to represent a moderately good example of its type)
_____ Poor (site is not a fair example of its type)

(F) Habitat Features (insert number of habitat features observed):

_____ Hummocks/Tussocks/Tree Mounds (per acre)
_____ Coarse Woody Debris (per acre)
_____ Large Standing per acre, Living or Dead, Trees (>12 inches DBH)
_____ Vernal pools where water may reside for a few weeks each season (per acre)

(G) Coverage of Highly Invasive Species (check one)

_____ <1% Aerial Coverage of Highly-Invasive Species
_____ 1 to 5% Aerial Coverage of Highly-Invasive Species
_____ 5 to 25% Aerial Coverage of Highly-Invasive Species
_____ 25 to 75% Aerial Coverage of Highly-Invasive Species
_____ >75% Aerial Coverage of Highly-Invasive Species

(H) Was wildlife or evidence of wildlife observed during the survey? Yes/No

List species and/or evidence:

(I) Approximate % Cover by Stratum throughout Study Site:

Herbaceous:_____%
Shrub:_____%
Tree:______%

(J) Do oiling conditions observed confirm with information provided by Response? Yes/No

Additional Comments (e.g., additional notes regarding services assessed with this checklist):

D. Floristic Quality Assessment Protocols

Michigan Rapid Assessment Method for Wetlands (MiRAM) Field Testing

Introduction

In 2007 and 2008, the Michigan Department of Environmental Quality undertook an effort to conduct field testing of the Michigan Rapid Assessment Method for wetlands (MiRAM) throughout Michigan. A plan was developed to divide the state into two distinct regions covering the southern half of the Lower Peninsula of Michigan in the first sampling season and the northern half of the Lower Peninsula and the Upper Peninsula of Michigan in the second sampling season. The effort included testing of a variety of wetland sites with a range of ecological and landscape conditions using the MiRAM, Ohio Rapid Assessment Method (ORAM), and a Floristic Quality Assessment (FQA) modified from the Floristic Quality Assessment for Michigan (Herman et al 2001). The overall goal of the field testing was to determine whether the MiRAM produced results similar to ORAM (Mack 2001) which identifies several wetland functions and values and also the Floristic Quality Assessment for Michigan which is an indicator of floristic condition.

Site Selection

A total of 96 individual sites were sampled throughout the testing period. The sampling area was divided into two regions based on the floristic tension zone in Michigan. The floristic tension zone is an area that divides the state into two regions of differing forest vegetation, climate, and soil compositions (Barnes and Wagner 1981). The sampling included 55 sites south of the floristic tension zone and 41 sites north of the floristic tension zone. Of the total 96 sites, 23 were sampled in both the spring and summer to determine any seasonality influences making a total sample size of 119. Sampling that occurred in the spring included a review of MiRAM and ORAM, while sampling in the summer included an evaluation of MiRAM, ORAM, and a modified floristic quality assessment.

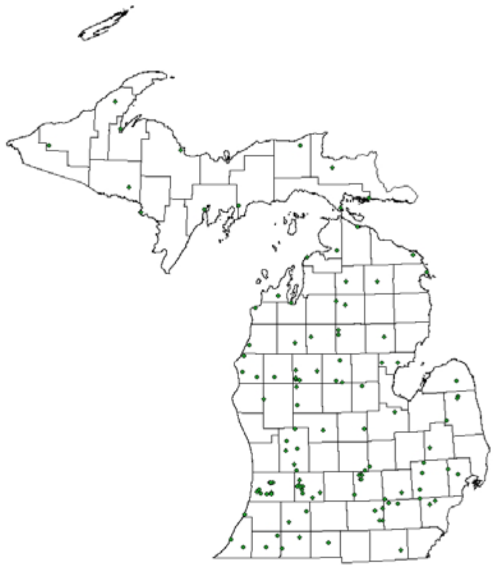


Figure 1: MiRAM Field Testing Site Locations

Every effort was made to select sites located on publicly assessable land; this would assure access to the sites during this sampling period and for potential future follow up studies. County maps were used as a course scale guide to identify public land which could potentially contain wetlands. The final selection process was completed using Geographic Information Systems (ArcGIS 9) to consider many of the existing landscape features and accessibility. Data layers containing U.S. Fish and Wildlife Service National Wetlands Inventory, 1999 Rockford Platt maps, 1998 NAPP Aerial Imagery (CIR), U.S. Geological Service topographic quadrangle maps, MI Framework Hydrology, and 2005 NAIP Aerial Imagery (NC) were referenced to determine wetland location, size, and hydrological connectivity.

The MiRAM Boundary Determination Guidelines were used in conjunction with the above reference materials to determine actual sampling area. As discussed in the MiRAM Users Manual, the MiRAM boundary is often the same as the jurisdictional wetland delineation boundary. However, for larger wetlands (greater than 50 acres), wetland complexes, and wetlands adjacent to open water bodies, the MiRAM boundary determination guidelines were used to ensure consistent and repeatable sampling areas. In instances where the actual on the ground boundary differed from the resource information boundary determined in the office, the boundaries were modified to follow the actual site conditions.

A wide variety of wetland types, sizes, and locations were selected for sampling. Sizes ranged from 1.5 to 50 acres (MiRAM limits the review area to 50 acres) while wetland types included forested, bogs, marshes, scrub-shrub and others. Surrounding land use varied from rural to industrial to urban/suburban.

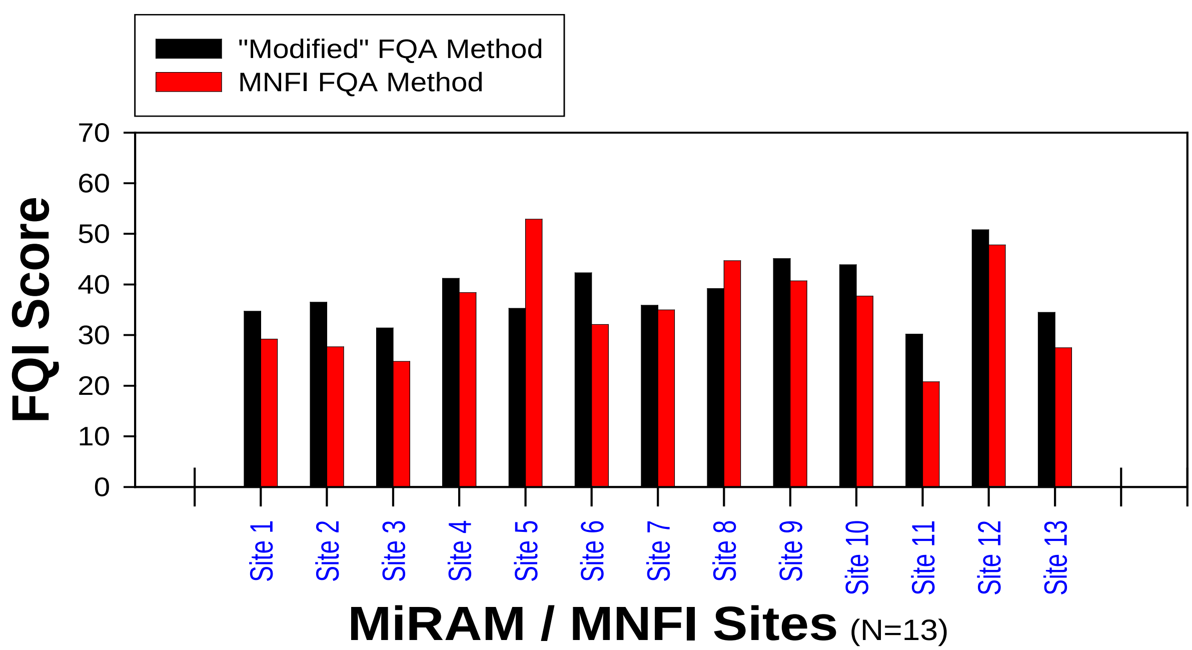
For tracking purposes, each site was assigned a name using a combination of the county name, year, and an assigned number. Longitude and latitude was obtained from ArcGIS9 and the coordinates entered into a handheld Garmin GPSMAP 76Cx unit for facilitating travel to the wetland. Reference maps were created for each site including MiRAM boundaries with the 1998 and 2005 aerial photographs and county road maps. In addition maps were created for each site that included a 150 foot and 1000 foot "buffer" zone around the MiRAM boundary, and a 2 mile radius from the center of the sample area showing all wetlands identified on the NWI.

Methods and Results

Modified Floristic Quality Assessment

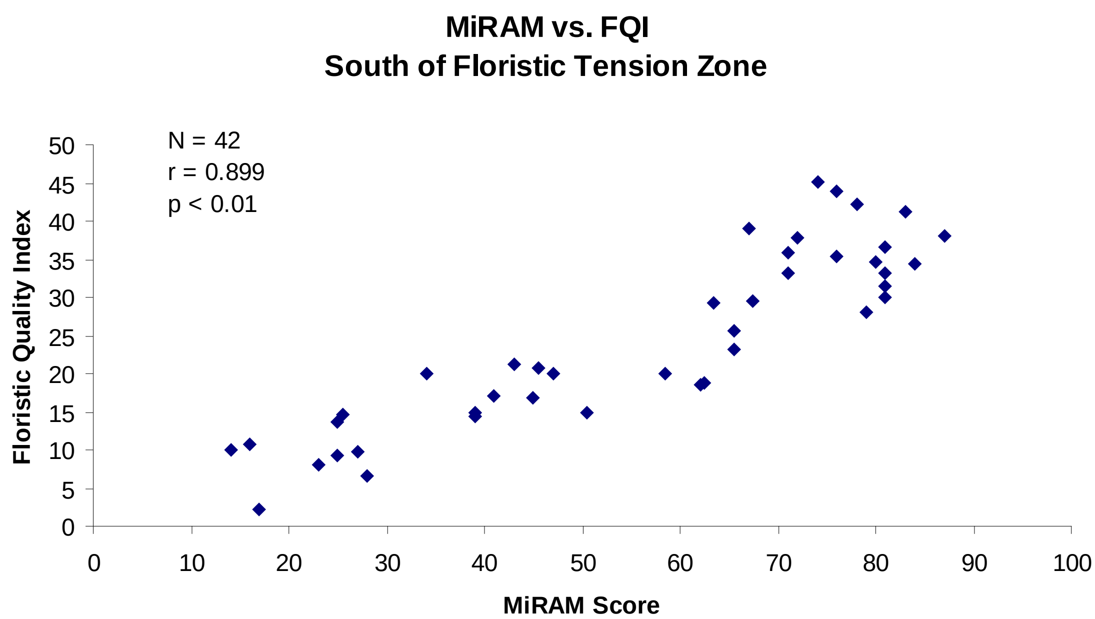
In 2007 in collaboration with the Michigan Natural Features Inventory (MNFI) ecologists, we developed a modified FQA sampling protocol to fit the time and budgetary constraints of the MiRAM project. Specifically; we established strict sampling timeframes that limited our review to a maximum of 4 hours per site. Each vegetation community type (emergent, scrub/shrub, forested, mixed) was limited to a maximum one hour sampling period. In addition, we stopped sampling in any community once we were unable to locate a new species for a period of 10 minutes. The sampling was done following the random meandering method within each community type present within the wetlands. All species not easily identified in the field were immediately collected for later laboratory identification. Significant time was required to ensure proper identification of all collected species.

To validate the modified FQA technique, we conducted the modified FQA sampling method on 13 sites where existing FQA survey results maintained in the MNFI database. A paired t-test was run on the 13 sites giving the resulting values of 1.543 for t and 0.149 for p with a degree of freedom equal to 12. Based on these results, there was no significant difference between the two methods.

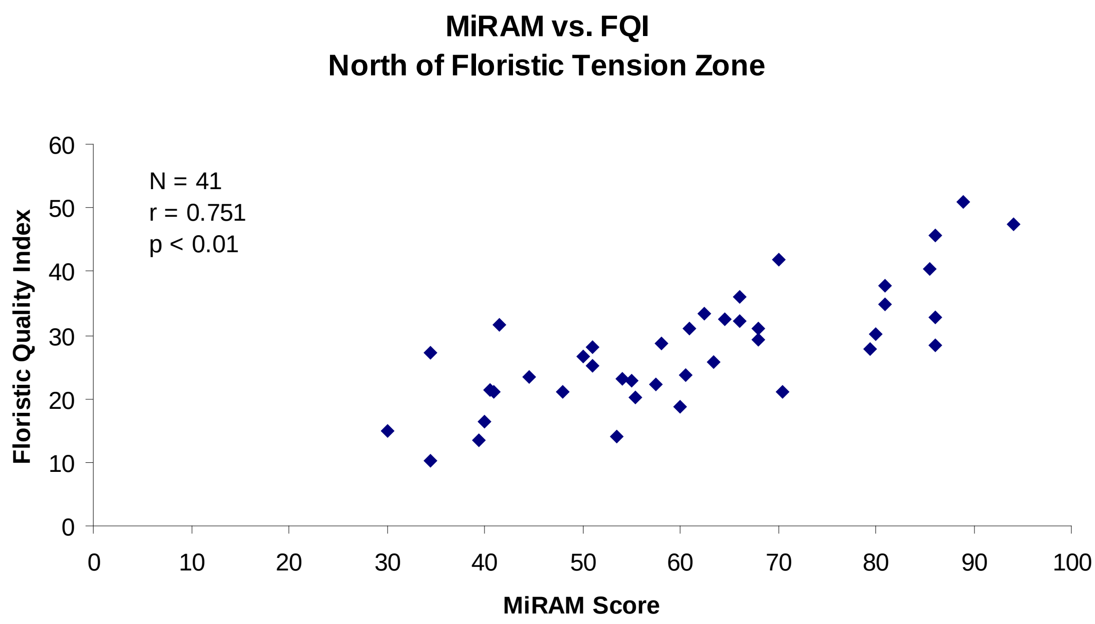


MiRAM vs. Modified FQA

Results South of the Floristic Tension Zone
During the 2007 sampling season, 42 sites were evaluated south of the floristic tension zone in Michigan using the MiRAM and the modified Floristic Quality Assessment. A Spearman's rank-order correlation indicates a significant positive association between MiRAM score and FQI. $r = 0.899$ with a p-value <0.01.

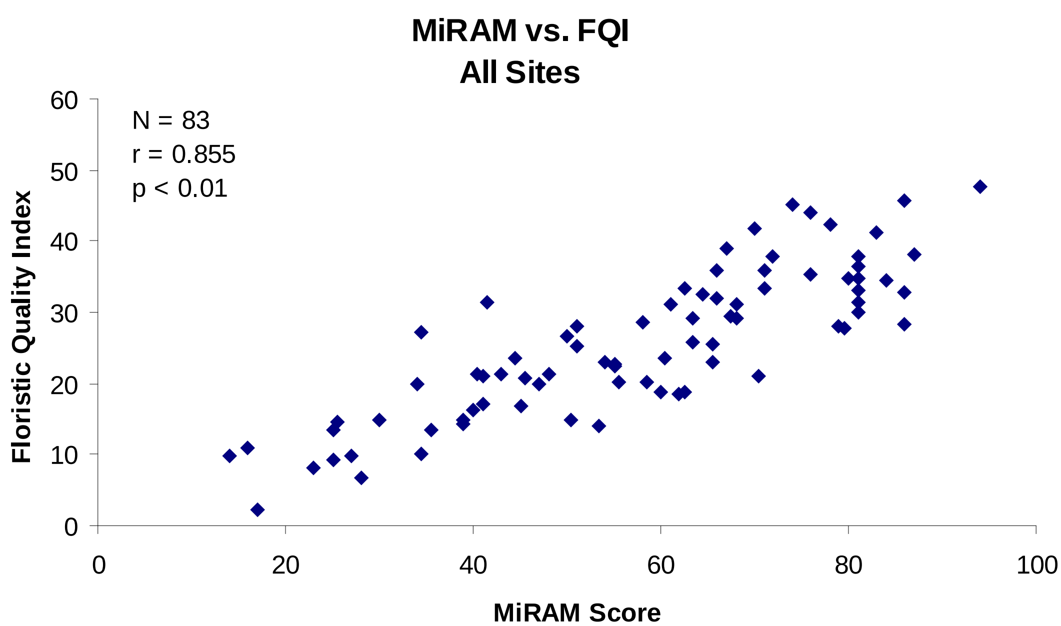


Results North of the Floristic Tension Zone
41 sites were evaluated north of the floristic tension zone in Michigan using the MiRAM and the modified Floristic Quality Assessment. A Spearman's rank-order correlation indicates a significant positive association between MiRAM score and FQI. $r = 0.751$ with a p-value <0.01.



Results All Sites

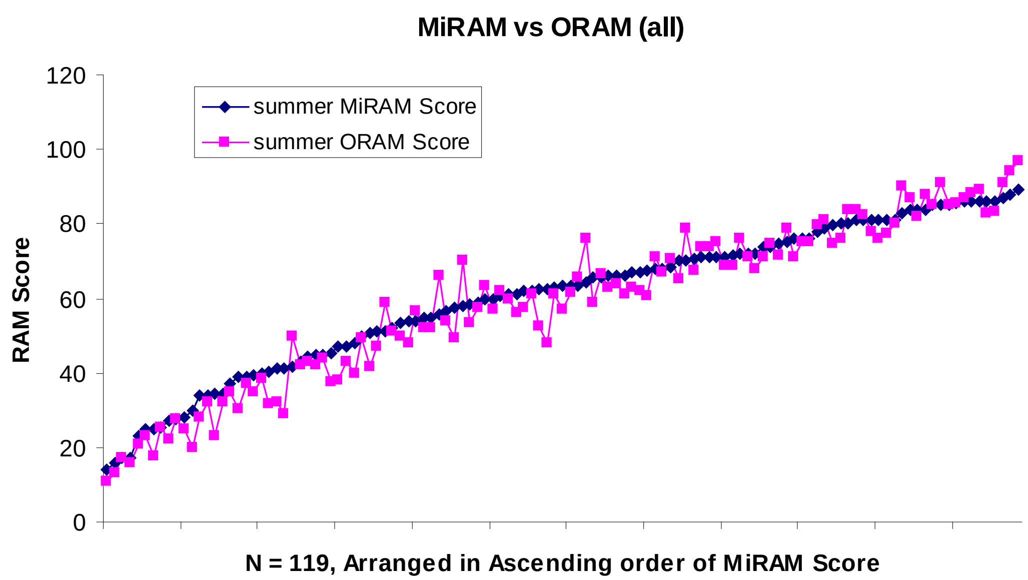
During the two year sampling period, 83 sites were evaluated throughout Michigan using the MiRAM and the modified Floristic Quality Assessment. A Spearman's rank-order correlation indicates a significant positive association between MiRAM score and FQI. $r = 0.855$ with a p-value <0.01.



All three of the MiRAM vs FQI comparisons indicate that as the MiRAM score increases, the FQI is also likely to increase resulting in a very high likelihood of also having an increased vegetation quality and condition.

MiRAM vs ORAM

We tested MiRAM and ORAM on 119 sites throughout the entire state of Michigan. This allowed us to track how the changes in MiRAM were affecting the ORAM evaluation in both the spring and summer seasons. Since ORAM has a long history of testing and development and was chosen as the model for the initial MiRAM development, we wanted to track how our changes in MiRAM were affecting the ORAM evaluation.



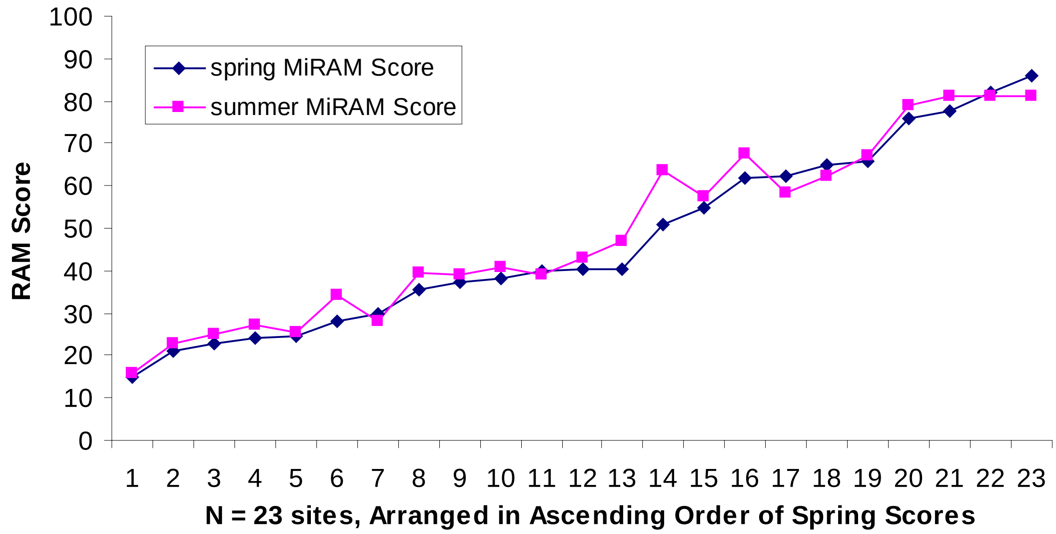
The results from comparing the MiRAM and ORAM indicate that even after significant modifications, MiRAM scores remains very consistent with ORAM scores.

The differences that we did find between the MiRAM and the ORAM were mostly attributed to the significant modifications that were made to Metric 5. In particular, we added submetrics for forested wetlands, critical habitat, urban/suburban, and followed MNFI's natural community rating systems for rare and imperiled wetland communities. In addition, the ORAM awards points for all bogs, while the MiRAM only awards points for bogs located south of the floristic tension zone.

Spring vs. Summer MiRAM Evaluations

To test for any seasonality influence, 23 sites were sampled both in the early spring and again in the summer. The results indicate a slightly lower spring score for most sites. To address this seasonality effect, the MiRAM requires that 10 points be added to any evaluations conducted outside of the growing season. Even with the added points, it is highly recommended that all wetland evaluations be conducted, or at least verified, during the growing season.

MiRAM, Spring vs. Summer



Conclusions

The MiRAM field testing indicated a significant correlation between the MiRAM score and the Floristic Quality Index regardless of location or wetland type. These results allow the MiRAM user to be confident that the MiRAM evaluates wetland functional condition regardless of the wetland's location and wetland type. We found that testing outside of the summer growing season tended to result in lower overall MiRAM scores. We believe that this difference is attributed to the inability to properly identify vegetation diversity and certain habitat features outside of the growing season.

Based on our sampling, we are confident that the MiRAM evaluation effectively represents a reasonable measure of wetland condition, especially in regards to floristic quality. In addition, we have shown that the modifications to MiRAM have not significantly changed the overall assumptions and function that have been tested and verified in ORAM.

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Barnes, B.V. and W.H. Wagner Jr. 1981. Michigan Trees: A Guide to the Trees of Michigan and the Great Lakes Region, University of Michigan Press, Ann Arbor.

Herman, K.D., L.A. Masters, M.R. Penskar, A.A. Reznicek, G.S. Wilhelm, W.W. Brodovich, and K.P. Gardiner. 2001. Floristic Quality Assessment with Wetland Categories and Examples of Computer Applications for the State of Michigan – Revised, 2nd Edition. Michigan Department of Natural Resources, Wildlife, Natural Heritage Program. Lansing, MI. 19 pp. + Appendices.

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Report Prepared by:

Todd Losee
Wetland Specialist
Land and Water Management Division
Michigan Department of Environmental Quality

Susan Jones
Wetland Specialist, Contract
Land and Water Management Division
Michigan Department of Environmental Quality

FLORISTIC QUALITY ASSESSMENT
WITH
WETLAND CATEGORIES
AND
EXAMPLES OF COMPUTER APPLICATIONS
FOR THE
STATE OF MICHIGAN

REVISED, 2ND EDITION – OCTOBER 2001

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Kim D. Herman
Wildlife Division
Michigan Department of Natural Resources
6833 Hwys US-2, 41 & M-35
Gladstone, Michigan 49837

Linda A. Masters
Conservation Research Institute
375 W. First St.
Elmhurst, Illinois 60126

Michael R. Penskar
Michigan Natural Features Inventory
P.O. Box 30444
Lansing, Michigan 48909-7944

Anton A. Reznicek
University of Michigan Herbarium
North University Building
Ann Arbor, Michigan 48109-1057

Gerould S. Wilhelm
Conservation Research Institute
375 W. First St.
Elmhurst, Illinois 60126

William W. Brodovich
King & MacGregor Environmental, Inc.
5860 N. Canton Center Road, Suite 387
Canton, Michigan 48187

Kevin P. Gardiner
Natural Heritage Program, Wildlife Division
Michigan Department of Natural Resources
P.O. Box 30444
Lansing, Michigan 48909-7944

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

For information or assistance on this publication, contact the MICHIGAN DEPARTMENT OF NATURAL RESOURCES, NATURAL HERITAGE PROGRAM, WILDLIFE, P.O. BOX 30180, LANSING, MI 48909.

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Since its publication in 1996, the DNR Natural Heritage Program has distributed over 1,000 copies of the first edition. We, the authors, would like to express our appreciation to all that have applied the Floristic Quality Assessment system to sites in Michigan. We especially recognize several that have found the Floristic Quality Assessment particularly useful and/or have assisted by providing us valuable feedback. These individuals include John Allan, David Borneman, Chris Clampitt, Peter Collins, F. Glenn Goff, Patrick Judd, Stu Kogge, Will MacKinnon, Pat Ruta, Lyn Samson, Ellen Weatherbee, and Richard Wolinski. We appreciate the continued support and resources of the Michigan Department of Natural Resources Natural Heritage Program, Nongame Wildlife Fund, Michigan Natural Features Inventory, USDA-NRCS Rose Lake Plant Materials Center and Conservation Design Forum, Inc. We also acknowledge our new sponsor, the U. S. Environmental Protection Agency, Great Lakes National Program Office. We thank the Tip-of-the-Mitt Watershed Council and the Natural Areas Association each for publishing an article on the Floristic Quality Assessment. The Natural Areas Journal provided the opportunity for us to share our ideas with the international scientific community.

Copies of this publication are available from the Michigan Department of Natural Resources, Wildlife Division, Natural Heritage Program, P. O. Box 30444, Lansing, MI 48909-7944. Questions regarding this publication should be directed to Ms. Kim Herman at the above address.

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I. FLORISTIC QUALITY ASSESSMENT

INTRODUCTION

Large areas of Michigan have been modified extensively from their presettlement condition (Chapman 1984, Crispin and Rankin 1994, Comer and Albert 1993, Comer et al. 1993b, 1994). Primary effects on the landscape have been due to extensive logging and farming. More recently, residential, urban, industrial, and recreational development have markedly altered the Michigan landscape. Hydrology, fire, and other important abiotic processes have been disrupted or altered. According to the Michigan Department of Natural Resources (1988), over 70 percent of Michigan's original wetlands have been drained or filled, while many remaining wetlands are no longer representative of original landscape types (Comer et al. 1993b).

As a consequence, much of Michigan's native biota is now restricted to relatively small and often isolated tracts of landscape across the state. With intensive pressure on Michigan's remaining natural lands, particularly in southern Lower Michigan, there is a need for a consistent and practical method for identifying and recognizing the potential significance of remnant areas for the long-term survival of Michigan's native biodiversity. Presented here is a simple, consistent, and repeatable method for evaluating the relative significance of tracts of land in terms of their native floristic composition.

Floristic Quality Assessment (FQA) is a tool to assist environmental consultants, scientists, natural resource managers, land stewards, environmental decision-makers, and restorationists in assessing the floristic, and implicitly, natural significance of any given area throughout Michigan. Floristic Quality Assessment will not replace criteria or methodology already employed by various resource agencies. This assessment system is not intended for use as a stand-alone method, but it can be applied to complement and corroborate other methods of evaluating the natural quality of a site.

Applications of this system include the identification of remnant habitats of native floristic significance, comparisons between different sites, long-term monitoring of floristic quality, monitoring the progress of habitat restoration, and the use of National Wetland Categories to assist in the identification of wetlands. FQA can also be used to help make permitting decisions and to develop performance standards and mitigation criteria (Wilhelm 1991, 1992, and 1993, Andreas and Lichvar 1995, Herman 1994).

METHODOLOGY

The Floristic Quality Assessment system for Michigan is modeled after that developed for the Chicago Region described in Swink and Wilhelm (1994). To develop the FQA for Michigan it was essential to compile a thorough list of the vascular plants known to occur in the state (Penskar et al. 2001, Appendix C). The Michigan Plant Database in Appendix C comprises 1,815 native taxa and 914 non-native (adventive) taxa, for a total of 2,729 taxa (Figure 1). This list is not to be regarded as a definitive flora, but as a utility database, only to be used as a reference for applications of the FQA for Michigan. The revisions to the database include: the addition of 11 native and 38 non-native taxa, changes in nomenclature (i.e., synonyms such as *Scirpus* to *Schoenoplectus*), the addition of life history (annual, biennial, perennial) to the physiognomic categories, and an update of the status category (endangered, threatened, special concern or extirpated) to match the March 1999 Michigan Special Plants List.

Life history categories largely follow Wilhelm and Masters (1995) and Taft et al (1997). Gray's manual of botany (Fernald, 1950) and the online USDA Plant Database (see Section IV – Resources) were also consulted. Nomenclature largely follows Michigan Flora (Voss 1996, 1985, 1972). Other references consulted include Case (1987) for all Michigan orchids, Case and Case (1997) for trillium, Gleason and Cronquist (1991) for selected genera, and Barnes and Wagner (1981) for several woody plant taxa. For pteridophytes (ferns and fern allies), we followed the treatments provided in the Flora of North America, Volume 2 (Morin et al. 1993).

Coefficients of Conservatism

The concept of species conservatism is the foundation for floristic quality assessment. Each native Michigan species was assigned a **coefficient of conservatism** (*C*)[1] following the methodology and philosophy detailed in Swink and Wilhelm (1994) and Wilhelm and Masters (1995). Coefficients of conservatism range from 0 - 10 and represent an estimated probability that a plant is likely to occur in a landscape relatively unaltered from what is believed to be pre-European settlement condition (Figure 1). A *C* of 0, therefore, is given to plants such as *Acer negundo* (box elder) that have demonstrated little fidelity to any remnant natural community, *i.e.* may be found almost anywhere, while a *C* of 10 is applied to those plants like *Potentilla fruticosa* (shrubby cinquefoil) that are almost always restricted to a presettlement remnant, *i.e.* a high quality natural area. Intermediate values are assigned to taxa such as *Quercus bicolor* (swamp white oak) or *Trillium grandiflorum* (large white trillium), when it is certain it is faithful to remnant natural communities, but it is uncertain that the condition of the community from which it comes is still representative of presettlement condition, *i.e.* the community may be degraded.

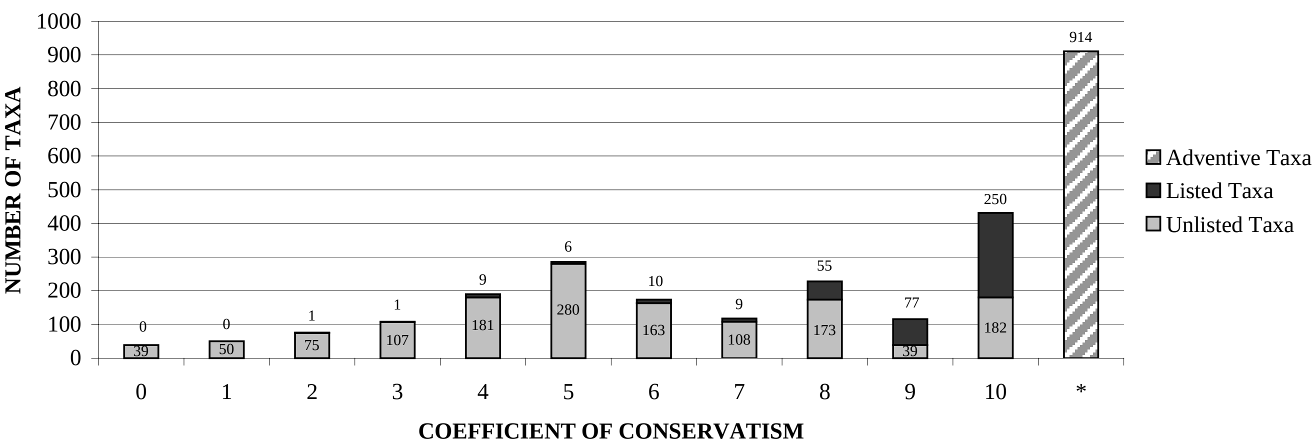

Figure 1: Number of adventive[2] plants and the distribution of coefficients of conservatism for native Michigan plant taxa, including the proportion of listed[3] plant taxa for each coefficient of conservatism.

In Michigan, certain species are known to exhibit varying degrees of conservatism over their statewide range, and thus the *C* assigned reflects what would be expected most commonly

[1] Coefficients of conservatism were assigned by Anton Reznicek, Michael Penskar, and William Brodovich with assistance from Gerould Wilhelm.
[2] Adventive taxa are plants spreading into Michigan from a source outside of Michigan since pre European settlement.
[3] Listed taxa refer to plant taxa listed as endangered, threatened , extirpated, or special concern by the State of Michigan.

throughout the state.[4] For example, *Thuja occidentalis* (northern white cedar) in southern Michigan is highly restricted to relatively few habitats and would justify a *C* of 8 or 9. Northward, however, this species inhabits a much broader range of natural communities and disturbed sites and would justify a *C* of 1 or 2; in this case, the assigned *C* is 4. While a number of species are widely distributed within the state, a small percentage exhibits a bimodal range of conservatism. Such species however, will have little influence on the measured floristic quality of any given site. Note the normal distribution of the coefficients of conservatism from 0 - 9 (Figure 1). By including those taxa with *C* = 10 with the distribution of coefficients of conservatism, the overall distribution becomes left skewed (Figure 1), similar to that for Illinois (Taft 1997).

The fidelity or faithfulness concept is not new. Phytosociologists have long used this as a practical application of empirical observation (Braun-Blanquet 1932). It is theoretically possible to measure empirically the fidelity of each of the approximately 1815 native plant taxa in Michigan (Figure 1) to given natural communities. We recognized it is not possible to take such measurements in the near future and that coefficients of conservatism have been effectively applied to different geographic regions without such measurements (Coastal Plain – Allain, pers. comm.; Northeast Ohio - Andreas and Lichvar 1995; Ohio – Andreas et al. in prep.; Wisconsin – Bernthal, pers. comm.; Iowa – Drobney pers. comm.; Missouri - Ladd 1997; Southern Ontario – Oldham et al. 1995; Chicago Region - Swink and Wilhelm 1979, 1994; Kentucky – Shea et al. in prep.; Illinois - Taft et al. 1997; Northern Great Plains – Northern Great Plains Working Group 2001). Therefore, we placed the "subjectivity up front" in assigning *a priori* a coefficient of conservatism to each native species in Michigan. As stated in Swink and Wilhelm (1994) *we cannot know the presettlement vegetational composition or structure for any given site, nor can we know how it would have changed over time* in the absence of European settlement. Therefore, we have employed as benchmarks our collective knowledge and understanding of species fidelity to the remaining high quality natural communities and otherwise disturbed lands in Michigan.

Floristic Quality Index

Floristic Quality Assessment is applied by calculating a **mean coefficient of conservatism** ($\overline{C}$) and a **floristic quality index** (*FQI*) from a comprehensive list of plant species obtained from a particular site. This is done by summing the coefficients of conservatism (*C*) of an inventory of plants and dividing by the total number of plant taxa (*n*), yielding an average or the mean coefficient of conservatism ($\overline{C} = \sum C/n$). The $\overline{C}$ is then multiplied by the square root of the total number of plants ($\sqrt{n}$) to yield the floristic quality index ($FQI = \overline{C}\sqrt{n}$). The square root of *n* is used as a multiplier to transform the mean coefficient of conservatism and allow for better comparison of the *FQI* between large sites with a high number of species and small sites with fewer species. Sites with the same $\overline{C}$ may have different *FQIs*, and sites with the same *FQI* may have different $\overline{C}s$ (Figures 2 and 3) (Goforth et al. 2001, Taft et al. 1997). For further discussion of this variation, refer to Taft et al. (1997) and Wilhelm and Masters (1995) in Appendix F. Some have found the $\overline{C}$ may be a more predictable indicator of floristic quality when comparing among similar natural communities such as remnant hardwood forests in Ontario (Frances et al. 2000) and river floodplains in Michigan, although this may be due to small sample sizes and narrow dispersion of $\overline{C}$ values (Goforth et al. 2001).

[4] The Michigan FQA differs from the Chicago Region application in that coefficients of conservatism were developed for a considerably larger geographic area and over a greater north to south gradient.

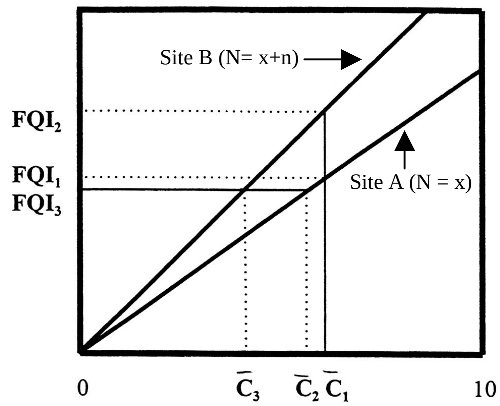

Figure 2: Baseline model comparing the Floristic Quality Index (FQI) and Mean Coefficients of Conservatism ($\overline{C}$) from two sites with differing total species richness (N). The example illustrates where two sites with different total species richness but similar mean coefficient of conservatism ($\overline{C}_1$) will differ in floristic quality indices (FQI_1 and FQI_2) and where two sites with similar floristic quality indices (FQI_3) will differ in mean coefficients of conservatism ($\overline{C}$) (Taft et al. 1997).

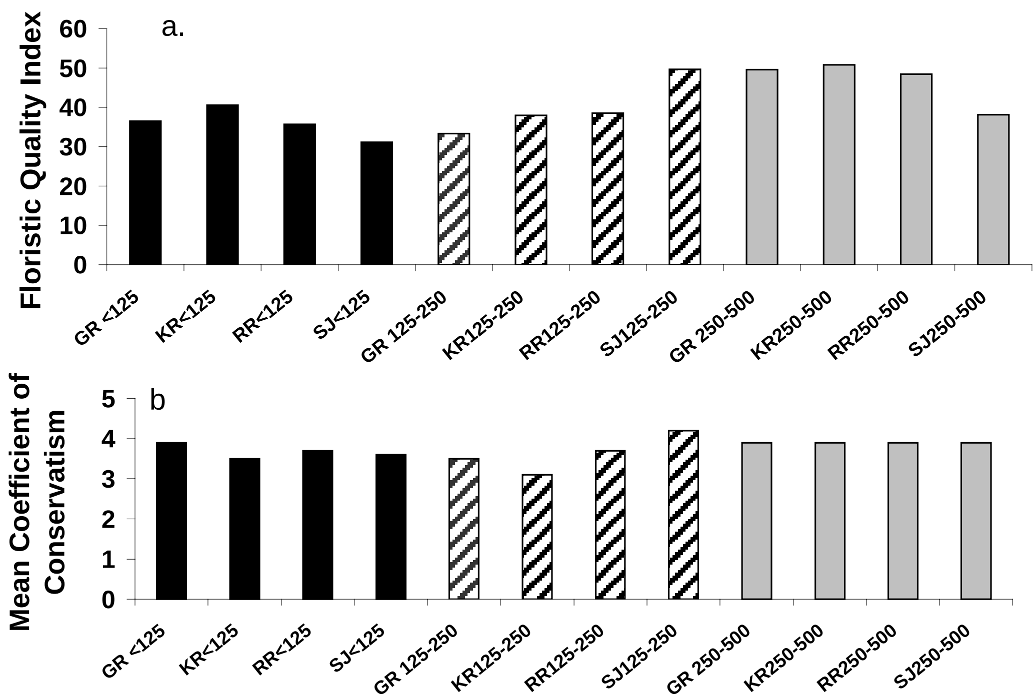

Figure 3: Floristic data from 12 riparian sites (GR = Grand River, KR = Kalamazoo River, RR = River Raisin , SJ = St. Joseph River) in southern Michigan grouped by buffer width (<125m black, 125-250m striped, 250-500m gray) showing equal mean coefficients of conservatism (b) and different floristic quality indices (a) in the 250-500 buffer width. The Kalamazoo River and Raisin River 125 – 250m buffer sites show similar floristic quality indices (a) with different mean coefficients of conservatism (b) (Goforth et al. 2001).

Based upon recent tests of the FQA system in Michigan in a wide variety of habitats, certain patterns have emerged. The range of coefficients of conservatism (*C*) of the plant taxa found in most of our undeveloped lands is 0 - 2, whereas 85% of the total native flora has a *C* of 4 or greater (Figure 1). The entire native flora has a $\overline{C}$ of 6.5. This indicates the principal elements of our native systems are poorly represented in the landscape today. Most of the remaining undeveloped land registers floristic quality indices (*FQI*) of less than 20 and has minimal significance from a natural quality perspective. Areas with a *FQI* higher than 35 possess sufficient conservatism and richness that they are floristically important from a statewide perspective. Areas registering in the 50s and higher are extremely rare and represent a significant component of Michigan's native biodiversity and natural landscapes.

Coefficients of Wetness

Analogs to the coefficients of conservatism are derived from the five main National Wetland Indicator Categories given by Reed (1988) and are referred to as **coefficients of wetness** (*W*) (Wilhelm 1992 - Appendix G). Michigan taxa not treated by Reed (1399 taxa) were assigned wetland indicator categories *de novo*.[5] The National Wetland Indicator Categories define the estimated probability for which a species occurs in wetlands (Table 1) (Reed 1988, Wilhelm 1989, 1992). Positive signs (+) indicating a wet tendency and negative signs (-) indicating a dry tendency are attached to the three "facultative" categories to express these exaggerated tendencies for those species (Reed 1988). Coefficients of wetness (*W*) have been assigned by Wilhelm (1989, 1992) to the eleven wetland indicator categories:

OBL = -5, FACW+ = -4, FACW = -3, FACW- = -2, FAC+ = -1, FAC = 0, FAC- = 1,
FACU+ = 2, FACU = 3, FACU- = 4, UPL = 5.

Table 1: Wetland category definitions and coefficients of wetness (*W*).

Wetland Category	Symbol	*W*	Definition
Upland	UPL	5	Occurs almost never in wetlands under natural conditions (estimated < 1% probability).
Facultative Upland	FACU	3	Occasionally occurs in wetlands, but usually occur in non-wetlands (estimated 1% - 33% probability).
Facultative	FAC	0	Equally likely to occur in wetlands or non-wetlands (estimated 34% - 66% probability).
Facultative Wetland	FACW	-3	Usually occurs in wetlands, but occasionally found in non-wetlands (estimated 67% - 99% probability).
Obligate Wetland	OBL	-5	Occurs almost always in wetlands under natural conditions (estimated > 99% probability).

[5] Wetland categories for taxa not treated by Reed (1988) were taken from Swink and Wilhelm (1994). Taxa not treated by Swink and Wilhelm were assigned by Anton Reznicek and Michael Penskar.

Wetness Index

Coefficients of wetness (*W*) of taxa recorded from a site inventory (*n*) can be averaged and the mean regarded as a **wetness index** ($\overline{W} = \sum W/n$). If the wetness index ($\overline{W}$) is zero or below, then the site has a predominance of wetland species (Wilhelm 1989). The $\overline{W}$ does not consider dominance as measured by percent cover of any species. Wilhelm (1989, 1991, 1992, 1993) hypothesizes that a wetness index calculated using only native species is a stronger indication of wetland status than a wetness index that includes adventive species. This is demonstrated by comparing the distribution of wetland status between native and adventive taxa. The 1815 native Michigan taxa show sensitivity to soil moisture ranging from wet to dry conditions as indicated by their inverse normal distribution (Figure 4). The 914 adventive plant taxa show a skewed distribution, with substantially more taxa in the upland categories (617) relative to all wetland categories combined (297) (Figure 5). Consult the Computer Program Application Section that follows and Appendix G for a more detailed explanation of this hypothesis and the application of the wetness index.

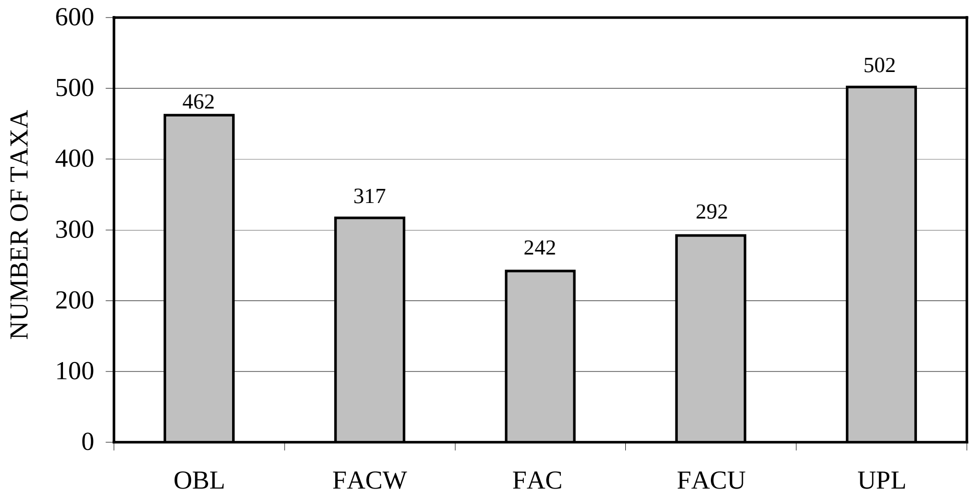

Figure 4: The distribution of wetland categories for the native plant taxa of Michigan**.**

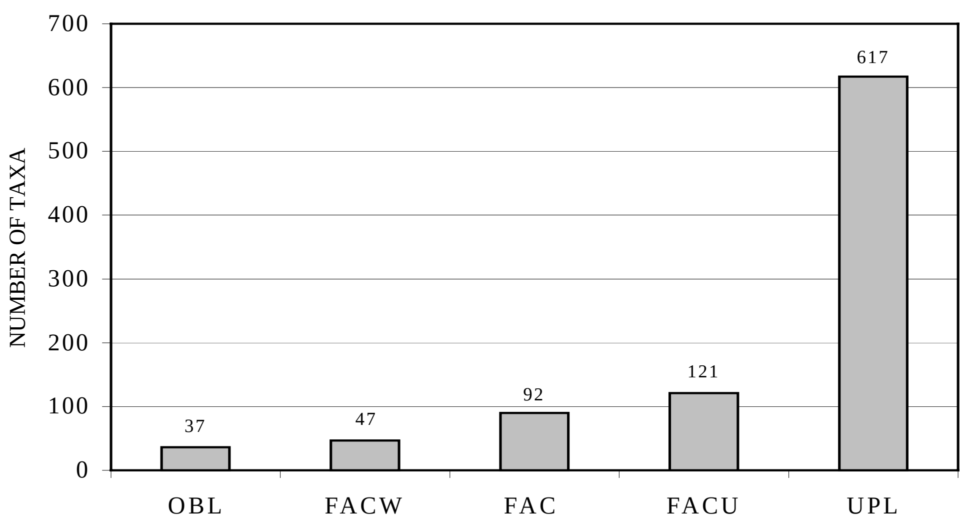

Figure 5: The distribution of wetland categories for adventive plant taxa in Michigan.

Physiognomy

The computer applications for FQA and the associated plant data bases traditionally include the physiognomic classes, since it is possible for community structure to change overtime without correlative changes in the *FQI* or $\overline{C}$ (Taft et al. 1997). The distribution of plant taxa by physiognomic classes show most plants in Michigan are native, perennial, dicot forbs (811), followed by adventive, perennial, dicot forbs (323) and adventive, annual, dicot forbs (291) (Figure 6). Native sedges and grasses comprise 23% of Michigan's native taxa and predominate in numbers over the adventive sedges and grasses (Figure 6). Life history categories are useful for protecting annual and biennial plants from over collection and potential local extirpation.

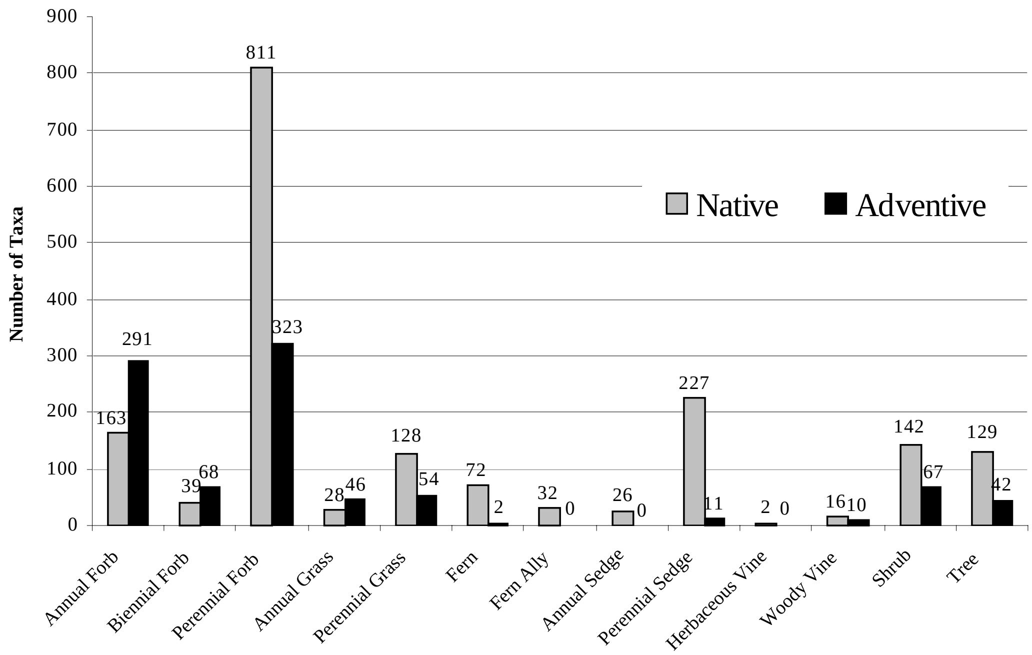

Figure 6: Distribution of native and adventive taxa of Michigan by physiognomic class

APPLICATION

Usefulness in deriving information from selected indicator species has long been valued by plant ecologists for community classification along environmental gradients (Magurran 1988, Whittaker 1975). Floristic Quality Assessment goes further in recognizing that all plant species at a location convey information about a site due to their adaptation to a unique set of biotic and abiotic conditions. As applied by the FQA system, plant taxa, when assessed in the aggregate, can give more information than an individual indicator taxon or even a group of indicators, often used for classification purposes.

Plant lists are often compiled during environmental site assessments and provided as appendices in environmental documents with little or no analysis beyond determining their wetland affinities or their legal status under federal and state endangered species acts. Often the ecological importance of species richness is not emphasized or recognized. Thus, FQA helps to give meaning to a group of plant species, beyond their presence on a list, by providing the mean coefficient of conservatism ($\overline{C}$) and the floristic quality index (*FQI*), which anyone can utilize and interpret.

The application of FQA is dependent on the aggregate presence of species in any area. With consistent application of the FQA system, the information derived from the $\overline{C}$ of the entire constellation of species within a site gives the system its robustness. Therefore, it is important the site surveyor be diligent and consistent in writing down ALL plant taxa observed at a site and to sufficiently cover the site's territory during standardly accepted times of the growing season. Essential to the successful use and application of the FQA system is the participation of botanists with a good knowledge of the Michigan flora and experience in conducting field inventories.

There are several applications of FQA. The following four are discussed in Swink and Wilhelm (1994) and by Wilhelm and Masters (1995 - Appendix F): (1) the identification of remnant native habitats of floristic significance, (2) the comparison of floristic quality among different sites, (3) long-term monitoring of floristic quality in natural areas, and (4) monitoring of habitat restoration. Use of the wetland categories as an aid in the identification of wetlands is discussed below and in Appendix G.

Floristic Quality Assessment can also be used to assist in making permitting decisions and developing performance standards and mitigation criteria (Andreas and Lichvar 1995, DuPage County Stormwater Management Committee 1992, Herman 1994, Swink and Wilhelm 1994, Wilhelm 1991, 1992, 1993, Wilhelm and Masters 1995 - Appendix F). The floristic quality index derived from an inventory provides information regarding a site's natural quality potential, which can also be used in certain sampling protocols. The *FQI* of individual quadrats established along a transect may be used to establish baseline data serving as a benchmark for future monitoring of changes in floristic quality during site restoration or site rehabilitation efforts. If one is comparing floristic quality data among similar communities, i.e. fen to fen, or bog to bog, data must be obtained using a standard ecological sampling design for comparison between sites. Details of survey methods and effort should accompany any reporting of inventory or sampling results derived from applying the FQA because indiscriminate comparisons of floristic quality with dissimilar methods used in evaluation can be misleading (Taft et al. 1997).

In addition, as discussed in the following by Taft et al. 1997, the assessment of ecosystem integrity based on a single index will be insufficient to account for all relevant aspects. For example, the *FQI* or $\overline{C}$ when reported alone can be misleading (Figure 2). Species richness (number of species) by itself can also be an insensitive indicator of habitat quality since it is possible for a degraded site to support a similar or greater number of taxa than an intact, high quality site. Six measures of biological integrity for wetlands have been suggested by Keddy et al. 1993. These include species diversity, indicator guilds, exotic species, rare species, plant biomass and amphibian biomass. Keddy et al. (1993) views diversity as an essential indicator of integrity, but also recommends assessing guild diversity. FQA readily addresses the first four recommended measures, provides a wetness index and can be applied to wetland and upland vegetation. Moreover, it can be expanded to include other community traits or other particular interests (Taft et al. 1997) (see summary tables in Appendices A and B). The transect computer application as shown in Appendix B also allows for the calculation of relative frequency, relative dominance, and importance values.

Two examples from Michigan, not detailed in Appendices B and F, are presented here. The first example discusses uses of the FQA in helping to make resource-permitting decisions and to establish performance standards and mitigation criteria. The second example discusses the use of the wetness index ($\overline{W}$) in the identification of problematic wetlands and their boundaries.

Permitting, Performance Standards, and Mitigation Criteria

Michigan has a variety of resource protection laws where the application of FQA can be useful. These include Parts 365 (Endangered Species Protection), 303 (Wetland Protection), 301 (Inland Lakes and Streams) and 353 (Sand Dunes Protection and Management) of Public Act 451 of 1994 (as amended). The following is an example excerpted from Herman (1994) where the FQA system was used as a performance standard and for establishing mitigation criteria in an endangered species permit for the Detroit Metropolitan Wayne County Airport expansion.

In 1989, expansion of the Detroit Metro Airport was expected to result in the on-site loss of three plant species listed as threatened under the M-ESA. The three species were *Aristida longispica* (slender three-awned grass), *Juncus brachycarpus* (short fruited rush), and *Ludwigia alternifolia* (seed box). The three species were found within remnant lakeplain wet-mesic prairies and mesic sand prairies. The statutory requirements of Part 365 (Endangered Species Protection) of P.A. 451 of 1994 were enhanced by making compliance with this act a condition of the state wetland permit. The provisions of the endangered species permit allowed the translocation of affected plants and seed bank to an off-site location, which had been excavated and graded to match the land contours and hydrology of the airport site. Unaffected areas on the airport were required to be protected and monitored as a baseline to compare the success of the translocated plants. Hydrology, soil moisture, and vegetation are being monitored for ten years.

The criteria for success, required by the permit, states that at the off-site mitigation location, populations of threatened plants must be at least as large and viable as populations eliminated by the airport expansion. In addition, the mitigation area is required to be free of aggressive weeds such as *Lythrum salicaria* (purple loosestrife), the species **diversity index** should be stable or show an increase in native species diversity throughout the monitoring period, and it should show a stable or increasing floristic quality index and mean coefficient of conservatism. As a contingency measure, the permit requires that if the mitigation fails, then a similar but larger and intact lakeplain prairie in Wayne or Monroe counties must be purchased and managed.

DuPage County, Illinois in implementing its stormwater and flood plain ordinance uses a $\overline{C}$ = 3.5 as a criteria for identifying “critical” wetlands and requires mitigation for the loss of these wetlands in the form of 3:1 acre wetland replacement (DuPage County Stormwater Management Committee, 1992). Administrative rules to the Illinois Wetland Policy Act of 1989 (20 ILCS 830, 17 Ill. Adm. Code 1090) also requires a 5.5:1 replacement ratio for mitigating loss of wetlands with a native floristic quality greater than 20 ($FQI \geq 20$) or a mean coefficient of conservatism greater than or equal to 4 ($\overline{C} \geq 4.0$). Wilhelm (1991, 1992, 1993) suggests, based on monitoring data obtained from Chicago region restoration sites, that areas with known high floristic quality ($FQI \geq 35$) cannot be routinely restored to their original floristic quality and therefore are unmitigable. Conversely, lower quality wetlands registering *FQI* in the teens and twenties may be mitigable.

Identification of Problematic Wetlands

Some Michigan natural communities that may be classified as wetlands are considered problematic because they can be difficult to distinguish from adjacent uplands (MacKinnon 1994). These natural communities are exemplified by some wooded dune and swale complexes, wet and wet-mesic prairies, including lakeplain prairies, coastal plain marshes, and alvars (MNFI 1990). These problematic communities, with the exception of alvars, all overlay coarse, well drained soils and often support a mix of wetland and upland species, especially at the upland-wetland boundaries (MacKinnon 1994). These communities often are not recognized as wetlands because of the upland vegetation component, sandy soils, and either small size or non-contiguousness to an inland lake or stream. Thus they are vulnerable to development largely because it is mistakenly assumed that wetland permits are not needed (MacKinnon 1994)[6].

Comer and Albert (1993) compared elevations along transects with the wetland indices ($\overline{W}$) for species from corresponding ridges and swales in Michigan to help clarify the relationship between landforms and vegetation within wooded dune and swale complexes in Michigan and to help determine their wetland status under the Goemare-Anderson Wetlands Act. At Sturgeon Bay (Emmet County), high wind-sorted dune ridges support upland vegetation clearly distinguishable from adjacent swales (Figures 4 and 5). Forested beach ridges, with soils of medium to course sand, show wetness indices from 0 - 3 indicating a proportionally higher number of plants in upland categories. Soil moisture conditions can change dramatically, with slight elevational changes reflected in the development of soil organic material and plant species. On lower ridges, moisture may be noticeably higher and soil organic material accumulation is greater (4-25 cm) with $\overline{W}$ below 0 indicating a higher proportion of plants in wetland categories.

MacKinnon (1994) points out that most swales in wooded dune and swale complexes are protected by the Michigan wetlands act because they are contiguous to the Great Lakes or a nearby surface water. However, it is often less clear for wetlands found in the glacial lakeplain counties of Michigan where topographic relief is measured in only a few feet. The FQA methodology combined with the use of wetness indices may become extremely useful in helping not only to determine a wetland boundary based on the presence of native wetland plants, but also to help practitioners recognize a wetland and its floristic significance in the first place. It is precisely the remnant lakeplain prairies on the glacial lakeplain that are rarest and most at risk of being unknowingly destroyed (MacKinnon 1994; Comer et al. 1995).

[6] Michigan's wetlands are regulated under "Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, Act 451 of the Public Acts of 1994, being sections 324.30301 to 324.30323 of the Michigan Compiled Laws Annotated. Permits are required for filling in, dredging from, constructing or developing in, or draining surface waters from wetlands. Wetlands less than five acres in size, that are not contiguous to surface waters, and all non-contiguous wetlands in counties with populations of under 100,000 are not subject to permit review (MacKinnon 1994).

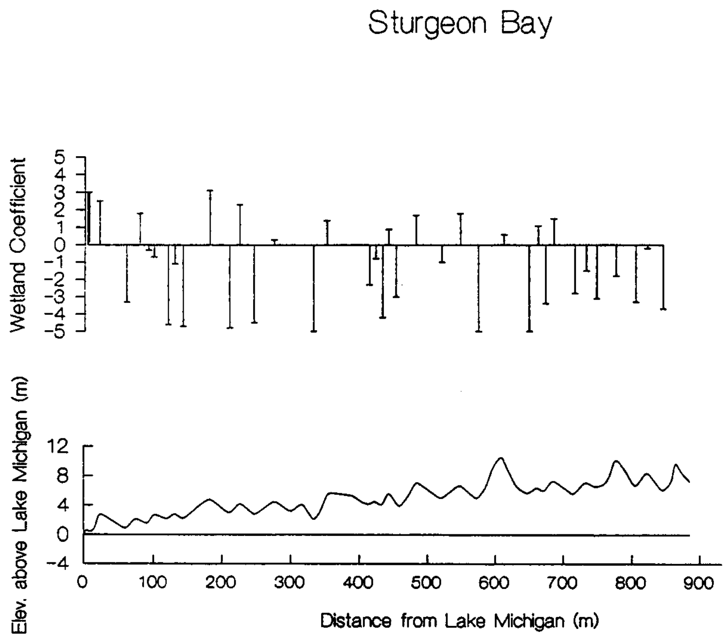

Figure 7: Elevational transect and corresponding wetness indices ($\overline{W}$) for the Sturgeon Bay wooded dune and swale complex Emmet County, MI (Comer and Albert 1993).

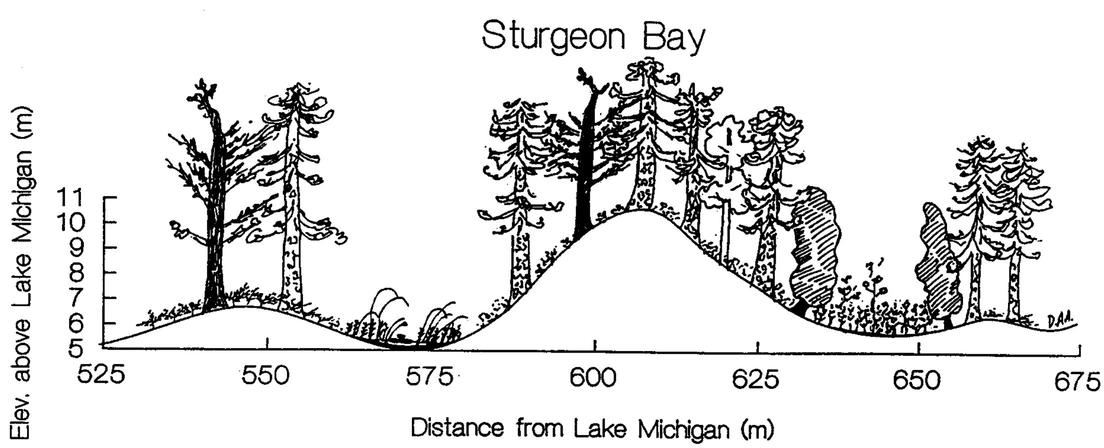

Figure 8: Illustration of the vegetation associated with a 150 meter portion of the transect at Sturgeon Bay, Emmet County, MI (Comer and Albert 1993).

DISCUSSION

The coefficient of conservatism is applied to a plant based upon its fidelity to a presettlement landscape, not its rarity or legal status. Although many plant species listed as endangered, threatened, or special concern by the State of Michigan are highly conservative, *C* = 8, 9, or 10, many are not, *C* = 4 - 7 (Figure 1). Many conservative, listed species are faithful to rare, high quality natural communities in Michigan. Such communities include prairies, where species rarity is largely attributable to habitat loss, and southern Michigan fens and bogs that have always been relatively rare. Losses of rare, high quality communities can have a serious impact on native biodiversity. Conversely, a number of rare species do not have a high fidelity to specific communities, or the communities to which they are faithful are relatively frequent. For example, the state threatened *Beckmannia syzigachne* (slough grass), *C* = 4, generally grows in wet places (Voss 1972), while respectively, the state threatened *Panax quinquefolius* (American ginseng), *C* = 10, grows in rich, mesic woods. Finally, many highly conservative species, such as *Potentilla fruticosa* (shrubby cinquefoil), with a *C* of 10 are not rare at all throughout Michigan.

All too frequently, areas where legally protected species are absent are considered expendable under current formal environmental evaluations. It is precisely because Floristic Quality Assessment is not based on species rarity or legal status that makes it a useful tool for assessing the natural quality of an area. Instead, FQA validates each plant taxa and goes beyond the simple measurement of species richness and abundance as defined and reviewed by Magurran (1988). FQA measures the extent and proportion to which constellations of conservative plants are present on a site (Swink and Wilhelm 1994, Wilhelm and Masters 1995 - Appendix F). Areas with a greater proportion of conservative species will have a greater $\overline{C}$ and higher *FQI*, alerting us to its or any community's floristic quality, potentially restorable floristic quality, and implicitly natural quality.

The decision to develop and provide a FQA system for Michigan was made because we recognized that its application could be useful in filling gaps in current natural quality assessment methods. The assignment of coefficients of conservatism for Michigan's native plants may be regarded as subjective, but it is based on the best estimates of botanists familiar with the flora and natural communities of Michigan. The methodology, however, is not subjective; it is standardized and repeatable, and requires only a skilled botanist to make an accurate and complete record of the plant species growing in a particular site.

Twenty three percent (418 species) of Michigan's native flora are extirpated, endangered, threatened, or listed as special concern by the State of Michigan. (Figure 1). Significant numbers of natural communities with conservative plants and associated animals are being lost piecemeal at an unprecedented rate throughout Michigan. We hope that the application of FQA on a statewide basis will help diminish somewhat the current rate of habitat loss due to ignorance of habitat or floristic quality. At a minimum, the use of the Floristic Quality Assessment system can provide decision makers with a standard, repeatable test for assessing the potential floristic and natural quality of a site, to be used in conjunction with other pertinent data and assessment tools prior to making important land-use decisions.

II. APPLICATION COMPUTER PROGRAMS

Those familiar with the first edition of the Floristic Quality Assessment will notice this edition is not accompanied by the original software application. In summer 2000, a new Windows-based program including both inventory and transect assessments was developed by Conservation Design Forum. This “stand-alone” software includes an up to date Michigan plant database. Copies of this program are available for purchase from The Conservation Research Institute, 375 W. First St., Elmhurst, IL 60126, or by telephone at (630) 559-2018.

The new program facilitates the application of the Floristic Quality Assessment system for the State of Michigan. The database consists of each species’[7] acronym, scientific name, common name, nativity, coefficient of conservatism (*C*) (0 = weedy, 10 = conservative, * = adventive), physiognomy, and National Wetland Category (Reed 1988) with its corresponding coefficient of wetness (*W*) (-5 = OBL, 0 = FAC, 5 = UPL). Adventive species are shown in ALL CAPS. See Appendix C for a listing of the database. There are two computer programs that use this database. The first evaluates a site inventory, and the second evaluates a sampling or monitoring transect. See Appendices A and B for examples of the Inventory and Transect Programs, respectively.

Both the Inventory and Transect programs access each species’ record in the database through six letter acronyms. These acronyms are derived from the plant species’ scientific name. **Using the acronym, eliminates the need to enter the full scientific name.**

Species -- The acronym of a binomial (two names) consists of the first three letters of the genus and the first three of the specific epithet. For example, the acronym for *Andropogon gerardii* is ANDGER. **An exception to this rule is the genus *Carex*.** Their acronyms consist of CX, followed by the first four letters of the epithet, for example, *Carex aggregata* = CXAGGR. Most acronyms are intuitive, but in some cases, where duplication occurs, non-intuitive acronyms are used to avoid data extraction errors. For example, ACESAU is the acronym for *Acer saccharum* and ACESAI is the acronym for *Acer saccharinum.* See Appendix C for a list of acronyms for all Michigan plants; see Appendix D for a list of non-intuitive acronyms[8].

Subspecies and Variety -- In the case of plants with recognized subspecies and varieties, the acronym consists of the first three letters of the genus, the first two letters of the species, and the first letter of the variety or subspecies. For example, the acronym for *Maianthemum canadense* var. *interius* is MAICAI. MAICAC is the acronym for *Maianthemum canadense* var. *canadense* where the typical variety is implied in the name. MAICAN, the intuitive acronym, in this nomenclatural context would be ambiguous and does not extract any plant in the database. As in the case of binomials, most trinomial acronyms are intuitive, but in some cases non-intuitive acronyms are used to avoid data extraction error. See Appendix D for a list of non-intuitive acronyms.

[7] The database also includes varieties and subspecies.

[8] In the new floristic quality assessment software, choices are presented if a duplicate acronym is entered. However, we have retained acronym lists in Appendices C and D as a useful reference.

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IV. RESOURCES

Websites

The following is a list of useful web sites for those searching for information and photos of Michigan's Flora and related assessment systems.

Aquatic Plants Database
http://aquat1.ifas.ufl.edu/database.html

Biota of North America Home Page (Synonymized Checklist for North America Plants)
http://www.bonap.org/

Northern Prairie Biological Resources
http://www.npwrc.usgs.gov/resource/taxa_P.htm

Links to Plant Databases
http://botany.about.com/science/botany/msub8.htm?once=true&

Orchids of Wisconsin
http://www.wisc.edu/botany/Orchids/Orchids_of_Wisconsin.html

Stein's Virtual Herbarium (Photos of several Michigan species)
http://home.usit.net/~info7/plants.html

University of Michigan Herbarium
http://www.herb.lsa.umich.edu/

USDA Plants National Database
http://plants.usda.gov/

Vascular Plants of Wisconsin
http://wiscinfo.doit.wisc.edu/herbarium/

Contacts

The following is a list of contacts for Floristic Quality Assessments that have been or are being developed for other geographic regions.

Coastal Plain – Contact Larry Allain. Email: Larry_Allain@usgs.gov

Chicago Region – Contact Sara Utter, The Conservation Research Institute, 375 W. First St., Elmhurst, IL 60126. Email: SUtter@cdfinc.com

Illinois - in Eregenia, No. 15, November 1997 available for $10. Contact the Illinois Native Plant Society c/o George Johnson, 9917 Reese Road, Harvard, IL 60033. Email: geomarjo@mc.net

Iowa – Contact Pauline Drobney, US Fish and Wildlife Service. Email: Pauline_Drobney@fws.gov

Ohio – Contact Barbara Andreas, c/o Ohio Biological Survey, Museum of Biological Diversity, Ohio State University, Columbus, OH 43212-1192. Email: Barbara.Andreas@tri-c.cc-oh.us

Kentucky – Contact Margaret Shea; Bernheim, PO Box 130, Clermont, KY 40110.
Email: mshea@bernheim.org.

Michigan – Contact Kim Herman, Michigan Department of Natural Resources, 6833 Hwys US-2, 41 & M-35, Gladstone, MI 49837. Email: hermank@state.mi.us

Missouri – Contact Beth Churchwell, The Nature Conservancy, St. Louis Field Office,
2800 S. Brentwood Blvd., St. Louis, MO 63144. Email: bchurchwell@tnc.org

Northern Great Plains - Contact David Mushet, U.S.Geological Survey, Northern Prairie Wildlife Research Center, 8711 37th Street SE, Jamestown, ND 58401.

Ontario – Contact Michael Oldham, Natural Heritage Information Centre, Ministry of Natural Resources, 300 Water Street, 2nd Floor, North Tower, Peterborough, Ontario K9J 8M5,Canada.
Email: michael.oldham@mnr.gov.on.ca

Wisconsin - Contact Thomas Bernthal, Wetland Ecologist, Wisconsin Department of Natural Resources, P.O. Box 7924, Madison, WI 53707-7921. Email: berntt@dnr.state.wi.us

E. Site Inventory Datasheets

Site ID:____________________

Line 6B NRDA Study Site Inventory Data Sheet

Date:______________

Team Members: ___________________

____

____

Fill out one data sheet per study site.

All species observed within the study site will be recorded by conducting a walk-through for up to 1 hour maximum.

The walk-through will cease if no new species are observed after 10 minutes.

Absolute percent cover will be estimated by species for the entire study site (50/20 Rule and 10% dominance methods).

Record species using the 6-letter identifier if at all possible.

If positive field ID is not possible, plants will be photographed at close range, but no sample will be collected.

Species	*Percent Cover*	*Species*	*Percent Cover*

Notes (e.g., observations of oiling, herbivory, vegetation health, general site conditions, etc.):

F. 2010 RVA Survey Protocol

U.S. FISH & WILDLIFE SERVICE

PROTOCOLS FOR RAPID ASSESSMENT OF VEGETATIVE COMMUNITIES

ENBRIDGE OIL SPILL INCIDENT

Prepared by:
Thomas Adams
Brian Huebner
Daniel DeJoode
Jeffrey Benefiel
Stephanie Millsap

FINAL August 29, 2010

INTRODUCTION

On July 26, 2010, a 30-inch diameter pipeline ruptured discharging crude oil into a culvert that leads to Talmadge Creek (Calhoun County), a tributary to the Kalamazoo River which drains into Lake Michigan. The amount of oil discharged is estimated at 819,000 – 1,000,000 gallons. The Kalamazoo River is bordered by wetland, forest, residential properties, farm land and commercial properties for the approximate 30-mile stretch of affected river between Marshall and Morrow Lake

In order to remove oil from the environment, a number of cleanup recommendations have been provided to Enbridge. Extensive areas of vegetation that has been oiled will be removed. Although efforts are being taken to reduce long-term impacts and protect sensitive environmental areas, the physical disturbance of habitats caused by response activities (vegetation cutting and scraping of pooled oil areas) may result in natural resource damage (NRD) claims by the Trustees. Of particular concern is that these disturbances will result in the loss of ecologically allow for non-native invasive species to become more dominant.

On 23 August, 2010, a botanical team was assigned by the U.S. Fish and Wildlife Service to assess dominance of plant species within areas that will be impacted both by physical oiling as well as the resulting oil removal activities. All team members shall have significant experience with identifying wetland flora. In general, teams shall have both a Trustee representative and an Enbridge representative.

OBJECTIVES

The objectives of these protocols is to standardize observations for a rapid assessment of dominant plant species within oil impacted sites on the banks and flood plains of the Kalamazoo River in the vicinity of Marshall and Battle Creek, Michigan. In addition, teams will note the presence of federal or state threatened and endangered species, ecologically important species, and estimate abundance of non-native invasive species.

The purpose of this rapid assessment is to inventory species that may be affected by oil spill response activities. This data will help inform baseline plant community conditions present along the Kalamazoo River between Talmadge Creek and Lake Morrow. The information collected during this assessment may be used to evaluate the effects of cumulative habitat modifications within response areas as well as to guide future restoration activities.

METHODS

Site Selection

The overall assessment area is the Kalamazoo River between Talmadge Creek and Morrow Lake. However, we decided to begin the assessment downstream of boat launch C3.2 (MP 9.5), as areas further upstream already have had varying degrees of vegetation removed, making plant identification difficult. Areas will be assessed moving downstream, through all the remaining downstream portions of Section C, as well as portions of Sections D. When deemed feasible, field crews may also go into areas of Section C upstream of boat launch C3.2 to conduct vegetation surveys.

Sites will be accessed by boat and foot and verified by remote sensing, maps, and collective team experience with local plant communities. In addition to islands and shoreline habitats, areas with wetland complexes that go further back than 50' from the river will also be inventoried. Teams will not traverse through pools of oil.

Assessment

An assessment of vegetation quality within oil impacted sites is drawn from a modified version of the Michigan Rapid Assessment Method For Wetlands (MiRAM)[1]. The MiRAM is a tool to determine the "functional value" of a particular wetland and assigns a rating level to that wetland as compared to other wetlands. For this project the MiRAM was edited for flexibility for working within the parameters of stated objectives for this project.

Vegetation communities will be mapped as polygons based on visual estimates and aerial photographic interpretation of boundary limits. Each polygon represents one type of vegetation community and will vary in length. Polygons may contain inclusions of multiple vegetation types. A sketch will be drawn on field maps to depict the approximate extent and location of habitat heterogeneity. Description of vegetation type inclusions will be noted on the data forms. To facilitate rapid assessment, inclusions of less than approximately 1/10 acre in size will not be individually mapped unless the area is deemed of particular importance due to the presence of unique features (e.g. vernal pools, groundwater springs, etc)

At minimum, one representative photograph depicting each mapped polygon will be taken. Photograph identification numbers will correspond to each site visit. In the field, a temporary identification number (camera default number) will be used until the photograph is digitally renamed at the conclusion of the work day. Field crews are also using their GPS units to generate a track log. In addition, a picture is also being taken of the GPS unit at the beginning of the day in order to facilitate linking photographs with GPS coordinates.

Expected rate of assessment is approximately 2.5 miles per day for a total period of five days.

Information collected by field teams for each polygon will include the following:

A. Metadata

- Feature ID - MP Bank Team # (no spaces)
- MP - Mile post identifier
- Bank - descending bank left or right (L or R)
- Team identifier – 1, 2…

[1] Michigan Department of Natural Resources and Environment Land and Water Management Division. MiRAM Version 2.1 Rating Form. July 23, 2010. www.michigan.gov/wetlands

- # - sequential polygon number between mile posts (e.g. the second polygon assessed between MP 13 and 14)

Example: MP18.70L2#2

- Date
- GPS coordinates
- Temporary Photo ID (specify on the form that this is the camera default number).
- Team Member Names
- Comments

B. Qualitative Assessment

Dominant plant species by for each of the following strata:
Overstory
Shrub/Sapling
Herbaceous
A species is considered to be dominant in a stratum if it represents $\geq$10% relative abundance. Diameter at breast height (DBH) will also be recorded for dominant trees in the overstory stratum.

Notable non-dominant species for each of the above strata as well as an estimate of absolute abundance for non-native invasive species will also be recorded. Notable non-dominant species include federal or state threatened or endangered species as well as those that are typically found in high quality wetlands (e.g. with a coefficient of conservatism $\geq$6 as indicated in the Michigan Floristic quality assessment – Appendix C)[2].

In the comments section, the following information may be recorded if present. These are based on MiRAM parameters:

Hydrology

- Groundwater: Seeps or evidence, for example skunk cabbage (*Symplocarpus foetidus*) or other fen-adapted species
- Seasonal/Intermittent Surface: Seasonal inundation from a lake, pond, or stream.
- Perennial Surface Water
- Other

Alterations to Natural Hydrologic Regime

- Ditch(es) in or near the wetland

[2] Herman, K. D. et. al 2001. Floristic Quality Assessment with Wetland Categories and Examples of Computer Applications for the State of Michigan – Revised, 2nd Edition. Michigan Department of Natural Resources, Wildlife, Natural Heritage Program. Lansing, MI. 19 pp. + Appendices.

- Drain tile(s) in or near the wetland
- Dikes(s) in or near the wetland
- Weir(s) in or near the wetland
- Stormwater inputs (addition of water)
- Stream channelization
- Point source discharge(s) (non-stormwater)
- Filling/grading activities in or near the wetland
- Road beds(s)/RR grades(s) in or near the wetland
- Dredging activities in or near the wetland
- Other (specify)
- Comments

Substrate/Soil Disturbance

- Human-induced erosion or exposure
- Human-induced sedimentation or burial
- Filling
- Grading
- Dredging
- Plowing, disking
- Intensive grazing (hooves)
- Off-road vehicle use
- Construction vehicle use
- Other (specify)
- Comment

Habitat Alteration

- Barriers such as road bed(s)/RR grades
- Selective cutting
- Clear cutting
- Mowing or shrub removal
- Coarse woody debris (CWD) removal
- Intensive grazing
- Sedimentation
- Dredging
- Filling/grading
- Plowing/disking/farming
- Other (specify)
- Comment

Significant Physical Features (describe as necessary)

Data Management

Data is hand written on forms during field activities. Polygons are drawn onto maps during field activities.

Data collected for floodplain assessment will be managed each day following return of field crews to the Incident Command Center according to the plan below

Field crews ensure that all data sheets are completely filled out.

a. Ensure that there are no blank spots (write n/a if there was no data recorded)

b. Ensure that handwriting is legible (have other team member check)

c. Ensure that maps are dated and have at least one team member name on them.

Field crews scan data sheets from that day.

a. File name scheme: Date_teamleadername (e.g., "08282010_adams.pdf")

Field crews scan maps with drawn polygons from that day

a. File name scheme: _teamleadername_map (e.g., "08282010_adams_map.pdf

Field crews download photos and rename photo files.

a. File name scheme: FeatureI.D._Photo# (e.g., "18.75L0202_A

Field crews download data from GPS Units

One person from each field crew gives electronic data to Trustee Supervisor who then places it on Trustee computer

Trustee Supervisor backs up electronic data onto external hard-drive and places onto FTP site.

G. 2010 Rapid Vegetation Assessment Datasheet

Rapid Vegetation Assessment Datasheet

Feature ID (MP, bank, team, polygon #) Date:	Team completing this form: Enbridge: Trustee:
GPS coordinate(s)	Temporary photo ID(s):

Plant Species

Forest Overstory Stratum: Canopy Cover:

Dominant Species	**DBH Range**	**Dominant Species**	**DBH Range**

Notable non-dominant species (< 10% relative abundance) (provide invasive absolute abundance):

Shrub/Sapling Stratum Canopy Cover:

Dominant Species	**Dominant Species**

Notable non-dominant species (< 10% relative abundance) (provide invasive absolute abundance):

Herbaceous Stratum (% absolute abundance only calculated for invasives)
Ground Cover:

Dominant Species	**Abun**	**Dominant Species**	**Abun**

Notable non-dominant species (< 10% relative abundance) (provide invasive absolute abundance):

Comments (note additional observations as well as see attachment for suggestions based on MiRAM)