

***Timed Meander Sampling Method Overview***

The timed meander sampling method described here is designed to provide a qualitative assessment of plant community condition for restoration projects funded by LCCMR Environment and Natural Resources Trust Fund (ENRTF) appropriations using relatively quickly obtained plant cover information. The timed meander sampling technique is a plotless assessment method that can be modified to adapt to site size and plant community variation. For the timed meander, the observer will walk one or more meander routes through the restored plant community, or Assessment Area, and record all of the species, both native and introduced, encountered during the meander. Aerial cover will be assigned to all species as well as abiotic variables when appropriate. The data will be analyzed to determine a Composite Invasive Species Abundance score (CISA) and Potential Natural Vegetation (%PNV). Together, these metrics express the quality of the restored plant community.

***Plant Communities and Vegetation Zones***

Determine whether the restored plant community should be broadly categorized as Prairie, Forest (including Woodland and Savanna), or Wetland (including Shallow Lake).

Identify the distinct vegetation zones within the plant community. A zone is considered distinct if there is a readily observable shift in dominant species that correspond to an environmental gradient. Do not count patches of clonal species such as those formed by invasive species as distinct vegetation zones unless that shift corresponds to an environmental gradient.

For example, when assessing a wetland plant community, the vegetation zones may include wet meadow, marsh, and/or wet prairie, etc. Likewise vegetation zones within a prairie may include upland dry prairie, upland mesic prairie, and/or wet prairie. Add time to the base meander time (described below) for each additional vegetation zone encountered on a meander route. For example, if the wetland is primarily sedge meadow, but includes emergent marsh, time will be added to the base meander time of any meander routes that encounter emergent marsh. Identification of additional vegetation zones may be done ahead of the site visit using aerial photos or on site.

***Assessment Area***

Identify the Assessment Area, or the area of the restoration to be surveyed. This may be an entire restoration site or a smaller area within a larger property. If the evaluation is being done as part of an audit or formal evaluation, the Assessment Area may be defined as the area funded by a grant. Prior to heading to the site, prepare maps or aerial images with the Assessment Area and plant communities delineated. On site, confirm that the Assessment Area and plant community boundaries are accurate. Also confirm that the plant community type is correct. Verify the presence of any additional vegetation zones on site.

***Meander Routes***

Determine the number of meander routes based upon the size of the restoration site as follows:

- 1 route for sites <5 acres
- 2 routes for sites 5-59 acres

- 1 route for every 30 acres for sites from 60-300 acres
- 10 routes for sites over 300 acres or break down larger sites into discreet smaller units

Select the meander route locations to sample the appropriate plant community within the area restored by the specified grant. Determine the placement of the meander routes based upon the size and shape of the area to be sampled. Locate meander routes in representative areas of the site. There are no designated plots or data points; therefore, no equipment is needed to mark plots or transects.

***Seasonal Sampling Window***

Sample in the height of the growing season during July or August when most plants are well established and identifiable. During this time, an optimum number of species will have well developed flowers or seed heads that will aid in identification. Avoid sampling the plant community prior to mid-June or after mid-September when many species are not well developed or have begun to senesce.

***Sampling Time***

Conduct each meander route for a base time of 30 minutes.

Add 20 minutes additional time to the 30 minute base time for each additional vegetation zone encountered in a meander route. Record all species encountered during the base time plus the additional time in the same column on the data sheet.

Pause the meander time when necessary to identify a species. Also pause the time when the Assessment Area is broken into smaller discontinuous units and it is necessary to move from one assessment area to another before resuming the survey.

Stop the meander before the base time expires if the entire Assessment Area or the meander route has been adequately surveyed in less than the allotted time. Record the stop time of the meander.

***Land Use/Cover Assessment Data Sheet***

Fill out the Land Use/Cover Assessment Data Sheet which provides a checklist of information to record during each site visit:

- Date
- Site
- County
- Observer
- Plant community restored
- Additional vegetation zones
- Photographs
- Landscape context/land use
- Sketch of the site and meander route (or draw route on printed maps/aerial photos/GPS route and transfer to digital map)
- Summary statement
  - Cover characterization
  - Disturbances/stressors/threats
  - Invasive species observed in the surrounding landscape

**Species List Data Sheet**

All species are recorded during the timed meander using the data sheets provided in the accompanying excel file. Record both native species and invasive/introduced species observed along the meander route. The following information will be recorded on the data sheet:

- Site
- Observer(s)
- Date
- Start time
- Added time
- End time
- Species observed for each meander route
- Standing water, litter, and bare ground if greater than 5% cover
- Cover class

When doing more than one meander, check the box in the appropriate column for each species observed. M1 for the first meander, M2 for the second meander, etc. Leave room in the column to add the cover class for each species at the end of each meander.

If desired, species checklist(s) developed from the *DNR Field Guide to the Native Plant Communities of Minnesota* can be formatted to be used as field checklists. Choose the list(s) that best represent the plant community being restored and the floristic region that the site is located in. If using the species checklists, blank data sheets will also be needed to record species that are not on the checklists. Identify unknown species outside of the meander time. Collect samples of unknown species for later identification and as voucher specimens. Take photographs if desired. Unless the sample easily be identified in the field, press and dry the specimen for identification and verification using microscopes and herbarium specimens.

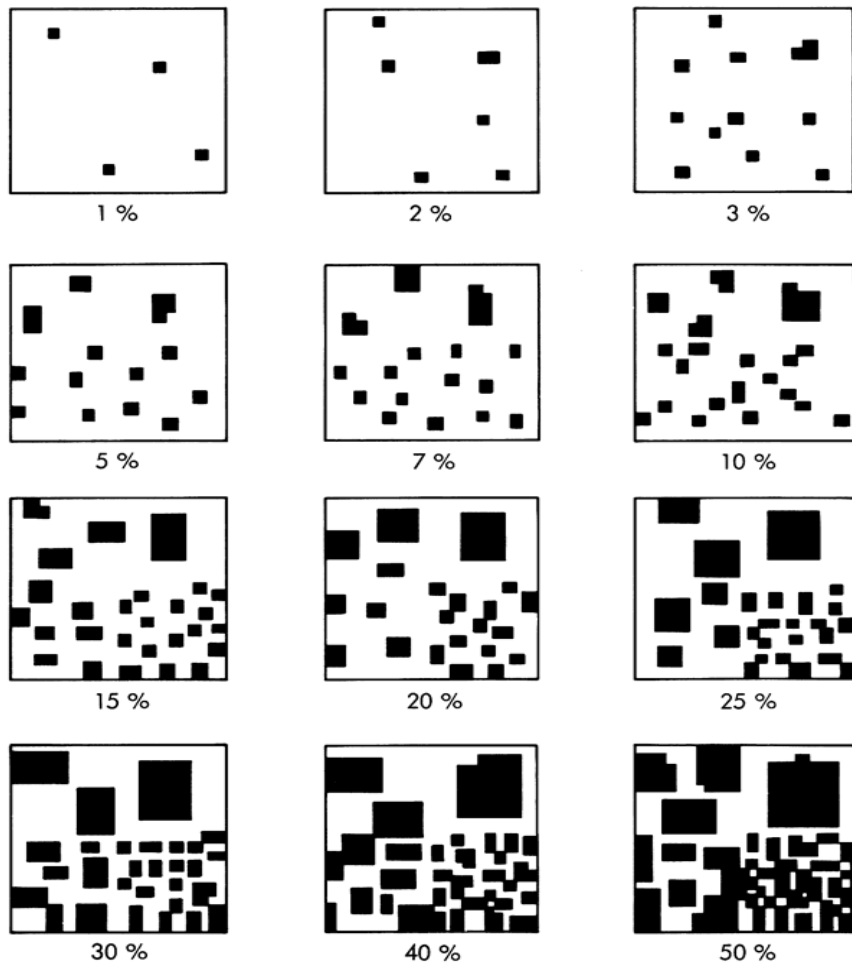
**Aerial cover estimates**

After the sampling time for each meander has elapsed and the species list has been completed, assign a cover estimate to each species using a six class cover scale (Table 1) before proceeding to the next meander location. Use an ocular guide to help estimate percent cover (Figure 1).

Table 1. Cover classes (Mueller-Dombois and Ellenberg 1974)

Cover Class	Range
.5	0-1%
1	1-5%
2	5-25%
3	25-50%
4	50-75%
5	75-100%

Figure 1. Ocular guide



### ***Deep water sampling***

The sampling method is adjusted for deep water sites where water depth and/or unconsolidated sediment depth make walking difficult, dangerous, or infeasible. When open water assessment areas are inaccessible, choose 3 representative locations along the interface of the emergent marsh and open water zones from which to sample.

At each location

1. Record aquatic species that are observed within visual range.
2. Sample additional species by tossing a rake on a 20' rope into the open water at 3 angles: perpendicular from shore, +45° from perpendicular, and -45° from perpendicular.
3. Record all species collected by rake.
4. Estimate aerial cover based on the abundance of retrieved and visually observed species.

Use a canoe or kayak to conduct the standard meander route survey for assessment areas accessible by water (i.e. wild rice projects). Collect aquatic samples within reach from the canoe/kayak.

### ***Equipment Needed***

- Clipboard
- Pen/pencil
- Data sheet
- DNR Field Guide to the Native Plant Communities of Minnesota
- Plant ID Guide
- Assessment Species Lists

### ***Finalize the Data Sheets***

Before leaving the assessment area, review the data sheets to confirm that all data is complete and accurate.

- 1) Identify unknowns with fresh samples in the field, if possible
- 2) Double check that each entry is complete; fill in the full name of each species
- 3) Double check that the site identification information is complete and accurate
- 4) Make any additional notes regarding site stressors, site characterization, or land use

### ***Transcribe the Data***

At a computer, finalize the information on the data sheet. Transcribe the data from the Species List Data Sheet into the Data Analysis Form in the accompanying excel document. Annotate the species list by adding guild, native or introduced status, and whether the introduced species are on the invasive species list. After annotating the species list, begin sorting the list in preparation for data analysis.

- 1) Identify any remaining unknown species for which vouchers were collected.
- 2) Transcribe the information from the data collection sheet into the excel file. Use the DataAnalForm template in the Assessment Species List excel document
- 3) Code each species by Guild (Woody, Forb, Graminoid).
- 4) Code each species by Native or Introduced.
- 5) Code species included on the Invasive Species list in the Assessment Species Lists excel document.
- 6) Sort the species list by Guild.
- 7) Sort the species list by Introduced/Native.

### ***Data Analysis***

The floristic data collected in the field will be used to generate two values needed to determine the quality of the assessed plant community compared to a set of 59 Minnesota ecological restorations. These comparison restorations were randomly selected as part of a statewide evaluation of LCCMR funded projects. Using percent Potential Natural Vegetation (%PNV) and a Composite Invasive Species Abundance score (CISA), researchers were able to determine which restoration projects were of relatively high quality or low quality. Projects in the study were evaluated to be “high quality” if they had higher than median %PNV and lower than median CISA. Projects were judged to be “low quality” if they had lower than median %PNV and higher than median CISA.

#### ***Calculate the Percent Potential Natural Vegetation (%PNV)***

The percent Potential Natural Vegetation (%PNV) is the percent of the total number of observed species that are listed in the Species Frequency and Cover tables (MNDNR Field Guides to the Native Plant Communities of Minnesota) for the plant community classes chosen to represent the restored plant community. The species frequency and cover tables are based on summaries of plot data and are thus a

list of species representative of those found in a particular plant community. The greater the %PNV, the greater the likelihood that the restored community resembles a native plant community of the class it was modeled on.

- 1) Using the DNR Field Guides to the Native Plant Communities of Minnesota, determine which Native Plant Community Class (Ecological Systems (Upland Prairie, Mesic Hardwood Forest, etc.) and Floristic Region (Northern, Southern, Central, etc.)) should be used to compare to the species list generated during the vegetation survey of the restoration.
- 2) Confirm that the restoration site occurs within the Documented or Possible Land Type Association (LTA) on the distribution maps in the plant community guides.
- 3) Using the Species Frequency and Cover list(s) for the chosen Native Plant Community Class(es) (use more than one if the restoration encompasses more than one plant community) mark the species on the list generated during the vegetation survey that match species on the NPC lists. The most commonly used Species Frequency and Cover checklists have been collated into the Assessment Species Lists excel document for easy access. For additional plant community checklists which are not in the excel document, the lists in the Native Plant Community Guides can be referenced. The Frequency and Cover lists are on the last page of each Native Plant Community Class narrative.
- 4) Tally the total number of species observed during the survey. Record this number on the data sheet.
- 5) Tally the number of species from the assessment species list that match species on the Species Frequency and Cover checklist(s). Record this number on the data sheet.
- 6) %PNV = the total number of species from the vegetation survey that match species in the Species Frequency and Cover checklist(s) divided by the total number of species documented during the vegetation survey. Record this value on the data sheet.

*Calculate the Composite Invasive Species Abundance score (CISA)*

The Composite Invasive Species Abundance score (CISA) is the counterpoint to the %PNV and represents the abundance of invasive species in the restored plant community. CISA is the sum of the midpoints of the cover class for each invasive species observed during the vegetation survey. Higher values of CISA decrease the likelihood that the restored plant community closely resembles a native plant community of that type.

- 1) For each invasive species documented during the survey, use the highest cover observed to determine the midpoint. (See Table 2).
- 2) Type the midpoint value for each invasive species in the Invasive column in the Data Analysis Form.
- 3) Sum all of the midpoint values. Record this value on the Data Analysis Form. This is the Composite Invasive Species Abundance score.

Table 2. Cover classes with midpoint

Cover Class	Range	Midpoint
.5	0-1%	.5%
1	1-5%	3%
2	5-25%	15%
3	25-50%	37.5%
4	50-75%	62.5%
5	75-100%	87.5%

### *Plot %PNV and CISA Scores*

The %PNV and CISA calculated from your data can now be plotted onto Graph 1. The lines in the graph represent standard median values of the %PNV and the CISA score for 3 habitat types: Forest, Prairie, and Wetland. The standard median values for each habitat type were developed from the data from ecological restorations surveyed in 2014-2015 for a state-wide restoration evaluation. They provide a standard against which other restorations can be measured.

- 1) Plot the %PNV calculated from your data along the x axis of Graph 1.
- 2) Plot the CISA score calculated from your data along the y axis of Graph 1.

### *Interpret your results*

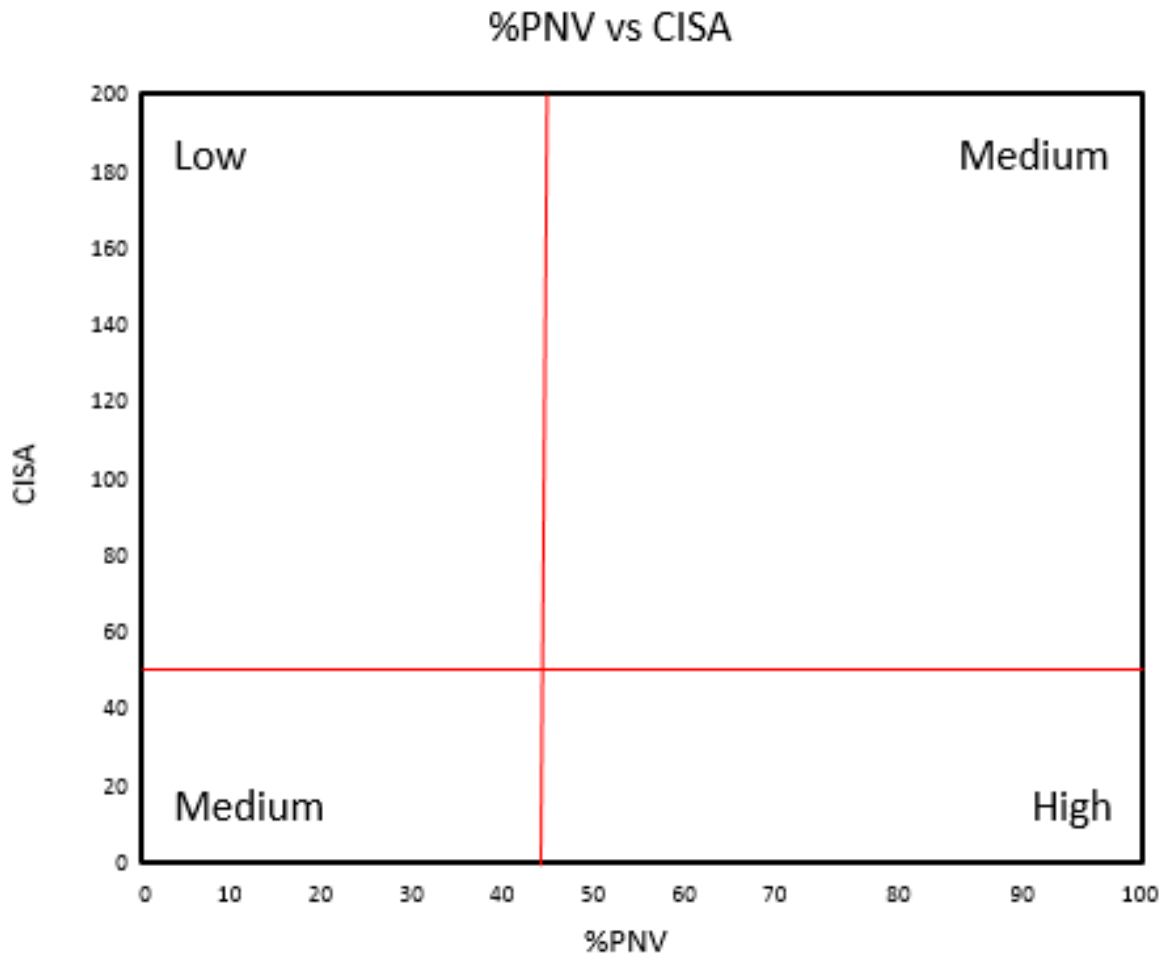
The purpose of monitoring restorations is to evaluate their current status and to provide guidance for ongoing management decisions. The two parameters chosen here, percent Potential Natural Vegetation and Composite Invasive Species Abundance score measure two conditions that strongly influence the quality of a restoration; the presence of a diverse native plant community typical for a native plant community of the particular region and the presence or absence of invasive species that may indicate a degraded habitat. The data obtained from your restoration evaluation and plotted against the data from the state-wide evaluation suggest the extent to which goals have been met and the site resembles a natural community.

**High Quality** - If the point plotted for the restoration falls into the bottom right quadrant of the plot, the restoration can be considered high quality based upon vegetative characteristics. The number of species typical of the model plant community being restored is high relative to the total number of species documented, while invasive species abundance is relatively low. Continue management practices to maintain current low cover of invasive species and diversity of native species typical for the plant community and the region.

**Low Quality** - If the point falls into the upper left quadrant, the restoration is low quality. Invasive species abundance is high and percent Potential Natural Vegetation is low. Review the implementation of current invasive species management practices. Introduce additional propagules of native species typical for the plant community and the region.

**Medium Quality** - If the point falls in the upper right or the lower left quadrants, the restoration quality is medium, having either high percent Potential Natural Vegetation but also high invasive species abundance or low invasive species abundance, but also low % Potential Natural Vegetation. Review the timing and implementation of invasive species management practices. Consider introducing additional propagules of native species typical for the plant community and the region or manage the restoration to facilitate the release of existing suppressed native vegetation.

Graph 1. Median %PNV and CISA values derived from statewide restoration evaluation results.



Median %PNV = 44%  
Median CISA = 50



**Method Citations**

- Bourdaghs, M. 2012. Rapid Floristic Quality Assessment Manual. MN Pollution Control Agency.
- Huebner, Cynthia D. 2007. Detection and Monitoring of Invasive Exotic Plants: A Comparison of Four Sampling Methods. *Northeast Naturalist* 14(2):183-206.
- Goff, F. G., G. A. Dawson, and J. J. Rochow. 1982. Site examination for threatened and endangered plant species. *Environmental Management* 6:4307–316.
- Peet, R. K., T. R. Wentworth, and P. S. White. 1998. A flexible, multipurpose method for recording vegetation composition and structure. *Castanea* 63:3262–274.
- Stohlgren, T. J., G. W. Chong, M. A. Kalkhan, and L. D. Schell. 1997b. Rapid assessment of plant diversity patterns: A methodology for landscapes. *Environmental Monitoring and Assessment* 48:25–43.
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**Land Use/Cover Assessment Data Sheet**

Site: \_\_\_\_\_ Observer: \_\_\_\_\_  
 County: \_\_\_\_\_ Date: \_\_\_\_\_

Plant Community Restored : \_\_\_\_\_  
 Additional Vegetation Zones : \_\_\_\_\_

Photographs:

Overview  Meander  Site Stressors  Buffer Stressors  Plants

**Adjacent Site Characteristics** (within ¼ mile of project site boundary):

Cover A=Absent (0%), VL=Very Low (1-5%), L=Low (5-25%), M=Medium (25-60%), H=High (60-100%)

Circle one	Land use	Circle category	Comments
A/VL/L/M/H	Urban	city/suburb/commercial-industrial	_____
A/VL/L/M/H	Agriculture	crop/livestock/other	_____
A/VL/L/M/H	Forestry	plantation/logging/conservationpltg	_____
A/VL/L/M/H	Forest	decid/conif/mix/windbrk	_____
A/VL/L/M/H	Grassland	native/non-native/fallow/pasture	_____
A/VL/L/M/H	Wetld/Lake	open water/EM/SM/WP/Lake	_____
A/VL/L/M/H	_____	_____	_____
A/VL/L/M/H	_____	_____	_____
A/VL/L/M/H	_____	_____	_____

**Use this space to sketch the site or write a summary statement**

- P Park car
- Meander route
- Road
- +++ Railroad
- Utility line
- R Residence
- F Farmstead
- C Commercial
- I Industrial
- x-x Fence
- RC Row crops
- SG Small grain
- H/P Hay/Pasture
- W Wetland
- F Forest
- Pr Prairie
- L Levee
- SL Stoplog
- PP Photo point

Cover Class	Range
.5	< 1%
1	1-5%
2	5-25%
3	25-50%
4	50-75%
5	75-100%