6. Riparian Plant Community Structure

Purpose

This section describes the equipment, sampling protocols, sampling frequency, and site selection considerations for monitoring of the riparian zone plant community. Parameters include species abundance, composition, percent cover, stem density, and basal area. These parameters describe the riparian plant community and identify changes in the riparian zone that may occur over time.

Monitoring Design

A plant community is an association of plant species in a given place. Community structure is inclusive of all plants that occur in the tree, sapling and shrub, and ground cover (vine/liana and herbs) vegetative layers. The composition and percent areal cover of plants, as well as their general condition with respect to both native and non-native species, describes riparian plant communities. Collecting and analyzing plant community data following well-recognized methods, such as the step-by-step protocol listed below, provides the basis for documenting these communities for purposes of their protection, conservation, and/or restoration. A data sheet that is specific to the protocol outlined below is provided in Appendix E. We recommend using it for your site assessments.

Minimum Equipment

Riparian vegetation monitoring requires relatively limited equipment but should be conducted by persons trained in botany, field plant identification, and the use of systematic keys for plant identification. Field equipment should include, at a minimum:

- ❑ Laminated, scaled maps (e.g., NWI, soil survey maps) or aerial photographs, protected in clear, resealable plastic bag or folder, depicting the stream/river reach, riparian study area, and bordering uplands
- ❑ Field notebook, pencils, waterproof permanent markers, and clipboard
- ❑ Data sheets (see Appendix E)
- ❑ Tape measure (100 ft or 300 ft open-reel fiberglass tape)
- ❑ Meter stick for measuring plant heights
- ❑ Rebar or wooden survey stakes to serve as permanent monuments/markers to identify transect endpoints and plot locations
- ❑ Diameter at breast height (DBH) tape to measure trees
- ❑ Camera and photo monitoring data sheets
- ❑ Resealable plastic bags for plant specimens
- ❑ Hand lens for keying-out plants
- ❑ Plant identification keys

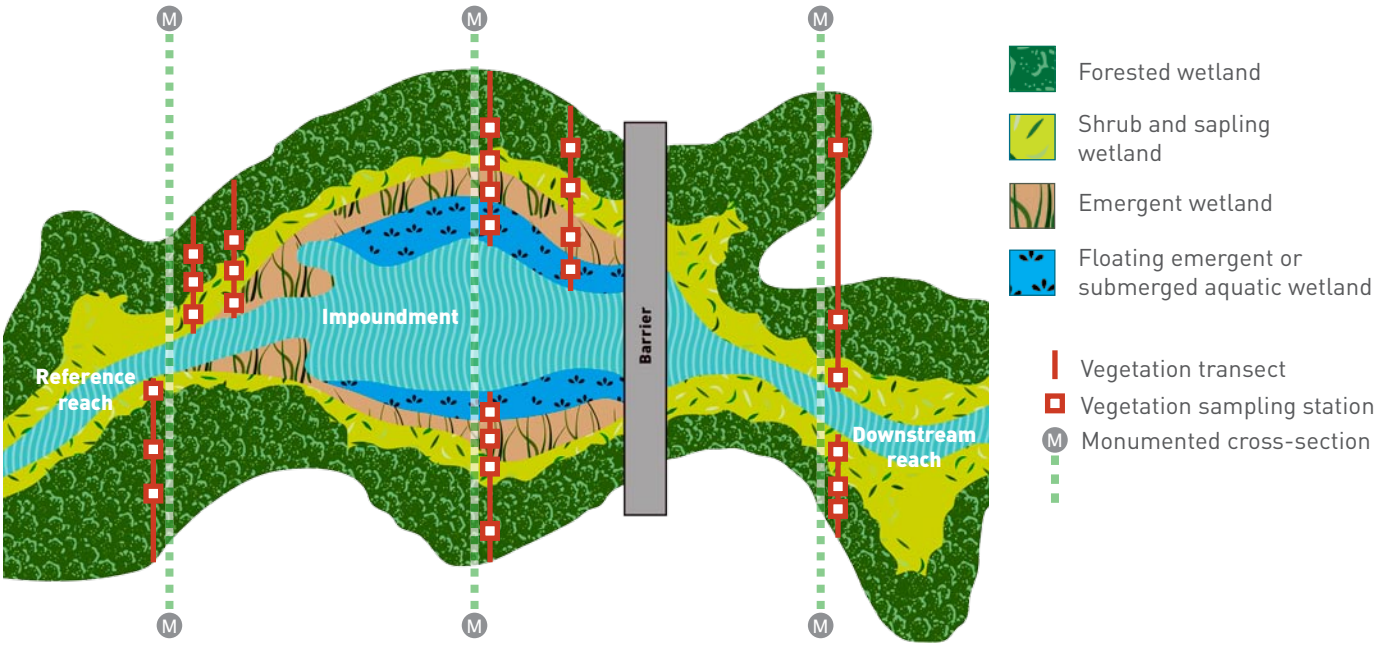

Figure 8. Establish 3 vegetation monitoring transects within the reference reach, 3 transects within the impoundment reach, and 2 transects in the downstream reach. A transect that spans the channel and both banks should be counted as 2 separate transects. At least 1 transect should coincide with, but be offset from, a monumented cross-section for each reach. The number and location of transects and vegetation sampling stations will depend on site-specific conditions. Figure not to scale.

Sampling Protocol

The goal of this protocol is to characterize riparian vegetation by sampling permanent vegetation monitoring stations along permanent transects. Transects should be established within each of the three reaches: 1) the reference reach upstream of the barrier's influence; 2) the impoundment or reach affected by the barrier; and 3) the reach downstream of the barrier. Along each transect, sampling stations are selected to characterize the vegetation within general cover types such as floating emergent and submerged aquatic vegetation; emergent wetlands; scrub/ shrub wetlands; and forested wetlands. The instructions below describe where to locate the transects and sampling stations and how to sample the vegetation at each station.

Additional Recommended Equipment

- ❑ Handheld GPS for recording the location of transects, plots, or other specific points
- ❑ Compass for laying out transects and describing photo station direction
- ❑ Plastic flagging tape for field marking monitoring plots and transects
- ❑ Hammer/mallet to install rebar or wooden stakes into the ground
- ❑ Daypack and/or field vest
- ❑ Waders, hip boots, brimmed hat, insect repellent, and sun block
- ❑ Storage cooler with ice to help preserve plant specimens and other field samples

1. Identify vegetation cover types present at the barrier removal monitoring site.
Using aerial photos and field visits, identify cover types (tree, shrub, vine, liana, and herbaceous layers), wetland versus adjacent upland community types, and their condition. See Cowardin et al. (1979) for classifying wetland cover types.

2. Establish the transects.
Establish a minimum of three transects in the reference reach, three transects in the impoundment reach, and two transects in the downstream reach (Figure 8). Transects should adequately represent the plant cover types identified in step 1. Additional transects should be established if time and resources allow, particularly for extended riparian zone/stream reaches that may be affected by the barrier removal.

3. Install rebar/wooden survey stakes at each transect's start and end point.
End points should be located upgradient of the wetland-upland boundary or outside the area that is expected to change with barrier removal. Label/number each transect stake. Transects may also be referenced to monumented cross-sections or offset a known distance from the cross sections. Transects should not be co-located with the monumented cross sections because surveying will trample vegetation.

4. Mark and label the transect start and end points.
Mark them on a scaled site map or aerial photo. Record the GPS coordinates of these locations.

5. Establish at least one sampling station within each distinct vegetation cover type along each transect.
Sampling stations should be chosen to characterize each of the cover types identified in step 1. Ideally, sampling stations will be established via a systematic random approach, where the vegetation units are first identified in step 1, and station locations are then randomly selected along the transect within the identified cover types (e.g., herbaceous plants sampled every 5 meters, shrubs every 15 meters, and trees every 30 meters). Supplemental, post-restoration sampling stations may need to be established to accommodate changing cover types, particularly where deepwater impoundment drawdown results in a vegetation community (Figure 9).

6. Mark each station with a stake or other permanent monument.
Use GPS to determine station location, and record the distance along the transect from the starting point to the station. Document whether a station stake is the center point or a corner point for each plot, particularly if a station differs from the layout used for the remainder of the monitoring area stations.

7. At each station, estimate species cover.
Estimate cover within all of the layers that are present: herbaceous; sapling and shrub; and tree. Herbaceous vegetation is sampled using a 1 m^2 (10.8 ft^2) quadrat. The sapling/shrub layer is sampled within a 5 m (approx. 16 ft) radius of the sampling station. Trees are sampled within a 9 m (approx. 30 ft) radius of the station.

The herbaceous layer includes all non-woody, emergent species of all heights (including bryophytes) and woody-stemmed plants < 3 ft (approx. 1 m) in height. The monitoring quadrat should be 1 m^2 (10.8 ft^2) and can be defined using an increment-calibrated, 1-meter-by-1-meter frame made of PVC-pipe, or a similar meth-

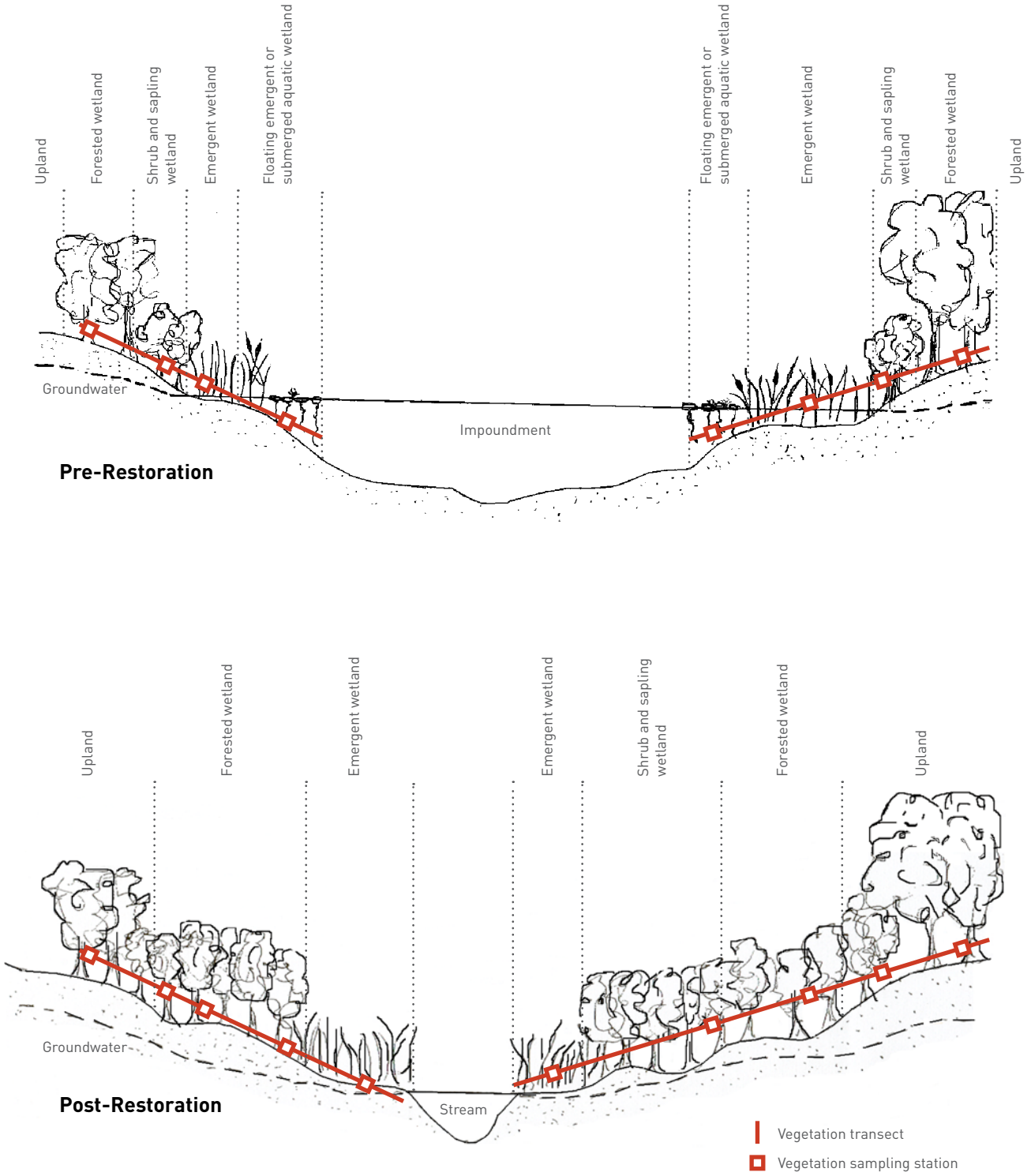

Figure 9. During pre-restoration monitoring (top), establish at least one vegetation monitoring station within each distinct vegetation cover type along each monumented vegetation transect. For post-restoration monitoring (above), vegetation monitoring stations may be added where vegetation has become established on the former bed of the impoundment. Within each monitoring reach, it is optimum to have three vegetation monitoring stations per cover type. Vegetation cover types should be sampled using the following plot size at each permanent monitoring station: 1 m^2 (10.8 ft^2) quadrat for the herbaceous layer, 5 m (approx. 16 ft) radius for the scrub and sapling layer, and 9 m (approx. 30 ft) radius for the tree layer. Figure not to scale.

Drawings by Kevin Lucey / NHDES

od. Estimate cover of the vertical plant shoots' aerial projections lying only inside the plot as a percentage of the plot area. Total cover in a plot may exceed 100 percent, as plant projections often overlap one another. When the project area has high stem density of herbaceous plants but relatively low species (< 5) diversity, a 0.5 m^2 (5.4 ft^2) quadrat may be used. When monitoring prior to barrier removal with plots located inside or near the edge of the impoundment, identify floating or submerged plants that are present. Identify each species, and record each species percent cover within the plot. Also estimate and record percent of both barren ground and dead plant cover. If time allows, also count the number of stems in a 0.25 m^2 (2.7 ft^2) or 0.5 m^2 (5.4 ft^2) quadrat.

The shrub and sapling layer includes all woody stemmed plants that are more than 3 ft (approx. 1 m) but no taller than 20 ft (approx. 6 m) tall and that have a diameter at breast height (DBH) between 0.4 inch (1 cm) and 5.0 inches (approx. 13 cm). DBH is measured at 4.5 ft (approx. 1.5 m) above ground level. For the shrub and sapling layer, monitor within a 5 m (approx. 16 ft) radius of the sampling station point. Identify the species of each plant, and record species percent cover within plot. Note the number of dead standing shrubs. If time allows, randomly sub-sample the plot by counting woody stems in a 1 m^2 (10.8 ft^2) quadrat.

The tree layer includes all woody plants that are taller than 20 ft (approx. 6 m) and have a DBH greater than 5 inches (approx. 13 cm). Monitor within a 9 m (approx. 30 ft) radius of the sampling station point. Identify the species of each plant, and use a DBH measuring tape to obtain individual DBHs, which will be used later to calculate basal area [$A = \pi (d)^2/4$, where $\pi = 3.14$ and d = DBH] of each species within each plot. Also note the number of dead standing trees within the sample area.

When estimating percent cover, values should be recorded as whole integers that can be categorized according to a standardized, commonly used Braun-Blanquet cover class scale (Table 6) (Braun-Blanquet, 1932; Mueller-Dombois and Ellenberg, 1974). These cover class categories can be used to expedite field sampling; the mid-point values are used in place of the actual corresponding field estimate values to minimize the variability of results that can arise when multiple people estimate cover. Once field assessments are completed, cover-abundance scores can be used to calculate plant species cover for assessment sites. Refer to the Analysis and Calculations section below for database management and calculations used for generating results.

Table 6. Braun–Blanquet cover class scale and mean values to estimate cover class.

Category	Percent Cover	Mid-Point
T	<1	None
1	1-5	3
2	6-15	10.5
3	16-25	20.5
4	26-50	38
5	51-75	63
6	76-95	85.5
7	96-100	98

Sampling Frequency

It is optimal to monitor vegetation during the peak of the vascular plant growing season. For the northeastern United States, this period is generally between July 15 and August 31. Some riparian plant species flower in spring or early summer, so the monitoring team may want to consider a site assessment during spring, if time allows. Monitoring is conducted at least once annually for each monitoring year (see below), and all stations should be monitored during each monitoring period. The project and reference sites should be monitored within the same time period and as close in time to one another as possible. Vegetation monitoring should include a minimum of one year of pre-restoration and three years of post-restoration assessment, and preferably over a longer period (such as once every 3 to 5 years) for post-restoration assessment. This is particularly important for reforesting sites and if a goal of the restoration is to document ecological succession of the riparian zone.

Baseline Versus Post-Removal Monitoring: Ideally, monitoring plots are monitored at least once prior to removal of the stream barrier to define a baseline condition. When funding and time allow, it may be beneficial to monitor two or more years prior to a barrier removal because this better accounts for environmental variability. Some removals result in very little change in riparian shoreline locations, whereas others can result in substantial change. If changes in shoreline vegetation are expected with impoundment drawdown, then baseline vegetation transects should include areas of impoundment habitat where vegetation and substrate conditions are documented.

Deborah Loiselle / NHDES

Using GPS to record location of a vegetation quadrat.

Analysis and Calculations

After field assessments are completed using standardized field data sheets and handwritten data are checked for clarity and legibility, vegetation data should be entered into an Excel spreadsheet where it can be manipulated for statistical analysis. In the spreadsheet, columns should represent species, and rows should represent the sampling plots. First create columns for all species found at the project site(s). Then enter percent cover data. Alternatively, the data can be entered using the Braun-Blanquet cover scale, which uses a ranking system that facilitates similarity testing and ordination procedures (Roman et al., 2001). Note that basal area for tree plot data can be calculated as described above. Tree plot basal areas are then totaled to derive percent cover of tree species within the plot.

Non-parametric tests can be used to evaluate differences in vegetation communities between sites (e.g., project restoration reach versus reference reach) or site conditions between sampling years. Refer to Kent and Coker (1992), Elzinga et al. (1998), and Roman et al. (2001) for detailed discussions on methods for statistical analysis of vegetation data.

Additional Information

As part of the vegetation sampling process, photographs should be taken routinely during each monitoring period to document vegetation and other riparian features. Refer to the photo station methods in this document for more detailed information (Section IV.B.4).

These plant monitoring protocols and the additional monitoring methods presented in Section III.B have been adapted from the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory, 1987), GPAC protocols for tidal wetland restoration (Neckles and Dionne, 2000), U.S. Geological Survey salt marsh protocols (Roman et al., 2001), and vegetation assessment methods of the Bureau of Land Management (Elzinga et al., 1998), U.S. Forest Service (USFS, 1987), and NOAA (Merkey and Keeland, 2005).

Elzinga et al. (1998) provides an in-depth discussion of monitoring plant populations (with a single species focus), including a step-by-step overview of developing and implementing a vegetation monitoring program, basic principles of sampling, sampling design, field techniques, data management, and statistical analysis of field data.

Many guides to plant identification are available. Some are comprehensive with user-friendly descriptive keys and accompanying drawings or photographs. Most provide specific geographic coverage, and many are targeted to a specific plant type such as woody plants, ferns and allies, bryophytes, or sedges. Guides specific to the northeastern United States include Gleason and Cronquist (1991), Magee and Ahles (1999), Conard, (1979), and Tryon and Moran (1997). Voss (1972, 1985, 1996) offers excellent keys for Michigan flora that are representative of northeastern U.S. plants; these volumes are noted for their clear, easy-to-follow keys, especially for difficult groups such as the sedges (genus *Carex*). Newcomb (1977) is another user-friendly plant guide.