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Minnesota Department of Natural Resources. 2005a. Field guide to the native plant communities of Minnesota: The Eastern Broadleaf Forest Province. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. St. Paul: Minnesota Department of Natural Resources.

Minnesota Department of Natural Resources. 2005b. Field guide to the native plant communities of Minnesota: The Prairie Parkland and Tallgrass Aspen Parklands provinces. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. St. Paul: Minnesota Department of Natural Resources.


1. Introduction

Definition

The word relevé (rel-ә-vә), of French origin, translates into “list,” “statement,” or “summary,” among the English meanings most relevant to its use in vegetation study. In this manual, a relevé is defined as a list of the plants in a delimited plot of vegetation, with information on species cover and on substrate and other abiotic features in the plot. Typically the vegetation is stratified into height layers by life forms (such as deciduous woody plants, forbs, graminoids, etc.) to describe the apparent vertical structure of the vegetation. In each layer each species is assigned a cover or abundance value based on its representation in that layer. Note that in this definition it is not specified how the placement of the plot in the vegetation is to be determined nor how the plot samples, or is related to, the surrounding vegetation. The relevé is simply any kind of plot with a list of the species in the plot, their cover or abundance, and some indication of the structure of the vegetation according to height classes and life forms. ¹

History

Relevés are closely associated with a procedure for describing and classifying vegetation that has a long history of development and use among European plant ecologists engaged in phytosociological studies. ² This procedure, documented in what is essentially its current form in the early 1900s by the Swiss biologist J. Braun-Blanquet (Poore 1955a), involves describing or characterizing recognizable units in the vegetation of a region by the description or characterization of the vegetation in a single representative standard plot—a relevé—within each unit. The relevés from many units are then analyzed to develop descriptions and classifications of the vegetation in the study region.

Although developed for use in conjunction with the above-described method of vegetation characterization, relevés have been increasingly used in other kinds of vegetation studies as a practical, relatively fast means of collecting information on vegetation. Relevés have been most widely used in Europe, particularly in studies involving vegetation classification, and the technique has also been employed in regions of Asia, Africa, South America, and, increasingly, North America (Benninghoff 1966, Westhoff and van der Maarel 1970, Mucina et al. 1993, Rodwell et al. 1995, Barbour et al. 1999, Box 1999, Jennings et al. 2004). The list of references at the end of this handbook includes examples of vegetation studies in North America that have used relevé data (see, for example, Klinka et al. 1996, Peinado et al. 1998, Emrick and Hill 1999, Rivas-Martinez et al. 1999, Mack et al. 2000, Stachurska-Swakon and Spribile 2002, Tomback et al. 2005).

¹ There appears to be variation among plant ecologists in application of the term relevé. For some, relevé is applied to any kind of plot-based vegetation sample that incorporates information on species presence and cover (see, for example, Knapp 1984c). For many if not most, however, relevé is applied to a vegetation plot linked to a specific approach to describing plant communities that involves: 1) determination of the minimal plot area needed to capture most species in the community (see page 6) and 2) subjectively placing plots in sample plant community stands to most efficiently characterize the vegetation in a study area (see page 2).

² The field of phytosociology was first defined in the late 1800s as the study of the sociological relationships of plants (Barbour et al. 1999), and has more recently been defined as the study of vegetation, including floristic composition, structure, development, and distribution (see, for example, Poore 1955a, Becking 1957 or Mueller-Dombois and Ellenberg 1974).
Use of Relevés

Methods of plot placement in relevé studies involve two general categories, subjective and objective. In a typical relevé study involving plant succession, plots are placed at random or by a researcher’s judgment. In another study, subjective placement is used to select habitat based on characteristics such as soil type, elevation, and exposure. In a study involving plant community classification, plots are placed at random to ensure that the data are representative of the study area and therefore is presented as a more efficient alternative.
The utility of subjective plot placement is made evident by considering projects whose aim is to describe or classify native vegetation in fragmented landscapes. In such cases, the purpose is to characterize as faithfully as possible the natural vegetation communities. Subjective plot placement is also used to study small areas, such as rare or isolated populations of species, or to sample areas that may contain important species. In these cases, the objective is to select the stands that are representative of the species of interest.

In contrast, objective plot placement involves the placement of sample plots that are designed to be representative of the study area as a whole. This method is useful when the goal is to study the distribution and abundance of species throughout a larger area.

The choice between subjective and objective plot placement depends on the specific research question and the available resources. Subjective plot placement is often used in exploratory studies where the goal is to gain a general understanding of the vegetation patterns in a given area. Objective plot placement is more appropriate for more detailed studies where the aim is to accurately quantify the distribution and abundance of species within a specific area.

In studies using objective plot placement, sample plots are placed either randomly or at regular intervals (i.e., systematically) across the entire study area, or alternatively the study area is divided into smaller units according to a specific criterion (e.g., using geographic or environmental gradients). A disadvantage of systematic sampling is that it provides information only about the study area as a whole, while subjective sampling allows for the recognition of spatial patterns and heterogeneity.

In conclusion, the choice between subjective and objective plot placement depends on the specific research question and the available resources. Subjective plot placement is often used in exploratory studies where the goal is to gain a general understanding of the vegetation patterns in a given area. Objective plot placement is more appropriate for more detailed studies where the aim is to accurately quantify the distribution and abundance of species within a specific area.
References


Appendix K. Plant Species Commonly Assigned Incorrect Life-form Codes (based on analysis of relevés in DNR Relevé Database).

<table>
<thead>
<tr>
<th>Woody Broadleaf Evergreens*</th>
<th>correct code</th>
<th>incorrect code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bog rosemary (Andromeda glaucophylla)</td>
<td>B D</td>
<td></td>
</tr>
<tr>
<td>Bearberry (Arctostaphylos uva-ursi)</td>
<td>B D</td>
<td></td>
</tr>
<tr>
<td>Leatherleaf (Chamaedaphne calyculata)</td>
<td>B D</td>
<td></td>
</tr>
<tr>
<td>Pipsissewa (Chimaphila umbellata)</td>
<td>B D</td>
<td></td>
</tr>
<tr>
<td>Tailing arbutus (Epigaea repens)</td>
<td>B D</td>
<td></td>
</tr>
<tr>
<td>Creeping snowberry (Gaultheria hispidula)</td>
<td>B D</td>
<td></td>
</tr>
<tr>
<td>Wintergreen (Gaultheria procumbens)</td>
<td>B D</td>
<td></td>
</tr>
<tr>
<td>Beach heather (Hudsonia tomentosa)</td>
<td>B D</td>
<td></td>
</tr>
<tr>
<td>Bog laurel (Kalmia polifolia)</td>
<td>B D</td>
<td></td>
</tr>
<tr>
<td>Labrador tea (Ledum groenlandicum)</td>
<td>B D</td>
<td></td>
</tr>
<tr>
<td>Large cranberry (Vaccinium macrocarpon)</td>
<td>B D</td>
<td></td>
</tr>
<tr>
<td>Small cranberry (Vaccinium oxycoccos)</td>
<td>B D</td>
<td></td>
</tr>
<tr>
<td>Lingonberry (Vaccinium vitis-idaea)</td>
<td>B D</td>
<td></td>
</tr>
<tr>
<td>Woody Climbing Plants*</td>
<td>C D</td>
<td></td>
</tr>
<tr>
<td>Climbing bittersweet (Celastrus scandens)</td>
<td>C D</td>
<td></td>
</tr>
<tr>
<td>Wild honeysuckle (Lonicera dioica)</td>
<td>C D</td>
<td></td>
</tr>
<tr>
<td>Grape honeysuckle (Lonicera  recticulata)</td>
<td>C D</td>
<td></td>
</tr>
<tr>
<td>Canada moonseed (Menispermum canadense)</td>
<td>C D</td>
<td></td>
</tr>
<tr>
<td>Virginia creeper (Parthenocissus spp.)</td>
<td>C D</td>
<td></td>
</tr>
<tr>
<td>Greenbrier (Smilax tamnoides)</td>
<td>C D</td>
<td></td>
</tr>
<tr>
<td>Vitis spp.</td>
<td>C D</td>
<td></td>
</tr>
<tr>
<td>Woody Broadleaf Deciduous Shrubs</td>
<td>D B</td>
<td></td>
</tr>
<tr>
<td>Sweet fern (Comptonia peregrina)</td>
<td>D B</td>
<td></td>
</tr>
<tr>
<td>Fly honeysuckle (Lonicera canadensis)</td>
<td>D C</td>
<td></td>
</tr>
<tr>
<td>Hairy honeysuckle (Lonicera hisalis)</td>
<td>D C</td>
<td></td>
</tr>
<tr>
<td>Rubus spp. (except R. pubescens and R. acaulis)</td>
<td>D H</td>
<td></td>
</tr>
<tr>
<td>Woody Needleleaf Evergreens</td>
<td>E D</td>
<td></td>
</tr>
<tr>
<td>Tamarack (Larix laricina)</td>
<td>E D</td>
<td></td>
</tr>
<tr>
<td>Graminoids</td>
<td>F G</td>
<td></td>
</tr>
<tr>
<td>Twig rush (Cladium mariscoides)</td>
<td>F G</td>
<td></td>
</tr>
<tr>
<td>Evergreen Forbs</td>
<td>G B</td>
<td></td>
</tr>
<tr>
<td>Goldthread (Coptis trifolia)</td>
<td>G B</td>
<td></td>
</tr>
<tr>
<td>Bunchberry (Cornus canadensis)</td>
<td>H B</td>
<td></td>
</tr>
<tr>
<td>Twinflower (Linnaea borealis)</td>
<td>H B</td>
<td></td>
</tr>
<tr>
<td>Partridgeberry (Mitchella repens)</td>
<td>H B</td>
<td></td>
</tr>
<tr>
<td>Pyrola spp.</td>
<td>H B</td>
<td></td>
</tr>
<tr>
<td>Climbing Forbs</td>
<td>I C</td>
<td></td>
</tr>
<tr>
<td>Clematis spp.</td>
<td>I C</td>
<td></td>
</tr>
<tr>
<td>Dodder (Cuscuta spp.)</td>
<td>I C</td>
<td></td>
</tr>
<tr>
<td>Common hops (Humulus lupinus)</td>
<td>I C</td>
<td></td>
</tr>
<tr>
<td>Fringed false buckwheat (Polygonum cilinum)</td>
<td>I C</td>
<td></td>
</tr>
<tr>
<td>Bur cucumber (Sicyos angustatus)</td>
<td>I C</td>
<td></td>
</tr>
<tr>
<td>Smilax spp. (except S. hispida)</td>
<td>I C</td>
<td></td>
</tr>
<tr>
<td>Graminoid-like Forbs</td>
<td>J G</td>
<td></td>
</tr>
<tr>
<td>Scheuchzeria (Scheuchzeria palustris)</td>
<td>J G</td>
<td></td>
</tr>
<tr>
<td>Typha spp.</td>
<td>J G</td>
<td></td>
</tr>
<tr>
<td>Moss-Like Forbs</td>
<td>K L</td>
<td></td>
</tr>
<tr>
<td>Lyopodium spp.</td>
<td>K L</td>
<td></td>
</tr>
<tr>
<td>Rock spikemoss (Selaginella rupestris)</td>
<td>K L</td>
<td></td>
</tr>
<tr>
<td>Non-Woody Rubus Species</td>
<td>H D</td>
<td></td>
</tr>
<tr>
<td>Arctic raspberry (Rubus acaulis)</td>
<td>H D</td>
<td></td>
</tr>
<tr>
<td>Dwarf raspberry (Rubus pubescens)</td>
<td>H D</td>
<td></td>
</tr>
</tbody>
</table>

*List includes all species with this life-form in Minnesota.

2. Methods

Relevé Plot Location

Surveyors with the Natural Heritage and Nongame Research Program, Minnesota Biological Survey, and Ecological Land Classification Program of the DNR do relevés primarily for use in characterizing or classifying native vegetation and follow the basic methods developed by Braun-Blanquet. Surveyors first divide the landscape into units, most often according to native plant communities.1 These units are identified using aerial photo interpretation, field experience in the study area, and other information (such as soils or surficial geology maps), and are transcribed onto topographic maps. Surveyors then begin field assessment of the plant community units, using the information transcribed onto the maps as a guide. The suitability of any plant community occurrence (or sample stand) for siting a relevé plot is determined by the quality of the vegetation and the absence of signs of human-related disturbance. An attempt is also made to select community occurrences or sample stands such that one captures all of the possible variability of the plant community within a given landscape or geographic region. This is done by distributing relevés among occurrences of the community that vary in habitat characteristics such as substrate, slope position, soils, and so on. In some landscapes, some community types may have few high-quality occurrences and it may not be possible for the surveyor to find enough sample stands to capture the full range of natural variation of the community. For example, good-quality remnants of deciduous forest in the agricultural regions of Minnesota are often limited to steep, un tillable slopes, while forests on level sites, which may have differed in plant species composition from those on slopes, may be absent or too disturbed to sample as native plant communities.

When a surveyor decides to do a relevé within a given stand, the criteria used in siting the plot are: 1) the site is representative of the stand as a whole; 2) the site is uniform in vegetation composition and structure as well as in habitat type (considering soil moisture, substrate, aspect, hydrology, and so on); 3) the vegetation in the plot area is ecologically intact and has not been visibly disturbed by human-related activity such as recent logging, heavy grazing, or invasion by non-native species; and 4) the plot is not close to any noticeable ecotone or boundary between different types of vegetation. If there is variation in the vegetation in the vicinity of the plot, the surveyor records some impressions on the relevé field form about the different vegetation types present and the nature of the boundaries between them (diffuse, sharp, etc.; see Figure 2 on page 9 for a sample copy of the DNR’s relevé field form). The surveyor also commonly notes which environmental factors may be causing the apparent vegetation pattern. The importance in classification studies of placing relevé plots in areas uniform in vegetation and habitat cannot be overly emphasized. If a relevé plot does contain a small area that clearly differs from the vegetation

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1The initial classifications of native plant communities used by the DNR in vegetation studies were based on review of available literature in Minnesota and adjacent regions and on field observations made by NHNRIP and MBS plant ecologists (Wendt 1984, DNR 1993). These classifications have since been supplemented by a classification based in large part on analysis of relevé data collected in plant communities across Minnesota (see DNR 2003, 2005a, or 2005b). For a general discussion of the process of dividing a landscape or study area into units to be sampled, see Muller-Dombois and Ellenberg (1974). (Note: it is not necessary to know the type of native plant community for the relevé to be suitable for classification, only that the community represents an association of native plants that repeats on the landscape and does not appear to be an artifact of human activity or some other unique or ephemeral event or set of events.)
of the rest of the plot—such as a small wet depression in an upland forest—the presence of the atypical area is noted on the field form.

On occasion, relevé plots are placed deliberately to include different vegetation types as, for example, when two distinct vegetation types are strongly associated with one another and are repeated on the landscape in a predictable pattern. In these cases, it is usually indicated on the field form that the purpose of the relevé is to characterize this association of vegetation types. DNR surveyors also do relevés for purposes other than classification of native vegetation, such as characterizing the habitats of rare plants or describing ecotonal areas. In these cases, the sample stands or the plot sites may be determined by criteria different from those used for classification purposes—this is usually indicated by the surveyor on the relevé data sheet.

**Relevé Plot Size and Shape**

Each relevé plot should be large enough to include most species regularly distributed through the sample stand. The appropriate relevé plot size for a particular type of vegetation in theory can be determined by constructing a species-area curve. This is often done by sampling nested plots in a homogeneous area in a representative stand of the vegetation type and then graphing the number of species recorded against plot size (Fig. 1). For vegetation in temperate regions, the species-area curve tends to be steep initially and then levels in number of species as the plot size increases. The intersection of plot size with the point at which the curve appears to level yields the minimal sample area. Ideally, this process is repeated in several representative stands of the vegetation type, with the largest resulting minimal area then used as a guide for relevé plot size (Mueller-Dombois and Ellenberg 1974; see also Kershaw [1973] for a discussion of the subjectivity associated with assessing homogeneity of vegetation and establishing minimal sample area; and Greig-Smith [1983] for a critique of using nested rather than randomly placed plots for developing the species-area curve, as well as a critique of the minimal area concept itself).

In practice, the minimal sample area is generally correlated with the life-forms of plants and the structure of the vegetation, so it is not necessary to determine minimal relevé sizes for each new study. Guidelines for relevé size based on species-area curve investigations for different types of vegetation are given in Mueller-Dombois and Ellenberg (1974), Westhoff and van der Maarel (1978), and Knapp (1984c) (see Table 1). Chytry and Otypкова (2003) have a review and discussion of plot sizes historically used in Europe. For Minnesota, a 400 square-meter plot in wooded vegetation and a 100 square-meter plot in treeless vegetation generally exceed the minimal sample area. Peet et al. (1998) present an approach to plot layout that incorporates an array of 10-meter by 10-meter modules and allows for flexibility in size and intensity of area sampled, depending on the requirements of the study.

DNR surveyors typically use square relevé plots—20 x 20 meters in upland forests, woodlands, savannas, and forested wetlands, and 10 x 10 meters in prairies, shrub swamps, and open wetlands. The shape of the plot and its orientation (if irregularly shaped) are important mainly in vegetation with regular or periodic patterns at scales finer than the plot size. For example, in the

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**Appendix J. Characteristics of Wetland Organic Soils**

<table>
<thead>
<tr>
<th>Texture Class</th>
<th>Value on Von Post peat decomposition scale</th>
<th>Color of organic material</th>
<th>Decomposition state of plant material</th>
<th>Color of water released when material is squeezed</th>
<th>Amount of organic material that escapes between fingers when squeezed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muck</td>
<td>H7 to H10</td>
<td>Very dark grey to black.</td>
<td>Composed of sapric organic material, in which plant remains are very highly decomposed.</td>
<td>Very dark, almost peaty. (if any is released).</td>
<td>Very muddy, and dark.</td>
</tr>
<tr>
<td>Mucky Peat</td>
<td>H1 to H3</td>
<td>Dark reddish brown to dark greyish brown.</td>
<td>Composed of hemic organic material, in which plant remains are slightly decomposed.</td>
<td>Very muddy and dark.</td>
<td>Up to one-third.</td>
</tr>
<tr>
<td>Peat</td>
<td>H1 to H3</td>
<td>Light yellowish brown or reddish brown.</td>
<td>Composed of fibric organic material, in which plant remains are undecomposed.</td>
<td>Clear to muddy brown.</td>
<td>None.</td>
</tr>
<tr>
<td>Peat</td>
<td>H1 to H3</td>
<td>Light yellowish brown or reddish brown.</td>
<td>Composed of fibric organic material, in which plant remains are undecomposed.</td>
<td>Clear to muddy brown.</td>
<td>None.</td>
</tr>
</tbody>
</table>

1An English-language version and brief explanation of the Von Post scale of peat decomposition is presented in Andriesse (1988).
Appendix I. Key to Mineral Soil Texture

1 Adapted from Richardson and Vepaskas (2000) and Thein (1979).
2 If ball cracks along edges when squeezed, it is too dry.

string bogs of Minnesota, which consist of alternating peat ridges and flooded troughs, the ridges and troughs may be sufficiently narrow that a 10 x 10 meter relevé plot would always contain a portion of both a trough and a ridge. If the surveyor wanted to contrast the vegetation of these two features, it would be appropriate to use rectangular relevé plots, laying out each plot entirely on either a ridge or in a trough. Alternatively, if the vegetation of the area as a whole was to be compared with some other type of bog vegetation, placing rectangular plots transversely across the ridges and troughs would be appropriate.
Table 1. Minimal areas for selected vegetation types (compiled from Mueller-Dombois and Ellenberg [1974], Westoff and van der Maarel [1978], and Knapp [1984]).

<table>
<thead>
<tr>
<th>vegetation type</th>
<th>example in Minnesota</th>
<th>area (sq. meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>temperate deciduous forest</td>
<td>southern mesic maple-basswood forest</td>
<td>100 - 500</td>
</tr>
<tr>
<td></td>
<td>central dry-mesic oak-aspen forest</td>
<td></td>
</tr>
<tr>
<td>boreal coniferous forest</td>
<td>northern poor conifer swamp</td>
<td>100 - 500</td>
</tr>
<tr>
<td></td>
<td>northern dry-sand pine woodland</td>
<td></td>
</tr>
<tr>
<td>shrub community</td>
<td>northern bedrock shrubland</td>
<td>10 - 250</td>
</tr>
<tr>
<td></td>
<td>mesic brush-prairie</td>
<td></td>
</tr>
<tr>
<td>grassland</td>
<td>southern dry prairie</td>
<td>25 - 100</td>
</tr>
</tbody>
</table>

Relevé shape might also be altered when sampling vegetation that varies in relation to slope or aspect. In general, the shape of the plot is dictated by the specific purpose of the vegetation study, although where feasible square plots are preferable to oblong or irregularly shaped plots because square plots have lower ratios of edge-to-plot area.

Recording the Relevé Location
After deciding on the location, size, and shape of the relevé plot, the plot location is determined using a GPS unit or, if the surveyor does not have a GPS unit, the location is recorded on the surveyor's field map (usually a 7.5 minute United States Geological Survey [USGS] topographic map). The location can also be recorded on an aerial photograph if aerial photos are being used for orientation in the field. Later, the GPS coordinates can be used to create a map showing the location of the plot, or photocopies of the surveyor’s field map or aerial photograph can be attached to the field form, expediting entry of location information into the DNR’s Natural Heritage Information System electronic relevé database and providing a clear record of the plot location. Often, it is helpful to provide a sketch showing the relation of the plot to unmapped features (such as trails, fencelines, buildings, clearcuts, or ponds) that might aid in relocating the plot. This sketch is usually attached to the original field form and archived in the DNR’s manual relevé file.

Delineating the Relevé Plot
The final step before recording field data is delineating the relevé plot. For most work, the plot boundaries and corners can be established by measuring with a tape along the perimeter of the plot and turning 90° at each corner with the aid of a field compass. A 10 x 10 meter plot laid out in this way is generally within 3 square meters of 100 square meters in size. (More accurate techniques for delineating plots are described in Appendix D.) Plot corners are usually marked with flagging. In dense, brushy vegetation, it is often helpful to mark the midpoint of each side and the center of the plot with flagging.

Recording Data
The relevé data form used by the DNR has site data fields on one side (Fig. 2) and lines and columns for recording species and plant physiognomic information on the other side (Fig. 6, page 26; see Appendix C for information on obtaining a printable copy of the DNR’s relevé field form). Some of the site data
Appendix G. Invasive Earthworm Rapid Assessment (cont.)

Castings = material cast by earthworms on the surface of the soil. Earthworm castings are composed of smooth and rounded clumps of soil, which distinguish them from the rougher, angular or crumb-like surface of soil aggregates that have not been worked by earthworms. Cast material is also usually very dark brown or black in color.
are recorded in the field; other site data are transcribed from maps, lists, or tables in the office. The species data are always recorded in the field, with the exception of corrections for species that are collected for identification.

**Site Data Fields**

**DNR Relevé #:** Each relevé is assigned a four-digit number when it is entered into the DNR's relevé database.

**Surveyor(s):** Record the name(s) of the surveyor(s) doing the relevé. If the relevé is being done by more than one person, record the name of the lead surveyor first. The lead surveyor is generally the person who finalizes the relevé for submission to the DNR's relevé database (filling in any blank fields, confirming the identity of any unknown species, etc.) and is responsible for checking the relevé for accuracy after it is entered into the database.

**Surveyor’s Relevé #:** (Optional) Because the DNR relevé number is not usually assigned until the relevé is entered into the database, this field is provided for the surveyor to assign a personal number or code to keep track of relevés during the field season. The surveyor’s relevé number can be up to 20 characters long and may contain a combination of numerals, letters, and other keyboard characters. Many surveyors begin the number with a year or a county-name abbreviation, followed by a hyphen and a number (for example, 06-01 or HN-01); some surveyors incorporate their initials (e.g., JKL06-01).

**Surveyor’s Place Name:** (Optional) This field is provided to allow the surveyor to record a place name for keeping track of relevés, especially for places that are not within MBS sites (see MBS Site # on page 12), or for large MBS sites where labeling smaller units is helpful for tracking data collected at the site.

**Institution:** The institution or organization with which the surveyor is affiliated is indicated by circling the first letter of the available choices:

- (M)BS – DNR Minnesota Biological Survey
- (E)CS – DNR Ecological Land Classification Program
- (N)HP – DNR Natural Heritage Program
- (U)SFS – United States Forest Service
- (U) of M – University of Minnesota
- (O)ther – other institution

If the choice is “(O)ther” the surveyor writes the name of the institution in the space provided (e.g., Natural Resources Research Institute–UMD, The Nature Conservancy, DNR Parks and Trails, Consultant, etc.). A list of institutions is available in Appendix E.

**Purpose of Relevé:** The surveyor indicates the purpose of the relevé here by circling the first letter of the best choice. If none of the specific choices is applicable, the surveyor marks “(O)ther” and writes the purpose in the space provided. As mentioned above, the purpose of any vegetation study greatly influences the type of vegetation sampled and how relevé plots are placed. The DNR's relevé database contains relevés done for many different purposes (such as community classification, rare plant habitat characterization, vegeta-

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**Appendix G. Invasive Earthworm Rapid Assessment (cont.)**

**Definitions**

Forest Floor (O Horizon) = layer of fresh and decaying organic material (leaves, needles, twigs, etc.) at the ground surface. May be separated into three layers: O, Oa, and Oo (all three are not always present).

- O = litter layer composed of intact leaves from the previous fall. Leaves often complete or nearly complete, readily distinguishable and even identifiable to species. Often layered or matted.

- Oa = litter layer of fragmented leaves just below O layer, consisting of leaves greater than one year old that are relatively undecomposed but fragmented so they are difficult to identify to species. Peat-like and generally not blackened in color.

- Oo = humus layer, consisting of decomposed organic material mixed with mineral soil (mineral soil content is less than 50% as estimated by visual inspection). May be very black and mixed with worm cast material, but still maintains network of fine roots (dead or alive) and recognizable organic material.

Mineral Soil or Top Soil (A Horizon) = soil horizon just below the O horizon (or if there is no O horizon, this horizon forms the surface horizon). Characterized by an accumulation of humified organic matter mixed with mineral material and composed of more than 50% mineral soil relative to organic matter. Sometimes the organic component is difficult to see, but is indicated by a black or dark brown color due to the accumulation of soluble organic molecules. Where earthworms are abundant this layer may be completely composed of worm cast material. In worm-free conditions this layer may not be present; rather, a leached, lighter-colored sandy or silty mineral horizon (E horizon) with measurably less organic material begins immediately below the O horizon.

Middens = distinctive piles of cast material around the openings of earthworm burrows. These middens are usually about 1–5cm in diameter and 1–3cm in height, with a burrow hole (2–4mm in diameter) near the center. The burrow entrances of middens also often have large numbers of leaf petioles or fragments of leaves sticking out of them. These become stuck as the inhabitants attempt to pull leaves into burrows.

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1 Great Lakes Worm Watch. Invasive earthworm rapid assessment tool. Natural Resources Research Institute, University of Minnesota Duluth. http://greatlakeswormwatch.org
Appendix G. Invasive Earthworm Rapid Assessment

Dichotomous key for 5-stage rapid classification of earthworm invasion in deciduous and mixed deciduous-coniferous forests (from Loss et al. 2013)

1. Leaf litter greater than one year present (Oi and Oe layers present).
   1a. Yes (go to 2)
   1b. No, leaf litter (Oi) from previous autumn only (go to 6)

2. Small, fragmented, relatively un-decomposed leaves greater than one year present.
   2a. Yes, Oe present (go to 3)
   2b. No, leaf litter (Oi) from previous autumn only (go to 6)

3. Intact, layered forest floor, leaves bleached and stuck together, Oi, Oe, and Oa layers present, fine plant roots in humus (Oa) and leaf fragments (Oe), no earthworms, castings, or middens present.
   3a. Yes (Stage 1 – potentially earthworm-free)
   3b. No (go to 4)

4. Layered forest floor, but leaves loose, Oi, Oe, and patches of Oa layers present. Some small earthworms and/or earthworm castings present in humus (Oa), fine plant roots present.
   4a. Yes (Stage 2)
   4b. No (go to 5)

5. Leaf litter (Oi) from previous autumn and small fragmented leaves (Oe) under intact leaves present, no humus (Oa), mineral soil (A horizon) present, earthworm castings present (≤50% of forest floor/mineral soil interface covered), fine plant roots absent.
   5a. Yes (Stage 3)
   5b. No (go to 6)

6. Leaf litter (Oi) from previous autumn present, mineral soil (A horizon) present, earthworm castings abundant (>50% of forest floor/mineral soil interface covered), fine plant roots absent, middens absent or present (≤9 middens in 5-m radius).
   6a. Yes (Stage 4)
   6b. No (go to 7)

7. No forest floor (Oi or Oa), humus (Oa) or fragmented leaves present, mineral soil (A horizon) present, earthworm castings abundant (>50% of forest floor/mineral soil interface covered), middens abundant (>9 middens in 5-m radius).
   7a. Yes (Stage 5)

Revisit: Indicate whether the relevé is a resurvey of an existing plot at the site. If “(Y)es” record the original four-digit DNR relevé number in the space provided.

Date: A two-digit number is entered for the day (e.g., “02” or “14”).

Month: The first three letters of the month are entered in this field (e.g., “APR”).

Year: The full four-digit year is entered in this field (e.g., “2006”).

MBS Site #: If the relevé is within an MBS site, the one- to three-digit site number is entered here. MBS sites are numbered sequentially within each county and have been designated only in counties in which MBS has completed or initiated biological surveys. If the surveyor is uncertain of the site number or whether the relevé is in an MBS site, the site number can be determined by data management staff. If the surveyor knows that the relevé is in an MBS site, they should make certain that the site number is entered, either by recording it themselves or alerting data management staff to look it up when the relevé is entered in the relevé database.

Ownership: Record the general ownership of the site (e.g., DNR Parks and Trails, USFS National Forest, The Nature Conservancy, County Park, Private, etc.). A list of ownerships is available in Appendix F.

Vegetation Group: Indicate whether the vegetation being sampled is a wooded upland, open upland, wooded wetland, or open wetland. By convention, the dividing point between wooded and open plant communities is set at greater than or less than 25% tree canopy cover (canopy trees are defined as trees > 33 feet [10 meters] tall). This a rough starting point. The most important feature will be the kinds of ground-layer plants that are abundant in the community, especially whether they are sunlight-requiring or shade-tolerant species. It is especially important to pay attention to ground-layer species on sites where canopy cover has been reduced by recent disturbances such as timber harvesting, windstorms, or fire. The same is true for sites that were savanna in the recent past but where fire suppression has resulted in an increase in tree canopy cover. Although these sites may have > 25% tree canopy cover, they are still considered open plant communities based on abundant presence of sunlight-requiring prairie species.
Upland sites include all sites where soils are saturated only briefly in the spring or following heavy rains. They very rarely have standing water. Wetland sites have persistently saturated soils because of high water tables, have standing water present through the growing season or for long periods in the spring and following heavy rains, or are flooded annually by streams or rivers.

**NPC Code (Name):** Indicate the native plant community in which the relevé occurs based on Version 2.0 of the DNR’s native plant community classification (DNR 2003, 2005a, 2005b). Enter as much of the native plant community code (and corresponding name) as can be determined using keys in the appropriate DNR NPC field guide. For example, if the surveyor can only identify the NPC to the highest level of the classification, the system, they record:

\[ A \ P \ _ \ _ \ _ \ _ \ \] (Acid Peatland System)

If the surveyor can identify the NPC to system and floristic region, they record:

\[ A \ P \ n \ _ \ _ \ _ \ _ \ \] (Acid Peatland System, Northern Floristic Region)

If the surveyor can identify the NPC to the lowest possible level of the classification, the subtype, they would record:

\[ A \ P \ n \ 0 \ 0 \ a \ 1 \] (Black Spruce Bog, Treed Subtype)

If the surveyor is not certain which NPC to assign to the relevé, they should provide a list of possible NPCs with their best guess listed first.

**NPC Ranking in Relevé:** This is the one- or two-letter quality ranking assigned to native plant community occurrences by DNR ecologists. The ranks are indicative of community quality and range from “A” for high-quality, relatively undisturbed occurrences, to “D” for highly disturbed occurrences. The community rank applies to the vegetation in the area of the relevé plot rather than to the stand as a whole. If the quality of the stand as a whole is different, this is recorded in the Remarks field and also in either the Remarks or Notes field. This ranking is a very useful guide for selecting relevés for analysis. The NHNRP and MBS have drafted guidelines for native plant community occurrence ranking in Minnesota, which are available by request.

**Stand Typical of NPC:** In some instances, it may be evident that the vegetation in the relevé is not representative of typical occurrences of the native plant community class, type, or subtype. This may be because the vegetation has been affected recently by human-related or natural disturbance, or for some other reason. Information of this kind is very useful in screening relevés for analysis. Information about human-related disturbance should be recorded here only if it has greatly altered the composition or structure of the vegetation. Examples would include recent clear-cutting of a forest or past cultivation of a prairie. If the disturbance is minor or occurred long ago (for example, cutting of an occasional tree, clear-cutting in the early 1900s, or grazing in the 1930s) this information is recorded below in the Remarks field.
Appendix D. Delineating a Square Relevé Plot

1. Using a tape scaled in meters, measure along a straight line the 14.14-meter diagonal of a 10 x 10 meter square plot (or 28.28 meters for a 20 x 20 meter square plot) and set chaining pins at each end (A and B). Leave the tape in place.

2. Using a second tape, measure 10 meters (or 20 meters for a 20 x 20 meter plot) from relevé corner B along a straight line that is approximately at a 45-degree angle from the diagonal tape on the ground (the angle is ca. 40 degrees in this example). Temporarily mark the relevé corner with a chaining pin (T), rewind the tape, and move to corner A of the diagonal.

3. Measure 10 meters (or 20 meters for a 20 x 20 meter plot) along a straight line that passes over the temporary relevé corner T and set a surveyor’s pin for the new relevé corner C. Remove the surveyor’s pin at T. Leave the tape in place.

4. Measure between relevé corners C and B. This distance is almost always within 10 centimeters of 10 meters (or 20 centimeters of 20 meters), even with a poor setting of the temporary corner (the actual angle was 40 degrees). If the distance between B and C is not sufficiently accurate, consider relevé corner C as temporary and repeat step 3 by beginning at B rather than A. When satisfied, leave the tape in place to form a triangle on the ground.

5. Repeat steps 3 and 4 to establish relevé corner D and form a square relevé plot outlined by tapes. The diagonal tape may be removed, although leaving it in place to delineate a half-plot is often helpful when estimating the cover of a species that is approximately 50%.

Relevé Typical of Stand: Record here whether the vegetation in the relevé area is typical of the stand as a whole or differs significantly in composition or structure from the rest of the stand. For example, a surveyor may sometimes place a relevé in an area that is of visibly higher quality than the rest of the stand, is of lower quality than the rest of the stand, contains a significant canopy gap, or differs in some other way from the rest of the stand. This field, like the previous field, serves to highlight relevés that may be in some way anomalous for their designated community class, type, or subtype.

Plot Location in NPC: This field provides information on the location of the relevé plot in relation to boundaries between the sample stand and adjacent plant communities. The choices are:

(F)ar from community boundary – boundaries with adjacent communities are not visible from the relevé plot (i.e., boundaries are > ca. 50 meters from the plot). This situation is most common when the plot occurs in a community that forms large patches or is the matrix or predominant vegetation in the study area.

(M)oderately far from boundary – boundaries with adjacent communities are not close to the relevé plot but are visible from the plot (i.e., boundaries are ca. 10–50 meters from the plot). This situation is most common when the plot occurs in a community that forms patches that are larger than the relevé plot but that is not the matrix community in the study area. This category can also be used to represent a localized habitat in a large occurrence of a community (e.g., a north slope in a mostly level site).

(C)lose to boundary – this occurs when the community patch is just large enough (or wide enough in the case of linear communities) to contain the relevé plot, or when the plot is placed close to (i.e., within 0–10 meters of) a community boundary in a larger patch.

(E)cotonal – the plot is in a visible ecotone or transition between two communities.

UTM: If the surveyor is using a GPS unit, the location of the plot is recorded here based on UTM coordinates in NAD83, Zone 15N. To prevent mistakes, the surveyor should provide an ArcMap printout of the relevé location with a USGS topographic map as a background layer. The map provides a means of confirming the accuracy of the location entered in the database and also serves as a quick reference for viewing the location of the plot.

UTM Accuracy: This space is for the accuracy of the GPS reading in meters, especially when the accuracy is less than typical. If the accuracy is provided in units other than meters (e.g., feet), be certain to indicate this on the form.

Permanent Marker: Indicate whether the relevé plot has been marked with a permanent marker. If the plot is marked, include the method (marker type and placement) in the space provided. Examples: rebar in plot corner, metal stake at one point, nails with washers in all four corners & double washer in SW cor-
ner, magnet buried in plot center, GPS referenced with marked tree(s). Other information about the specific location of the plot can be written under Notes or sketched on a separate sheet and attached to the original relevé form.

**Location Source:** Indicate whether the geographic coordinates or location of the relevé plot were determined with a GPS unit, or from an air photo, a topographic map, LIDAR imagery, or another source. In any case, the surveyor should submit a paper copy of a map showing the location of the relevé with the relevé form.

**County:** This space is provided to allow the surveyor to track relevés by county during the field season. The county recorded by the surveyor also is a useful check against errors in entering the UTM coordinates provided by the surveyor (see Note on County, Township, Range, and Section below).

**Township:** This is the township in which the relevé is located (e.g., 143N). Township numbers can be determined by the surveyor in GIS or from the margins of USGS topographic maps (they are printed near the boundaries between townships).

**Range:** This is the range in which the relevé is located (e.g., 32W). Range numbers can be determined by the surveyor in GIS or from the margins of USGS topographic maps (they are printed near the boundaries between ranges).

**Section:** This is the number of the section in which the relevé is located. Section numbers can be determined by the surveyor in GIS and are printed near the center of each section on USGS topographic maps.

**QRT:** The quarter-quarter section is recorded using the codes NE, NW, SE, or SW. If the relevé is near a boundary and its quarter-quarter-section location is questionable, half-quarter sections may be indicated using the codes N_, S_, E_, or W_.

**QRT:** The quarter section is recorded using the codes NE, NW, SE, or SW. If the relevé is near a boundary and its quarter-section location is questionable, half sections may be indicated using the codes N_, S_, E_, or W_.

**Note on County, Township, Range, and Section:** County, township, range, and section are requested from the surveyor to provide location information that is independent from the UTM coordinates recorded by the surveyor. The relevé database calculates county and legal information based on the UTM coordinates entered in the database. This information then appears on the relevé QC printout and can be compared to the field form to screen for errors in entering or recording plot location.

**Plot Size:** The dimensions of the releve plot are recorded in meters and the resulting plot size is given in square meters. DNR surveyors typically use 20-meter by 20-meter plots for forest, woodland, and savanna plant communities, and 10-meter by 10-meter plots for open communities such as prairies and wet meadows. If the plot is larger than 999 square meters, enter “999” and indicate

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### Appendix A. Contributing Samples to the DNR Relevé Database

Most relevé samples are contributed to the DNR’s Relevé Database by providing the DNR with paper copies of the relevés. For studies involving large numbers of relevés, the contributor should contact the DNR to determine whether it would be more efficient to arrange some other method of submission. For further guidance on submitting relevés to the DNR’s Relevé Database, please contact:

Norm Aaseng  
Minnesota Biological Survey  
Minnesota Department of Natural Resources  
500 Lafayette Road, Box 25  
St. Paul, Minnesota 55155  
(651) 259-5069  
Norm.Aaseng@state.mn.us

### Appendix B. Obtaining Data from the DNR Relevé Database

Electronic datasets or paper copies of relevés housed in the DNR’s Relevé Database are available to researchers interested in vegetation study. For information on obtaining relevé datasets or printouts, please contact:

Daniel Wovcha  
Minnesota Biological Survey  
Minnesota Department of Natural Resources  
500 Lafayette Road, Box 25  
St. Paul, Minnesota 55155  
(651) 259-5154  
Daniel.Wovcha@state.mn.us

### Appendix C. Obtaining a Copy of the DNR Relevé Field Form

A printable version of the DNR relevé field form is available on the DNR’s website at [www.mndnr.gov/eco/mcbs/vegetation_sampling.html](http://www.mndnr.gov/eco/mcbs/vegetation_sampling.html).

A paper copy of the field form can be obtained by contacting:

Daniel Wovcha  
Minnesota Biological Survey  
Minnesota Department of Natural Resources  
500 Lafayette Road, Box 25  
St. Paul, Minnesota 55155  
(651) 259-5154  
Daniel.Wovcha@state.mn.us
2 = Assigned to species where the plants form small, often dense clumps. These small clumps may be rather evenly dispersed within the relevé. This code is often applied to woody or herbaceous plants where several aerial stems originate from the rootstock of a single genet.

1 = Assigned to species growing solitarily. This code is applied to both woody and herbaceous plants with single stems that appear to be evenly dispersed within the relevé plot.

**Remark Codes:** Remark codes are two-character codes that indicate some special attribute of the species as it occurs in a physiognomic group. Some remark codes refer to the species' viability (that is, they are qualitative estimates of the ability of the species to perpetuate itself). Other remark codes refer to the condition of the species as affected either by inherent factors (such as seasonal phenology or life-cycle) or external factors (such as herbivory, windthrow, or fire). When a vitality code is used, it is good practice to either enter an associated condition code that helps to explain the vitality of the species, or to include an explanatory note in the Remarks or Notes fields on the first side of the relevé form. For example, if the vitality code “PV” (indicating poor vitality) is applied to a species record, then one would also apply a condition code to that species record to indicate why it had poor vitality (for example, it may have been defoliated by insects, in which case one would also enter the condition code “DF” for “defoliated” in the remark code column). The list of potential remark codes is not strictly limited, and miscellaneous remarks pertaining to features other than vitality or condition may be created to suit particular vegetation studies. Some commonly used standard remark codes are listed in Table 8.

**Table 8. Standard codes for plant species remarks.**

<table>
<thead>
<tr>
<th>Vitality</th>
<th>Condition</th>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD = dead</td>
<td>BU = budding</td>
<td>IN = introduced</td>
</tr>
<tr>
<td>DY = dying</td>
<td>BR = browsed</td>
<td>MN = introduced</td>
</tr>
<tr>
<td>EX = being</td>
<td>DF = defoliated</td>
<td>RA = rare in</td>
</tr>
<tr>
<td>driven out</td>
<td>OG = open</td>
<td>Minnesota</td>
</tr>
<tr>
<td></td>
<td>grown</td>
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<tr>
<td></td>
<td>FL = flowering</td>
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<tr>
<td></td>
<td>FR = fruiting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FS = fire scarred</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GE = germinating</td>
<td></td>
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<tr>
<td></td>
<td>GR = grazed</td>
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<tr>
<td></td>
<td>DF = defoliated</td>
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<td></td>
<td>OG = open</td>
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<td></td>
<td>FL = flowering</td>
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<td>FS = fire scarred</td>
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<td></td>
<td>GE = germinating</td>
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<td>GR = grazed</td>
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<tr>
<td>LU = luxurious</td>
<td>ME = multiple</td>
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<tr>
<td>growth</td>
<td>MS = multiple</td>
<td></td>
</tr>
<tr>
<td>PV = poor</td>
<td>WS = multiple</td>
<td></td>
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<tr>
<td>vitality</td>
<td>MV = mowed</td>
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<tr>
<td></td>
<td>OG = open</td>
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<tr>
<td></td>
<td>PF = past fruiting</td>
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<tr>
<td></td>
<td>SE = present</td>
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<tr>
<td></td>
<td>SD = seedling</td>
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<td></td>
<td>ST = sterile</td>
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<td>SP = sprout</td>
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the actual size of the plot in the Remarks field. If the plot is irregularly shaped, this should be recorded either in the Remarks field, or under Notes if there is not enough space in Remarks.

**Elevation:** The plot elevation in feet is usually estimated from USGS 7.5 minute series topographic maps, either to the nearest contour or to the midpoint between two contours.

**Slope:** The slope of the relevé plot is recorded either in degrees or in percent, using the appropriate space. Values of less than 10 degrees or 10 percent are prefixed by “0.” For example, a slope of eight degrees is recorded as “08.” Level sites are recorded as “00.”

**Aspect:** The slope aspect (i.e., the downslope direction of the plot) is recorded using the abbreviations NE, NW, SW, SE, N, S, E, and W. For level sites, use “LV.”

**Topographic Context:** Circle the choice that best characterizes the topographic context of the plot in relation to any slope or slopes (Fig. 3) that may be affecting the flow of runoff or groundwater to or from the plot. For example, a plot that is on a local high point will tend to receive little runoff or groundwater flow from above and moisture reaching the plot will drain readily. Conversely, a plot that is topographically low in relation to adjacent or surrounding slopes will receive runoff or shallow groundwater flow from the full length of any slope above and drainage away from the plot will be gradual. The definitions of topographic context in relation to slope are:

- **Crest** – the uppermost portion of a slope, typically without a distinct aspect.
- **Upper** – the upper portion of a slope immediately below the crest, usually with a distinct aspect.
- **Middle** – the area of a slope between the upper slope and the lower slope, usually with a distinct aspect.
- **Lower** – the lower portion of a slope immediately above the toe, usually with a distinct aspect.
- **Toe** – the lowermost portion of a slope. The toe is immediately below the lower slope and grades rapidly to level with no distinct aspect.
- **Flat** – any level area excluding the toe of a slope. There is no distinct aspect.
- **Depression** – any area that is concave in all directions, usually at the toe of a slope or in level topography.

**Soil Information**
To collect data on the soil in the relevé plot, it is suggested that the surveyor

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dig a soil pit, preferably at least 60 centimeters (24 inches) deep. If it is not feasible to dig a soil pit, the surveyor could use a soil probe, auger, or peat sampler to lay out a sample core of the soil in stratigraphic sequence. The data recorded includes information on litter, humus, and organic soil layers such as peat or muck, as well as any natural mineral-soil layers that differ from one-another in soil texture. At a minimum, the surveyor should record information on the litter, humus, and the texture of the surface soil layer.

**Litter Thickness:** Litter consists mainly of leaves, needles, twigs, and other organic material in which the original structures are easily identifiable (compare with Humus below). Record the thickness of the litter layer in centimeters. Also record the predominant component of the litter, such as leaves, needles, or grass, under Litter Type.

**Humus Thickness:** Humus consists of leaves, needles, twigs, and other organic material in which the original structures have been decomposed by soil organisms and are not readily identifiable. Record the thickness of the humus layer in centimeters and the appropriate **Humus Type.** The possible types are:

- **Mor** – derived from organic material that has been decomposed largely by fungi. Mor humus develops from litter composed predominantly of conifer needles and mosses and is little mixed with the underlying mineral soil. Mor humus has a brown fibrous structure throughout and leaves little or no residue on fingers when rubbed.

- **Moder** – derived from organic material that is being decomposed by soil fauna. Moder humus develops from litter composed predominantly of deciduous leaves and is partially incorporated into the underlying mineral soil by the activity of soil fauna. Moder humus is fibrous at the top and amorphous at the bottom; the amorphous portion leaves a fine, black silty residue when rubbed between fingers.

- **Prairie Mull** – develops in grasslands, in which plant roots decay in place to form a dark-colored, organic-rich surface horizon. Surface litter and humus would be classified as a single individual. This code is also assigned to species that fall just outside the relevé plot (no matter how numerous they are outside the plot). For species that are assigned an abundance code of “R” because they fall outside the plot, the surveyor also enters “OP” in the Remarks column. The recording of species that are outside the plot is meant to alert others that these species are present in the stand, but happened not to fall in the relevé plot. The convention for species outside of the plot is to record only those species that are representative of the stand (rather than of anomalous microhabitats within the stand) and that are within 2 meters of the plot boundary.

**Sociability Codes:** (Optional) Sociability codes describe how a species is distributed within the relevé plot. They are only rarely recorded by DNR surveyors as they do not contribute useable information for classification analyses. When recorded, sociability codes refer only to the distribution of a species as it occurs in a particular physiognomic group. For example, it often happens that the distribution of a tree species is uniform within the tree stratum and clumped within the seedling stratum. The codes for sociability are (after Mueller-Dombois and Ellenberg 1974):

- **5** = Assigned to species where the plants are growing in a large, essentially monotypic stand or swarm that forms an extensive mat. This code typically is applied to non-woody plants (for example, moss or lichen carpets, graminoid sods, etc.)

- **4** = Assigned to species where the plants are growing in small colonies or broken mats. This code typically is applied to non-woody plants (for example, broken moss or lichen carpets and also colonies of herbaceous plants that have enlarged to the point where they are beginning to coalesce).

- **3** = Assigned to species where the plants are growing in small patches or in cushions. This code typically is applied to small isolated clones of herbaceous plants, patches of shrubs, and moss or lichen colonies.

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One convention used by the DNR is that whenever the cover of a plant is greater than 5% in the plot, cover takes precedence over abundance. For example, if there is a single individual of a tree species in the canopy in a plot, but that individual has a leaf area that covers 30% of the plot, the species would be given a “3” for cover/abundance rather than an “r”. If, however, there was a single individual with leaf area covering less than 5% of the plot, that species would be given an “r” for cover/abundance. The same holds for canopy trees whose stems fall outside the plot but whose leaf area covers a portion of the relevé plot. If the leaf area covers more than 5% of the plot, the species is given the appropriate cover value (i.e., 2, 3, 4, or 5). If the leaf area covers less than 5% of the plot, the species is given an abundance value of “r” and “OP” is recorded in the Remarks column to indicate that the stem is outside the plot. It is useful for surveyors to keep in mind that when conducting visual estimates of species cover there is a tendency for observers to overestimate cover of large species, species in flower or clumped in distribution, and species that are known, and to underestimate cover of small species, species in vegetative state, species distributed evenly in the plot, and species not known to the observer (Kershaw 1973, Kent and Coker 1992).

The Braun-Blanquet cover/abundance scale (after Mueller-Dombois and Ellenberg 1974) is as follows:

5 = 75%–100% (Cover code.) Assigned to a species within a particular physiognomic group when that species’ cover is between 75% and 100% of the relevé plot area.

4 = 50%–75% (Cover code.) Assigned to a species within a physiognomic group when that species’ cover is between 50% and 75% of the relevé plot area.

3 = 25%–50% (Cover code.) Assigned to a species within a physiognomic group when that species’ cover is between 25% and 50% of the relevé plot area.

2 = 5%–25% (Cover code.) Assigned to a species within a physiognomic group when that species’ cover is between 5% and 25% of the relevé plot area.

1 = < 5% (Abundance code.) Assigned to a species within a physiognomic group when there are numerous individuals of the species, but those individuals collectively cover less than 5% of the relevé plot area.

+ = < 5% (Abundance code.) Assigned to a species within a physiognomic group when there are only a few (approximately 2–20) individuals of the species and those individuals collectively cover less than 5% of the relevé plot area.

r = < 5% (Abundance code.) Assigned to a species within a physiognomic group when there is only a single individual of the species (a plant with two stems arising from the same

are usually absent, with the exception of thatch that may have accumulated between fires.

Wormed Mull – may be present in deciduous forests that have been invaded by exotic earthworms. In wormed mull, worms transport litter and humus into the soil to form a dark-colored, organic-rich surface horizon. Worm castings are usually evident beneath the current year’s leaf litter or at the surface if the litter has been consumed.

Earthworms Present: Indicate whether earthworms are present in the plot. Evidence of earthworms includes worm castings at the surface, absence of humus, absence of leaf litter greater than one year old, etc. See Invasive Earthworm Rapid Assessment Rank below for more information on signs of earthworms. Note: This field is provided to allow the surveyor to record basic information on the presence of earthworms in the event that the surveyor is not able to accurately determine the Invasive Earthworm Rapid Assessment Rank.

Invasive Earthworm Rapid Assessment Rank: For deciduous and mixed deciduous-coniferous forests, it is helpful to indicate the level of invasive earthworm infestation using the Great Lakes Worm Watch Invasive Earthworm Rapid Assessment protocol (Loss et al. 2013). Appendix G contains a dichotomous key for ranking the level of invasive earthworm presence. Basic definitions of the assessment ranks are:

(1) – the forest floor (defined as the leaf litter and humus layers) is fully intact and layered; fine roots are present in humus and leaf fragments; the forest floor has intact recognizable layers; no earthworms or earthworm signs are present; the understory has appropriate plant diversity dominated by native species, with no evident expansion of Carex pensylvanica.

(2) – humus is present in patches and may be slightly mixed with the mineral soil; the rest of the forest floor is intact, with large and small fragmented leaves; some fine roots are present in the forest floor, but are not thick; small earthworms are present in the forest floor; no large castings of Lumbricus terrestris middens are present; small castings may be present in the humus layer of an otherwise intact and layered forest floor; the understory remains somewhat diverse and is dominated by native plant species, with minimal expansion of Carex pensylvanica.

(3) – larger, mostly intact leaves from the previous litter fall are present, along with mostly intact, partially decayed leaves from the previous year; small leaf fragments are present under intact leaves; humus is absent; earthworm castings are present in the mineral soil but make up <50% of the forest floor/mineral soil interface; L. terrestris middens are absent or rare; fine plant roots are absent or sparse in the forest floor; the understory may be somewhat diverse in native plant species and may have broken patches of Carex pensylvanica.

(4) – larger, mostly intact leaves from the previous litter fall are present, sometimes with mostly intact, partially decayed leaves from the previous
year; no humus or small leaf fragments are present; earthworm castings are abundant in the mineral soil, representing >50% of the forest floor/mineral soil interface; L. terrestris middens are absent or rare (≤ 9 middens per 5 meter radius); fine plant roots are absent in the forest floor; the understory is often sparse, or dominated by worm-tolerant native species or exotic species, or has a broken to unbroken carpet of Carex pensylvanica.

(5) – the organic forest floor is absent or only larger, mostly intact leaves from the previous litter fall are present; humus is absent or only small leaf fragments are present; earthworm castings are abundant in the mineral soil, representing >50% of the forest floor/mineral soil interface; L. terrestris middens are abundant (>9 middens per 5 meter radius); fine plant roots are absent in the forest floor; the understory is sparse, or dominated by worm-tolerant native or exotic species, or has a broken to unbroken carpet of Carex pensylvanica.

Depth to Semi-Permeable Layer: Information on the presence of a water-impeding horizon can help in interpreting the moisture or drainage regime for upland sites. Fine-textured (i.e., clay, silty clay, sandy clay, clay loam, silty clay loam, or sandy clay loam) soil layers greater than 13 centimeters (ca. 5 inches) thick will perch water, as will coarse-textured layers if these layers are cemented or compacted. Cemented or compacted layers are evident in the field by having peds, or structural units, that do not deform or disintegrate easily when squeezed. Record the depth to the top of the semi-permeable layer.

Depth to Gley Colors or Redoximorphic Features: The presence of gley soil colors or redoximorphic features is indicative of prolonged soil saturation and provides useful information on the drainage or hydrology of the site. Gley soil colors include various shades of gray, bluish-gray, or greenish gray present in minerals containing reduced iron (Fe\(^{2+}\)), which forms when soils are permanently wet. In the Munsell system of notation for identifying soil colors, gley soil colors have gray hues, values of 4 or greater, and chromas of 2 or less and are identified in the field by comparison with the color chips on a Munsell Soil gley color chart (Munsell Color 1994). Redoximorphic features include gray zones of iron depletion and bright orange or red bodies of iron enrichment in the soil. These features are caused by prolonged soil saturation and the reduction of iron to a soluble form (Fe\(^{2+}\)) under anaerobic conditions; the transport of reduced iron within the soil by water; and the oxidation of the reduced iron to form iron oxides and hydroxides, which precipitate and accumulate into bright-colored nodules or masses (Veprokaškas 2001). The zones of depletion (which directly indicate continuously saturated and reduced conditions) are identifiable by their gray colors; these may span several hues (i.e., charts) in the Munsell system of soil color notation but always have values of 4 or more and chromas of 2 or less.

Drainage Class: Circle the choice that best describes the drainage class of the site. Soil drainage classes are an important but rough measure of how long soils are saturated or are able to hold water available for plants. Appendix H provides a key to soil drainage classes; the six possible drainage classes are defined in Table 6. 

6 = The genus identification is in doubt.
Example
*cf. Baptisia sp.*

7 = The plant is unknown but only one species is probably included.
Plants recorded as “unknown” should be collected for later identification (unless the surveyor knows from experience that the specimen does not have the developed taxonomic characters necessary for identification) and the collection number entered in one of the remarks fields in the species data line.

In practice, the majority of species records on any given relevé are assigned a reliability of “2”. Therefore, in order to save time when recording species data on the relevé data sheet, it is common practice for surveyors to record reliability of identification codes only when they differ from “2”. If this is the convention used, the surveyor should indicate clearly that the code is “2” unless otherwise marked.

Cover/Abundance Codes: The DNR uses the Braun-Blanquet cover/abundance scale to designate the cover or abundance of each plant species within a given physiognomic group or layer. The categories in this scale are recorded on the relevé form using codes that include numbers (1 to 5) and characters (“+” and “*”). The numbers 2, 3, 4, and 5 designate cover classes for species with 5% to 100% cover in the physiognomic group. The convention for estimating species cover is to sum the “canopy cover” of each individual of the species in the layer. (Canopy cover is defined as the percentage of the ground covered by the downward projection of the outermost perimeter of the spread of foliage of each plant. This is in contrast to “foliar cover,” which is defined as the percentage of the ground covered by the downward projection of stem and leaf area, exclusive of gaps between stems and leaves [Society for Range Management 1989; Jennings et al. 2004].) The codes 1, +, and * designate qualitative estimates of the abundance (number) of plants of a species with less than 5% cover in a physiognomic group. See Mueller-Dombois and Ellenberg (1974) or McCune and Grace (2002) for discussions of the Braun-Blanquet cover/abundance scale and similar scales.

The use of both cover and abundance classes is intended to enable the recording of meaningful data from one relatively large plot for both large, cover-forming plants and small plants that seldom cover much of the plot. For example, if one used a pure cover scale there are many species that would almost always be assigned the lowest cover value because even when numerous in a relevé plot they tend to cover very little of the plot area. This is true for many diminutive forb and graminoid species. On the other hand, if one used a scale with classes based only on abundance, the importance of canopy trees would be diminished relative to that of herbaceous species because canopy trees typically have few individuals within a plot, even when the leaf area of a species may effectively cover the entire plot. Other sampling methods overcome the need for a split cover/abundance scale by using large plots to sample larger, cover-forming plants (such as trees and shrubs), and small plots nested within the large plots for sampling herbaceous plants.
**Reliability of Identification Codes:** It is often not possible to identify with certainty all of the plant specimens in a relevé plot because some of the plants in the plot will lack the taxonomic characters (such as flowers or mature fruit) needed to identify them. It is the surveyor's responsibility to indicate any uncertainty in the identification of plant specimens in the plot so that others can evaluate the work. To indicate uncertainty in identification of plants, the surveyor should use both the abbreviation “cf.” (for the Latin *confer*, which in this context has the meaning “appears to be” or “shows some likeness to”) in the species written name, as well as the numerical reliability of identification codes that are entered in association with the written name. (The numerical codes for reliability of identification are necessary for entry of information into the DNRF's relevé database. If the surveyor has recorded the numerical code, the use of “cf.” in the written name is redundant but using “cf.” in addition to the numerical code reduces the chance for confusion during entry of the species record into the relevé database.)

The numerical codes were developed by E. Cushing at the University of Minnesota (personal communication 1986) and are defined as follows:

0 = Identification of the plant is confident to the level of variety or subspecies.

Example: *Baptisia bracteata* var. *glabrescens*

*Alnus incana* ssp. *rugosa*

1 = The species identification is confident but the variety or subspecies identification is in doubt.

Example: *Baptisia bracteata* cf. *var. glabrescens*

2 = The species identification is confident but the variety or subspecies is not distinguished, even though varieties or subspecies occur in Minnesota; or, varieties or subspecies are not recognized in collections in Minnesota.

Example: *Baptisia bracteata*

3 = Species identification is trivial because of hybridization among several recognized species but hybrid complexes are recognized within the group.

Example: *Amelanchier interior* complex

4 = The genus identification is confident but the species identification is in doubt.

Example: *Baptisia cf. bracteata*

5 = The genus identification is confident but the species is not distinguished.

Example: *Baptisia sp.*

---

**Table 6. Soil Drainage Classes.**

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(E)xcessively and Somewhat Excessively Drained</td>
<td>Water drains very rapidly. These soils are commonly sandy, gravelly, on steep slopes, or shallow over bedrock, or have a combination of these conditions. Neither gray mottles nor a gray soil matrix are present within 150 cm of the surface.</td>
</tr>
<tr>
<td>Well Drained</td>
<td>Water drains quickly enough in the upper 100 cm of soil to prevent the formation of gray mottles or a gray matrix.</td>
</tr>
<tr>
<td>Moderately Well Drained</td>
<td>Water drains slowly. Soils are saturated long enough to form gray mottles or a gray matrix within 50-100 cm of the surface. Saturation is caused either by a semi-permeable layer that retards downward movement of water or by a high water table. A mixture of gray and orange or brown colors indicates fluctuation between saturated and unsaturated conditions during the growing season. A gray matrix indicates that saturation occurs for most of the growing season.</td>
</tr>
<tr>
<td>Somewhat Poorly Drained</td>
<td>Water drains slowly. Soils are saturated long enough to form gray mottles or a gray matrix within 25-50 cm of the surface. Saturation is usually caused by a high water table but occasionally may be caused by a semi-permeable layer that retards downward movement of water. A mixture of gray and orange or brown colors indicates fluctuation between saturated and unsaturated conditions during the growing season. A gray matrix indicates that saturation occurs for most of the growing season.</td>
</tr>
<tr>
<td>Poorly Drained</td>
<td>Water drains very slowly. Soils are saturated long enough to form gray mottles or a gray matrix within 25 cm of the surface. A mixture of gray and orange or brown colors indicates fluctuation between saturated and unsaturated conditions during the growing season. A gray matrix indicates that saturation occurs for most of the growing season. Muck and peat are absent from the surface or are &lt;20 cm thick if present.</td>
</tr>
<tr>
<td>Very Poorly Drained</td>
<td>Water drains very slowly. Saturation occurs at the surface or immediately below the surface all year. Gray with a blue or green hue is the dominant color within 25 cm of the surface. These soils usually have a high water table for most of the growing season. Muck or peat &gt;20 cm thick is present at the surface.</td>
</tr>
</tbody>
</table>

**Height of Moss Hummocks:** In peatland communities, the height of moss hummocks is often correlated with the degree of acidification of the peatland. The surveyor should record an average of the heights of hummocks in the plot.

**Sphagnum Cover:** For peatland communities, record the percentage of the plot that is covered by sphagnum moss.
**Depth of Standing Water:** This field is mainly for use in plant communities where standing water is a typical feature, such as aquatic or wetland communities. If water depth is greater than the measuring device used by the surveyor, the length of the device is entered in the space provided and the surveyor circles the "(>)" symbol.

**pH of Surface Water:** The pH of surface water is useful to record for all wetland communities, especially peatland communities. Important distinctions include how far the pH is from 5.6, which is the dividing point between acid and rich peatland communities, and also whether the pH is very high (>7.0). The pH is best recorded from an open pool. Compressing or digging holes in the peat mat to reach water can result in elevated readings, although in communities on floating mats or with a surface layer of loosely consolidated moss, the measuring device can be gently pressed into the mat or moss until contact with standing water. If possible, the surveyor should record the published accuracy of the measuring device in the space following the pH value. (If using pH paper, the accuracy is generally ± 0.5; properly calibrated pH meters typically have accuracies of ± 0.1 or better.)

**Average Depth to Bedrock:** This is the depth in centimeters of soil over bedrock and is recorded in areas of Minnesota where glacial deposits are thin and bedrock is close to the surface. One typically uses the average of several measurements from within the plot. Important distinctions made in northwestern Ontario forest ecosystem classification studies were soil depths greater than 100 centimeters or less than 20 centimeters (Sims et al. 1997).

**Exposed Rock:** The percentage of the plot surface with exposed bedrock is often useful information in areas of Minnesota where glacial deposits are thin and bedrock outcrops are common.

**Rock Group, Rock Type:** The rock group and type are recorded when there is exposed bedrock in the plot. The surveyor records the general rock group according to the categories below. If they are also able to identify the rock beyond broad rock group, they should record the specific rock type. The rock groups and the possible types within them are:

<table>
<thead>
<tr>
<th>Rock Group</th>
<th>Rock Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>(F)elsic</td>
<td>Granite, Schist, Gneiss, etc.</td>
</tr>
<tr>
<td>(M)afic</td>
<td>Basalt, Gabbro, Diabase, etc.</td>
</tr>
<tr>
<td>(C)alcareous</td>
<td>Limestone, Dolomite, Shale, Slate, Argillite, etc.</td>
</tr>
<tr>
<td>(S)sandstone</td>
<td>Sandstone</td>
</tr>
<tr>
<td>(S)sioux Quartzite</td>
<td>Sioux quartzite</td>
</tr>
<tr>
<td>(O)ther</td>
<td></td>
</tr>
</tbody>
</table>

**General Soil Texture:** This is the texture of the soil material in the rooting zone. The purpose of recording general soil texture is to provide at least a basic level of soil texture data for all relevés in the event that the surveyor does not complete a more detailed description of the soil profile (see Soil Layer Table below). The categories for general soil texture are:

- (C)lay
- (L)om
- (S)and
- (S)ilt
- (R)ock
- (M)uck
- (P)eat

**SPECIES OCCURRENCE DATA VARIABLES**

**Species Names:** Species names are recorded on the relevé form in the lines below the associated physiognomic group line, using the Latin name for the species. The nomenclature used by the DNR is based on the published volumes of *Flora of North America North of Mexico* (Flora of North America Editorial Committee 1993–). For species not yet published in *Flora of North America*, nomenclature is based on *Manual of Vascular Plants of Northeastern United States and Adjacent Canada* (Gleason and Cronquist 1991). There are a few exceptions to this convention for some woody species and some rare species. The DNR’s official checklist of names for the vascular plant species that have been documented in Minnesota is available at www.mndnr.gov/eco/mcbs/plant_lists.html. The surveyor records as much of the species name on the relevé form as is warranted by their confidence in the identity of the plant (e.g., *Solidago* sp., *Solidago nemoralis*, *Solidago nemoralis ssp. decemflora*, etc.). It is good practice to write the full binomial name of a species on the relevé form whenever a plant has been reliably identified to species, even if there is only one species of the genus in Minnesota; if data entry personnel are not familiar with a particular species they are likely to enter the species record exactly as it appears on the relevé form. (For example, if a surveyor recorded only “Amphicarpaea” on the relevé form, it is possible that the plant would be entered in the DNR’s relevé database only to the level of the genus, even though there is only one species of *Amphicarpaea* in Minnesota (i.e., *A. bracteata*).) It is conventional to record dead individuals of canopy tree species separately from live individuals of the same species. Species record lines for dead specimens are denoted by entering the code “DD” in the Remarks field (see Remark Codes below).
One aspect of identifying height classes that merits closer attention is the method of delineating height classes for canopy trees in a forest relevé. Some surveyors delineate the canopy as ranging from the lower parts of the crowns of the canopy trees to the tops of the canopy trees. This method tends to provide insight into vegetation structure and ecological function.

### Tree Canopy Code

The physiognomic groups for canopy tree species in forest, woodland, or savanna communities are given an additional label (“Ca”) to document that the group forms the tree canopy of part of the community. This method allows for the identification of the canopy trees to the tops of the canopy trees. The method tends to provide insight into vegetation structure and ecological function.

### Coverage Class Codes

Coverage class codes are one-letter codes that indicate the percent of the leaf area covered by each species or group of species. The cover is defined as the percent of the leaf area that would be covered by the downward vertical projection of the leaf area. Coverage class codes are written in lowercase letters to distinguish them from the life-form codes.

### Soil Layer Table

Soil layers are described by recording changes in soil texture and soil depth at which they occur. Appendix I contains a key with instructions for determining the texture of soil layers. The soil texture is recorded in the soil layer table. The bottom layer of the profile is recorded as rock (RO).

### Table 7: Height Class Codes

<table>
<thead>
<tr>
<th>Height Class</th>
<th>Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>&gt; 35</td>
</tr>
<tr>
<td>7</td>
<td>20 - 35</td>
</tr>
<tr>
<td>6</td>
<td>10 - 20</td>
</tr>
<tr>
<td>5</td>
<td>5 - 10</td>
</tr>
<tr>
<td>4</td>
<td>2 - 5</td>
</tr>
<tr>
<td>3</td>
<td>0.5 - 2</td>
</tr>
<tr>
<td>2</td>
<td>0.1 - 0.5</td>
</tr>
<tr>
<td>1</td>
<td>0 - 0.1</td>
</tr>
</tbody>
</table>

### Table 2: Soil Texture Class Codes

<table>
<thead>
<tr>
<th>Texture</th>
<th>Cl, clay loam</th>
<th>SCL, sandy clay loam</th>
<th>SC, sandy clay</th>
<th>LS, loamy sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>sand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>loam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCL</td>
<td>sandy clay loam</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 3: Organic Soil Layer Codes

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>peat</td>
</tr>
<tr>
<td>MP</td>
<td>mucky peat</td>
</tr>
<tr>
<td>MU</td>
<td>muck</td>
</tr>
<tr>
<td>-m</td>
<td>moss origin</td>
</tr>
</tbody>
</table>

### Figure 9: Example of physiognomic group labeled as tree canopy.
Measurements of depth are recorded for the top and bottom of each layer. Note that the same number will be entered for the bottom of a given layer and the top of the layer immediately below it. If the bottom of the soil profile is encountered below the bottom of the soil profile, all the fragments in any given layer should be recorded. The percent volume of coarse fragments in any given layer is represented by the number of rock fragments, defined by fragment size (Table 5). The height of the plants in each physiognomic group is represented by numbers ranging from one to eight. These numbers are written after the life-form code in the physiognomic group line. The code for a given height class would be "1-3-6". In this example, the physiognomic group code is "F", which refers to floating-leaved aquatic species that have flowering parts extending above the water surface, such as Myriophyllum spicatum and Utricularia vulgaris. If all of the plants in a physiognomic group fall within one height class, a single height-class code is used. For example, if 10 to 20 meters in height, the physiognomic group code for height would be "1-3-4-6". In this example, the code for the physiognomic group would be "F". If the plants of a given height class are not strongly stratified or occupy more than one height class, a range of contiguous height classes is entered. For example, if just a few of the trees in the above example were taller than 35 meters and the rest were between 10 and 20 meters, the code might be "1-3-6-8".
**Physiognomic Group Variables**

**Life-Form Codes:** The life-form of each physiognomic group is represented by a one-letter code. This code is the first character of the physiognomic group line and is capitalized to distinguish it from the code for the physiognomic group coverage class (see Coverage Classes below). The definitions and codes for life-forms used by the DNR follow Küchler (1967). Appendix K provides a list of the life-forms for selected species in Minnesota whose life-forms are not obvious. A checklist of all vascular plant species in Minnesota with life-form (physiognomic) codes is available on the DNR’s website at www.mndnr.gov/eco/mcbs/plant_lists.html.

**Woody Plants**

**B = Broadleaf Evergreen.** This group of woody plants has broad leaves (as distinguished from needle-like leaves) that persist for two to several years. In Minnesota, this group is most often represented by members of the Ericaceae (Andromeda, Arctostaphylos, Chamaedaphne, Epigaea, Gaultheria, Kalmia, and the cranberry and lingonberry species in the Vaccinium genus). Also included are the non-ericaceous species Chimaphila umbellata, Hudsonia tomentosa, Empetrum atrorubescens, and E. nigrum.

**D = Broadleaf Deciduous.** This group of woody plants has broad leaves that are either shed annually or are dead (non-photosynthetic) during some part of the year. In Minnesota, this group encompasses many tree and shrub genera (e.g., Acer, Betula, Corylus, Fraxinus, Quercus, Ulmus, etc.).

**E = Needleleaf Evergreen.** This group of woody plants includes both needle-leaved and scale-leaved evergreens, which in Minnesota are all gymnosperms. The needle-leaved evergreen genera are Abies, Picea, Pinus, Taxus, and Tsuga; the scale-leaved genera are Juniperus and Thuja. By convention, Larix, the only needle-leaved deciduous genus in Minnesota, is currently placed in the needleleaf evergreen (E) group, although in the past it was separated into a needleleaf deciduous (N) group.

**Herbaceous Plants**

**G = Graminoids.** This group of herbaceous plants includes most plants that appear grass-like because of their long, linear leaves and unbranched form. In Minnesota, all members of the Cyperaceae, Juncaceae, and Poaceae are considered graminoids. Note: Typha species, although grass-like in form, are considered forbs. See Appendix K for a listing of other forb species in Minnesota that are grass-like in form.

**H = Forbs.** This group of herbaceous plants has broad leaves and is represented in Minnesota by many angiosperm families. By convention, ferns and fern allies are grouped with forbs.

**L = Lichens.** This group includes all lichens that grow on the ground (either on soil or bare rock). In Minnesota the lichen genera Cladonia and Parmelia are examples of ground-covering taxa. Epiphytic lichens are included in the epiphyte special life-form (see below).

**M = Mosses and Liverworts.** This group includes all mosses that grow on the ground (either on soil or bare rock). In Minnesota the moss genera Brachythecium, Hylocomium, Mnium, Pleurozium, Polytrichum, Ptilium, of disturbance species, or abnormally high abundance of forbs in a prairie is appropriate for the Remarks field). The location of the relevé plot also can be determined from information entered elsewhere (i.e., from the UTM coordinates) and should not be described under Remarks. If a detailed record of the plot location is necessary, one can either describe the location under Notes on the relevé form (for example, plot located 300m southeast of visitor station) or attach a sketch to the relevé form showing the location of the plot relative to nearby landmarks. Neither of these records is entered in the relevé database, but they are archived in the DNR’s manual relevé file in St. Paul. It is useful to record locational information in the Remarks field only when relating the relevé to a nearby feature (such as a road or a clearing) that may itself have some influence on the vegetation.

In analyses of relevés for vegetation classification in Minnesota, the most useful environmental information in the Remarks field has been:

- indication of vegetation quality (e.g., old-growth forest, mature forest, young forest, overgrown savanna, high-diversity prairie, etc.)
- the type, extent, and history (if known) of any disturbance (e.g., recently heavily grazed, hayed annually in late summer, clearcut in 1930s, recently selectively cut, margins with broad zone of reed canary grass, burned in 1980s, soils eroded and compacted, etc.). For forests in particular, it is helpful to note the presence of old stumps (especially old pine or cedar stumps in northern forests), the presence of a browse line, or potential evidence of earthworm activity (absence of duff over large patches, abundant worm castings). For prairies, noting the abundance of thatch or the abundance of forbs relative to graminoids is often useful. The absence of any evidence of disturbance is also useful to record.
- the growth form of trees (e.g., open-grown, forest-grown, crooked, forked, multi-stemmed, etc.) or the uniformity of tree crowns in a forest.
- the context of the relevé in the surrounding vegetation or landscape (e.g., plot upslope from nearby stream, relevé in 5-acre strip of pine forest on slope within area of oak forest, plot in upland forest island in large peat-
land, relevé in 10-acre prairie surrounded by cropland) or the presence of atypical or unusual landscape features nearby (e.g., plot located near base of steep cliff). This kind of information may help either to explain or to highlight the presence of plants in the relevé that are unusual for the community type. For upland communities, information on the presence of nearby rivers, streams, lakes, or wetlands has been useful.

- indication of anomalous microhabitat conditions (such as a canopy gap, a wet depression in an upland site, or dry hummocks in a swamp forest) that may explain the presence or absence of some plant species.

- basic hydrological observations that provide information about how water may be affecting the plot. Examples include the presence of vernal pools, seeps, springs, flotsam, and plant growth-forms indicative of flooding such as tussocks, stooks, and raised root systems. Also useful is information on the length of any slope above the plot.

Other useful kinds of information for the Remarks field are tree ages (when trees have been cored), presence of snags or downed logs, amount and decay-stage of coarse woody debris, presence of charcoal, or in general any information that might help to describe the structure or quality of the vegetation in the vicinity of the relevé plot. The Remarks field should also include information on relevé methodology when it deviates from standard procedures (e.g., relevé plot larger than 400 square meters). Because the Remarks field is limited to 1,000 characters, there may not be enough space to record all of the environmental information one might consider important. It is therefore common to write information under Notes when actually doing the relevé, and prioritize or condense the information afterward for entry into the Remarks field.

**Basal Area and Tree Diameter Measurements:** Tree diameter measurements provide useful information about stand structure and succession. If the surveyor has time, diameters at breast height (DBH) are recorded in centimeters for all trees in the plot larger than 10cm DBH. If the surveyor does not have time to measure all trees in the plot, measurements for a representative sample of trees larger than 10cm DBH are also useful. Diameters are listed separately by species. For each species, live trees (L) are recorded separately from standing dead trees (D). Indicate whether the list is complete or partial by circling the appropriate choice above the tree diameter table (Fig. 5).

<table>
<thead>
<tr>
<th>Basal Area &amp; Tree Diameters</th>
<th>DBH List (C)omplete (P)artial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
<td>L/D</td>
</tr>
<tr>
<td>Acer saccharum</td>
<td>L</td>
</tr>
<tr>
<td>Ulmus americana</td>
<td>L</td>
</tr>
<tr>
<td>Ulmus sp.</td>
<td>D</td>
</tr>
<tr>
<td>Tilia americana</td>
<td>L</td>
</tr>
</tbody>
</table>

**Prism Factor:** 10

**Relevé-Wide DBH Statistics (cm):**

Min: Max: Median:

**Figure 5.** Sample basal area and tree diameter data.
abundance, species distribution or sociability, and remarks about vegetative condition.

As illustrated above, the column headings on the relevé form refer only to the species data variables (reliability of i.d., cover, sociability, name, and remarks). The structural data codes (life-form, height class, and physiognomic group) are kept separate and are used to record the structure of the vegetation in the relevé. The surveyor is instructed to record the number of species, number of height classes, and number of physiognomic groups in the releve. The table below the column headings is used to enter the data for each species.

One potentially confusing aspect of doing relevés is determining the number of separate physiognomic groups within each relevé. The total number of groups is determined by the plant species present in the plot. The number of height classes that are delineated depends on the surveyor's field observations. In a forested relevé, for example, deciduous trees, coniferous trees, and shrubs would be delineated into separate height classes. In a grassland relevé, only one height class is used. The number of physiognomic groups in any relevé is dependent, to some extent, on the surveyor's field observations.

Another potentially confusing aspect of relevé species data is that it is common for a species to be recorded in several different physiognomic groups if it exhibits more than one life-form. For example, in a forested relevé, a species might be recorded in the canopy, subcanopy, and shrub layer. The number of physiognomic groups in any relevé is dependent, to some extent, on the surveyor's field observations.

Photos Taken: Photos of the plot often provide useful information about the condition of the vegetation. Photos are stored in the Division of Ecological and Water Resources Image Gallery and are associated with the releve by releve number. The surveyor can access these photos in the Image Gallery and use them to verify the relevé data entered into the releve database.

Vegetation Data

GENERAL OVERVIEW

The second side of the relevé data form (Fig. 6) has fields for recording releve information about the structure and condition of the vegetation. Relevé photos are stored in the Division of Ecological and Water Resources Image Gallery and are associated with the releve by releve number. The surveyor can access these photos in the Image Gallery and use them to verify the releve data entered into the releve database.

Notes: (Optional) As mentioned above, this space is provided for the surveyor to record any additional releve-specific information that might be useful in interpreting the releve or in providing a general impression of the vegetation, with information that might be useful in interpreting the releve data form entered into the releve database. This space is also useful in recording releve-specific information that might be useful in interpreting the releve data form entered into the releve database.

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In accord with the division of the vegetation in a relevé into groups by life-form and height, the vegetation and plant species data are recorded on the relevé form in blocks of data lines that delineate the layers based on the life-forms and heights of the plant species. Each species is divided into a tree canopy layer, a shrub and herb layer, a forbs layer, and a fine herb and moss layer. The data for each species in each layer are recorded on the datasheet along with their cover or abundance.

In this example, "E" is the life-form code for needle-leaf evergreen plants, "4–6" is the range of height classes of the plants in the layer (which in this case is 2 meters to 20 meters), and "c" is a code for the cover of the group. The first line of each group has a letter code designating the life-form class, and another letter code for the collective cover class of the group. The second line of the group has the life-form class range, and another letter code for the collective cover class of the group. An example of a physiognomic group line is:

E 4–6 c

The individual species records are written immediately below the physiognomic group line. Each species data record consists of a code indicating the reliability of the identification of the species, a code for the abundance of the species as a whole, and codes describing the vegetative state of the species. An example of a typical physiognomic record is given in Figure 7.

Figure 6. Example of physiognomic group.

The first line of data in this example (E 4–6 c) gives the life-form, height class range, and another letter code for the collective cover class of the group. As an example, within the physiognomic group "E," the data record for the species "Pinus strobus" (E 4–6 c) indicates the species' reliability, cover, and vegetative state.

Figure 7. Example of physiognomic record.