# Chapter 5

## A Handbook for Collecting Releve Data in Minnesota [1]

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[1] This is one of several versions of the Releve Handbook. Omitted from this version are several length appendices that cover topics specific to Minnesota. A complete version of the Handbook and information on data management systems for releves are available from J. C. Almendinger at the above address.

## INTRODUCTION

The procedure for collecting and summarizing vegetation data at almost any scale involves four "essential steps" (Mueller-Dombois and Ellenberg 1974). First, the researcher must define the area to which the study applies and then segment the study area into preliminary vegetation units. Second, for each preliminary vegetation unit. the researcher must select the stands to be sampled. Third, a sampling method must be chosen. And fourth, the researcher must decide what properties of the vegetation to measure. Several approaches might be adopted to complete these steps, and choosing the best or most practical approach requires (1) a clear definition of the project purpose and (2) field reconnaissance.

The purpose of this handbook is to explain how the Minnesota Natural Heritage Program (MNHP) has approached these four essential steps to accomplish specific goals and al so to promote general interest in studying the vegetation of Minnesota. The first section of the handbook -- Using Releves to Study the Vegetation of Minnesota -- describes in general whet the goals of the MNHP are and how the releve method of vegetation analysis (Mueller-Dombois and Ellenberg 1974, Westhoff and Van Der Maarel 1978) is used to meet those goals. This first section also describes the initial classification of Minnesota's vegetation and how sample stands are Located in those units (steps 1 & 2 above). The second section of this handbook -- The Minnesota Natural Heritage Program Releve Methods -- describes in detail the technical aspects of the releve sampling method as practiced by the MNHP staff [steps 3 & 4 above]. This section includes both releve field methods, and the transcription of releve site information from maps and other scientific literature.

The Minnesota Natural Heritage Program encourages researchers working in Minnesota to contribute their releve data to the MNHP database. By doing so, contributors gain access to the entire releve database and to the MNHP staff for assistance in any phase of collecting or analyzing releve data. By following the guidelines set forth in this handbook, researchers are assured that releve data of comparable quality can be obtained to extend their datasets or to construct datasets for hypothesis testing. Individuals or institutions needing vegetational data or distributional data on particular plant species should contact the MNHP for more information.

**General Description of a Releve Sample**

Releve is a French word with one connotation that translates to the English word "abstract" (see Mueller-Dombois and Ellenberg 1974). As a Literary abstract is a concise summary of a body of text, a releve is a concise summary of a unit of vegetation. Note that both the releve and the literary abstract are used to characterize a predetermined unit. Thus, releves are used to characterize larger vegetation units that have already been classified according to some criteria. These criteria might be related to geography, physiognomy, canopy dominants, or environmental gradients. The criteria selected depend entirely upon the purpose of a particular study. Releve data can be used to express the variability of the vegetation within each predetermined unit and also to express the hierarchal relationship among those units.

Physically, releves are small plots, within which the vegetation is described both structurally and compositionally. Releve plots are typically square and may cover 25 to 1000 square meters. The vegetation structure is recorded by estimating the collective cover of taxa in life-form groups that form the height strata characteristic of the stand. For example, the strata recorded in a deciduous forest would typically include three strata of woody, deciduous species (trees, shrubs, and seedlings), as well as separate stratum Layers for graminoids, mosses, and herbs. Then, for each stratum. the cover of each component species is recorded. Thus, plant occurrences are recorded by Life-form group, then by height stratum, and finally, by species -- making it possible fur a species to be doubly recorded if it occurs in different height strata or in different Life-form groups. Releve data, therefore, are multidimensional and may be numerically ordinated or classified on a physiognomic/life-form basis or a floristic basis.

**General Description of the Releve Method of Analysis**

The releve method has come to represent not only a method of vegetation sampling, but also a method of data analysis. At the heart of the releve method of analysis is the phytosociological table. The rows of a phytosociological table record the occurrence of a particular species in a set of releves (columns). Thus, the cells of the species by releve matrix contain information about a species (row designate) in a particular releve (column designate). Cell values are usually cover estimates, which are often accompanied by an indication of how that species is distributed within the releve plot (sociability). The rows and columns of a phytosociological table are arranged so that spacies having similar distibutions among the rel eves are placed in contiguous rows, and releves having similar sets of species are placed in contiguous columns. A table thus arranged (Table 1.1) is an effective way to visually summarize releve data, and it provides a basis for a hierarchal classification of the releves.

**Table 1.1** A sample phytosociological table showing how releves with similar species occurrences are placed in contiguous columns and how species with similar distributions among the releves are placed in contiguous rows. The table elements are Braun-Blanquet cover values. (The table data were selected from Almendinger, 1985)

| Releve Number | 253345 980267 | 235 46556 | 1 78901 | 444 34045 | 21221 23565 | 55124 34608 |
|---|---|---|---|---|---|---|
| Hieracium scabrum | 12221. | ..... | ..... | ...1. | ..... | ..... |
| Equisetum hyemale | 2.1.2. | .1... | ..... | ..... | ..... | ..... |
| Epigea repens | 222... | .1... | ...2. | ..... | ..... | ..... |
| Polygala paucifolia | .22222 | ..... | ..... | ..... | ..... | ..... |
| Picea glauca | .211.1 | ..2.. | ..... | ..... | ..... | ..... |
| Pyrola virens | .212.. | ..2.. | ..... | ..... | ..... | ..... |
| Linnaea borealis | .....2 | ...22 | 2.22. | .21.2 | ..... | ....2 |
| Betula papyrifera | ....2. | ...32 | .22.1 | 2..2. | 2.... | ..... |
| Acer rubrum | ..... | ...3. | .23.2 | 2.221 | ..... | ..... |
| Monotropa uniflora | .....2 | ..2.2 | ..... | 22.1. | ..... | ..... |
| Pyrola rotundifolia | ..... | 2.... | ..... | .1222 | ..... | ..... |
| Smilax herbacea | ..... | .1... | ..... | ..... | 21.21 | 2.11. |
| Populus tremuloides | ..... | .3... | ....3 | ..... | .3.2. | 2...2 |
| Puercus borealis | ..... | ..... | ..... | ..2.. | 1.1.2 | .21.. |
| Quercus macrocarpa | ..... | ..... | ..... | ..... | ..2.2 | .52.. |
| Amorpha canescens | ..... | 2.... | ..... | ..... | 2.... | .21.. |
| Prunus serotina | ..... | ..... | ..... | 1.1.. | ..... | 22122 |
| Cornus racamosa | ..... | ..... | ..... | ..... | ..... | ..2.2 |
| Viburnum rafinesquianum | ..... | ..... | ..... | ..... | ....1 | .2212 |
| Pyrola asarifolia | .2.... | ..... | ..... | ..... | 2.... | ...21 |
| Viola sororia | ..... | ..... | ..... | ..... | ...2. | 2.... |

The procedures for arranging the rows and columns of a phytosociological table were developed in Europe by Braun-Blanquet (1928, 1932) and his associates at Zurich and Montpellier (see Westhoff and Van Der Maarel 1978 for European references). These procedures were the subject of considerable debate in Europe, which inevitably led to the formation of vegetational ideology and terminology. The ideology of the followers of Braun-Blanquet (the Zurich-Montpellier School, see Becking 1957) dictated how tables were to be rearranged or compared to best illustrate the "natural" grouping of species into associations -- the fundamental vegetation unit. The three major premises of the Zurich-Montpelier School ideology are: (1) plant communities are best recognized by their floral composition with equal weighting of the component species, (2) a subset of all species in a table have wil l have "diagnostic" properties that will consistently al low for the identification of a particular plant community, and (3) "diagnostic species" (character species,

differential species, or constant companions] can be used to create a hierarchal classification of the plant communities (Westhoff and Van Der Maarel 1978). The terminology of the releve method as it pertains to species, spacies groups, or groups of releves is linked to a particular table. That is, terms like character species, differential species, and constant companions are applied to species by calculating table-dependent statistics like presence, fidelity, and constancy. The hierarchal classes of releve groups are named according to formal rules of nomenclature and a structured taxonomy beginning with divisions as the largest units, followed by classes, orders, alliances, and finally associations.

Today, most plant ecologists perceive plant communities as varying continuously along complex environmental gradients (Gauch 1982, Whittaker 1967). This perception of plant communities is reflected in the commonly used methods of analysis. This is particularly true of ordination and direct-gradient analysis, where the continuity of sample variation is obvious in the graphically displayed results. In spite of a shift away from the Zurich-Montpellier School's ideology and terminology, the phytosociological table -- the backbone of their method -- remains as particularly useful way to display vegetation data. Grouping releves of similar species composition and grouping species with similar occurrence patterns is particularly conducive to constructing hypotheses about the factors controlling plant distributions. Unlike ordination results, phytosociological tables retain all of the sample information. It is good practice to create a phytosociological table to help interpret a particular ordination or classification by allowing the ordination scores or classification groups to determine the order of the rows and columns of the table. Phytosociological tables may be constructed directly from programs where reciprocal averaging (correspondence analysis) is the primary algorithm for determining spacies or sample scores. Of such programs, TWINSPAN (Hill 1979) is the most consistent with the Braun-Blanquet method of producing a phytosociological table.

### The Need For Community Data in a *Natural* Heritage Program

A major function of the Minnesota Natural Heritage Program is to maintain a database of "element occurrences" according to a set of guidelines prepared by The Nature Conservancy (1986). The term "element" may apply to any component of a natural ecosystem -- particularly plant and animal species, natural landscape features, and plant communities. The element concept is fairly straightforward when applied to species because a physical specimen may serve as an element occurrence record and that specimen may be identified as a particular species (element) according to a documented taxonomic classification system. In contrast, the occurrence of a plant community element is difficult to record objectively because there is no agreement as to what constitutes an individual specimen (record), nor is there a universally accepted classification system. Plant communities lack a mechanism for inherent redundancy such as reproduction within the relatively narrow confines of a species genome. In spite of the obvious problems of dealing with community elements, the MNHP is charged with the responsibility of (1) identifying community element occurrences, (2) classifying those occurrences, (3) determining the relative rarity of community classes, and (4) recommending management or protection policies for the rarer community types.

A state Natural Heritage Program may meet the above responsibilities on a short-term basis by constructing a vegetation classification system from the available literature. One problem in doing so is that different researchers use different vegetation sampling methods, resulting in classification systems that are not generally comparable. That is, it is often impossible to merge several datasets and reclassify the samples in an attempt to determine which community types are equivalent or different among the studies. A second problem is that researchers tend to focus on small areas, and the resulting classifications are not applicable on a state-wide scale, i.e. the community distinctions are too fine. Thus, a state-wide classification pieced together from several local studies results in too many community types, most of which are artificially rare.

An alternative to a literature-based classification is for Natural Heritage Programs to collect their own vegetation data and then produce a community classification appropriate for their own needs. In most cases, this is prohibitively time consuming and expensive. In Minnesota, however, this is not the case. The consistency of instruction at the University of Minnesota has led several researchers to adopt the releve method of vegetation sampling. There are nearly 1,500 releves of comparable quality available to the MNHP (Almendinger 1985, Glaser 1983, Glaser et al. 1981, Glaser and Wheeler 1977, Janssen 1967; end unpublished data from the Minnesota Natural Heritage Program, Coper-Nickel Project. Kawishiwi Mapping Project, The Nature Conservancy, Chippewa National Forest, Nerstrand Woods State Park, and other miscellaneous sources). Thus, much of the data necessary for a preliminary, statewide community-classification has been collected -- but until now, there has been no serious attempt to compile all of this information.

## Natural Communities as Pre-Defined Vegetation Units

A primary goal of the Minnesota Natural Heritage Program (MNHP) is to identify and conserve ecological communities that are rare on a state-wide scale. The first step in meeting the above goal was to devise a community classification system based upon ecological criteria that vary continuously across Minnesota. The Natural Community classification [Fig. 1.1, Wendt 1984) was the result of this first step, and the definitive ecological criteria include several habitat features -- vegetation, floristic province, topography, hydrology, land form, substrate, and soils. These criteria are by no means equally weighted or evaluated in a specified order. A natural community is subjectively named by its most characteristic feature -- biotic or abiotic -- such as Sioux Quartzite Outcrop, Calcareous Fen, Jack Pine Forest, or Gravel Prairie. Because vegetation integrates much of the variability of abiotic habitat features, Natural Community distinctions are strongly correlated with vegetation.

The Natural Community classes were initially identified from the existing literature on the vegetation and natural areas of Minnesota. The classes are also intentionally broad, so that the classification of any particular site is relatively unambiguous. The literature base and the broad categories make it easy for anyone familiar with Minnesota's natural areas to envision the appearance of a site based upon its class designation. Thus, the classification serves well the need for communication among researchers.

teachers, students, naturalists, legislators, and others interested in the conservation of natural areas. The classification is less useful for other purposes and interests. For example, management plans for particular sites need more detailed information on the vegetation and abiotic features. The classification is also too coarse to demonstrate meaningful relationships between vegetation end environmental gradients. The lack of a true hierarchical structure makes classification revisions at any level (clustering or splitting) equally subjective.

Recognizing the need for more detailed descriptions of the vegetation and the need to classify the vegetation more objectively, the MNHP initiated the RELEVE project in 1986. With regard to the Natural Community classification, the MNHP plans to use releve data to (1) describe the variability of the vegetation within Natural Communities and (2) to establish a hierarchical relationship among Natural Community classes where the vegetation is the primary factor distinguishing the classes. To serve this need, releves collected by the MNHP staff have been subjectively located within areas representative of a particular Natural Community class -- i.e. the Natural Community classes are the pre-determined units (see Step 1, Introduction) controlling the location of releves. The MNHP releve database also contains releves located by site (management projects) and by plant community (University of Minnesota studies). For anyone using the MNHP releve database, it is critical that they understand the criteria used to initially locate the releves that make up the subset to be ordinated or classified. Extensive site information is kept on each releve so that researchers can evaluate the degree to which a subset of releves from the MNHP database meets their own criteria for analysis.

**NATURAL COMMUNITIES OF MINNESOTA**
**Minnesota Natural Heritage Program**

**Format Communities**

Aspen - Birch Forast
Black Spruca - Feather Moss Forast
Floodplain Forast
Great Lakea Pine Forest
Maple - Basswood Forast (Big Woods Section)
Maple - Basswood Forast (Drifltless Section)
Maple - Basswood Forest (East Central Section)
Maple - Basswood Forest (West Central Section)
Mixed Oak Forest
Northern Hardwood - Conifer Forest
Spruca - Fir Forest
Upland White Cedar Forest

**Savanna end Parkland Communities**

Aspen Parkland Complex
Dry Sand Savanna, Jack Pine Subtype
Dry Send Savanna, Oak Subtype
Mesic Blacksoil Sevenna

**Prairie Corunitiaa**

Bluff Prairie
Dolomite Prairie
Dry Send Prairie
Glacial Till Hill Prairie
Gravel Prairie
Mesic Blacksoil Prairie (EC)
Mesic Blacksoil Prairie (NW)
Mesic Blacksoil Prairie (NW) Calcareous Seepage Subtype
Mesic Blacksoil Prairie (NW) Saline Subtype
Mesic Blacksoil Preiria (SE)
Mesic Blacksoil Prairie (SW)
Mesic Blacksoil Prsiris (SW) Sioux Quartzite Subtype
Wet Blecksoil Prairie (EC)
Wet Blecksoil Prairie (MI)
Wet Blacksoil Prairie (SE)
Wet Blecksoil Prairie (SW)

**Wetland Communities**

Calcareous Fan
Conifer Swamp
Emergent Marsh
Floating-Leaved Marsh
Forested Bog
Hardwood Swamp
Opan Bog
Patterned Peatland Complex
Poor Fen
Rich Fen
Sedge Meadow
Shrub Swamp
Submergent Marsh

**Primary Corunitiaa**

Algific Talus Slope
Bedrock Beach
Cobble Beech
Dry Cliff (Driftless Section)
Dry Cliff (NE)
Granite Outcrop (MNR Valley)
Moist Cliff (Driftless Section]
Moist Cliff (NE)
Sand Beach
Sioux Quartzite Outcrop

**Figure** 1.1 The Natural Communities of Minnesota (Wendt 1984), which serve as the pre-determined units controlling the distribution of releves taken by the Minnesota Natural Heritage Program staff. Releves are generally located within stands characterfstic of the above communities. Abstracts dascribing the general appearance and composition of some of the above communities are available at the MNHP office.

## LOCATING AND CONSTRUCTING THE RELEVE PLOT

### Releve Location

Locating releves within sample stands is probably the most critical field decision to influence the results of a vegetation study. In a well-designed study, the landscape is initially segmented into study units by some predetermined criteria, eg. management units, forest cover-types, physiographic units, soil units. etc. Sample stands from within each study unit should be chosen by design (random, stratified-random, systematic, etc.) and then sampled by releve. If releve plots are not placed within areas of the sample stand that are representative of the study unit, then the purpose will not be met. More specifically, a researcher would not be able to use the segmentation criteria or sampling design to draw inferences about the vegetation as it is perceived from the releve samples. Thus, the very first consideration that one should have when surveying a sample stand is to identify the portions of the stand that meet the criteria that define the study unit to which it belongs.

After acceptable portions of the sample stand are located, the surveyor should then consider the vegetation itself. Because the segmentation criteria (management units, cover types, soils. etc.) vary at a coarser scale than the vegetation, the vegetation will appear to vary within acceptable sampling areas. (If it did not, then a single releve would be sufficient to sample a stand.) One of the major purposes of sampling the stand is to express the variability of the vegetation within the study unit and the releves should be placed in a way to record that variability.

In the releve method, the process by which one surveys the vegetation of acceptable sample stand areas is called entitetion, i.e. visually dividing the vegetation into apparently homogeneous entities. The requirement of homogeneity applies to both the canopy and the understory vegetation. Obviously, entitation involves the recognition of vegetational boundaries, and the releve plot should not be placed near boundaries. It it especially appropriate to record on a releve data sheet some impressions about the vegetational entities within a stand and the nature of the boundaries between them (diffuse, sharp, etc.). It is also appropriate to hypothesize as to what environmental factors are causing the apparent vegetational pattern. The convention for recording these observations on the MNHP Releve Data Sheet (see next subsection, Figures 2.1 and 2.3) is to record observations about the stand in general under the "Notes or Other Data Collected" section, and to record the position of the actual releve plot ralative to the entities and boundaries in the "Remarks" data-entry field

The importance of entitation should not be underestimated. Remarks concerning entitation are field data, and as such, a review of thesa remarks is a valid means of rejecting sample stands or even reassessing the criteria by which the predetermined study units were defined. Most vegetation studies would be improved if the cycle of defining segmentation criteria and entitation was repeated several times before the first releve plot was described.

**Releve Size and Shape**

A releve should be sufficiently large to include most species having a regular distribution within the sample stand. The appropriate releve size for a particular vegetation unit can be determined empirically by sampling nested plots and then plotting the number of species recorded versus plot size (Fig 2.1). For vegetation of temperate regions, the species/releve – area curve assymptotically approaches some maximum number of species as the releve size increases, i.e. the derivative approaches zero with increasing sample size. There are formal rules for using such curves to determine the "minimal sample area" for a vegetation unit (see Mueller-Dombois and Ellenberg 1974). In traditional European releve work, the "minimal sample area" is often considered a property of vegetation units.

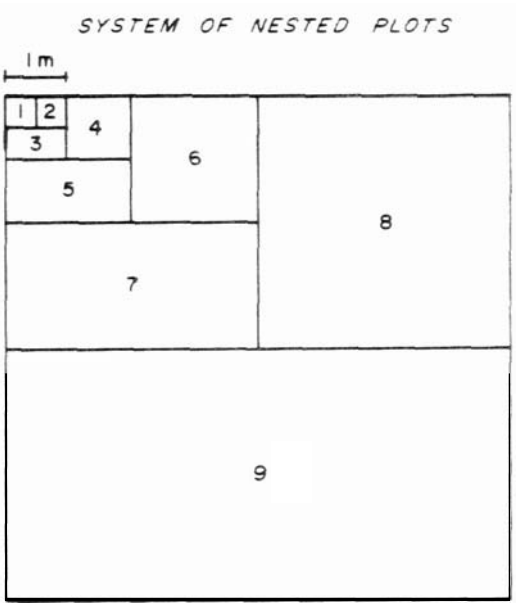
In practice, the "minimal sample area" is sufficiently correlated with the structure and life – form of the vegetation so that it is not necessary to determine minimal releve sizes for each new study. Guidelines for releve sizes in communities of different physiognomy can be found in Mueller-Dombois and Ellenberg (1974), Westhoff and Van Der Maarel (1978), Benninghoff (1966), and Table 21 For the vegetation of Minnesota, a 400 square meter plot in forested communities and a 100 square meter plot in treeless communities safely exceed the minimal sample areas for those physiognomic units.

**Table 2.1** Minimal area values for physiognomically distinct plant communities. Releve plot sizes should exceed the minimal area values. Compiled from Westhoff and Van Der Maarel (1978) and from Mueller-Dombois and Ellenberg (1974).

| PLANT COMMUNITY | SIMILAR MINNESOTA COMMUNITY | AREA $m^2$ |
|---|---|---|
| Tropical rain forest | | 200 - 1000 |
| Temperate deciduous forest | Maple – basswood forest | 100 - 500 |
| Dry grassland | Upland prairie | 50 - 100 |
| Scrub communities | Oak barrens | 25 - 100 |
| Weed communities | Old – field | 25 - 100 |

The MNHP uses square releve plots--20 x 20 meters in forest and 10 x 10 meters in prairie or open wetlands. The shape of the plot and its orientation (if not a square or circle) are important only if it interacts with a regular or periodic vegetation pattern. For example, the "string bogs" of Minnesota consist of alternating peat ridges and inundated troughs, topographically resembling the surface of a washboard. In some regions these ridges and troughs are sufficiently narrow so that a 10 x 10 meter square releve plot would always contain a portion of both trough and ridge. Under such circumstances it migh be advisable to use long – rectangular releve plots,

placing them entirely on a ridge or trough if the vegetation of those two features is to be contrasted or, alternatively, placing them transverse1y across the ridges and troughs if the vegetation of the area as a whole is to be compared with some other type of bog vegetation. Releve shape might also be altered when sampling vegetation that varies with regard to slope or aspect. The specific purpose of a vegetation study should dictate releve shape.



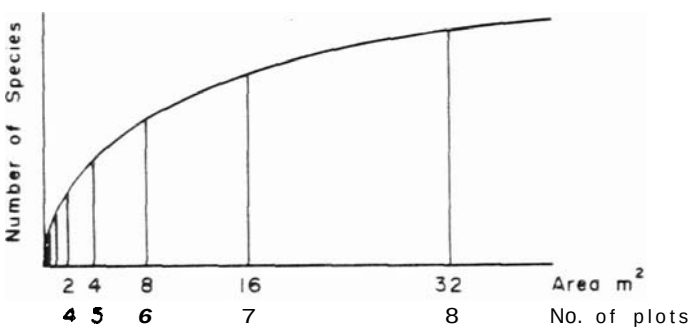




Figure 2.1 A nested-plot system used to determine minimal area, and a hypothetical species/area curve for the system. In general, a releve plot is considered to be sufficiently Large when doubling the sample area results in en increase of less then 10% in the number of species -- 32 $m^2$ om the above example. (After Mueller-Dombois end Ellenberg 1974)

**Mapping the Releve Site**

After deciding upon the location, size, and shape of a releve plot. the location of the plot should be mapped while in the field. The Location should be plotted on e 7.5 minute U.S.G.S. topographic map and when possible, one should also plot the releve on the appropriate air photograph and township plat. A photocopy of the appropriate map sections should later be made and attached to the field form. This much effort in the field greatly expediates the transcription process end aids in relocating permanent releve plots.

It is appropriate to sketch on the topographic map or on a separate piece of paper, unmapped features that would aid in relocating a releve site. Sketch maps showing trails, fencelines, buildings, clearcuts, etc. should be photocopied and attached to the Releve Data Sheet.

**Constructing the Releve Plot**

The final step to be completed before filling out the Releve Data Sheet is to lay out the actual releve plot. For most work, the plot boundaries and corners can be established by measuring along the perimeter of the plot and turning 90º at each corner. The 90º angles may be turned by using a field compass or by measuring – in small, right triangles (30-60-90 or 45 – 45 – 90 triangles) in the releve corners. Releve plots (10 x 10 m) established in this manner generally close to within 0.5 m of the point of origin (i.e. within 3 $m^2$ of 100 m2).

**THE MNHP RELEVE DATA SHEET**

After the releve plot has been properly located and constructed, the actual releve data are recorded. This is accomplished by filling out both sides of the MNHP Reieve Data Sheet (Figures 2.2 and 2.3). Copies of the MNHP releve date sheet, suitable for photocopying. are available from the MNHP office.

Site information is recorded on the "SITE INFORMATION" side of the data sheet, by filling in blenk date – entry fields (Figure 2.2) Some of these data-entry fields ere filled in <u>while in the field</u> end others are filled in while <u>in the office</u> by transcribing site information from maps, lists, or tables.

The structure and species – composition data are entered on the "VEGETATION" side of the Releve Data Sheet (Fig. 2.3) while in the field. Structure data lines and species occurrence records are entered in the rows of a blank table with the appropriate. labeled columns. Some site information fields are repeated on this side of the Releve Data Sheet so that single – sided photocopy would contain sufficient site information to find the computer record of that releve in the MNHP database.

**Recording Site Information**

General information about the site, locational information, and specific information about the releve plot are recorded on the SITE INFORMATION side of MNHP Releve Data Sheet (Fig. 2.2). All of the data-entry fields are of a specific length and of a specific type (character or numeric). The reason for this is that the data entered in these fields is eventually entered into the MNHP computer database as the values for variables of specific length and type. Much of the information entered in these fields is coded so that it can be more efficiently stored and retrieved on the computer. Code dictionaries end coding schemes are available from the MNHP office.

**SITE INFORMATION VARIABLES**

DNR Releve Number, Transcribed variable. Each releve is assigned a four-character number as it is entered into the MNHP releve database. The numbers are assigned by the HNHP data-manager. Numbers less than 1000 are to be prefixed with "0"s to fill out the entry field, e.g. releve number 35 is entered as "0035."

Surveyor's Releve Number. Field variable. The surveyor should identify the releve plot with a number or code. This code should be created by the individual surveyors to distinguish the releve from others that they have col lected. The code can be any combination of alphabetic or numeric characters, in an eight-character field.

Surveyor's I.D. Code. Field variable. Surveyors should enter their identification codes in the three-character field. The code is generally the surveyor's initials, however the surveyor should first check with the MNHP data manager to avoid duplicate coding of surveyors with the same initials. Surveyors without an assigned I.D. code should fill in the parenthetical blank with their full name so that the MNHP data manager can make the code assignment.

Date: Field variable. The date of the month is entered in a two-character field. Because it is a character field, single-digit dates dates should be prefixed with a "0," e.g. 04 for the fourth day of the month. Otherwise "04" and "_4" and "4_" will not be interpreted by the computer as the same date.

Month. Field variable. The first three letters of the month are entered in the three-character field.

Year. Field variable. The full four-digit AD year is entered in the four-character field.

Site Name Code. Transcribed variable. The four-character code for site name is entered by the MNHP data manager.

**MINNESOTA NATURAL HERITAGE PROGRAM**
Department of Natural Resources
BOX 7, 500 Lafayette Road
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FORM CREATED -- February 1987

---------- **SITE INFORMATION FOR MINNESOTA VEGETATION DATABASE** ----------

**GENERAL INFORMATION** ----------
DNR Releve Number: 0002 Surveyor's Releve Number: JD-061
*Surveyor's I.D. Code: JCA ( JOHN C. ALMENDINGER )
Date: 04 Month: AUG Year: 1986 (e.g. 16 JUL 1986)
Site Name Code: NONE ( NO FORMAL SITE NAME )
DNR Ownership Code: 00 ( PRIVATE, NORTHWEST PAPER CO. )
*Natural Community Code: JP ( JACK PINE FOREST )
*Natural Community Section: -- ( NONE )
*Natural Community Subtype: -- ( NONE )
Element Occurrence Ranking: B
In Acres give the Element Occurrence size: 160 and Site size: 280

**LOCATION INFORMATION** ----------
State Code: MN *County Code: 18 ( CROW WING )
Quadrangle Codes DNR: 6130 Universal: 46094S1 ( TROMMALD )
Township (e.g. 141N): 136N Range (e.g. 32W): 27W Prin. Meridian: 5
Section (e.g. SW of NE of section 31): NW of SW of section 32
Latitude: 46 degrees, 33 minutes, 00 seconds
Longitude: 94 degrees, 07 minutes, 05 seconds

**RELEVE INFORMATION** ----------
Releve size (sq. m): 400 Elev: 1215 Slope (e.g. 15SW): FLAT
From the Minnesota Soil Atlas give the Soil Landscape Unit: SSWL and
the *Geomorphic Unit: 013 ( CROW WING OUTWASH PLAIN )

Remark: OPEN STAND OF JACK PINE BETWEEN BONNIE AND BASS LAKES. STAND MIXED WITH SOME 8/4 RED PINES, OAK, & BIRCH, AND ASPEN. RELEVE IS ON LEVEL GROUND, SOILS MENAHGA SERIES, POSSIBLY DUNE SAND (200 Char)

**OTHER DATA COLLECTED** (Y or N Reference to Other Datasets) ----------
Soils: Y Forestry: N Water-Chemistry: N Elements: N Publication: N

The above form is identical to the data-entry screen used for the Minnesota Natural Heritage Program's releve data-base. All plant ecologists collecting releves in Minnesota are encouraged to use and contribute to this data base. Dictionaries of the various codes and general instructions for collecting releves can be obtained by contacting the Heritage staff.
* = Variables with computerized code dictionaries.

---------- **NOTES OR OTHER DATA COLLECTED** ----------

EXACT PLOT LOCATION PLOTTED ON TNP PLOT MAP, SEE ATTACHED COPY.

**Figure 2.2** The "SITE-INFORMATION" side of the MNHP Releve Data Sheet.

DNR Ownership Code. Transcribed variable. The two-character code is entered by the MNHP data manager. The dictionary of ownership codes is found in the MNHP Operations Manual. If the surveyor knows the land ownership, the owner's name should be entered in the parenthetical blank. When possible a township plat map showing the location of the releve should be attached to the Releve Data Sheet to aid in transcribing this variable.

Natural Community Code, Transcribed variable. The surveyor should enter the two-character code. The dictionary of codes for Minnesota Natural Communities is available from the MNHP office. If the surveyor is not certain as to which natural community to assign to the releve, a list of the possible community codes should be included in the parenthetical blank.

Natural Community Section, Transcribed variable. The surveyor should enter the two-character code. The natural community section codes and maps ere available from the MNHP office.

Natural Community Subtype Transcribed variable. The surveyor should enter the two-character coda. The natural community subtype codes are available from the MNHP office.

Element Occurrence Ranking. Transcribed variable. The two-character element occurrence ranking is assigned by the MNHP data manager. The rules for determining the rank are described in detail in the MNHP Operations Manual.

Element Occurrence Size. Field variable. The number of acres characterized by the releve are entered in the four-numeric field. The surveyor should review the entitation process in the "Releve Location" section above in order to make this estimate.

Site Size. Transcribed variable. The number of acres of the site is entered in the five-numericfield by the MNHP data manager. For small sites the acreage is often known with some precision (e.g. TNC properties, Scientific and Natural Areas, etc.). For very large sites like the Red Lake Peatlands or the Superior National Forest, site size should roughly correspond to the size of the forest cover-type within which the releve occurs.

State Code, Field or Transcribed variable. The surveyor should enter the standard, two-letter, U.S. Postal Service state coda in the two-character field.

County Code. Field or Transcribed variable. The surveyor should enter the number code for the Minnesota county in the two-character field. The dictionary of county codes is available from the MNHP office.

DNR Quadrangle Code. Transcribed variable. The four-character code is entered by the DNR data manager. A dictionary of DNR codes for USGS quadrangles in Minnesota is kept in the MNHP offices. To avoid transcription errors, it is good practice to enter the quadrangle name in the parenthetical blank while in the field.

Universal Quadrangle Code. Transcribed variable. The seven character code is entered by the MNHP data manager. A dictionary of Universal codes for quadrangles in Minnesota is kept in the MNHP offices.

Township. Field variable. The surveyor should enter the township number and the direction relative to a standard parallel in the four-character field. The number of the township is entered in the first three field blanks. with two-digit township numbers being prefixed with a "0," eg. township 34 north would be entered as "034N." In Minnesota, all townships are north of the reference parallel, therefore, "N" will always be the fourth character of this field in Minnesota.

Range. Field variable. The surveyor should enter the renge number and the direction relative to a principal meridian in the three-character field. The number of the range is entered in the first two field blanks, with single-digit range numbers being prefixed with a "0," e.g. range 2 west would be entered as "02W."

Principal Meridian, Transcribed variable. The surveyor should enter the number of the principal meridian that references the range given above. It is a one-character field. In Minnesota, ranges are west of the 5th principal meridian, and they are either west or east of the 4th principal meridian. A map showing the regions of Minnesota that ere relative to the 4th and 5th principal meridians is available from the MNHP office.

Section. Field variable. The surveyor should locate the releve to quarter-quarter-section accuracy (approximately 40 acre cells). The two-character quarter-quarter-section field precedes that of the quarter-section field, and they are both filled in with the following codes: NE, northeast; NW northwest; SW, southwest; SE, southeast. If the releve Location is near a boundary and its quadrant location questionable, half-sections and half-quarter-sections may be indicated by the following codes: N, north; S, south; E, eest; W, west. The section number is entered in a two-character field, with single-digit section numbers prefixed with a "0," e.g. section 3 is entered as "03."

Latitude and Longitude, Transcribed variable. The surveyor should record the location of the releve by latitude and longitude by entering the degrees, minutes, and seconds in their respective two-character fields. A special map overlay for determining the latitude end longitude of a point on a 7.5 minute USGS topographic map is kept at the MNHP office.

Releve Size. Field variable. The releve size in square meters is entered in a three-numeric field. If a releve is larger then 999 square meters, 999 should be entered and the actual size of the releve indicated in the "Remarks" data-entry field. The convention is to right-justify areas Less than 100 square meters within the data-entry field.

Elevation, Field variable. The elevation of the releve site in feet is entered in the four-numeric field. The convention is to right-justify elevations Lass than 1000 feet within the data-entry field. The elevation may be estimated to the nearest contour elevation or the midpoint between two contour elevations.

Slope, Field variable. The degrees of slope end the downslope direction ere recorded in the four-character field. The degrees of slope are entered in the first two field blanks. Slopes of less then 10 degrees are prefixed by e "0," e.g. slope of 8 degrees southwest is recorded as "08SW." The two-character direction abbreviations are the same as the quarter-section end half-section abbreviations (NE, NW, SW, SE, N_, S_, E_, W_).

Soil Landscape Unit. Transcribed variable. The four-letter code for the Soil Landscape Unit in which the releve occurs is determined from the Minnesota Soil Atlas maps (1969, 1971, 1973, 1977, 1979, 1980 a,b,c, 1981 a,b). The codes as they appear on the map are entered in the four-character field. The Convention for codes having less than four characters is to left-justify them within the data-entry field.

Geomorphic Unit, Transcribed variable. The alphanumeric codes for the Geomorphic Unit in which the releve occurs is determined from the Minnesota Soil Atlas maps. The codes as they appear on the map are entered in the three character field. The convention for entering a code is to left-justify the two numbers and to use the rightmost column for letters when needed (e.g. 03_, 13_, 10A).

Remark. Field variable. Remarks pertaining specifically to the releve plot are recorded in the 200-character field. Any environmental factor that has possibly effected or that might effect the vegetation within the plot should be mentioned. A list of such factors would include some of the items listed below:

Soils: texture, color, aeration, parent material
Geology: bedrock outcrops, landform
Topography: hill crest, swale, foot of slope, midslope
Disturbance: fire, Logging, burrows, disease, erosion
Management: prescribed burn, selective cutting

The remarks field should also include deviations from standard releve procedures, for example, releves larger then 999 square meters. A brief description of other data collected might also be included.

Because the data-entry field is just 200 characters long, it is good practice to record potential remarks in the "Notes of Other Data Collected" section of the Releve Data Sheet. After some review and much condensation, the set of concise remarks can be fitted into the "Remarks" data entry field.

Other Data Collected. Field and transcribed variables. If soils, forestry, or water-chemistry date have been collected within the releve plot or sufficient1y nearby as to be considered a characteristic of the releve plot, then that should be indicated by entering a "Y" in those one-character fields. Otherwise, enter an "N" in those fields. If such additional data exist for the releve, then the location of those data should be e priority comment in the "Remark" data-entry field.

The Plant Elements date-entry field should be filled with a "Y" if a plant designated as a MNHP element occurs in the releve. A list of plants with the element distinction is availabel from the MNHP office.

The Publication data-entry field cannot be entered in the field. It is to be filled with a "Y" if the releve has served as a sample in a published paper.

Recording Structure and Species Composition

The structure and species composition data-lines are entered on the rows of a blank table on the "VEGETATION" side of the Releve Data Sheet (Figure 2.3). A structure data line is a coded record of the collective cover of a group of plants having the same life-form and also in a particular physiognomic height stratum. A species composition data line is a coded record of the cover (and some other information) for a plant species that is a component of a particular stratum. Every structural data line has associated with it a set of species composition data lines describing the occurrences of its component species in the releve plot.

Because releves record both stratum cover and species cover, and because species data other than cover are being recorded, it is impossible to design a simple fill-in-the-celltype of table for data entry. The data are multidimensional and only partly compatable, i.e. they cannot be merged into a single n-dimensional dataset. Entering multidimensional and non-compatable data in an essentially two-dimensional fashion on the Releve Data Sheet is very confusing to someone who has never collected a releve. In practice. however, entering these data is not difficult -- if it is understood that the multidimensionality of the releve data is maintained by entering the releve data concurrently and in a specified order. The releve data entered concurrently in that data lines containing structural information are intermixed with data lines for species occurrences. The specific order of entering releve data is first by life-form, then by physiognomic height stratum, and finally by species. This confusing concept is best explained by example.

**RELEVE DATA SHEET**
**VEGETATION**

Surveyor's Releve Number: JP-46 / Surveyor's Name: JOHN C HUMENDINGER
MN County: CROW WING Township, Range, Section: NW¼SW¼ 32, 136N R27W
Date: 4 Aug '86 Releve Size (sq. m): 400 Site name: NONE

Enter additional site information on the reverse side of this sheet.

| SPECIES NAME OR CODE | ** | C.S. | REMARKS | SPECIES NAME OR CODE | ** | C.S. | REMARK |
|---|---|---|---|---|---|---|---|
| E 6 i | | . | | H 1-2 c | | . | |
| PINUS BANKSIANA | 0 | 4.1 | | APOCYNUM HYPOSAEMIFOLIUM | 0 | r.1 | |
| PINUS RESINOSA | 0 | r.1 | | ASTER CILIOLATUS | 0 | r.1 | |
| | | . | | CAMPANULA ROTUNDIFOLIA | 0 | r.1 | |
| D 4-5 r | | . | | CH ERIGERON | 6 | r.1 | #3 OP |
| ACER RUBRUM | 0 | r.1 | | LITHOSPERMUM CANESCENS | 0 | r.1 | |
| BETULA PAPYRIFERA | 0 | r.1 | | MONARDA FISTULOSA | 0 | r.1 | |
| POPULUS TREMULOIDES | 0 | r.1 | | PHYSALIS VIRGINIANA | 0 | r.1 | |
| QUERCUS MACROCARPA | 0 | r.1 | | PREMANTHES ALBA | 0 | r.1 | |
| AMELANCHIER INTERMEDIA CMX. | 3 | +.2 | | SMILAX HERBACEA | 0 | r.1 | |
| QUERCUS RUBRA | 0 | +.1 | | ACHILLEA MILLEFOLIUM | 0 | +.2 | |
| SALIX HUMILIS | 0 | +.1 | | ANEMONE QUINQUEFOLIA | 2 | +.1 | |
| | | . | | ARALIA NUDICAULIS | 0 | +.2 | |
| | | . | | ASCLEPIAS SP. OVALIFOLIA | 4 | +.1 | #2 OP |
| D 1-3 i | | . | | DRYOPTERIS INTERMEDIA | 0 | +.2 | |
| CORYLUS AMERICANA | 0 | 2.3 | | FRAGARIA VIRGINIANA | 0 | +.1 | |
| RHUS RADICANS | 2 | 2.1 | | GOODYERA TESSELATA | 0 | +.2 | |
| VACCINIUM ANGUSTIFOLIUM | 2 | 1.1 | | HEUCHERA RICHARDSONII | 0 | +.1 | |
| FRAXINUS PENNSYLVANICA | 0 | r.1 | | LATHYRUS OCHROLEUCUS | 0 | +.1 | |
| PRUNUS PENNSYLVANICA | 0 | r.1 | | | | . | |
| ACER RUBRUM | 0 | +.2 | | | | . | |
| AMELANCHIER HUMILIS CMX. | 3 | +.2 | | | | . | |
| AMELANCHIER INTERMEDIA CMX. | 3 | +.2 | | G 1-2 i | | . | |
| PARTHENOCISSUS INSERTA | 0 | +.1 | | CAREX PENSYLVANICA | 0 | 3.4 | |
| POPULUS TREMULOIDES | 0 | +.1 | | ANDROPOGON GERARDI | 0 | 2.3 | |
| PRUNUS VIRGINIANA | 0 | r.1 | | BROMUS CILIATUS | 0 | 1.1 | |
| QUERCUS MACROCARPA | 0 | +.1 | | SCHIZACHNE PURPURASCENS | 0 | 1.2 | |
| ROSA ACICULARIS SSP. SAYI | 0 | +.1 | | MUHLENBERGIA RACEMOSA | 0 | r.1 | |
| RUBUS STRIGOSUS | 0 | +.2 | | UNKNOWN | 7 | r.1 | #4 |
| SALIX HUMILIS | 0 | +.2 | | AGROSTIS SCABRA | 0 | +.2 | |
| | | . | | AGROPYRON TRACHYCAULUM | 2 | +.1 | #1 |
| | | . | | DANTHONIA SPICATA | 0 | +.1 | |
| E 1 8 | | . | | MUHLENBERGIA GLOMERATA | 0 | +.2 | |
| ABIES BALSAMEA | 0 | r.1 | | ORYZOPSIS ASPERIFOLIA | 0 | +.2 | |
| | | . | | | | . | |
| | | . | | | | . | |
| B 1 r | | . | | | | . | |
| GAULTHERIA PROCUMBENS | 0 | 1.1 | | | | . | |
| PYROLA SECUNDA | 0 | 1.2 | | | | . | |
| CHIMAPHILA UMBELLATA VAR CIST. | 0 | +.1 | | | | . | |
| | | . | | | | . | |
| | | . | | | | . | |
| C 1-2 b | | . | | | | . | |
| VITIS RIPARIA | 0 | +.2 | | | | . | |

** = code for reliability of identification
C.S = cover value . sociability value

**Figure 2.3** The "VEGETATION" side of the MNHP Releve Data Sheet.

Example--Entering Releve Data Blocks. Releve data are recorded in blocks of data lines belonging to a structural entity cal Led a physiognomic/life-form group. The data block consists of a single structure data-line end one to several species-composition data lines. The first data line of a block defines the physiognomic/life-form group by recording a code for the life-form, followed by a code for the physiognomic height class, followed by an estimate of the collective cover of that group of plants. An example of a physiognomic/life-form data line is as follows:

E 4-6 c

In this example, "E" is the life-form code for needleleaf evergreen plants, "4-6" refers to the range of height classes [classes 4, 5, end 6) of the "E" plants, and "c" is the cover class code (75% to 100% cover] for for the "E 4-6" stratum. (See below and Appendix A for code descriptions.)

Obviously, physiognomic/ life-form groups are composed of species. The data Lines for species occurrences immediately follow the data line for the physiognomic/life-form group of which they ere a part. Let's say that for the above example, the component species are white pine (Pinus strobus], balsam fir (Abies balsamea), and white spruce (Picea glauca). The entire entry for the "E 4-6 c" physiognomic/life-form group would take the following general form on a Releve Data Sheet:

| SPECIES NAME OR CODE | ** | C.S | REMARKS |
|---|---|---|---|
| E 4-6 c | | | |
| Pinus strobus | 0 | 4.1 | FR |
| Abies balsamea | 0 | 1.2 | DF BR |
| Picea cf. glauce | 4 | +.1 | 01 |

In this example, the codes following the species names (see below end Appendix A) describe the occurrence of a species in the releve plot as follows:

"**" refers to the column in which the codas for reliability of identification of the species are entered. These codes (0,0, and 4 above) indicate the level of taxonomic certainty of the plant identification (family, genus, species, variety, etc.).

"C" refers to the column in which cover/abundance codes are entered. These codes (4,1, and + above) ere estimates of the species' absolute coverage or abundance within the releve plot.

"S" refers to the column in which sociability codes are entered. These codes (1,2, and 1 above] describe how the species is distributed within the releve plot (evenly, clumped, etc.)

"Remarks" refer to the column in which two-character remark codes are entered. These codes (FR, DF, BR, and 01 ) describe the vitality and condition of the species and also refer to miscellaneous remarks. Several remark codes may be entered on the Releve Data Sheet, but only two are entered into the RELEVE database. Thus, the codes should be entered in order of importance.

As illustrated above, the column headings of the Releve Data Sheet refer only to species-composition variables, which were entered by recording the appropriate code values for these variables in their respective columns. The structural data codes -- life-form, height stratum, and stratum cover -- are entered in the "SPECIES NAME OR CODE" column, and it is understood that the record of these structural variables applies to all of the species in the rows immediately following that entry. Blank rows are Left to separate the blocks data Lines for physiognomic/life-form groups. Refer to the sample records given in Figure 2.3 to clarify the entry of structural and species composition data by physiognomic/life-form groups.

Organization by Physioqnomic/life-Form Groups. From the above discussion and example, it should be clear that releve data are collected and organized as blocks of records describing physiognomic/life-form groups. This structure is obvious in a completed releve form (Figure 2.3). While organization by physiognomic/life-form group assures that the multidimensionality of the releve data is preserved, experience has shown that it causes the novice surveyor to be confused on two issues: (1) the factors that determine the number of physiognomic/life-form groups and (2) the number of data lines that can be entered for a single species.

The number of physiognomic/life-form groups recorded for a releve is determined by both the number of Life-forms and the number of distinct strata recognized for each Life form--in that order. For example, a releve with three distinct height strata and plants of four life-forms would NOT have three physiognomic/ Life-form groups composed of plants with different life forms. Rather, the releve would have minimum of four physiognomic/life-form groups because there are four Life-forms. The releve could have as many as twelve groups if representatives of all four life-form groups occurred in all three height strata. The height strata need not correspond between life-form groups as they do in this simple example. The estimates of height pertain to a particular life-form group only.

It is possible for a species to be listed several times if it occurs in different height strata, or if it exhibits different life-forms. For instance, releves in which sugar maple occurs almost always have three records of sugar maple -- one record in each of the height classes corresponding to tree, sapling, and seedling classes. Occasionally, species exhibiting some plasticity with regard to life-form also may be doubly entered. An example would be woody species like poison ivy or woodbine which can grow either as lianas or as erect, deciduous shrubs.

**STRUCTURE DATA LINE VARIABLES**

Life-Form Codes. Structure Data Line. The life-form groups are represented by one-character codes (Table 2.2 and Appendix A). The codes are capitalized to distinguish them from the Lower-case codes for classes of stratum coverage (see below). The definitions and codes for life-forms follow Kuchler (1967). The MNHP uses Rosendahl (1975) as a guide to the life-form of woody plants in Minnesota.

Structure data-line example: B 1-2 b

In the above example the "B" is the Life-form code for woody plants with broad-leaf form and the evergreen habit. Note its distinction from the lower case "b," which is a cover code for the "B 1-2" stratum.

**Table 2.2** Code definitions for life-forms of Minnesota plants. See Appendix A for detailed descriptions of the codes and examples of plants with particular life-forms.

| Woody Plants | Herbaceous Plants | Special Life-Forms |
|---|---|---|
| B broedleef evergreen | 6 graminoids | C climbers |
| D broadleaf deciduous | H forbs | K stem succulents |
| E needleleaf evergreen | L lichens, mosses | X epiphytes |
| N needleleaf deciduous | | |

Height Class Codes. Structure Data Line. Height class codes ere numbers (I to 8) that refer to the heights of plants in a particular Life-form category. Each code refers to a range of heights (Table 2.3). These codes should be entered singly if the plants of that Life form fall within the range of heights defined by a code. Alternatively, a range of contiguous height classes may be given when plants of a certain life-form are not strongly stratified. The height class codes and definitions are follow Kuchler (1967).

Structure data-line example: B 1-2 b

In the above example the "1-2" defines the range of heights for broadleaf evergreen plants. When a renge is given, it is implied that the heights of the individual broadleaf evergreen plants ere evenly distributed between 0.0 cm(the Low range value for height class 1) and 50.0 cm (the high range value for height class 2). If, for example, there were just a few species of broadleaf evergreen plants in this releve, some with a creeping growth form (height class 1) and the others mostly 40 to 50 cm tall, then it would be appropriate to record the species as occurring in two, relatively distinct physiognomic/life-form classes, B 1 and B 2.

Table 23 Code definitions for physiognomic height classes. (After Kuchler 1967)

| CLASS CODE | | HEIGHT |
|---|---|---|
| 8 | = | > 35 m |
| 7 | = | 20 - 35 m |
| 6 | = | 10 - 20 m |
| 5 | = | 5 - 10 m |
| 4 | = | 2 - 5 m |
| 3 | = | 0.5 - 2.0 m |
| 2 | = | 0.1 - 0.5 m |
| 1 | = | < 0.1 m |

Coverage Classes. Structure Date Line. Coverage class codes are one-character codes that record the estimated cover of the entire physiognomic/ life-form stratum (Table 24). Cover is defined as the percent of the releve area covered by the vertical projection of leaf surface-areas. The cover class codes and definitions follow Kuchler (1967).

Structure data-line example: B 1-2 b

In the above example the "b" is the coverage class code for the entire "B 1-2" stratum. Note that coverage class codes ere entered in lower case as a means of distinguishing them from the upper case life-form codes.

Table 24 Code definitions for coverage classes of physiognomic/ life-form groups. See Appendix A for detailed descriptions of the classes. (After Kuchler 1967)

| CLASS | | COVERAGE | DESCRIPTION |
|---|---|---|---|
| c | = | > 75% | Continuous |
| i | = | 50 - 75% | Interrupted |
| p | = | 25 - 50% | Parklike |
| r | = | 5 - 25% | Rare |
| b | = | 1 - 5% | Barely present |
| a | = | < 1% | Almost absent |

**SPECIES OCCURRENCE DATA-LINE VARIABLES**

Species Names and Codes. Species Occurrence Data Line. The surveyor has the option to enter in the "SPECIES NAME OR CODE" column, either the Latin binomial for the plant or the MNHP eight-character code for the plant. The MNHP uses the Minnesota Checkl ist written by G. B. Ownbey, curator of the University of Minnesota Herbarium, as the authoritative guide to Minnesota's vascular plant names. The mnemonic codes were constructed directly from the Latin binomials in e way that minimizes the use of a code dictionary (Appendix B) and allows for construction of the codes at the date-entry step. The MNHP manages the Minnesota checklist, plant codes, and other species specific data in both manual and computer files. When recording the occurrence of nonvascular plants, the surveyor should enter the entire binomial and also cite the authoritative reference work that was used to identify those plants.

Species occurrence data-line: Pinus strobus 0 4.1 00 BR
PINUSTRO 0 4.1 00 BR

In the above examples, the alternatives for referencing an occurrence of white pine are shown -- by its binomial "Pinus strobus," and by its mnemonic code "PINUSTRO." It is important to reference the variety or subspecies if it is known, because the mnemonic codes are constructed differently for taxa identified below the level of species.

Reliability of Identification Code. Species Occurrence Data Line. The codes for the reliability of identification are numbers that indicate the Level of taxonomic certainty at which plants have been identified (Table 2.5). It is important to recognize that plants cannot always be identified to the species level. When collecting plot data, the surveyor must identify particular specimens, and particular specimens often lack key taxonomic characters as they ere influenced by flowering-phenology, physical condition, life-cycle stages, and herbi vory. It is the surveyor's responsibility to express this uncertainty so thet others can evaluate the work. The MNHP uses these codes to make decisions about including species or releves into large datasets comprising the releves of several surveyors with varying degrees of taxonomic expertise. The codes were constructed by E.J. Cushing, University of Minnesota (personal communication, 1986).

Note that the computer MNHP system requires the entry of valid genus or valid binomial codes for plants-even if a plant has not been identified to that level of certainty. The MNHP system uses the codes for reliability of identification to correctly express the uncertainy (by inserting "cf.") when writing the binomial names in reports.

Species occurrence date line: Pinus strobus **0** 4.1 00 BR

In the above example, the "0" following the species binomial is the code for reliability of identification. The "0" indicates that the binomial is assigned without qualification, i.e. the surveyor is certain thet the species is white pine and there are no varieties or subspecies recognized in Minnesota.

**Table 2.5** Code definitions for reliability of identification at the lowest taxonomic level. The identifications at higher taxonomic levels are presumed to be certain. See Appendix B for a detailed description of the codes. (After Cushing, unpublished)

| CODE | RELIABILITY OF IDENTIFICATION |
|---|---|
| 0 = | variety or subspecies identified |
| 1 = | species identified, but variety or subspecies unknown |
| 2 = | species identified |
| 3 = | species complex identified |
| 4 = | species identification is uncertain |
| 5 = | genus identified |
| 6 = | genus identification is uncertain |
| 7 = | unknown taxon |

Cover/Abundance Codes, Species Occurrence Data Line. The cover/abundance codes are both numbers (1 to 5) and the characters "+" and "r" [Table 2.6 and Fig. 2.4). The numbers 2, 3, 4, and 5 refer to the cover classes for species with 5% to 100% cover in the releve plot. Species cover is defined as the percent of the releve covered by the vertical projection of the Leaf-area of that species as it occurs in a particular physiognomic/ life-form stratum. Codes 1, +, and r refer to qualitative estimates of the abundance [number) of plants of a species with less than 5% cover in that physiognomic/life-form stratum. See Mueller-Dombois and Ellenberg (1974) for discussion of the Braun-Blanquet cover/abundance scale and similar scales.

Species occurrence data Line: Pinus strobus 0 4.1 00 BR

In the above example, the "4" is the cover/abundance code for white pine as it accounts for 75% to 100% of the cover in a particular physiognomic/ life-form stratum. Note that the cover/abundance code is always separated from the sociability code, "1," (see below) by a period, ".".

Table 2.8 Code definitions for the Braun-Blanquet cover/abundance scale. See Appendix B for a detailed description of the codes and scale (After Mueller-Dombois and EL Lenbarg 1974)

| CODE | CWER | TYPE |
|---|---|---|
| 5 = | > 75% | Cover |
| 4 = | 50 - 75% | Cover |
| 3 = | 25 - 50% | Cover |
| 2 = | 5 - 25% | Cover |
| 1 = | < 5% | Cover |
| + = | < 5% | Abundance |
| r = | < 5% | Abundance |

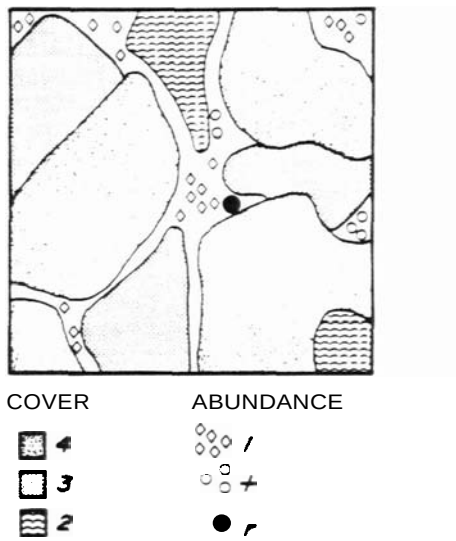


Figure 2.4 Example of cover/abundance values as described in Table 2.6.

Sociability Code. Species Occurrence Data Line, Sociability codes describe how a species is distributed within the releve plot (Table 2.7). These numeric codes refer only to the distribution of a species as it occurrs in a particular physiognomic/life-form stratum. For example, it often happens that the distribution of a tree species is uniform within the tree stratum and clumped within the seedling stratum.

Species occurrence data Line: Pinus strobus 0 4.1 00 BR

In the above example, the "1" is the sociability code, which indicates that the white pines are distributed uniformly across the releve for a particular physiognomic / life– form stratum.

Table 2.7 Code definitions for sociability. See Appendix B for a detailed description of the sociability codes. [After Mueller-Dombois and Ellenberg 1974)

| CODE | DESCRIPTION |
|---|---|
| 5 = | Extensive mat |
| 4 = | small colonies, broken mat |
| 3 = | large group. many plants |
| 2 = | grouped, few plants |
| 1 = | growing singly |

Remark Codes, Species Occurrence Data Line. Remark codes are two-charecter codes that indicate some special attribute of the species as it occurs in a particular physiognomic/life-form stratum (see Releve Code Sheet in back pocket). Some remark codes refer to the species' vitality, i.e. they are qualitative estimates of the ability of the species to perpetuate itself. Other remark codes refer to the condition of the species, which varies as a result of both inherent forces (seasonal phenology, life-cycle, etc.) and external forces [herbivory, windthrow, fire, etc.). Miscellaneous remarks, which do not refer to vitality or condition, may be created to suit particular vegetation studies.

Species occurrence data Line: Pinus strobus 0 4.1 00 DF

In the above example, the "00" and the "BR" are remark codes. "00" is a vitality code that indicates that the white pines are of poor vitality. "BR" is a condition code that indicates that the white pines have been defoliated. When vitality codes are given, it is good practice to express a condition code that helps explain the vitality condition or, alternatively, to include an explanatory note in the "REMARK" or "NOTES OR OTHER DATA COLLECTED" fields on the SITE INFORMATION side of the releve data sheet. For this example it would be appropriate to explain that the white pines are of poor vitality (00) because they have been defoliated (DF) by white pine blister rust.

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## CODE DEFINITIONS FOR LIFE-FORM

After Kuchler (1967)

### 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, Epigea, Gaultheria, and the cranberries of Vaccinium). The MNHP also includes suffruticose evergreen plants in this group (e.g. Pyrola, Chimaphila, and some of the above Ericeceous genera).

**D:** Broadleaf Deciduous, This group of woody plants have broad leaves as in "B" above, but these leaves are either shed or dead (nonphotosynthetic) during some part of the year. In Minnesota, this group encompases e very large number of tree and shrub genera (e.g. Acar, Betula, Corylus, Fraxinus. Quercus, Ulmus, etc.).

**E:** Needleleaf Evergreen. This group of woody plants includes both needle–leaved and scale–leaved evergreens. In Minnesota these plants are gymnosperms. Needle–leaved genera are: Abies, Picea, Pinus, Taxus, Tsuga. Juniperus and Thurja are examples of scale–leaved evergreens.

**F:** Needleleaf Deciduous. This group of woody plants has needle–like leaves as in "E" above, however these leaves are shed every year. The only Minnesota species having this life–form is Larix Laricina.

### HERBACEOUS PLANTS

**G:** Graminoids. This group of herbaceous plants includes all plants that appear grasslike because of their long, linear Leaves and unbranched form. In Minnesota all members of the following families are considered to be graminoids: Cypereceae, Gramineae, Juncaceae, and Typhaceae.

**H:** Forbs. This group of herbaceous plants have broad Leaves as opposed to the graminoids [above] and are not lichens or mosses [below]. In Minnesota, this group is represented by a very large number of angiosperm familie s as well as the ferns and fern allies.

**L:** Lichens and Mosses. This group includes all lichens and mosses that grow on the ground (rock or soil). In Minnesota the Cladonia lichens and the moss genera. Brachythecium, Hylocomnium, Mnium, Pleurozium, Polytrichum, and Ptilium are examples of ground–covering taxa. Epiphytic mosses and Lichens are included within the epiphyte special life form.

**LIFE-FORM CODES cont...**

**SPECIAL LIFE FORMS**

**C:** Climbers. This group includes al l woody plants that are rooted in the ground and climb objects or other plants. In Minnesota, this group is most often represented by Rhus, Parthenocissus, and Vitis, Herbaceous climbers Like Convolvulus, Cuscuta, Oioscorea, Lathyrus, Vicia, etc. are included in the "H" group.

**K:** Stem Succulents. In Minnesota, this group includes only the native cacti, Coryphantha, and Opuntia. Plants with fleshy eaves, Like Sedum, are included within the "H" group.

**X:** Epiphytes, Epiphytes includes a wide variety of plants with different growth forms, therefore plants in this group are not all similar in appearance. The HNHP convention is to include all plants that live on the above-ground parts of other plants in this group. This group includes all epiphytic mosses, lichens, and higher plants Like Arcauthobium. Parasitic plants that are apparently rooted in the soil ( Monotropa, Orobanche, etc.) are included within the "H" group.

**CODE DEFINITIONS FOR HEIGHT CLASSES**
After Kuchler **(1967)**

| CLASS CODE | | HEIGHT | |
|---|---|---|---|
| 8 | = | > 35 | m |
| 7 | = | 20 - 35 | m |
| 6 | = | 10 - 20 | m |
| 5 | = | 5 - 10 | m |
| 4 | = | 2 - 5 | m |
| 3 | = | 0.5 - 2.0 | m |
| 2 | = | 0.1 - 0.5 | m |
| 1 | = | < 0.1 | m |

## APPENDIX A — STRUCTURE DATA LINES

### CODE DEFINITIONS FOR COVERAGE CLASSES

After Kuchler (1967)

| CLASS | COVERAGE | EXPLANATION AND EXAMPLES |
|---|---|---|
| c = | > 75% | Continuous. Implies that the cover is distributed evenly across the releve. In general, plant canopies will touch and the coverage will exceed 75%. For some sparsely-leaved species (needleleaf evergreens, graminoids, etc.), the plant canopies will touch, but not account for 75% coverage--these are still designated as having continuous cover. |
| i = | 50 - 75% | Interrupted. Generally assigned (1) to strata with a "hole" in an otherwise continuous coverage, (2) to strata in which plant canopies do not touch. and (3) to strongly clumped herbaceous or graminoid species when the clump canopies don't touch. |
| p = | 25 - 50% | Parklike or in Patches. This code is most often assigned to shrub strata where the shrobs occur in patches or to patchy colonies of herbaceous plants. |
| r = | 5 - 25% | Rare. Applies to strata in which the plants are more widely scattered than in "p." Often, the distinction between "p" and "r" is to separate strata composed primarily of plants with vegetatively reproducing colonies from strata composed of plants reproducing by Long rhizomes or seeds. |
| b = | 1 - 5% | Barren or Barely Present. Generally assigned to strata with widely scattered plants that have fairly large leaf-areas (eg. bracken fern). |
| a = | < 1% | Almost Absent. Generally assigned to strata with widely scattered plants that have small leaf-areas (eg. graminoids, conifer seedlings, etc.) |

## APPENDIX B - SPECIES-OCCURENCE DATA LINES

### MNEMONIC CODES FOR MINNESOTA PLANTS

Codes assigned by J.C. Almendinger

Mnemonic codes were assigned to all of the vascular plants listed in Ownbey's (in press) Checklist of the Vascular Plants of Minnesota. All of the appropriate codes can be assigned by using Ownbey's checklist and the rules given below, with only a few exceptions. The exceptions are cases of duplicate codes for different plants, and a listing of these plants is given below. The MNHP maintains a computer dataset of Ownbey's checklist of species along with their codes, authors, hybrid crosses, end other species specific data. A Listing of this datafile is available upon request. The codes are eight characters long and were assigned according to the following rules:

#### GENERA

The codes for genera are the first eight characters of the genus name.

Example: MUHLENBE for MUHLENBErgia

#### SPECIES WITH NO RECOGNIZED VARIETIES OR SUBSPECIES IN MINNESOTA

The code is constructed by concatenating the first four letters of the genus name with the first four letters of the species name.

Example: LITHCANE for LITHospermum CANEscens

#### SPECIES WITH RECOGNIZED VARIETIES IN MINNESOTA

The code is constructed by concatenating the first four letters of the genus name, with "VA" for variety, end with the first two letters of the variety name.

Example: LATHVAIN for LATHyrus venosus VAr. INtonsus

#### SPECIES WITH RECOGNIZED SUBSPECIES IN MINNESOTA

The code is constructed by concatenating the first four letters of the genus name, with "SS" for subspecies, and with the first two letters of the variety name.

Example: LITHSSCR for LITHospermum cerolinense SSp, CRoceum

## HYBRID SPECIES

The code is constructed by concatenating the first four letters of the genus name, with "XX" for hybrid, and the first two letters of the species name for the hybrid.

Example: LYCOXXBU for LYCOpodium X BUttersii
(L. Lucidulum X L. selago)

## SPECIES WITH SHORT NAMES

Occasionally a species or genus name will be too short to form the code according to the above rules. In such cases, the code is formed by leaving blanks within the concatenation.

Example: POA WOLF for Poa wolfii
ACER for Acer

## DUPLICATE CODES

Constructing the codes according to the above rules resulted in some duplicate codes for different plants. The codes were made different by assigning numbers as the last character.

## APPENDIX B — SPECIES-OCCURRENCE DATA LINES

### CODE DEFINITIONS FOR RELIABILITY OF IDENTIFICATION

Codes assigned by E.J. Cushing

| CODE | RELIABILITY OF IDENTIFICATION |
|---|---|
| 0 | = Binomial assigned without qualification. This includes plants identified to species level when (1) varieties or subspecies are not distinguished in Minnesota collections and (2) when the typical variety is understood.<br><br>Example: Baptisia bracteata var. glabrescens<br>Aster cordifolius ssp. sagittifolius<br>Pinus strobus [var. tvpica understood] |
| 1 | = The species identification is confident, but the variety or subspecies identification is in doubt.<br><br>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.<br><br>Example: Baptisia bracteata |
| 3 | = Species identification is trivial because of hybridization among several recognized species, but hybrid complexes are recognized within the genus.<br><br>Example: Amelanchier interior complex |
| 4 | = The genus identification is confident, but the species identification is in doubt.<br><br>Example: Baptisia cf. bracteata |
| 5 | = The genus identification is confident, but the species is not distinguished.<br><br>Example: Baptisia |
| 6 | = The genus identification is in doubt.<br><br>Example: cf. Baptisia |
| 7 | = The plant is unknown. but only one species is probably included. Plants recorded as unknown should be col lected and the collection number given in one of the remark fields in the species occurrence data line. |

**BRAUN-BLANQUET COVER/ABUNDANCE SCALE**

After Mueller-Dombois and Ellenberg (1974)

| CODE | COVER | EXPLANATION |
|---|---|---|
| 5 = | > 75% | A cover code. Assigned to a species occurrence within a particular stratum where that species' cover is more then 75% of the releve area. |
| 4 = | 50 - 75% | A cover code. Assigned to a species occurrence within a particular stratum where that species' cover is between 50 and 75% of the releve area. |
| 3 = | 25 - 50% | A cover code. Assigned to a species occurrence within a particular stratum where that species's cover is between 25 and 50% of the releve area. |
| 2 = | 5 - 25% | A cover code. Assigned to a species occurrence within a particular stratum where that species' cover is between 5 and 25% of the releve area. |
| 1 = | < 5% | An abundance coda. Assigned to a species occurrence within a particular stratum where there ere numerous individuals of a species, but those individuals collectively cover less than 5% of the releve area. |
| + = | < 5% | An abundance code. Assigned to a species occurrence within a particular stratum where only a few (appx. 2 - 20) individuals occur and collectively cover Less than 5% of the releve area. |
| r = | < 5% | An abundance code. Assigned to a species with only a single individual occurring within a particular stratum and also to species occurring just out of the plot (Remark **"OP").** |

## CODE DEFINITIONS FOR SOCIABILITY

After Mueller-Dombois and Ellenberg **(1974)**

| CODE | EXPLANATION |
|---|---|
| **5** | = Assigned to species occurrences where the plants ere growing in large, essentially monotypic stands that form an extensive mat. Typically this is applied to non-woody plants, eg. moss or Lichen carpets, graminoid sods, etc. |
| 4 | = Assigned to species occurrences where the plants are growing in small colonies or broken mats. Typically this is applied to non-woody plants, eg. broken carpets as described above, and also colonies of herbaceous plants that have enlarged to the point that they are beginning to coalesce. |
| 3 | = Assigned to species occurrences where the plants are growing in small patches or as cushions. Typically the small patches include small, isolated clones of herbeceous plants as well as patches of shrubs. Cushions generally refer to moss or Lichen colonies. |
| 2 | = Assigned to species occurrences where the plants form small, often dense, clumps. These small clumps may be rather evenly dispersed within the releve. This often applies to woody or herbeceous plants where several aerial stems originate from the rootstock of a single genet. |
| **1** | = Assigned to species growing solitarily. This applies to both woody and herbaceous plants where single stems appear to be evenly dispersed within the releve. |