A GUIDE TO THE WISCONSIN PLANT ECOLOGY LABORATORY DATA

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This project is dedicated to J.T. Curtis and the other members of the Wisconsin Plant Ecology Laboratory.

INTRODUCTION

The Wisconsin Plant Ecology Laboratory (PEL) studies of the 1940s and 1950s proved a landmark in ecology, formed the basis for John T. Curtis' (1959) now classic **Vegetation of Wisconsin** and represent the most comprehensive and extensive regional survey of vegetation in North America. Computerization of the PEL data set ensures preservation of this work and provides opportunities for the reanalysis and reuse of the PEL data in studies of long-term vegetation dynamics.

In computerizing a large data set like the Wisconsin PEL files -- there are over 1400 stands -- many decisions are made. These include what to computerize, how to organize, and what not to include. One decision was to enter the PEL data in LOTUS spreadsheet or ASCII formats. User access is initially more difficult than if the data were in a system designed for information retrieval (dBase or GIS systems for example), but the LOTUS and ASCII formats are readily accessible by most researchers and probably will remain so far into the future. This report provides information on (1) organization of the Wisconsin PEL files (2) use of MATRIX, a matrix expansion program, (3) species names and synonymy and (4) technical notes on data entry and use of the data. Detailed information on field methods is contained in Curtis (1959).

GENERAL FILE ORGANIZATION

Most of the Wisconsin PEL computer files are data files, but included is a synonymized species list (NAMES.*) and a matrix expansion program with associated miscellaneous files (MATRIX.COM, MATRIX.PAS, EXAMPLE.CVT and NAMES.KEY). MATRIX and NAMES are discussed at length in following chapters.

Vegetation data were available for almost all of the natural communities described in **Vegetation of Wisconsin** and were divided into separate files based on Curtis (1959) -- Table 1 and see Table IV-2 in **Vegetation of Wisconsin**. File names are descriptive with the first three or four letters of each file being a community type abbreviation (Table 1). For each community type there is a stand information file (*INF.*) which contains information on stand location and environment; a file containing herb and shrub data (*HERB.*); and for forests a file with information on tree abundance (*TREE.*). Stands are entered in the different types of files in the same order.

Stands in a particular community type will always be listed in the information file and one or both of the other file types, depending on community type and available data. Files are formatted in either LOTUS 123 (*.WK1) or ASCII (*.ASC) formats, and with few exceptions organization of files in the two formats is identical.

Stand information files contain data on stand structure, environment and location. The first 10 rows of each file describe file contents. Stand information begins on row 11. In many cases stand information was not complete but is given in the same order and includes:

1. ID -- a file utilities number which is useful in sorting files.

2. STAND # -- the original PEL stand number. This corresponds to numbers on file folders housed in the PEL records room in the Dept. of Botany, UW-Madison.

3. CI -- the original prairie, or upland and lowland forest continuum index numbers. These were taken from original stand summary sheets but are **unchecked!!** Prairie CI values did not correspond with recalculated values.

4. TREES/ ACRE -- Based on the average squared distance between trees (in feet) divided by area of an acre. See Cottam and Curtis (1956).

5.BA/ACRE -- Average basal area/tree (sq inches) multiplied by the number of trees/acre.

6.A0,A1,A2 -- Soil horizon depths in inches. Total Depth

In most cases the following soil test results are for samples taken from the A1 horizon.

7. pH -- Soil pH, often based on a litmus strip test.

8. WRC(%) -- Soil water retaining capacity. A measure of the amount of water that a sample of

dry soil can absorb (wet weight/ dry weight). Hildegard method.

9. ORG. MAT. -- Percent dry weight of organic matter.

10.CA,MG,PK,NO3,NH4 -- Calcium, magnesium, phosphorous, potassium, nitrate nitrogen, ammonium nitrogen, nitrate nitrogen, ammonium nitrogen in LBS/ACRE. Soil tests were done by WI Soils Lab and reported values assume a 7 inch soil depth. PEL workers often converted these numbers to ppm or multiplied values by the depth of the A1 / 7". T = trace amount.

11. QUALITATIVE SOIL DESCRIPTION -- Information on soil type, color or texture.

12. COUNTY CODE -- Codes for Wisconsin counties and surrounding states. Key to code numbers is in COUNTY.NAM or COUNTY.WK1.

13. TWN,RA,SE -- Township, range and section.

14. 1/4 SEC. -- Quarter section.

15. VERBAL DESCRIPTION -- Contains a lot of different qualitative information. This may include information on stand location to the 1/8 or 1/16 section, and a description of nearby towns, highways or parks. Also included is total stand size (not area sampled), stand condition, and estimates of total tree cover (usually eye-balled). Comments in square brackets were not originally part of the PEL records.

In LOTUS format stand information is contained on a single line: in ASCII format, space constraints necessitated moving the stand location and verbal descriptions to the bottom of the file as a separate section. There is a large amount of stand information available for the major communities, but beyond stand location there is very little information for minor communities. Where data were unavailable or unrecorded a blank was left. For communities where information about a character was completely missing (or inappropriate) the entire column(s) was removed but column order was unchanged.

Herbaceous vegetation files (*HERB.*) contain herb and shrub vegetation data and are organized identically in LOTUS and ASCII formats. Herb files for prairies and minor communities occasionally contain trees. The first 10 rows of each file describe file contents and data begins on row 11. Vegetation data for a single stand usually occupies several rows. The first column of numbers is for sorting a file and allows the user to sort the file back to its original order; the second column is the PEL stand number and again is useful in sorting files in Lotus; the third column contains a PEL stand number in the first row of each new stand.

The next 16 columns of numbers are pairs of species code numbers and values, and there are a maximum of 8 species in each row. Species code numbers correspond to species names and abbreviations listed in NAMES.WK1 (or .ASC). The species value is the absolute frequency of a species based on its occurrence in 20 one meter square quadrats -- in only a few cases 10,30 or 40 quadrats were sampled. A species value of 1 indicates that a species was present in the stand but not found in a quadrat. For most of the prairies and minor communities only presence data were collected. The last species code number-values pair in a stand is followed by a -99. This number is used by the matrix expansion program MATRIX but is also useful in creating species frequency lists.

Tree vegetation data files (*TREE.*) are nearly identical to the herb files, except they contain two different matrices of tree data. In LOTUS files, the first matrix contains data on the relative basal area of tree species (basal area of species x / basal area of all species) and to the right of this matrix is a matrix of tree relative density (number of trees of species x/ total number of trees sampled). In ASCII format the relative density matrix follows below the relative basal area matrix. In most cases data are based on 40 sample points.

USE OF MATRIX

The PEL data are entered in a compact data format not unlike the compact formats used by PC-ORD (McCune 1987) or the Cornell ordination programs. With some work it would be possible to use the data directly with either of these programs. To make it easier to the use the data, a program called **MATRIX.COM** was developed to convert PEL files to a fully expanded matrix format (including zeros) or a CORNELL programs format. The program includes several options and the easiest way to learn how to use it is to run MATRIX (just type MATRIX) and convert the provided example file, EXAMPLE.CVT. The program is somewhat anachronistic in places because of limited programing experience, but the source file (*.PAS) is included; also, initially it would be good to check the file converted against the converted file to verify proper program operation.

EXAMPLE.CVT is a print file taken from FENHERB.WK1. If you are starting with a *.WK1 vegetation file the first step to conversion is to output data as a print (ascii) file. In creating a print file, the print range should be set to not include the first two columns of sorting numbers and should end and start with rows containing data. If the file was sorted be sure that data to be printed have been sorted on the ascending utility numbers (first column) which ensures that each stand ends with a -99 in its last row and begins with a stand number in the third column of its first row. Necessary print options include setting the left, top and bottom margins to zero and the right margin to 100 and using the OTHER/UNFORMATTED option. If starting with an ASCII format file the first 10 rows of the file must be removed and there should not be any empty rows at the bottom of the file.

To run **MATRIX** type matrix and then enter the name of the file you want to convert. If the program crashes check that everything is identical to the format of EXAMPLE.CVT. The next prompt is for the name of the new file (Beware!! Program will overwrite any preexisting files with the same name). The next prompt is for full or Cornell format. If you select full format you will be asked if you want to eliminate rare species and then whether or not you want to add species abbreviations to the file. Species abbreviations are located in **NAMES.KEY** (which was abstracted from NAMES.WK1). If you select the CORNELL format file you will not have the option of removing rare species and will be prompted automatically for the species abbreviations file name. Converted CORNELL format files are ready to run, but FULL format files need to be edited prior to use with PCORD or other software packages.

SPECIES NAMES AND SYNONYMY

Curtis' taxonomy is based largely on Gleason's 1952 treatment of the flora of the Northeast United States. Some PEL workers used Gray's Manual of Botany and other references. In writing **VEGETATION OF WISCONSIN** Curtis created a synonymized species list based on Gleason, standardizing the PEL taxonomy; but while many of the names or synonymys used by Curtis and coworkers are valid today others have changed markedly.

As part of computerizing the PEL data set, a synonymized species list was created (**NAMES.WK1 or NAMES.ASC**). Hugh Iltis and Ted Cochrane -- director and curator respectively -- of the University of Wisconsin herbarium were consulted extensively in updating and modifying Curtis' original list and this work would not have been possible without their assistance; changes are based in part on (1) information found in the published Preliminary Reports on the Flora of Wisconsin and (2) extensive collections of Wisconsin's flora housed in the UW herbarium. In cases where species were incorrectly lumped together, it was usually not possible to resplit because of incomplete information. In such cases the original species name was retained and notes made as to which species were probably included under that single name. Nomenclature and synonymy are based on Kartesz and Kartesz (1980).

The first ten rows of the **NAMES.*** contain information on how the file was created. Organization of the following rows is in a standard format.

1. The first column of numbers are the PEL species code numbers, used in the vegetation data file. Note that a species has only one code number. Two errata are Potentilla recta and Hackelia virginiana (each listed twice). Numbers are not all in ascending order.

2. The second column contains six letter species abbreviations, constructed from the first three letters of the Kartesz and Kartesz genus and species names. Numbers are used in place of the last letter if abbreviations are identical for two or more species.

3. The third column is Kartesz and Kartesz genus and species names.

4. Fourth and fifth columns are Engler and Prantl family numbers and Kartesz and Kartesz

family names respectively. Family numbers were arbitrarily assigned to nonflowering plant families.

5. The sixth column is the taxonomy used by Curtis in **Vegetation of Wisconsin**.

6. Seventh column contains annotations. Names in parentheses are synonymys recognized by Curtis. Remaining notes are based on conversations with Hugh Iltis, Director of the UW -Madison Herbarium, and published Preliminary Reports on Flora of Wisconsin.

TECHNICAL NOTES AND HINTS

DATA ENTRY

The computerized data files are based on stand summary sheets housed in the PEL records room in the Department of Botany, University of Wisconsin, Madison, WI 53706. For most stands the original field sheets are available but it would have been too time consuming to read from those sheets. No mistakes were found when raw and summarized data for a stand were compared.

Data were entered using LOTUS 123 on either an IBM XT or Leading Edge AT. All data were proofed at least once. Matrices were double-checked with a program that checked if (1) species code numbers were repeated in a stand, (2) if relative density or relative basal area values added to 100 (plus or minus 1) and (3) if stands ended with -99. An average of about 2 or 3 mistakes per large data file were found. With such a large data set it is inevitable that there were mistakes in the data before it was computerized and that additional errors entered with computerization. Care should be taken in making too much out of small differences in species distributions, especially with rare species.

Many data were not computerized but are still housed in the PEL records room. Notably, this includes forests on the Apostle Islands, pine relics in S. Wisconsin, deer yards in N. Wisconsin, grazed forests in S. Wisconsin, and weed communities. Data for submerged plant communities were not found in the PEL records room. Seedling and sapling data are available for many stands: S. Upland and S. Lowland seedling and sapling data were computerized and are available from the author if requested. Data are still housed in the PEL records room.

TAXONOMY

While the taxonomy of the PEL data set is generally quite good, care should be taken with some taxa, especially when working with stands from two or more different communities. In most of the PEL files, the genus Carex is treated as spp. but in some cases it is separated into individual species. The same is true for Rosa. Separation between Quercus ellipsoidallis and Quercus velutina was often based on whether a stand was located north or south of the tension zone (Cottam, pers. comm.). For the prairies, species that were considered to be exotic to the state, notably Poa spp, were not recorded.

The **NAMES** files should not be used as a flora of Wisconsin because it is incomplete. Likewise, not all species listed in the NAMES files, notably the Potamogetons, are found in the computerized vegetation data files.

TIPS FOR WORKING WITH THE PEL DATA

It is easiest to work with the LOTUS format version of the PEL files; print out the NAMES and relevant INF files before working with the data files. When printing these files you will not be able to print entire rows and will have to divide the files accordingly. If you use ASCII files be sure to set margins to zero and paper width to at least 16" before beginning work.

In reanalyzing the Wisconsin Prairie Continuum (Umbanhowar 1990) and preparing species lists on a regional basis for the Wisconsin Department of Transportation, I learned a number of things about working with the PEL files. When sorting be sure that all columns in the file are sorted, so the mistake of only sorting half a file is avoided. Use the LOTUS Macros, they save a lot of time. I often combined (FILE/COPY/COMBINE) the information and vegetation files and used the stand information to sort the vegetation data. Stand information was "expanded" with COPY so that every row for a particular stand was coded. If parts of different files are combined it is a good practice to bring along the stand numbers as a check that information for the same stand is being combined.

For species lists, the entire NAMES.WK1 file was often combined with a data file and with the @CELLPOINTER, @VLOOKUP and RANGE VALUE commands combined in a macro, species code numbers are readily converted to species names. If you try this, @VLOOKUP requires that the NAMES.WK1 file be sorted by species code number. When expanding files with MATRIX it is often easier to stay with the code numbers than use the six letter abbreviations: you can create a code file

similar to NAMES.KEY simply by creating two columns of code numbers.

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Table 1. PEL data files and abbreviations. Community type names follow those used by Curtis 1959 (see Table IV-2). Abbreviations followed by the acronyms INF, HERB or TREE depending on file type.

Community Type	Abbreviation
S. Upland Forest	SUP
S. Lowland Forest	SLOW
N. Upland Forest	NUP
N. Lowland Forest	NLOW
Beech Forest	BEE
Boreal Forest	BOR
Prairie	PRA
Savanna	SAV
Beaches and Sand Dunes	SDUN
Bracken-Grassland	BRAC
Cliffs	CLIF
Emergent Aquatics	EMER
Fen	FEN
Open Bog	BOG
Pine Barrens	PBAR
Sand Barrens	SBAR
Sedge Meadows	SEDG
Shrub-Carr	SHRU