# Land Cover of Wisconsin

## User's Guide to WISCLAND Land Cover Data

The Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data (WISCLAND) is a consortium of government and private organizations formed in 1993 to promote development of digital geographic data for the state. The initial focus of the consortium was to acquire funding and resources to develop a land cover classification. That effort has now been completed statewide. This document serves as a technical overview and guide to appropriate use of the digital data.

### Source Data

The land cover data product was derived from Landsat Thematic Mapper (TM) satellite imagery acquired from fly-overs in August, 1991; May, July, September, and October, 1992; and May, 1993. TM data are organized by rectangular areas referred to as scenes, each 108 miles on a side. Twelve scenes are required to cover Wisconsin. A scene is comprised of millions of cells, or pixels, each representing a 30-meter square, or an on-the-ground area of 900 square meters.

The TM sensor measures the sun's energy as reflected from elements of the land surface. The full spectrum of reflected energy is measured at discrete intervals, referred to as bands, with each band capturing a narrow range of wavelengths. Six bands were used for classification of land cover, including visible (blue, green, red) and non-visible (near infrared, and two mid-infrared) wavelengths. A TM data set includes reflectance values for each pixel for each of the six bands. A unique combination of reflectance values comprises a spectral "signature", and allows each element of the landscape to be identified as a particular type of land cover.

Reflectance from vegetative cover varies significantly over the course of a growing season. Thus, acquisition of multiple dates of coverage, e.g., early and late in the growing season, often allows a further refinement of spectral signatures, and thus a higher degree of resolution among vegetation types. For example, plant species that have spectrally similar signatures early in the growing season may diverge in this regard later in the season, thus allowing their unique identities to be resolved. Where multiple layers of vegetation exist, such as forest canopy and understory, the measured reflectance is that of the top-most layer. Consequently, a closed forest canopy would not allow understory vegetation to be identified, and an open canopy forest would yield a mix of both tree canopy and understory reflectance.

### Data Preparation

Satellite imagery were processed with Imagine software, v. 8.1 - 8.3, of ERDAS Corporation. Data were initially separated into three general classes that could be readily identified: upland, wetland and urban. This allowed each class to be processed separately using slightly different techniques. Uplands and wetlands were separated by using the vector boundaries of the Wisconsin Wetlands Inventory (WWI) digital data. Urban areas greater than 40 acres were identified using pre-existing vector data sources, then manually delineated and separated. Uplands and wetlands were further stratified into smaller, more manageable spatial units, as opposed to an entire TM scene. These units were derived by identifying relatively homogenous,

contiguous aggregations of pixels based on similar reflectance, and thus represent Spectrally Consistent Classification Units, or SCCUs. These were delineated manually, using, in addition to the spectral characteristics, a representation of the ecoregions of the state and a minimum size criterion. From one to five SCCUs per scene resulted. Accuracy assessment of the final classification was performed separately for each SCCU.

The SCCUs are provided as digital vectors with the land cover data. Each SCCU is designated by a 4-digit satellite scene number followed by a 1-digit SCCU number (e.g., 2428-2). SCCUs are specific to this project only and should not be interpreted or used as an ecoregion-like data set. A map depicting SCCUs is attached as **Appendix A**.

## Classification Scheme

The WISCLAND classification scheme was developed by reviewing several published classification schemes as well as Landsat TM classifications done previously in Wisconsin. It was based on the known capabilities of the TM sensor and a general knowledge of land cover types that exist in Wisconsin. The classification scheme is hierarchical insofar as possible. There are three levels to the hierarchy. Level one is just the eight most general classes, and of necessity included cloud cover. The cloud cover class indicates that the land surface features could not be classified due to the presence of clouds in all available TM scenes. Level two is more specific and was applied uniformly in all SCCUs. This level is considered appropriate for most applications. Level three is the most specific, but could not be consistently applied over all SCCUs, and thus is not exclusively hierarchical. For example, corn (level 3) may be identifiable in one SCCU, but not in another, even if corn was present in both. In this case the latter SCCU could have "Row Crops" assigned at level 3 for areas of corn. Or, alternatively, corn could be assigned to the more general "Herbaceous/Field Crops" at level 2, in which case level 3 would be null for that category. Application of the level 3 classes should only proceed given a knowledge of this variability across SCCUs. This phenomenon also can produce visual edge effects along SCCU boundaries, depending on the color scheme chosen for display of the various classes. For example, if corn is depicted in yellow and row crops in orange, a sharp yellow/orange demarcation along an SCCU boundary will appear where corn was classified in a particular SCCU but only identified as row crops in an adjacent SCCU.

In general, for all vegetation, attempts were made to classify to level 3 whenever possible. When not possible, as with the corn example above, species were grouped into another appropriate class at the same level, or aggregated into a more general class at the next higher level. Each pixel in the data set was assigned a 3-digit number representing its class and a 1-digit number representing its level. The WISCLAND land cover classification scheme and definitions for each class is attached as **Appendix B**.

## Ground Truth - Uplands

In order to convert the raw satellite imagery into meaningful data, it was necessary to perform on-site verification of land cover types at selected sites throughout the state. This is known as "ground truth" and is an essential component of any remote sensing project. Ground truth data are used to 1) "train" the computer to recognize and thus differentiate among various land cover types, and 2) to derive estimates of the degree of accuracy of the computed classification. Selection of ground truth sites was based on a stratified random sampling technique using the

USGS 1:24,000-scale quadrangle map boundaries as geographic stratification units. For each quadrangle, an area representing one quarter-quarter of the full area, or $1/16^{th}$ of the quadrangle, was chosen at random as a ground truth site. Polygons representative of homogenous cover types were then delineated within the selected area on aerial photographs (NAPP at 1:40,000 scale) and the satellite imagery. Field work was then conducted to identify cover types in each polygon and to record ancillary information from the site. Over 25,000 polygons were verified on-the-ground as to cover types for training and accuracy assessments in this project.

Ground truth polygons were 5 acres or larger in size, and a minimum of 10 per class per SCCU was used as a criterion for determining which land cover types would be included in the classification. For example, if 10 unique sites were verified on the ground for cover type maple, then five of those sites were allocated to training and five to accuracy assessment of the maple cover type in that SCCU. For cover type verification, the definition of each class (see **Appendix B**) was used as a benchmark against which the ground truth data were compared. Thus, again for maple (level 3), its definition requires both a predominance of at least 80% maple tree species and a canopy closure of at least 70%. So, if 10 ground truth sites met these definition criteria, then classification of the maple cover type proceeded. If fewer than 10 sites were found, classification of maple was not attempted, and the classification procedures would place areas of maple into either mixed/other broad-leaved deciduous (also level 3) or into a more general class such as broad-leaved deciduous (level 2). This example also illustrates why maple may be included in one SCCU, but not in a neighboring one, even if the presence of maple in the neighbor was verified in some - but not enough - ground truth sites. For these reasons, as stated above, level 3 classes could not be uniformly applied statewide, but rather were variable across SCCUs.

**Ground Truth - Wetlands and Urban**

Wetland data were processed similar to upland, except that the Wisconsin Wetland Inventory (WWI) data were used as ground truth for both training and accuracy assessment. The final wetland classes were derived from both the WWI attributes and TM classification techniques. The relationship of WWI classes to TM-derived classes is given in the definitions (**Appendix B**).

Urban areas were classified as an entire scene, rather than by SCCU. A size threshold of 40 acres was chosen as a minimum for classifying as urban, although smaller areas were included if they occurred near a larger urban complex. Standard automated procedures were used to separate high intensity and low intensity urban, but golf courses were identified and delineated manually. No ground truthing was done - or required - in urban areas.

**Classification Methodology**

"Guided clustering", which is a hybrid supervised/unsupervised classification method, was used to perform the classification. This technique uses a maximum likelihood algorithm which groups "like" pixels together. See Lillesand et al. (1998) under **Additional Documentation** below for more information on the classification method. Upland data were "smoothed", or generalized, by dropping out single pixels and pixel clusters comprised of less than four contiguous pixels. This smoothing procedure is known as a "clump-sieve-and-fill" technique that eliminates the "salt and pepper" effect of scattered, isolated pixels. As a result, the minimum size area of like pixels in upland areas is about one acre, as represented by 2x2 pixel clusters or linear chains of minimally four contiguous pixels in any direction. Even though the smaller clusters may have been

correctly classified, they were considered below the minimum resolution for these data and therefore not reliable. Refer to the **Usage Guidelines** section for a discussion of data resolution.

Wetland data were smoothed by the above procedure, except that individual wetlands less then one acre were retained (not smoothed). The smaller wetlands were considered reliable since the source WWI data are captured at a scale (1:24,000) that accurately depicts areas as small as a fraction of an acre.

Open water data were not smoothed since this class is known to be rendered very accurately in TM classifications. Urban areas also were not smoothed and thus may depict areas as small as one 30-meter pixel, or about ¼ acre. See **Usage Guidelines** below for how to interpret these small areas.

**Accuracy Assessment**

As stated above, at least 10 ground truth sites per class per SCCU were required to include a class in the final classification for a given SCCU. In addition to the ground-truthed cover types matching the class definitions (given in **Appendix B**), cover type identities also had to be of a "high confidence" level as judged by the ground-truthing individual. An assessment of accuracy was based on the classified majority within the ground truth polygon. The 5-acre minimum size for these sites represents an area of about 25 pixels. Thus, if 13 or more pixels were classified as maple and ground truth indicated that 25 pixel equivalents were maple, then the majority criterion was met and class maple was considered correct for that site.

Classification accuracy assessments were performed by a standard technique that produces an error matrix, also referred to as a "confusion" matrix. This procedure detects errors of both omission and commission, i.e., a pixel omitted from its correct class, or a pixel committed to the wrong class. Error matrices were produced separately for uplands (at both level 2 and level 3), wetlands, and urban areas. When data smoothing was done, accuracy assessments were performed on the smoothed data.

An error matrix is included as **Appendix C** for upland classes at level 3. The matrix compares, for each class, its known cover type from ground truthing of selected sites (the "Reference" columns) and its classified cover type for those same sites based on computing techniques ( the "Classified" rows). These data can be used to determine how well the computing process classified the set of ground truth polygons that were chosen for accuracy assessment. There is one row and one column entry for each class included at level 3 for SCCU #24/29-3. Diagonal entries represent the number of polygons correctly classified. Non-diagonal entries are the number of polygons incorrectly classified, where columns represent errors of omission and row entries are errors of commission. So, for Corn (column 113), 38 polygons were assigned correctly, relative to a total of 40 polygons (the column total) known to be Corn from ground truth. Thus, two polygons were omitted from their correct class - one went to Other Crops and one to Grassland. This yielded 95% correct, and is entered as the "Producer's" entry, referring to the Producer (or Analyst) of the classification desiring a measure of how well the known polygons were classified. In the row entry for Corn, 38 polygons were classed correctly, but two that were classed as Corn were in fact "Other Crops" and thus were committed to Corn erroneously. That yielded 95% correct as the "User's" measure of accuracy, referring to Users of the data needing to know the probability that the classified polygons will actually be that cover type on the ground.

Two other descriptive measures are derived from the matrix. The overall percent correct is the number of correctly classed polygons divided by the total number of polygons for all classes; in this case, 196/227, or 86% overall correct for the sites in this SCCU. The other statistic is "KHAT" which is a measure of the degree to which the computed classification was an improvement over a completely random assignment of classes to polygons. KHAT values are reported as percentages between 0 and 100 where higher values indicate a greater improvement from the procedure versus random chance. For SCCU #24/29-3, this value was 84%, and indicates that the derived classification was 84% better than that due to chance. KHAT can also be used to compare SCCUs for significant differences, by using standard statistical techniques, provided each SCCU has the same classification domain.

Note in the matrix of **Appendix C** that there was substantial "confusion" among Forage Crops and Grassland in both dimensions, i.e., errors of omission and commission. This is an example of where multiple measures of accuracy may be important. If a user is interested primarily in locating grassland, it is evident from the Producer's accuracy that 83% of known grassland polygons were classified correctly. However, of all ground-truthed polygons classified as grassland, only 15 of 29 (52%) were verified as grassland from ground truth, and 13 were in fact Forage Crops. In this case ground truthing indicates that the user would have only about a 50-50 chance of finding grassland on the ground based on computed classes. Similarly, of 48 polygons known to be Forage Crops, 13 were incorrectly classed as Grassland, for a Producer's accuracy of 73%. But 35 of 39 polygons classified as Forage Crops were correct, for a User's accuracy of 90%. So, again, a User could expect to find Forage Crops in the field for 90% of the polygons classified as such. Lastly for this example, it is noteworthy that Red Pine and Oak classes were highly reliable in this SCCU based on both User's and Producer's measures.

The example above illustrates subtle differences among the accuracy measures, and is an indication of why serious users of the land cover data must become well-versed in use of the accuracy matrices. The importance of this cannot be overstated. The various accuracy measures utilize entries in the matrix slightly differently, each approaches the accuracy issue from a somewhat different perspective, and each has unique application depending on how the classification is to be used. Two points stressed by Lillesand and Kiefer (1994, p. 612 and 617) have relevance here: "A classification is not complete until its accuracy is assessed." And "…the quality of any accuracy estimate is only as good as the information used to establish the true land cover types present in the test sites." Accuracy assessments typically are assumed to apply over an entire SCCU, even though the data were derived from ground truth areas only. The validity of extrapolating the accuracy results in this way depends on the degree of heterogeneity of cover types in a selected SCCU, and the degree to which ground truth sites are representative of the various classes present across the entire SCCU.

All error matrices are included with the land cover data. For uplands this includes accuracy measures for Producers, Users, Overall, and KHAT. Matrices for wetlands and urban include only User's and Overall statistics since the method of classifying these categories did not lend itself to construction of complete confusion matrices. The user is urged to consult Lillesand and Kiefer (1994), and references cited therein, for a more in-depth discussion of accuracy assessment.

**Appendix D** gives a summary of User's accuracy assessments, by class averaged over all SCCUs, as percentages of correct cover types. However, these statewide estimates mask the

variability among SCCUs, since they are generalized relative to estimates derived for each individual SCCU, as shown in **Appendix C**.
Finally, it is noteworthy that the final classification was derived entirely from automated computing techniques. Even though extensive ground truth data were gathered, these were used for training and accuracy assessment only. Classified pixels that were subsequently shown to be incorrect based upon ground truth data were not re-assigned values to make them correct. The entire data set is thus consistent with respect to how class values were assigned. Of course, all ground truth data were retained as attributed vector polygons and are considered a valuable adjunct to the classified data set.

## Positional Accuracy

The source TM data were geometrically corrected by EROS Data Center to fit the USGS 1:24,000-scale quadrangle maps. Accuracy standards were on the order of RMS error no greater than one pixel, or +/- 30 meters. The data were projected using Arc/Info (of Environmental Systems Research Institute, or ESRI) as the map projection software (see **Data Format** below). The chosen spectral resampling algorithm was "nearest neighbor". Positional accuracy of the projected data was evaluated empirically by overlaying vector data that were known to meet National Map Accuracy Standards at 1:24,000 scale (i.e., USGS DLG data). The fit of the overlay was evaluated at 1:40,000 scale, which is the minimum recommended for display of land cover data, and thus would reveal any mis-registrations to the greatest degree. This subjective evaluation proved satisfactory, and although projecting of raster data introduces some degree of spatial error, it is assumed that the stated positional accuracy of the original data was preserved insofar as possible.

## Data Format

The Land Cover data are kept in a raster format known as "grid", a format developed by ESRI. The map projection and coordinate system is "Wisconsin" Transverse Mercator (WTM) based on a 1991 adjustment to the North American Datum of 1983 (NAD83/91). WTM differs from Universal Transverse Mercator (UTM) primarily in that the origin has been adjusted to allow the entire state of Wisconsin to reside within the east-west dimensions of a standard UTM zone. WTM coordinate units are meters. Attributes of the land cover grid are kept in an associated "info" file referred to as the Value Attribute Table (VAT). This table encodes for each cell the following:

| Field Name | Content |
|---|---|
| Value | Classification numeric code, 3-digit |
| Count | Number of cells (per value) statewide |
| Levels | Number of classification levels, 1, 2 , or 3 |
| Class | Classification name, 47-character |
| Level1 | Classification value at level 1, 3-digit |
| Level2 | Classification value at level 2, 3-digit |
| Level3 | Classification value at level 3, 3-digit or 0 (where not applicable) |

Accuracy assessment matrices are provided as Microsoft Excel spreadsheets, and the land cover documentation is in Microsoft Word format.

## Usage Guidelines

The TM scenes were primarily from fly-overs in spring and summer of 1992, supplemented with a few scenes from summer 1991 and spring 1993. The data are thus a "snap shot" of land cover conditions at that time. The data's currency for a particular application should be judged accordingly. With a 30-meter pixel size, narrow linear features such as roads and streams are not readily detected. It is recommended that vector data, such as the USGS digital line graph (DLG) data, be used to display those features.

Most applications should use the level 2 classes in order to have a uniform and comprehensive view across all SCCUs. Although level 3 classes are more detailed, they could not be uniformly resolved across SCCUs, and thus comparisons of level 3 classes between SCCUs may not be appropriate. The user should consult the error matrices before making comparisons at level 3 between SCCUs. In addition, level 3 is not exclusively hierarchical. Thus, as shown in Appendix B, to get row crops at level 3, the user must select three classes: Row Crops, Corn, and Other Row Crops. Similarly for oak: Oak, Northern Pin Oak, and Red Oak would need to be aggregated to get all oaks.

Distinguishing among certain vegetation species can be problematic with TM data, due to their similar spectral signatures. Examples are maple versus aspen, maple versus basswood, and white pine versus red pine. Where these classes are encountered in the data, the user is urged to consult the accuracy assessment matrices for the SCCUs of interest for estimates of reliability. Accuracy goals for the final data set were 85% minimum correct at level 2 and 75% at the more detailed level 3. These were considered reasonable goals given the known capabilities of the TM sensor and the reliability of analysis techniques employed herein.

The land cover data can be appropriately used for a range of display scales from 1:40,000 to 1:500,000. Computer display and query systems typically allow unlimited zoom-in capability. However, a minimum display scale of 1:40,000 is recommended given the known resolution of these data. At that scale, the data can be used to identify cover types and distribution of land cover over a fairly broad area, but not at a specific location. Also, single pixels should not be relied upon to depict a particular class or its distribution. Rather, aggregations of pixels that represent a homogenous area of 5 acres in size (about 25 pixels) is considered a reasonable minimum for these data.

The data can be used to derive areal estimates by cover types for an area of interest. However, resulting areal accuracies will depend on the size of the area of interest. For a large area, such as a county, the 30-meter cell size would represent a relatively fine-grained spatial array, and errors due to omission and commission of cells along the county boundary would probably be insignificant for most applications. In contrast, for a smaller area, the cell size would be relatively more coarse-grained, and thus edge effects would be more pronounced. This is because raster data cannot represent a linear boundary exactly, but rather can only simulate it as a "stair-step" pattern of cells. To illustrate this, land cover types were summed by area for Dane County, one PLSS Township in Dane County, and one PLSS Section in the county. Those areal estimates were then compared to areas derived from vector (or polygon) representations of the same areas. Results are shown below in units of acres.

| Land Cover area | vector area | difference | % difference |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Dane Co. | 791,870 | 791,916 | -46 | <0.01 |
| Township | 23,232 | 23,206 | +26 | <0.12 |
| Section | 633 | 640 | -7 | <1.10 |

## Metadata

A metadata document that meets the Federal Geographic Data Committee standards was prepared and is attached as **Appendix E**. This document also is available as a stand-alone, ascii-format file upon request.

## Documentation and References

This project followed ground truth procedures, classification schema, and accuracy assessment as presented in:

**Lillesand, T., J. Chipman, D. Nagel, H. Reese, M. Bobo, and R. Goldmann, 1998. Upper Midwest GAP Analysis Image Processing Protocol. U. S. Geological Survey, Environmental Management Technical Center Document # 98-G001, 25 pages.**

The above document is available on the Internet at http://www.emtc.nbs.gov/umgaphome.html

**Lillesand, T. M. and R. W. Kiefer, 1994. Remote Sensing and Image Interpretation. 3rd edition. John Wiley and Sons.**

**Step-by-step Technical Procedures Used in the WISCLAND Project, April, 1996** gives additional details on procedures employed.

**Accuracy Assessment Matrices** were prepared separately for upland, wetland, and urban classes for each SCCU. They are supplied with the land cover data as Microsoft Excel spreadsheets.

**Lineage Documents** for each SCCU give dates of imagery used, and comments by the analysts regarding source data quality, accuracy assessments, and any caveats or anomalies encountered.

The **Ground Truth Database** includes vector polygons of ground truth sites and an associated database containing information gathered in the field.

**Genesis of the WISCLAND Classification Scheme - January 18 & 19, 1995** details the derivation of the final classification scheme.

**WISCLAND Land Cover Data Project, Final Report, April 1998**

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## Appendix A

**Spectrally Consistent Classification Units (SCCUs) of the WISCLAND Land Cover Project**

## Appendix B

### Land Cover Classes Present in the WISCLAND Data Product

Numeric class values assigned to pixels are in parentheses. The three-level hierarchy is indicated by decimal values and indentation. Gaps in the numeric and hierarchical sequence are due to entries in the "extended" classification which were not part of the final classification scheme (see **Metadata** below).

(100) 1. **URBAN/DEVELOPED**
(101) 1.1 **High Intensity**
(104) 1.2 **Low Intensity**
(105) 1.3 **Golf Course**

(110) 2. **AGRICULTURE**
(111) 2.1 **Herbaceous/Field Crops**
(112) 2.1.1 **Row Crops**
(113) 2.1.2 **Corn**
(118) 2.1.7 **Other Row Crops**
(124) 2.1.8 **Forage Crops** → includes Hay and Hay/Mix
(148) 2.3 **Cranberry Bog**

(150) 3. **GRASSLAND** (includes timothy, rye, pasture, idle, CRP, grass and volunteer)

(160) 4. **FOREST**
(161) 4.1 **Coniferous**
(162) 4.1.1 **Jack Pine**
(163) 4.1.2 **Red Pine**
(166) 4.1.5 **White Spruce**
(173) 4.1.11 **Mixed/Other Coniferous**
(175) 4.2 **Broad-leaved Deciduous**
(176) 4.2.1 **Aspen**
(177) 4.2.2 **Oak**
(179) 4.2.4 **Northern Pin Oak**
(180) 4.2.5 **Red Oak**
(183) 4.2.8 **Maple**
(185) 4.2.10 **Sugar Maple**
(187) 4.2.12 **Mixed/Other Broad-leaved Deciduous**
(190) 4.3 **Mixed Deciduous/Coniferous**

(200) 5. **OPEN WATER**

(210) 6**. WETLAND**
(211) 6.1 **Emergent/Wet Meadow**
(212) 6.1.1 **Floating Aquatic Herbaceous Vegetation**
(217) 6.2 **Lowland Shrub**
(218) 6.2.1 **Broad-leaved Deciduous**
(219) 6.2.2 **Broad-leaved Evergreen**
(220) 6.2.3 **Needle-leaved**
(222) 6.3 **Forested**
(223) 6.3.1 **Broad-leaved Deciduous**
(229) 6.3.6 **Coniferous**
(234) 6.3.10 **Mixed Deciduous/Coniferous**

(240) 7. **BARREN**
(241) 8. **SHRUBLAND**
(242) 9. **CLOUD COVER**

## Appendix B (continued)

## Classification Definitions

The following definitions were used in the classification of the WISCLAND Land Cover data.

I. **Urban/Developed**: Structures and areas associated with intensive human activity and land use.

a. High Intensity: Greater than 50% solid impervious cover of man-made materials. *Examples: parking lot, shopping mall, or industrial park*.

b. Low Intensity: Less than 50% solid impervious cover of man-made materials. May have some interspersed vegetation. *Examples: sparse development, single family residence*.

c. Golf Course

*Note:* Areas meeting the requirements of both Urban/Developed and Forest classes should be classified in the Urban/Developed category. (i.e., residential areas with greater than 10% crown closure of trees would be classified as Urban/Developed, rather than Forest).

II. **Agriculture**: Land under cultivation for food or fiber.

a. Herbaceous/Field Crops: includes the sub categories of Row, Forage, and Small Grain Crops.

i. Row Crops: includes Corn, Peas, Potatoes, Snap Beans, Soybeans, and Other Row Crops.

ii. Forage Crops: includes Alfalfa, Hay and Hay Mix.

c. Cranberry Bog

III. **Grassland**: Lands covered by non-cultivated herbaceous vegetation predominated by grasses, grass-like plants or forbs. *Examples: cool or warm season grasses, restored prairie, timothy, rye, pasture, idle farmland, CRP land, "volunteer" grasses.*

IV. **Forest**: An upland area of land covered with woody perennial plants, the tree reaching a mature height of at least 6 feet tall with a definite crown.

a. Coniferous: Upland areas whose canopies have a distinct crown closure of which no less than two-thirds (67%) should be of the coniferous tree group. If the broad-leaved deciduous species group is present, it should not exceed one-third (33%) of the canopy. *Examples: Jack Pine, Red Pine, White Spruce, Hemlock, Tamarack.*

*i.* Jack Pine: No less than 80% of the canopy should be Jack Pine.

*ii.* Red Pine: No less than 80% of the canopy should be Red Pine.

*xiii.* Mixed/Other Coniferous: In the case of Mixed Coniferous, canopy percent must have a distinct crown closure of which no less than 80% is of a single coniferous species, but rather a mix of coniferous species. Other Coniferous is characterized by coniferous species that have a distinct canopy closure, and 80% or greater of that species in the canopy, but that has fewer than the sufficient number of training sets required (at least 5) for classification at the species level.

b. Broad-leaved Deciduous: Upland areas whose canopies have a distinct crown closure of which no less than two-thirds (67%) should be of the broad-leaved deciduous tree group. If the coniferous species group is present, it should not exceed one-third (33%) of the canopy. *Examples: Aspen, Oak, Maple, Birch, Balsam Poplar*

*i.* Aspen : No less than 80% of the canopy should be Aspen.

*ii.* Oak: No less than 80% of the canopy should be Oak

vii. Mixed/Other Broad-leaved Deciduous: In the case of mixed broad-leaved deciduous, canopy percent must have a distinct crown closure of which no less than 80% is of a

single broad-leaved deciduous species, but rather a mix of broad-leaved deciduous species. Other broad-leaved deciduous is characterized by deciduous species that do have a distinct canopy closure, and 80% or greater of that species in the canopy, but that has fewer than the sufficient number of training sets required (at least 5) for classification at the species level.

c. Mixed Broad-leaved Deciduous/Coniferous: In the case of mixed broad-leaved deciduous/coniferous forest, canopy percent must have a distinct crown closure, of which no more than two-thirds (67%) should be from either of the species group (coniferous or deciduous).

V. **Open Water**: Areas of water with no vegetation present.

VI. **Wetland**: An area with water at, near or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation, and which has soils indicative of wet conditions.

a. Emergent/Wet Meadow: Persistent and non-persistent herbaceous plants standing above the surface of wet soil. *Examples: Cattails, Marsh Grass, Sedges*

b. Lowland Shrub: Woody vegetation, less than 20 feet tall, with a tree cover of less than 10%, and occurring in wetland areas.
*Broad-leaved deciduous examples: Willow, Alder, Buckthorn*
*Broad-leaved evergreen examples: Labrador-tea, Leather-leaf, Bog Rosemary*
*Coniferous examples: Stunted Black Spruce*

c. Forested Wetland: Wetlands dominated by woody perennial plants, with a canopy cover greater than 10% , and trees reaching a mature height of at least 6 feet.
*Broad-leaved deciduous examples: Black Ash, Red Maple, Swamp White Oak*
*Coniferous examples: Black Spruce, Northern White Cedar, Tamarack*
*Mixed Broad-leaved deciduous/Coniferous examples: Mixture of the species above.*

Note: If an area meets the requirements of Forested Wetland, it should take precedence over any other "Forest" Category.

VII. **Barren**: Land of limited ability to support life and in which less than one-third (33%) of the area has vegetation or other cover. If vegetation is present, it is more widely spaced and scrubby than that in Shrubland. *Examples: Sand, Bare Soil, Exposed Rock, Mixed Barren*

VIII. **Shrubland**: Vegetation with a persistent woody stem, generally with several basal shoots, low growth of less than 20 feet, and coverage of at least one-third (33%) of the land area. Less than 10% tree cover interspersed. *Examples: Scrub Oak, Buckthorn, Sumac*

# Appendix C

## Error Matrix

### 24/29-3 Upland Level 3 Accuracy Assessment

| Classified | Reference | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 113 | 118 | 124 | 150 | 163 | 173 | 177 | 183 | 187 | 190 | 200 | 240 | Total | User's |
| Corn (113) | 38 | 2 | | | | | | | | | | | 40 | 95% |
| Other Crops (118) | 1 | 14 | | 1 | | | | | | | | | 16 | 88% |
| Forage Crops (124) | | 2 | 35 | 2 | | | | | | | | | 39 | 90% |
| Grassland (150) | 1 | | 13 | 15 | | | | | | | | | 29 | 52% |
| Red Pine (163) | | | | | 28 | | | | | | | | 28 | 100% |
| Mixed/Other Coniferous (173) | | | | | | 4 | | | | | | | 4 | 100% |
| Oak (177) | | | | | | | 26 | | 3 | | | | 29 | 90% |
| Maple (183) | | | | | | | | 5 | 3 | | | | 8 | 63% |
| Mixed/Other Deciduous (187) | | | | | | | 1 | | 11 | 1 | | | 13 | 85% |
| Mixed Deciduous/Coniferous (190) | | | | | | | 1 | | | 6 | | | 7 | 86% |
| Open Water (200) | | | | | | | | | | | 10 | | 10 | 100% |
| Barren (240) | | | | | | | | | | | | 4 | 4 | 100% |
| Total | 40 | 18 | 48 | 18 | 28 | 4 | 28 | 5 | 17 | 7 | 10 | 4 | 227 | |
| Producer's | 95% | 78% | 73% | 83% | 100% | 100% | 93% | 100% | 65% | 86% | 100% | 100% | | |
| No. Correct | 196 | | | | | | | | | | | | | |
| Overall | 86% | | | | | | | | | | | | | |
| KHAT | 84% | | | | | | | | | | | | | |

## Appendix D

**Accuracy assessment compilation**

This document is a brief summary, but is NOT a complete accuracy assessment table, and should NOT be used as accuracy assessment percentages for any particular area of the WISCLAND Land Cover dataset. Refer to the WISCLAND Metadata for the appropriate and detailed accuracy assessment matrices.

| Class | Mean (User's) |
|---|---|
| **Level II - Upland Classes** | |
| Agriculture | 1,428/1,573 = 91% |
| Grassland | 407/572 = 71% |
| Coniferous Forest | 655/699 = 94% |
| Deciduous Forest | 2,348/2,524 = 93% |
| Mixed Coniferous/Deciduous Forest | 75/139 = 54% |
| Open Water | 230/230 = 100% |
| Barren | 94/130 = 72% |
| Shrubland | 46/71 = 65% |
| **Overall…… 5,283 / 5938 = 89%** | |
| | |
| **Level III - Upland Classes** | |
| Corn | 520/589 = 86% |
| Other Row Crops | 160/212 = 75% |
| Forage Crops | 423/578 = 73% |
| Jack Pine | 67/85 = 79% |
| Red Pine | 403/459 = 88% |
| Mixed/Other Coniferous | 109/145 = 75% |
| Aspen | 220/335 = 66% |
| Oak | 313/475 = 66% |
| Maple | 125/190 = 66% |
| Mixed/Other Deciduous | 1,091/1,486 = 75% |
| **Overall…… 3,431 / 4554 = 75%** | |
| | |
| **Urban** | |
| Rural Other | 268/289 = 93% |
| High Intensity | 248/258 = 96% |
| Low Intensity | 275/283 = 97% |
| **Overall…… 791 / 830 = 95%** | |
| | |
| **Wetland Classes** | |
| Emergent/Wet Meadow | 1,477/1695 = 87% |
| Lowland Shrub | 362/482 = 75% |
| Broad-leaved Deciduous Shrub | 807/1,103 = 73% |
| Broad-leaved Evergreen Shrub | 180/221 = 81% |
| Needle-leaved Deciduous Shrub | 15/25 = 60% |
| Broad-leaved Deciduous Forested Wetland | 1,289/1593 = 81% |
| Coniferous Forested Wetland | 924/1085 = 85% |
| Mixed Deciduous/Coniferous Forested Wetland | 468/647 = 72% |
| Open Water | 545/615 = 89% |
| **Overall…… 6,067 / 7,466 = 81%** | |

## Appendix E

## FGDC-compliant metadata

Identification_Information:
Citation:
Citation_Information:
Originator: Wisconsin Department of Natural Resources (WiDNR)
Publication_Date: 1998
Title: WISCLAND Land Cover (WLCGW930)
Geospatial_Data_Presentation_Form: Map
Publication_Information:
Publication_Place: Madison, Wisconsin
Publisher: Wisconsin Department of Natural Resources (WiDNR)
Other_Citation_Details:
Upper Midwest Gap Analysis Program (UMGAP) Image Processing Protocol (1997)

Description:
Abstract:
The WISCLAND (Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data) Land Cover data set is a raster representation of vegetation/land cover for the state of Wisconsin. The source data were acquired from the nationwide MRLC (Multi-Resolution Land Characteristics Consortium) acquisition of dual-date Landsat Thematic Mapper (TM) data primarily from 1992. The image processing technique followed was published in the UMGAP Image Processing Protocol (1997). The original pixel size of the source TM data is 30 meters, however the classified WISCLAND Land Cover data (excluding URBAN) are generalized or "smoothed" to an area no smaller than four contiguous pixels (equivalent to approximately one acre). The result of this smoothing is that any feature five acres or larger may be resolved in the data (i.e., Minimum Mapping Unit (MMU) of five acres). The Land Cover data are usable at nominal scales of 1:40,000 to 1:500,000 for a wide variety of resource management and planning applications. The classification scheme was designed to be compatible with existing classification schemes such as UNESCO's and Anderson's.

Purpose:
These data can be used for landscape scale analysis in various disciplines such as wildlife ecology, forestry, or land use planning. The data have been developed for inclusion in the Gap Analysis Program. The data should be used at a scale of at least 1:40,000. It is also suggested that the data be used at no less than the five acre MMU.
Supplemental_Information:
The spatial extent of this data layer is the state of Wisconsin. This data set is named according to a file naming convention in which key characteristics of each data layer are encoded; refer to <http://www.dnr.state.wi.us/org/at/et/geo/guide_2e/app_a/meta_4a.htm> for further details.

Time_Period_of_Content:

Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 1991
Ending_Date: 1993
Currentness_Reference:
Date of the Landsat TM satellite data acquisition for the MRLC Consortium

Status:
Progress: Complete
Maintenance_and_Update_Frequency: Maintenance based on User feedback. No plans currently for update.

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: -92.75
East_Bounding_Coordinate: -87.08
North_Bounding_Coordinate: 47.08
South_Bounding_Coordinate: 42.50

Keywords:
Theme:
Theme_Keyword_Thesaurus: none
Theme_Keyword: Land Cover
Theme_Keyword: Vegetation
Theme_Keyword: Landsat Thematic Mapper
Theme_Keyword: Gap Analysis
Theme_Keyword: Wisconsin

Access_Constraints: None
Use_Constraints: None; Recommendations/guidelines documented.

Point_of_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization:
Wisconsin Department of Natural Resources (WiDNR), Bureau of Enterprise Information Technology and Applications (BEITA), Geographic Services Section (GEO), ET/8
Contact_Person: Lance Perry
Contact_Address:
Address_Type: mailing address
Address:
Mailcode: ET/8
101 South Webster Street
P.O. Box 7921
City: Madison
State_or_Province: Wisconsin (WI)
Postal_Code: 53707-7921
Country: United States of America (USA)
Contact_Voice_Telephone: (608) 267-5181
Contact_Facsimile_Telephone: (608) 266-0870
Contact_Electronic_Mail_Address: perryl@dnr.state.wi.us

Browse_Graphic:

Browse_Graphic_File_Name:
http://www.dnr.state.wi.us/org/at/et/geo/wiscland/lcov_smp.gif
Browse_Graphic_File_Description:
The graphic includes a map and legend showing a sample subset of WISCLAND Land Cover data for a small area in northwestern Wisconsin, and illustrating a representative set of land cover classes for that part of the state.
Browse_Graphic_File_Type: GIF

Native_Data_Set_Environment:
ARC/INFO Grid format;
Data Format Version Number - ARC7.1.1;
Resident Computer Operating System -
DEC (Digital Equipment Corporation) Alpha 2100 server running Pathworks and OSF version 4.0a (Digital Unix);
Resident Size of Dataset -
Approximately 80 Megabytes (projected for completed statewide version)

Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:
Accuracy Assessment matrices have been completed for each classification unit of the dataset, or "SCCU" (Spectrally Consistent Classification Unit). These matrices should be referred to when using the WISCLAND Land Cover Data, and are included as MS Excel spreadsheets. Accuracy Assessment was calculated separately for wetlands and uplands. With uplands, errors of omission and commission (both at species level, and generalized level) have been tallied for each classification unit or "SCCU", including an overall percentage of accuracy, and a K-hat statistic. Wetlands accuracy was also based on the classification unit, with percentage User's accuracy for each class and an overall percentage accuracy. Urban accuracy assessment was performed on its unit of classification, the full TM scene. Both User's and an overall accuracy assessment are given.

Logical_Consistency_Report:
Because of the 8-bit file structure used for the WISCLAND Land Cover data, the ERDAS software prevents the assignment of invalid pixel values outside of a 0-to-256 range. In addition, the data have undergone visual, on-screen review by members of the WiDNR/GEO Land Cover development team to check for classification errors or other anomalies.

Completeness_Report:
A stratified random sampling technique was used to identify "ground truthing" points for the purpose of land cover classification and accuracy assessment, as described in the WISCLAND Land Cover Protocol. A "Lineage" document (see **Additional Documentation** above) lists the final land cover classifications, and classes omitted, for each processing SCCU.

Positional_Accuracy:
Horizontal_Positional_Accuracy:

Horizontal_Positional_Accuracy_Report:
The source nationwide MRLC (Multi-Resolution Land Characteristics Consortium) data were geometrically corrected by EROS Data Center to 1:24,000 scale USGS topographic quadrangle maps. Accuracy standards were on the order of RMS error no greater than 1 pixel. The WISCLAND Land Cover data are considered to reflect the stated positional accuracy of the source MRLC data set, with positional error of no more than plus or minus 1 pixel (30 meters).

Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator:
US Geological Survey, EROS (Earth Resources Observation Systems) Data Center
Publication_Date: 1993
Title:
MRLC (Multi-Resolution Land Characteristics Consortium) acquisition of dual-date Landsat Thematic Mapper (TM) data
Edition: None
Geospatial_Data_Presentation_Form: Remote-sensing image
Publication_Information:
Publication_Place: Sioux Falls, South Dakota
Publisher: EROS Data Center
Other_Citation_Details: None
Source_Scale_Denominator: 40,000 (nominal)
Type_of_Source_Media: 8mm magnetic tape
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 1991
Ending_Date: 1993
Source_Currentness_Reference:
Date of the Landsat TM satellite data acquisition for the MRLC Consortium.
Source_Citation_Abbreviation: MRLC Landsat TM satellite data.
Source_Contribution:
Remote-sensing imagery used to derive land cover information. For more information refer to: Barra, T.J. and D. Shaw, 1994. Multi-Resolution Land Characteristics Consortium: Documentation Notebook. Contract 68-DO-0106.

Process_Step:
Process_Description:
The geo-rectified MRLC data were processed according to the protocol published in the UMGAP Image Processing Protocol (1997), found at http://www.emtc.nbs.gov/umgaphome.html. The classified data (except URBAN) were generalized from their original 30-meter resolution to a one acre area of any four contiguous like pixels using a clump-sieve-fill algorithm devised within Imagine and described in detail within the in-house technical procedures document. Strata were clipped at the SCCU boundary, converted from Imagine v.8.3 files into ARC/INFO Grids, projected into WTM

NAD83 with adjustment for 91, and then joined for continuous coverage.
Process_Date: 1994-1998

Spatial_Data_Organization_Information:
Indirect_Spatial_Reference: None
Direct_Spatial_Reference_Method: Raster

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Map_Projection:
Map_Projection_Name: Transverse Mercator
Transverse_Mercator:
Longitude_of_Central_Meridian: 90 degrees West (-90)
Latitude_of_Projection_Origin: 0 degrees
False_Easting: 520000
False_Northing: -4480000
Scale_Factor_at_Central_Meridian: 0.9996
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: row and column
Coordinate_Representation:
Abscissa_Resolution: 30
Ordinate_Resolution: 30
Planar_Distance_Units: meters

Geodetic_Model:
Horizontal_Datum_Name:
North American Datum of 1983 - 1991 Adjustment
Ellipsoid_Name: Geodetic Reference System 80
Semi-major_Axis: 6378137 meters
Denominator_of_Flattening_Ratio: 298.25722210088

Entity_and_Attribute_Information:
Overview_Description:
Entity_and_Attribute_Overview:
Each pixel within the WISCLAND Land Cover raster dataset has an associated 8-bit value which corresponds to a Land Cover class. The WISCLAND Land Cover classification scheme is a hierarchical scheme which is modeled after Anderson's Classification scheme (USGS, 1976) but adaptable to other existing classification schemes, especially the UNESCO/The Nature Conservancy classification system.
Entity_and_Attribute_Detail_Citation:
WISCLAND LAND COVER CLASSIFICATION SCHEME - Classes listed in UPPER CASE are the base minimum WISCLAND classes. Extended categories are in lower case, and are not part of the base minimum classification. 8-bit numeric ID codes are listed in parentheses.

(100) 1. URBAN/DEVELOPED
(101) 1.1 HIGH INTENSITY
(104) 1.2 LOW INTENSITY
(105) 1.3 GOLF COURSE
(107) 1.4 Transportation

(110) 2. AGRICULTURE
(111) 2.1 HERBACEOUS/FIELD CROPS
(112) 2.1.1 ROW CROPS
(113) 2.1.2 CORN
(114) 2.1.3 Peas
(115) 2.1.4 Potatoes
(116) 2.1.5 Snap beans
(117) 2.1.6 Soybeans
(118) 2.1.7 OTHER ROW CROPS
(124) 2.1.8 FORAGE CROPS: includes Hay and Hay/Mix
(125) 2.1.9 Alfalfa
(131) 2.1.10 Small Grain Crops
(132) 2.1.11 Oats
(133) 2.1.12 Wheat
(134) 2.1.13 Barley
(140) 2.2 Woody
(141) 2.2.1 Nursery
(142) 2.2.2 Orchard
(143) 2.2.3 Vineyard
(148) 2.3 CRANBERRY BOG
(150) 3. GRASSLAND: includes timothy, rye, pasture, idle, CRP, grass and volunteer
(151) 3.1 Cool Season Grass
(152) 3.2 Warm Season Grass
(153) 3.3 Old Field
(160) 4. FOREST
(161) 4.1 CONIFEROUS
(162) 4.1.1 JACK PINE
(163) 4.1.2 RED PINE
(164) 4.1.3 Scotch Pine
(165) 4.1.4 Hemlock
(166) 4.1.5 WHITE SPRUCE
(167) 4.1.6 Norway Spruce
(168) 4.1.7 Balsam Fir
(169) 4.1.8 Northern White Cedar
(170) 4.1.9 Black Spruce
(171) 4.1.10 White Pine
(173) 4.1.11 MIXED/OTHER CONIFEROUS
(175) 4.2 BROAD-LEAVED DECIDUOUS
(176) 4.2.1 ASPEN
(177) 4.2.2 OAK
(178) 4.2.3 White Oak
(179) 4.2.4 NORTHERN PIN OAK
(180) 4.2.5 RED OAK
(181) 4.2.6 White Birch
(182) 4.2.7 Beech
(183) 4.2.8 MAPLE
(184) 4.2.9 Red Maple
(185) 4.2.10 SUGAR MAPLE
(186) 4.2.11 Balsam-Poplar
(187) 4.2.12 MIXED/OTHER BROAD-LEAVED DECIDUOUS
(190) 4.3 MIXED DECIDUOUS/CONIFEROUS
(191) 4.3.1 Pine-deciduous
(192) 4.3.2 Jack Pine - Deciduous
(193) 4.3.3 Red/White Pine - Deciduous

(194) 4.3.4 Spruce/Fir - Deciduous
(200) 5. OPEN WATER
(210) 6. WETLAND
(211) 6.1 EMERGENT/WET MEADOW
(212) 6.1.1 FLOATING AQUATIC
(213) 6.1.2 Fine-leaf Sedge
(214) 6.1.3 Broad-leaved Sedge-grass
(215) 6.1.4 Sphagnum Moss
(217) 6.2 LOWLAND SHRUB
(218) 6.2.1 BROAD-LEAVED DECIDUOUS
(219) 6.2.2 BROAD-LEAVED EVERGREEN
(220) 6.2.3 NEEDLE-LEAVED
(222) 6.3 FORESTED
(223) 6.3.1 BROAD-LEAVED DECIDUOUS
(224) 6.3.2 Red Maple
(225) 6.3.3 Silver Maple
(226) 6.3.4 Black Ash
(227) 6.3.5 Mixed/Other Deciduous
(229) 6.3.6 CONIFEROUS
(230) 6.3.7 Black Spruce
(231) 6.3.8 Tamarack
(232) 6.3.9 Northern White Cedar
(234) 6.3.10 MIXED DECIDUOUS/CONIFEROUS
(240) 7. BARREN
(241) 7.1 Sand
(242) 7.2 Bare Soil
(245) 7.3 Exposed Rock
(246) 7.4 Mixed
(250) 8. SHRUBLAND
(255) 9. CLOUD COVER

Distribution_Information:
Distributor:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization:
Wisconsin Department of Natural Resources, Bureau of
Enterprise Information Technology and Applications,
Geographic Services Section
Contact_Person: Brad Duncan or John Laedlein
Contact_Address:
Address_Type: mailing address
Address:
Mailcode: ET/8
101 South Webster Street
P.O. Box 7921
City: Madison
State_or_Province: Wisconsin (WI)
Postal_Code: 53707-7921
Country: United States of America (USA)
Contact_Voice_Telephone: (608) 264-8916
Contact_Facsimile_Telephone: (608) 266-0870
Contact_Electronic_Mail_Address: duncab@dnr.state.wi.us
Distribution_Liability:
WiDNR and its GIS database cooperators will not be liable in any way

for the accuracy of these data, and assume no responsibility whatsoever for direct, indirect, special, consequential, exemplary, or other damages. The burden for determining fitness for use rests entirely upon the data requester.

Standard_Order_Process:
  Digital_Form:
    Digital_Transfer_Information:
      Format_Name: ARC/INFO Grid format
      Format_Version_Number: ARC7.1.1
      File_Decompression_Technique: WINZIP
      Transfer_Size: 80 (approximate megabytes, uncompressed)
    Digital_Transfer_Option:
      Online_Option:
        Computer_Contact_Information:
          Network_Address:
            Network_Resource_Name:
              <Contact (608) 264-8916 for URL to obtain data by FTP or HTTP>
      Offline_Option:
        Offline_Media: CD-ROM
        Recording_Capacity:
          Recording_Density: 650
          Recording_Density_Units: megabytes
        Recording_Format: ISO 9660
      Offline_Option:
        Offline_Media: 4mm cartridge tape
        Recording_Capacity:
          Recording_Density: 2
          Recording_Density: 5
          Recording_Density: 10
          Recording_Density_Units: gigabytes
        Recording_Format:  tar
      Offline_Option:
        Offline_Media: 8mm cartridge tape
        Recording_Capacity:
          Recording_Density: 2
          Recording_Density: 5
          Recording_Density: 10
          Recording_Density_Units: gigabytes
        Recording_Format:  tar

  Digital_Form:
    Digital_Transfer_Information:
      Format_Name: ERDAS Imagine format
      Format_Version_Number: ERD83
      File_Decompression_Technique: WINZIP
      Transfer_Size: 400 (approximate megabytes, uncompressed)
    Digital_Transfer_Option:
      Online_Option:
        Computer_Contact_Information:
          Network_Address:
            Network_Resource_Name:
              <Contact (608) 264-8916 for URL to obtain data by FTP or HTTP>
      Offline_Option:
        Offline_Media: CD-ROM

Recording_Capacity:
Recording_Density: 650
Recording_Density_Units: megabytes
Recording_Format: ISO 9660
Offline_Option:
Offline_Media: 4mm cartridge tape
Recording_Capacity:
Recording_Density: 2
Recording_Density: 5
Recording_Density: 10
Recording_Density_Units: gigabytes
Recording_Format: tar
Offline_Option:
Offline_Media: 8mm cartridge tape
Recording_Capacity:
Recording_Density: 2
Recording_Density: 5
Recording_Density: 10
Recording_Density_Units: gigabytes
Recording_Format: tar

Fees:
Fees for obtaining copies of WiDNR data sets are intended to cover the cost of reproduction and vary depending on the particular data set and the requested type of transfer media. The fees for standard data request generally include a $50 order processing fee, a data layer handling fee of $50 per data layer, and a transfer media fee of $40 per CD or magnetic tape cartridge. There is no transfer media fee when data are obtained by ftp. Refer to the "WiDNR GIS Datasharing Policy" at http://www.dnr.state.wi.us/org/et/at/geo/ for further details.
Ordering_Instructions:
To order data, complete a "DNR Data Request Order Form", available from the distributor or via the internet at http://www.dnr.state.wi.us/org/et/at/geo/

Metadata_Reference_Information:
Metadata_Date: 199712
Metadata_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: John Laedlein
Contact_Organization:
Wisconsin Dept. of Natural Resources, Bureau of Enterprise Information Technology and Applications, Geographic Services Section, ET/8
Contact_Address:
Address_Type: mailing address
Address:
101 South Webster St.,
P.O. Box 7921,
City: Madison
State_or_Province: WI
Postal_Code: 53707-7921
Contact_Voice_Telephone: (608) 264-8916

Contact_Facsimile_Telephone: (608) 266-0870
Contact_Electronic_Mail_Address: laedlj@dnr.state.wi.us
Metadata_Standard_Name:
FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: 199704