



*Improving Michigan's Access to
Geographic Information Networks*

Updating Land Cover / Use Data

An IMAGIN Working Paper

Prepared by
The IMAGIN Land Cover / Use Update Work Group
In Cooperation with
The Center for Remote Sensing and GIS
Michigan State University

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The Michigan Resource Inventory System

The Michigan Resource Inventory System (MIRIS) was created by a legislative act (Public Act No. 204, which is currently embodied in Part 609, Resource Inventory, of the Natural Resource and Environmental Protection Act, Act 451 of the Public Acts of 1994) in 1979. The program was to prepare two types of inventories about the State's land and water resources: a current use inventory to illustrate land cover and land use and a land resource inventory which would include resources, unique areas, areas hazardous to development, etc. An Inventory Advisory Committee (IAC), appointed by the governor, oversaw the entire program. The IAC was composed of representatives from the major land resource based industries, utilities, local, state, and federal agencies, universities, and environmental groups.

The Current Use Inventory is the largest component of the Michigan Resource Inventory System. The Current Use Inventory was compiled from photo interpretation of color infrared aerial photography (1:24,000-scale or 1 inch to 2,000 feet) obtained in 1978/79. Aerial photography obtained in 1985 was used for the inventory of Detroit and seven highly urbanized counties in Southeast Michigan.

The Michigan Land Cover/Use Classification System (Division of Land Resource Programs, 1981) is similar to the national system developed by the U.S. Geological Survey (Anderson, et al., 1976). This multi-level, hierarchical system classifies Michigan's land cover/use into approximately 500 categories. The Current Use Inventory is a subset (approximately 60 level I and II categories) of the Michigan Land Cover/Use Classification System, unfortunately, some of the category numbers and category definitions were changed. The Current Use Inventory in eleven counties was supplemented with a detailed forest land component (level IV and V data which includes species designation and stand size and stocking classification).

The Michigan Resource Inventory Act specified that the "current use portion of the inventory shall be reviewed and updated when necessary, but not less than once each 5 years." This provision recognized that one of the most important uses of the current use inventories is to locate the amount and types of changes in the landscape over time. This ability is especially important to local governments who are monitoring the implementation of local plans, foresters who are creating cutting and regeneration plans, biologists who are tracking wildlife population fluctuations based on habitat, etc.

Updating Land Cover / Use Maps

Land cover and land use can and do change with time. Effective decision making and land management require reasonably "current" land cover and land use data. Land conversion and changes in land use are likewise of interest to the land manager.

The IMAGIN (Improving Michigan's Access to Geographic Information Networks) organization, in cooperation with the Center for Remote Sensing and GIS at Michigan State University, has reviewed land cover/use update issues through a work group (Appendix I). The work

group met on the campus of Michigan State University in December, 1999 to review land cover/use classification methods and updating procedures for the State of Michigan. The work group provided an open forum for discussion of technical procedures and classification issues. The goal of this group was to reach consensus on a number of land cover/use update issues raised at the December meeting. A secondary goal was to summarize these techniques which is the purpose of this IMAGIN working paper.

Specific questions, concerns, and comments posed during the “technical portion” of the Land Cover/Land Use Work Group Meeting and those posted to a Land Cover / Land Use Electronic Bulletin Board (www.imagin.org or www.crs.msu.edu/lclu) have been addressed by committees and their recommendations noted below.

Statewide Aerial Photography

Question/Concern - Should we use leaf-off photography (does this affect the interpretability of forests)?

A team of Center scientists, aided by graduate student assistants, compared image types and scales for photography available on a statewide basis. These included, (1) 1978 color infrared transparencies at 1:24,000 scale from the Michigan Department of Natural Resources (MDNR), (2) 1998 black-and-white infrared transparencies at 1:15,840 scale from the MDNR, and (3) 1998 color infrared transparencies at 1:40,000 scale from the National Aerial Photography Program (NAPP). Each film/scale type was scanned at 1 and 2 meter resolution and judged for interpretability by a panel of experienced photo interpreters. The results of the image scale comparisons are summarized in the accompanying table. With regards to the ability to interpret forests, the leaf-off photography appears to be totally suitable for **updating** existing land cover/use maps (making the assumption that the 1978 forest species were correctly interpreted).

The IMAGIN work group endorses the use of 1998 leaf-off, color infrared transparencies, at a scale of 1:40,000, from the National Aerial Photography Program, as the image of choice for updating land cover/use data as mapped in the Current Use Inventory.

Comparison of Several Image Types and Scales

Agency	MDNR	MDNR	MDNR	MDNR	USGS - NAPP	USGS - NAPP
Year	1998	1998	1978	1978	1998	1998
Scale	1:15,840	1:15,840	1:24,000	1:24,000	1:40,000	1:40,000
Film Type	BWIR	BWIR	CIR	CIR	CIR	CIR
d.p.i./resolution	402 / 1 m	201 / 2 m	610 / 1 m	305 / 2 m	1016 / 1 m	508 / 2 m
File Size (MB)	13	3.5	90	23	250	62
Scan time/image (minutes)	2.5	1	3	1	9	3
Interpretability	good	poor to average	very good	good	very good	good
# photos/twp.	~ 40	~ 40	~ 20	~ 20	6 - 8	6 - 8
Total Size/twp. (MB)	520	140	1800	460	1500 - 2000	370 - 500
Rectification Time/Photo (Cross-Validated Polynomial)	N/A	N/A	N/A	N/A	75 To 105 Minutes	60 To 90 Minutes
Time to Construct Mosaic	N/A	N/A	N/A	N/A	5 To 7 Hours	4 To 6 Hours

Classification Systems

Question/Concern - What are the differences between the Federal Land Use and Land Cover Classification System, the Michigan Land Cover/Use Classification System, and the Current Use Classification System (MIRIS).

The accompanying tables compare the three classification systems.

The IMAGIN work group recommends the accompanying re-code table be used for comparing land cover/use data compiled by the MIRIS Current Use Inventory with data compiled using the Federal (USGS) classification system.

The IMAGIN work group recommends the accompanying minor modifications be made to the Michigan Land Cover/Use Classification System and the Current Use Inventory Classification system to make the two comparable.

Federal (U.S. Geological Survey) and Michigan (MIRIS) Classification Systems*

USGS	Michigan
11 Residential	Residential
12 Commercial and Services	Commercial, Services, and Institutional
13 Industrial	Industrial
14 Transportation, Communications, and Utilities	Transportation, Communications, and Utilities
15 Industrial and Commercial Complexes	
16 Mixed Urban or Built-up Land	
17 Other Urban or Built-up Land	Extractive
19	Open Land and Other
21 Cropland and Pasture	Cropland
22 Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas	Orchards, Bush Fruits, Vineyards, and Ornamental Horticulture Areas
23 Confined Feeding Operations	Confined Feeding Operations
24 Other Agricultural Land	Permanent Pasture
29	Other Agricultural Lands
31 Herbaceous Rangeland	Herbaceous Openland
32 Shrub and Brush Rangeland	Shrubland
33 Mixed Rangeland	Pine or Oak Opening (Savannah)
41 Deciduous Forest Land	Broadleaved Forest (generally deciduous)
42 Evergreen Forest Land	Coniferous Forest
43 Mixed Forest Land	
51 Streams and Canals	Streams and Waterways
52 Lakes	Lakes
53 Reservoirs	Reservoirs
54 Bays and Estuaries	Great Lakes
61 Forested Wetland	Forested (wooded) Wetlands
62 Nonforested Wetland	Nonforested Wetlands
71 Dry Salt Flats	[Not applicable in Michigan]
72 Beaches	Beaches and Riverbanks
73 Sandy Areas other than Beaches	Sand Dunes
74 Bare Exposed Rock	Bare Exposed Rocks
75 Strip Mines, Quarries, and Gravel Pits	
76 Transitional Areas	
77 Mixed Barren Land	

* Except for minor definitional and nomenclature differences, the following changes (re-codes) are necessary to make Michigan data comparable with Federal data.

Federal (USGS)	Michigan (MIRIS) Re-code
15 Industrial and Commercial Complexes	138 Industrial Parks → 15
16 Mixed Urban or Built-up Land	Not mapped
17 Other Urban or Built-up Land	19 Open Land and Other → 17
21 Cropland and Pasture	21 Cropland + 24 Pasture → 21
24 Other Agricultural Land	29 Other Agricultural Land → 24
31 Herbaceous Rangeland	31 Herbaceous Openland + 33 Pine or Oak Opening → 31
33 Mixed Rangeland	Not mapped
43 Mixed Forest Land	Not mapped
75 Strip Mines, Quarries, and Gravel Pits	17 Extractive → 75
76 Transitional Areas	Not mapped
77 Mixed Barren Land	Not mapped

Michigan Land Cover/Use and Current Use Inventory (MIRIS) Classification Systems*

Michigan Land Cover/Use

Current Use Inventory (MIRIS)

1 Urban and Built Up	Urban and Built Up Lands
11 Residential	Residential
111 Multi-Family, Medium- to High-Rise	111 Multi-Family, Medium- to High-Rise
112 Multi-Family, Low Rise	112 Multi-Family, Low Rise
113 Single Family/Duplex	113 Single Family/Duplexes
115 Mobile Home Parks	115 Mobile Home Park
12 Commercial, Services, and Institutional	12 Commercial, Services, and Institutional
121 Primary/Central Business District	121 Primary/Central Business District
122 Shopping Center	122 Shopping Center/Malls
124 Secondary/Neighborhood Business District	124 Secondary/Neighborhood Business District
126 Other Institutional	126 Institutional
13 Industrial	13 Industrial
	138 Industrial Parks
14 Transportation, Communications, and Utilities	
141 Air Transportation	141 Air Transportation
142 Rail Transportation	
143 Water Transportation	143 Water Transportation
144 Road Transportation	
145 Communications	145 Communications
146 Utilities	146 Utilities
17 Extractive	17 Extractive
171 Open Pit	171 Open Pit
1711 Sand and Gravel	1711 Metallic Mineral Quarry
1712 Rock Quarry	1712 Nonmetallic Mineral Quarry
1713 Coal (strip)	1713 Sand and Gravel
172 Shaft	172 Underground
1721 Salt	1721 Metallic
173 Wells	173 Wells
1731 Oil	1731 Oil
19 Open and Other	19 Open Land and Other
193 Outdoor Recreation	193 Outdoor Recreation
194 Cemeteries	194 Cemeteries

Michigan Land Cover/Use and Current Use Inventory (MIRIS) Classification Systems*

Michigan Land Cover/Use	Current Use Inventory (MIRIS)
2 Agricultural Land	Agricultural Lands
21 Cropland, Rotation and Permanent Pasture	21 Cropland
22 Orchards, Bush-Fruits, Vineyards and Ornamental Horticulture Areas	22 Orchards, Bush-Fruits, Vineyards and Ornamental Horticulture Areas
23 Confined Feeding Operations	23 Confined Feeding Operations
	24 Permanent Pasture
29 Other Agricultural Land	29 Other Agricultural Land
3 Rangeland	Nonforested Lands
31 Herbaceous Rangeland	31 Herbaceous Openland
32 Shrub Rangeland	32 Shrubland
	33 Pine or Oak Opening (Savannah)
4 Forest Land	Forest Land
41 Broadleaved Forest (generally deciduous)	41 Broadleaved Forest (generally deciduous)
411 Upland Hardwoods	411 Northern Hardwood
412 Aspen, White Birch, and Associated Species	412 Central Hardwood
413 Lowland Hardwoods	413 Aspen, White Birch, and Associated Species
	414 Lowland Hardwoods
42 Coniferous Forest	42 Coniferous Forest
421 Upland Conifers	421 Pine
422 Lowland Conifers	422 Other Upland Conifers
	423 Lowland Conifers
	429 Managed Christmas Tree Plantation

Michigan Land Cover/Use and Current Use Inventory (MIRIS) Classification Systems*

Michigan Land Cover/Use	Current Use Inventory (MIRIS)
5 Water	Water Bodies
51 Streams and Waterways	51 Streams and Waterways
52 Lakes	52 Lakes
53 Reservoirs	53 Reservoirs
54 Great Lakes	54 Great Lakes
6 Wetlands	Wetlands
61 Forested (Wooded) Wetlands	61 Forested (Wooded) Wetlands
612 Shrub Swamps	611 Wooded Wetland
	612 Shrub/Scrub wetland
62 Non-Forested (Non-Wooded) Wetland	62 Nonforested Wetland
622 Mudflats	621 Aquatic Bed Wetland
623 Shallow Marshes	622 Emergent Wetland
	623 Flats
7 Barren	Barren
72 Beaches and Riverbanks	72 Beaches and Riverbanks
73 Sand Other than Beaches	73 Sand Dunes
74 Bare Exposed Rock	74 Bare Exposed Rocks

* The following changes are necessary to make the Michigan Land Cover/Use Classification System compatible with the Current Use Inventory Classification System definitions.

122	Rename	Shopping Center → Shopping Center / Malls
126	Rename	Other Institutional → Institutional
	Add	138 Industrial Parks
1711	Re-define	Sand and Gravel → Metallic Mineral Quarry
1712	Re-define	Rock Quarry → Nonmetallic Mineral Quarry
1713	Re-define	Coal (strip) → Sand and Gravel
172	Rename	Shaft → Underground
1721	Re-define	Salt → Metallic
19	Rename	Open and Other → Open Land and Other
21	Split	Cropland, Rotation and Permanent Pasture → 21 Cropland → 24 Permanent Pasture
3	Rename	Rangeland → Nonforested Lands
31	Rename	Herbaceous Rangeland → Herbaceous Openland
32	Rename	Shrub Rangeland → Shrubland
	Add	33 Pine or Oak Opening (Savannah)
411	Re-define	Upland Hardwoods → Northern Hardwood
412	Re-define	Aspen, White Birch, and Associated Species → Central Hardwood
413	Re-define	Lowland Hardwood → Aspen, White Birch, and Associated Species
	Add	414 Lowland Hardwoods
421	Split	Upland Conifers → 421 Pine → 422 Other Upland Conifers
	Add	429 Managed Christmas Tree Plantation
5	Rename	Water → Water Bodies
	Add	611 Wooded Wetland
612	Rename	Shrub Swamps → Shrub / Scrub Wetland
	Add	621 Aquatic Bed Wetland
622	Re-define	Mudflats → Emergent Wetland
623	Re-define	Shallow Marshes → Flats
73	Rename	Sand Other than Beaches → Sand Dunes

In addition, the following changes need to be made to the Current Use Inventory definitions.

Add	142	Rail Transportation (mapped, but inadvertently left out of Current Use Inventory documents)
Add	144	Road Transportation (mapped, but inadvertently left out of Current Use Inventory documents)
Remove	1467	Waste Injection Wells (not mapped in any Michigan County)
Remove	1713	Coal (not mapped in any Michigan County)
Remove	1719	Other (not mapped in any Michigan County)
Remove	1722	Nonmetallic (not mapped in any Michigan County)
Remove	1723	Coal (not mapped in any Michigan County)

Remove 1729 Other (not mapped in any Michigan County)
Remove 1732 Gas (not mapped in any Michigan County)
Remove 1733 Brine Production (not mapped in any Michigan County)
Remove 1734 Waste Disposal (not mapped in any Michigan County)
Remove 1739 Other (not mapped in any Michigan County)
Remove 179 Other Extractive (not mapped in any Michigan County)

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Question/Concern - the fundamental goal that we need to keep sight of is: Ability to do change analysis, ability to compare the 1978 work with what will be done now.

Question/Concern - In the updated product, we need to be assured that “change” is a result of land cover / use change, not a result of a change in the classification scheme.

Various classification systems were compared and contrasted for their appropriateness for updating existing land cover and land use maps. These included the Federal, USGS system (A Land Use and Land Cover Classification System for Use with Remote Sensor Data, USGS Professional Paper 964), the Michigan Land Cover/Use Classification System, the Current Use Inventory System (MIRIS), the MIRIS Land Cover/Use Classification System Version II, and the American Planning Association’s Land-Based Classification Standards (update of the 1965 Standard Land Use Coding Manual). In addition, the new Federal Geographic Data Committee Standards were reviewed. These included the Earth Cover Classification System (Draft), the National Vegetation Classification Standard (FGCD-STD-005), and the Classification of Wetlands and Deepwater Habitats of the United States (FGCD-STD-004).

Keeping in mind the fundamental goal outlined above, the starting point for choosing / building a classification system is to carefully examine the previous (1978 Current Use Inventory) classification system and the larger system (Michigan Land Cover / Use Classification System) from which it was drawn. The following suggested mapping legend for updating land cover / use maps uses the previous classifications from the Current Use Inventory Classification System definitions where appropriate, uses more detailed categories from the Michigan Land Cover / Use Classification System where needed, and adds new categories (including definitions) where they are necessary and lacking in the existing systems. Specific concerns and suggestions which have been raised about the various classes are noted where appropriate. Note - definitional changes in the Land Cover / Use Classification System Version II inconsistent with the original Current Use Inventory are shown in **bold**.

Note - the proposed classification scheme includes virtually ALL the categories in the MIRIS Current Use Classification System Version II. A fairly straightforward recode of the proposed system would collapse the classes to the equivalent of the Version II system (Appendix II).

The IMAGIN work group reaffirms the Michigan Land Cover/Use Classification System, with minor modifications, as the statewide standard, and supports its use in updating land cover/use maps.

Residential Land Uses

Current Use Inventory Classification System (MIRIS)

- 111 Multi-Family Residential -- Medium to High Rise
- 112 Multi-Family Residential -- Low Rise
- 113 Single Family / Duplexes
- 115 Mobile Home Park

Michigan Land Cover / Use Classification System (Proposed changes in italics)

11 Residential

- 111 Multi-Family, Medium- to High-Rise
- 112 Multi-Family, Low-Rise
- 113 Single-Family / Duplex
 - 1131 Single Family*
 - 1132 Duplex*
 - 1135 Manufactured Home*
- 115 *Manufactured Home Parks*

Land Cover / Use Classification System Version II

Residential

- 111 Multi-Family: High-Rise
- 112 Multi-Family: Low Rise
- 113 Single Family
- 114 Duplex
- 115 **Mobile Home**

Additional suggested scheme

11 Residential

- 111 Multi-family, medium- to high-rise
- 112 Multi-family, low-rise
- 113 Single family / duplex
 - 1131 Single family
 - 1132 Duplex
- 115 Manufactured home park
- 116 Group and transient quarters

Land-Based Classification Standards, Structure Dimension (American Planning Association)

1000 Residential Buildings

- 1100 Single Family Buildings
 - 1110 Detached Units
 - 1120 Attached Units
 - 1121 Duplex Structures
 - 1122 Zero Lot Line, Row Houses, Etc.
 - 1130 Accessory Units
 - 1140 Townhouses
 - 1150 Manufactured Housing
- 1200 Multifamily Structures
 - 1202 Two Units
 - ...
 - 1299 Ninety-Nine Units and More
- 1300 Other Specialized Residential Structures
 - 1310 Barracks
 - 1320 Dormitories
 - 1330 Hotels, Motels, and Tourist Courts
 - 1340 Single Unit Occupancy Units
 - 1350 Temporary Structures, Tents, etc. for Shelter
 - 1360 Other Structurally Converted Buildings

All three suggested revisions to the Current Use Inventory Classification System accommodate the desire to map the five major types of residential structures (high-rise multi-family, low-rise multi-family, duplex, single family, and manufactured homes) and to separate single family / duplex / and manufactured homes. Version II does not distinguish between high-density manufactured home parks and single manufactured homes on platted properties. The additional suggested scheme also recognizes a group and transient quarters category similar to the 1300 (Other Specialized Residential Structures) of the APA Classification and the 116 (Group and Transient Quarters) of the full Michigan Land Cover / Use Classification System.

Commercial, Services, and Institutional

Current Use Inventory Classification System (MIRIS)

- 12 Commercial, Services, and Institutional
 - 121 Primary / Central Business District
 - 122 Shopping Center / Malls
 - 124 Secondary / Neighborhood Business District
 - 126 Institutional

Michigan Land Cover / Use Classification System (Proposed changes in italics)

- 12 Commercial, Services, and Institutional
 - 121 Primary / Central Business District
 - 122 Shopping Center / Malls / *Retail Centers*
 - 124 Secondary / Neighborhood Business District
 - 126 Institutional
 - 127 Indoor Cultural, Public Assembly, and Recreation
 - 128 *Office*

Land Cover / Use Classification System Version II

- Commercial, Services, Institutional
 - 121 Central Business District
 - 122 Retail Center
 - 124 **Other Retail, Services**
 - 125 **Public Assembly**
 - 126 **Institutional**
 - 128 Office

Industrial

Current Use Inventory Classification System (MIRIS)

13 Industrial

138 Industrial Parks

Michigan Land Cover / Use Classification System (No proposed changes)

13 Industrial

138 Industrial Parks

Land Cover / Use Classification System Version II

Industrial

138 Industrial Park

139 **Other Industrial**

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Transportation, Communications, and Utilities

Current Use Inventory Classification System (MIRIS)

- 141 Air Transportation
- 142 Rail Transportation
- 143 Water Transportation
- 144 Road Transportation
- 145 Communications
- 146 Utilities

Michigan Land Cover / Use Classification System (Proposed changes in italics)

14 Transportation, Communications, and Utilities

- 141 Air Transportation
- 142 Rail Transportation
- 143 Water Transportation
- 144 Road Transportation
- 145 Communications
- 146 Utilities
 - 1461 *Utility Line*
 - 1464 Solid Waste Disposal and Transfer
 - 1465 Sewage Treatment and Transmission
 - 1466 Water Treatment and Transmission
 - 1467 *Other*

Land Cover / Use Classification System Version II

- 141 Air Transportation
- 142 Rail Transportation
- 143 Water Transportation
- 144 Road Transportation
- 145 Communication
- 146 Utility Line
- 147 **Waste Disposal**
- 148 Other Utility

Extractive

Current Use Inventory Classification System (MIRIS)

17 Extractive

- 171 Open Pit
 - 1711 Metallic Mineral Quarry
 - 1712 Nonmetallic Mineral Quarry
 - 1713 Sand and Gravel
- 172 Underground
 - 1721 Metallic
- 173 Wells
 - 1731 Oil

Michigan Land Cover / Use Classification System (No proposed changes)

17 Extractive

- 171 Open Pit
 - 1711 Metallic Mineral Quarry
 - 1712 Nonmetallic Mineral Quarry
 - 1713 Sand and Gravel
- 172 Underground
 - 1721 Metallic
- 173 Wells
 - 1731 Oil

Land Cover / Use Classification System Version II

Extractive

- 171 Open Pit: Sand and Gravel
- 172 Underground Mine
- 173 Wells
- 174 Open Pit: Rock

Open Land and Other

Current Use Inventory Classification System (MIRIS)

- 19 Open Land and Other
 - 193 Outdoor Recreation
 - 194 Cemeteries

Michigan Land Cover / Use Classification System (Proposed changes in italics)

- 19 Open Land and Other
 - 191 Outdoor Cultural
 - 1913 Historical Sites*
 - 192 Outdoor Public Assembly
 - 193 Outdoor Recreation
 - 1931 *Parks*
 - 1933 Sports Areas
 - 1934 Other Land-Based Activities
 - 1935 Water-Dependent Recreation
 - 194 Cemeteries
 - 195 Vacant*
 - 196 Under Construction*

Land Cover / Use Classification System Version II

- Recreation, Open Use
 - 191 Marina, Boat Launch
 - 192 Campground
 - 193 Day-Use Recreation
 - 194 Cemetery
 - 195 Group Camp

The proposed Michigan Land Cover / Use Classification System maps components of outdoor public assembly separate from indoor public assembly. The user of the data is free to combine the individual categories into whatever scheme best suits their needs.

Agricultural Land

Current Use Inventory Classification System (MIRIS)

Agricultural Lands

- 21 Cropland
- 22 Orchards, Bush Fruits, Vineyards, and Ornamental Horticulture Areas
- 23 Confined Feeding Operations
- 24 Permanent Pasture
- 29 Other Agricultural Lands

Michigan Land Cover / Use Classification System (No proposed changes)

2 Agricultural Lands

- 21 Cropland
- 22 Orchards, Bush Fruits, Vineyards, and Ornamental Horticulture Areas
 - 223 Ornamental Horticulture and Nurseries
- 23 Confined Feeding Operations
- 24 Permanent Pasture
- 29 Other Agricultural Lands
 - 291 Farmsteads

Land Cover / Use Classification System Version II

Agriculture

- 21 Cropland
- 22 Orchard, Vineyard
- 23 Confined Feeding
- 24 Permanent Pasture
- 25 Farmstead
- 26 Ornamental
- 29 **Other Agricultural**

Nonforested Lands

Current Use Inventory Classification System (MIRIS)

Nonforested Lands

- 31 Herbaceous Openland
- 32 Shrubland
- 33 Pine or Oak Opening (Savannah)

Michigan Land Cover / Use Classification System (Proposed changes in italics)

Grass and Shrub Lands

- 31 *Grasses*
- 32 *Shrubs*
- 33 Pine or Oak Opening (*prairie*)
 - 331 Hardwood*
 - 332 Coniferous*

Land Cover / Use Classification System Version II

Upland Field

- 31 Upland Grass
- 32 Upland Shrub
- Savanna
 - 331 Hardwood Savanna
 - 332 Coniferous Savanna
- 34 Vacant

Forest Land

Current Use Inventory Classification System (MIRIS)

Forest Land

- 41 Broadleaved Forest (Generally Deciduous)
 - 411 Northern Hardwood
 - 412 Central Hardwood
 - 413 Aspen, White Birch, and Associated Species
 - 414 Lowland Hardwoods
- 42 Coniferous Forest
 - 421 Pine
 - 422 Other Upland Conifers
 - 423 Lowland Conifers
 - 429 Managed Christmas Tree Plantation

Michigan Land Cover / Use Classification System (Proposed changes in italics)

4 Forest Land

- 41 Broadleaved Forest (*Generally Deciduous*)
 - 411 Northern Hardwood
 - 412 Central Hardwood / *Oak*
 - 413 *Aspen-Birch*
 - 414 Lowland Hardwoods
- 42 Coniferous Forest
 - 421 Pine
 - 422 Other Upland Conifers
 - 423 Lowland Conifers
 - 429 Managed Christmas Tree Plantation
- 43 Mixed Conifer-Broadleaved Forest
- 44 *Clearcut*

Land Cover / Use Classification System Version II

Upland Forest

Deciduous

- 413 Aspen-Birch
- 419 Other Upland Hardwood

Coniferous

- 421 Pine
- 422 Other Upland Conifer
- 429 Christmas Tree
- 43 Mixed Deciduous-Coniferous
- 44 Clearcut

Michigan Department of Natural Resources Forest Type Mapping Specifications

Broadleaved Cover Types

- Northern Hardwoods
- Oak
- Aspen-Birch
- Lowland Hardwoods

Coniferous Cover Types

- Pine
- Spruce-Fir
- Swamp Conifers

U.S. Forest Service Forest Types

Hardwoods

- Maple-Beech-Birch
- Oak-Hickory
- Aspen
- Paper Birch
- Swamp Hardwoods

Conifers

- White-Red-Jack Pine
- Spruce-Fir
- Mixed Swamp Conifers

Society of American Foresters Forest Cover Types

Hardwoods

- Northern Hardwoods
- Upland Oaks
- Boreal Hardwoods (Aspen / Birch)
- Black Ash-American Elm-Red Maple

Conifers

- Pine and Hemlock Types
- Balsam Fir / White Spruce
- Northern White Cedar
- Black Spruce-Tamarack

Detailed Forest Inventory Supplement (Michigan Inventory Advisory Committee 1985)

Forest Classification – The forest cover types are identified according to a 5-digit code. The first four digits are given in the species description key. The fifth digit is defined in the Stand Size and Stocking Key.

411 Northern Hardwoods

- 4110 Undifferentiated Northern Hardwood
- 4111 Sugar Maple
- 4112 Red Maple
- 4113 Elm
- 4114 Beech
- 4116 Cherry
- 4117 Basswood
- 4118 White Ash

412 Oak / Hickory

- 4120 Undifferentiated Oak/Hickory
- 4121 Red Oak
- 4122 White Oak
- 4123 Black Oak

413 Aspen, White Birch and Associated Species

- 4130 Undifferentiated Aspen/White Birch
- 4131 Trembling Aspen
- 4132 Bigtooth Aspen
- 4133 White Birch

414 Lowland Hardwoods

- 4140 Undifferentiated Lowland Hardwood
- 4141 Ash
- 4142 Elm
- 4143 Soft Maple
- 4144 Cottonwood
- 4145 Balm-of-Gilead
- 4146 Aspen
- 4147 White Birch

421 Pine

- 4210 Undifferentiated Pine
- 4211 White Pine
- 4212 Red Pine
- 4213 Jack Pine
- 4214 Scotch Pine

422 Other Upland Conifer

- 4220 Undifferentiated Upland Conifer
- 4221 White Spruce
- 4222 Balsam Fir
- 4226 Hemlock

423 Lowland Conifer

- 4230 Undifferentiated Lowland Conifer
- 4231 Cedar
- 4232 Black Spruce
- 4233 Tamarack
- 4234 Balsam Fir/White Spruce
- 4235 Balsam Fir
- 4236 Jack Pine

429 Managed Christmas Tree Plantation

- 4290 Undifferentiated Christmas Tree Plantation
- 4291 Scotch Pine
- 4293 Blue Spruce
- 4294 White Pine

Stand Size and Stocking Key

- 0 Nonstocked (less than 17%)
- 1 Seedling – Sapling: Poor (17-39%)
- 2 Seedling – Sapling: Medium (40-69%)
- 3 Seedling – Sapling: Well (greater than 69%)
- 4 Poletimber: Poor: (17-39%)
- 5 Poletimber: Medium: (40-69%)
- 6 Poletimber: Well: (greater than 69%)
- 7 Sawtimber: Poor: (17-39%)
- 8 Sawtimber: Medium: (40-69%)
- 9 Sawtimber: Well: (greater than 69%)

NOTE: 412 is called Central Hardwood in the Current Use Inventory System

Because color infrared photography will be used for interpretation, and only for **updating** existing land cover / use maps, the complete forest land classification used in the original Current Use Inventory can be used instead of the proposed single category for upland hardwood forest not associated with aspen-birch.

Water

Current Use Inventory Classification System (MIRIS)

Water Bodies

- 51 Streams and Waterways
- 52 Lakes
- 53 Reservoirs
- 54 Great Lakes

Michigan Land Cover / Use Classification System (No proposed changes)

5 Water

- 51 Streams and Waterways
- 52 Lakes
- 53 Reservoirs
- 54 Great Lakes

Land Cover / Use Classification System Version II

Open Water

- 51 River, Stream, Canal
- 52 Lake, Pond
- 53 Reservoir
- 54 Great Lakes

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Barren

Current Use Inventory Classification System (MIRIS)

Barren Land

- 72 Beaches and Riverbanks
- 73 Sand Dunes
- 74 Bare Exposed Rocks

Michigan Land Cover / Use Classification System (Proposed changes in italics)

7 Barren Land

- 72 Beaches and Riverbanks
- 73 Sand Dunes / *Exposed Bluff*
- 74 Bare Exposed Rocks

Land Cover / Use Classification System Version II

Barren

- 72 Beach, Riverbank
- 73 Sand Dune, Exposed Bluff
- 74 Rock Outcrop
- 79 Other

DRAFT

Michigan Land Cover / Use Classification System Suggested Mapping Legend for Updating

- 1 Urban and Built Up
 - 11 Residential
 - 111 Multi-Family, Medium- to High-Rise
 - 112 Multi-Family, Low-Rise
 - 113 Single-Family / Duplex
 - 1131 Single Family
 - 1132 Duplex
 - 1135 Manufactured Home
 - 115 Manufactured Home Parks
 - 12 Commercial, Services, and Institutional
 - 121 Primary / Central Business District
 - 122 Shopping Center / Malls / Retail Centers
 - 124 Secondary / Neighborhood Business District
 - 126 Institutional
 - 127 Indoor Cultural, Public Assembly, and Recreation
 - 128 Office
 - 13 Industrial
 - 138 Industrial Parks
 - 14 Transportation, Communications, and Utilities
 - 141 Air Transportation
 - 142 Rail Transportation
 - 143 Water Transportation
 - 144 Road Transportation
 - 145 Communications
 - 146 Utilities
 - 1461 Utility Line
 - 1464 Solid Waste Disposal and Transfer
 - 1465 Sewage Treatment and Transmission
 - 1466 Water Treatment and Transmission
 - 1467 Other
 - 17 Extractive
 - 171 Open Pit
 - 1711 Metallic Mineral Quarry
 - 1712 Nonmetallic Mineral Quarry
 - 1713 Sand and Gravel
 - 172 Underground
 - 1721 Metallic
 - 173 Wells
 - 1731 Oil

- 19 Open Land and Other
 - 191 Outdoor Cultural
 - 1913 Historical Sites
 - 192 Outdoor Public Assembly
 - 193 Outdoor Recreation
 - 1931 Parks
 - 1933 Sports Areas
 - 1934 Other Land-Based Activities
 - 1935 Water-Dependent Recreation
 - 194 Cemeteries
 - 195 Vacant
 - 196 Under Construction
- 2 Agricultural Lands
 - 21 Cropland
 - 22 Orchards, Bush Fruits, Vineyards, and Ornamental Horticulture Areas
 - 223 Ornamental Horticulture and Nurseries
 - 23 Confined Feeding Operations
 - 24 Permanent Pasture
 - 29 Other Agricultural Lands
 - 291 Farmsteads
- 3 Grass and Shrub Lands
 - 31 Grasses
 - 32 Shrubs
 - 33 Pine or Oak Opening (prairie)
 - 331 Hardwood
 - 332 Coniferous
- 4 Forest Land
 - 41 Broadleaved Forest
 - 411 Northern Hardwood
 - 412 Central Hardwood / Oak
 - 413 Aspen-Birch
 - 414 Lowland Hardwoods
 - 42 Coniferous Forest
 - 421 Pine
 - 422 Other Upland Conifers
 - 423 Lowland Conifers
 - 429 Managed Christmas Tree Plantation
 - 43 Mixed Conifer-Broadleaved Forest
 - 44 Clearcut
- 5 Water
 - 51 Streams and Waterways
 - 52 Lakes
 - 53 Reservoirs
 - 54 Great Lakes
- 7 Barren Land
 - 72 Beaches and Riverbanks
 - 73 Sand Dunes / Exposed Bluff
 - 74 Bare Exposed Rocks

Question/Concern - Particular issues which were raised included:

Should we address land use or land cover?

Homes located in the midst of forest land?

Beachfront property - “shorelines” or “residential”?

The proverbial question (problem) of land cover vs land use has been partially alleviated by mapping multiple attributes. For example, the Federal Earth Cover Classification System does not consider wetlands to be an earth cover, but instead, maps them as a separate data layer (using the Classification of Wetlands and Deepwater Habitats of the United States (FGCD-STD-004) realizing that “wetlands” can also be recreational lands, croplands, residential land, etc. The issues raised above can likewise be answered by mapping land cover separate from land use. An undeveloped city park can be mapped as forest (land cover) and as park (land use), the data user has the choice of which attribute to display. The original Michigan Land Cover / Use Classification System recognized this when it stated that “double coding is permissible.” Where appropriate, two separate classifications of the landscape are both desirable and possible with current GIS technologies.

The IMAGIN work group recommends the use of multiple data layers; including wetlands, land cover, and land use, when updating land cover/use data as mapped in the Current Use Inventory.

Question/Concern - What is the quality of the 1978 data?

Sample study in Garfield Township, Grand Traverse County, performed under contract to the MDNR by the Center for Remote Sensing, Michigan State University, found that of the 1000 urban and rural polygons, only about 10 (~ 1%) were found to be “errors.” Similar results (errors less than 10%) have been found while updating the land cover / use for Maple Valley Township in Montcalm County.

The IMAGIN work group recommends that a statistically valid estimate of thematic mapping accuracy be made of the 1978 land cover / use data during any update phase. Likewise, an error sampling scheme, including field/site verifications, should be made of the updated data. These data should be reported as accuracies using a confusion matrix and Kappa coefficient

Question/Concern - What is ground truth? 1978 or 1999?

Except for re-interpreting the 1978 aerial photographs, it is basically impossible to determine exactly what was on the ground in 1978. Therefore, whenever there is any doubt as to the validity of any 1978 interpretation, and it is not obvious on the 1978 or 1999 photography, without further evidence (land records, personal familiarity with the site, etc.), the 1978 land cover / use determination should not be changed.

The IMAGIN work group recommends that during any update project, whenever the interpreter is uncertain of the validity of a 1978 land cover / use, but does not have convincing evidence otherwise, will NOT change the 1978 interpretation.

Question/Concern - We must develop standards, so that land cover / use is interpreted the same by different interpreters.

Question/Concern - Definitions from the “Green Book” (MIRIS I, 1978) need to be “tightened.”

Question/Concern - In many places, very little has changed, making “updating” very easy.

The Center for Remote Sensing and GIS at Michigan State University, in cooperation with the IMAGIN organization, has undertaken the task of updating a number of land cover interpretation manuals. The manual “Interpretating Land Cover and Land Use” is being totally revised to reflect current definitions of land cover / use categories and will include hundreds of photographic examples to aid photo interpreters. Likewise, the manual “Updating Land Cover / Use Maps”, originally compiled for the MDNR, is being revised in light of the semi-automatic procedures currently being developed. Several new sections are being written for training purposes and include appendicies covering land use and land cover classification definitions, the use of supplemental and collateral materials, detailed forest inventory definitions, an index to selected land use / cover activities and features, and a comprehensive key to land cover / use.

The IMAGIN work group recommends that any organization conducting land cover / use updating be provided with a copy of pertinent manuals.

Question/Concern - Is the minimum mapping unit (currently 2 1/2 acres for new polygons) still appropriate?

It appears that the 1978 data is fairly variable concerning minimum mapping size with some interpreters having mapped below the minimum 2 1/2 acres for some categories. Re-codes (to a consistent 2 1/2 acre minimum) do not appear to be necessary at this time. Tests with the NAPP, color infrared aerial photography at 1:40,000 scale, indicate that mapping land cover / use changes at 2 1/2 acres is easily obtainable.

The IMAGIN work group recommends that when updating existing land cover / use maps, or when creating new maps, that a two and a half acre minimum mapping unit be utilized.

Question/Concern - It is absolutely essential that other source material/data layers be integrated into the map compilation process; one cannot rely solely on aerial interpretation. This is true for any type of mapping. Documentation on availability and use of other source material may be helpful for those that do not already do this.

The IMAGIN work group recommends that all interpreters be provided with necessary source materials, including, where available, parcel maps, topographic quadrangles, soil survey data, GPS data, local input, DRG's, plat books, LandScan and previous photography, and ground verification opportunities.

Technical Issues

Question/Concern - Rectification process: Framework data has +/- 40 feet or error, does the rectification process add significant additional error?

Question/Concern - Rectification process: In CRS&GIS method, the accuracy check is sampled by elevation, how does the accuracy of the DEM (1:24,000) affect this process?

Question/Concern - How difficult will it be to attain ground control points (GCP's) for the rectification process in townships that border the Great Lakes?

Question/Concern - Is Michigan Georef a FGDC "approved" projection?

Question/Concern - Is Michigan Georef the best projection to perform this update in?

Question/Concern - Should we use digital orthoquads (DOQ's) for our registering/rectifying process?

Question/Concern - Current base data is not ortho-rectified (although, it will be at some point in the future), land cover / use data interpreted from DOQ would no longer match State of Michigan base data.

Question/Concern - CRS&GIS method: uses cross-validation to estimate error across the photo, areas of high relief need sample points at all "very important points" (VIP's), this method does not produce an orth-rectified product.

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Appendix II

Michigan Land Cover/Use Classification System Re-code to MIRIS Version II

	<u>MI</u>	<u>MIRIS II</u>
1 Urban & Built Up	1	1
11 Residential	11	11
111 Multi-family, medium- to high-rise	111	111
112 Multi-family, low-rise	112	112
113 Single family / duplex		
1131 Single family	1131	113
1132 Duplex	1132	114
1135 Mobile home	1135	115
115 Mobile home parks	115	
12 Commercial, Services, & Institutional	12	12
121 Primary / central business district	121	121
122 Shopping center / malls / retail centers	122	122
124 Secondary / neighborhood business district	124	124
127 Indoor cultural, public assembly, and recreation		
[Auditorium, arena, and convention/exhibition hall]		125
[Multiple purpose recreation center, library, museum, art gallery, and civic center]		126
126 Institutional	126	
128 Office	128	128
13 Industrial	13	138
138 Industrial park	138	139
14 Transportation, Communications & Utilities	14	14

	<u>MI</u>	<u>MIRIS II</u>
141 Air transportation	141	141
142 Rail transportation	142	142
143 Water transportation	143	143
144 Road transportation	144	144
145 Communications	145	145
146 Utilities		
1461 Utility line	1461	146
1463 Petroleum storage and transmission	1463	138
1464 Solid waste disposal and transfer	1464	147
1465 Sewage treatment and transmission	1465	
1466 Water treatment and transmission	1466	148
1467 Other	1467	
[15] Industrial park		
17 Extractive	17	17
[Tailings Basins]	147	
171 Open pit		
1711 Metallic mineral quarry	1711	
1712 Nonmetallic mineral quarry	1712	174
1713 Sand and gravel	1714	171
172 Underground	172	172
173 Wells	173	173
19 Open Land & other	19	19
191 Outdoor cultural	191	193

	<u>MI</u>	<u>MIRIS II</u>
192 Outdoor public assembly	192	125
[Drive-in movie] _____		124
193 Outdoor recreation		
1933 Sports areas		
[Golf courses and shooting ranges] _____		193
[Miniature golf courses and golf driving ranges] _____		124
1934 Other land-based activities		
[Campground] _____		192
[Ski areas] _____		193
[Group camp] _____		195
1935 Water-dependent recreation	1935	191
194 Cemeteries	194	194
195 Vacant	195	34
196 Under Construction	196	
2 Agricultural Land	2	2
21 Cropland	21	21
22 Orchards, Bush-Fruits, Vineyards, and Ornamental Horticultural Areas		
[Orchards, Bush-Fruits, and Vineyards] _____		22
223 Ornamental horticulture and nurseries	223	26
23 Confined Feeding Operations	23	23
[Fur-bearing animal farms] _____		29
24 Permanent pasture	24	24

	<u>MI</u>	<u>MIRIS II</u>
29 Other Agricultural Land [Greenhouses, mushroom houses, horse training facilities, riding or boarding stables, and barns or outbuildings]	_____	29
291 Farmsteads	291	25
3 Grass and Shrub Lands	3	3
31 Grasses and forbs	31	31
32 Shrubs	32	32
33 Pine or oak opening (prairie)	33	33
331 Hardwood	331	331
332 Coniferous	332	332
34 Vacant	34	34
4 Forest Land		
41 Broadleaved Forest		
411 Northern hardwoods	411	} 419
412 Central hardwoods / oak	412	
413 Aspen, white birch, and associated species	413	413
414 Lowland hardwoods	414	614
42 Coniferous Forest		
421 Pines	421	421
422 Other upland conifers	422	422
423 Lowland conifers	423	613
429 Managed Christmas tree plantation	429	429
43 Mixed Conifer-Broadleaved forest	43	43
44 Clearcut	44	44

	<u>MI</u>	<u>MIRIS II</u>
52 Lakes	52	52
53 Reservoirs	53	53
54 Great Lakes	54	54
6 Wetlands		
61 Forested (wooded) Wetlands		
[613] Lowland conifers		
[614] Lowland hardwoods		
[615] Mixed forested wetlands		
612 Shrub / scrub wetland	612	625
62 Non-Forested (non-wooded) Wetlands		
621 Aquatic bed wetland		
6211 Floating aquatic bed	6211	631
62111 Great Lakes	62111	632
6212 Submerged aquatic bed	6212	633
62121 Great Lakes	62121	634
622 Emergent wetland	622	622
623 Flats	623	623
629 Other non-forested wetland	629	629
7 Barren	7	7
72 Beaches & Riverbanks	72	72
73 Sand dunes / exposed bluff	73	73
74 Bare exposed rock	74	74