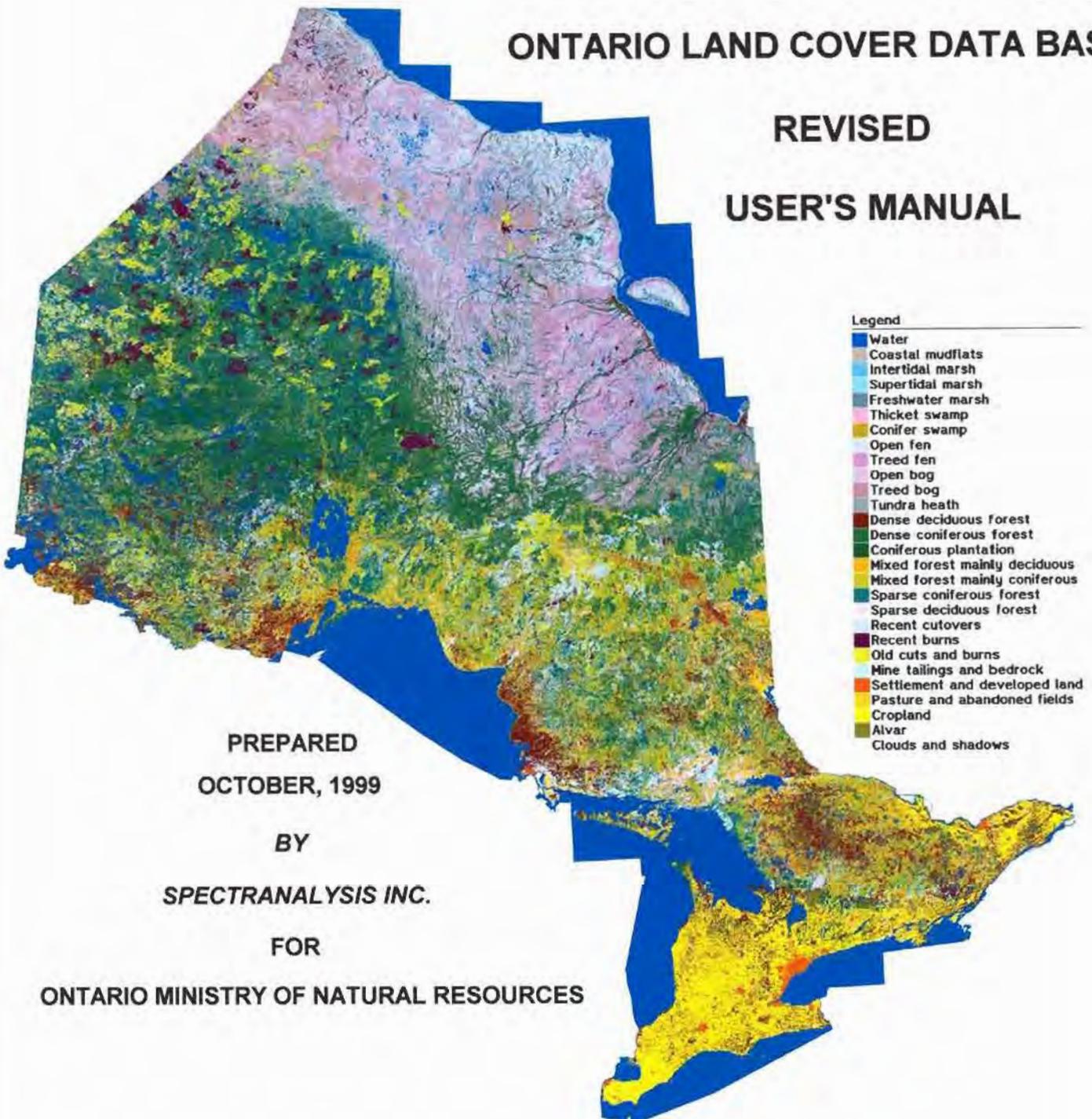


ONTARIO LAND COVER DATA BASE

REVISED

USER'S MANUAL



Legend

- Water
- Coastal mudflats
- Intertidal marsh
- Supertidal marsh
- Freshwater marsh
- Thicket swamp
- Conifer swamp
- Open fen
- Treed fen
- Open bog
- Treed bog
- Tundra heath
- Dense deciduous forest
- Dense coniferous forest
- Coniferous plantation
- Mixed forest mainly deciduous
- Mixed forest mainly coniferous
- Sparse coniferous forest
- Sparse deciduous forest
- Recent cutovers
- Recent burns
- Old cuts and burns
- Mine tailings and bedrock
- Settlement and developed land
- Pasture and abandoned fields
- Cropland
- Alvar
- Clouds and shadows

PREPARED
OCTOBER, 1999

BY
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FOR
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ONTARIO LAND COVER DATA BASE

USER'S MANUAL

Revised October, 1999

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**Natural Resources Management Information Branch
Ontario Ministry of Natural Resources**

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Remote Sensing and GIS Services
Oakville, Ontario, Canada**

October 18, 1999

1.0 INTRODUCTION

The Ontario land cover data base provides spatial information on vegetation cover for the entire province. This complete provincial coverage is coherent in classification scheme, level of detail, time period represented, and digital format. At the time of writing (1999), the Ontario land cover data base is the only complete provincial land cover data set in Canada derived entirely from remote sensing sources.

The Ontario land cover data base is one of the foundations of a developing provincial information system for managing natural resources and the environment. The land cover data provides a basic thematic layer for a wide range of GIS applications, a comprehensive framework for incorporating various other data sources, and a basis for hard-copy map production at selectable scales. Some of the possible applications implemented to date are as follows:

- landscape ecological analyses, including biodiversity analyses;
- spatial analyses of parks, wilderness areas and wildlife corridors;
- spatial analyses of the relative representation of wetland types;
- woodlot distribution analysis for wildlife habitat studies;
- mapping of mixedwood forest; and
- basic land cover inventories for local forest and land management.

The data base was developed by the Ontario Ministry of Natural Resources (OMNR), initially to serve specific information needs, and subsequently to provide a public land cover data resource. The Natural Resources Information Branch of OMNR is the custodian and distributor of the data set. By 1997, the various segments (termed "tiles") of the province had been individually classified. These segments were then aggregated to form complete coverage across the province. In 1998, the forest cutover and burn classes were updated through the use of satellite data recorded in 1996.

In 1999, two further improvements were made in the data base. First, the land cover classification scheme compiled by aggregating the regional data segments was rationalized to eliminate inconsistencies and overlaps among certain classes. Secondly, the rationalized classes were reviewed and condensed into a provincial-scale data base of 28 land cover classes. These two steps resulted in the standard provincial land cover data base which OMNR distributes to users today. In addition to serving a wide range of applications, this data base provides a baseline and framework for conducting updates and producing new data base generations in the future.

To request data segments or to obtain current information on the terms of distribution, users are invited to contact the following address, specifying their area of interest and intended data use:

Geomatics and Data Acquisition Services Section
Natural Resources Information Branch
Ontario Ministry of Natural Resources
300 Water Street, North Tower, 2nd Floor
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1.1 Purpose of the User's Manual

This manual is intended to provide a general reference source for users on the content and origin of the Ontario land cover data base. The first user's manual, produced in 1997, described the data base in its original form; that is, as an aggregation of land cover classification data sets produced for individual segments of the province. The present manual, which is the first revision of the 1997 document, describes the newly rationalized, 28-class provincial land cover data base and outlines the process by which this data base was produced from the aggregated data segments.

Appendix I provides a table listing the initial land cover classes prior to the rationalization process, as they were aggregated from the nine tiles in which the land cover classification was prepared. The list indicates the tile(s) from which each class was drawn. This information is included purely for historical documentation of the lineage of the land cover data.

Appendix II provides a description of a new data set of 15 land cover classes that has been generalized from the provincial Ontario land cover data base for distribution through the GeoGratis system of Natural Resources Canada. This data set provides a national perspective on Ontario's land cover.

2.0 PRODUCTION OF THE ONTARIO LAND COVER DATA BASE

This section provides the user with information on the concepts, source data, and methods used in generating the Ontario land cover data base.

2.1 Definition of Land Cover

The land cover classes consist of vegetation types (such as forest, wetlands, and agricultural crops or pasture) and categories of non-vegetated surface (such as waterbodies, bedrock outcrops, or settlements). The data reflects the nature of the land surface rather than land use. For example, provincial parks are not discriminated as areas of recreational land use, but are mapped as part of the provincial mosaic of waterbodies, forest types, wetlands, and other cover classes.

2.2 Recognition of Classes

Satellite land cover classification identifies cover types by their spectral character. This spectral character is determined by the electromagnetic energy reflected by the vegetation and other surfaces that make up that cover type. For example *forest types* are identified by the mixture of coniferous and deciduous species, the degree of canopy closure, and the ground cover visible through canopy gaps. Similarly, *wetland types* are identified by the nature of the vegetation cover (trees, grasses, or mosses) and the proportion of open water. *Agricultural land cover* is distinguished by the spectral character of growing row crops, pasture, or open soil. *Forest cutovers* are recognized by a combination of spectral reflectance, internal pattern, and context.

2.3 The Source Data: LANDSAT Thematic Mapper Image Data

The Ontario land cover classification was produced from multispectral data recorded by the Thematic Mapper sensor, operating on the LANDSAT-5 satellite. This satellite circles the globe at an altitude of approximately 700 km. in a north-south orbit, scanning a swath of the surface as it passes and revisiting the same path every 16 days. The north-south strips of image data are segmented into frames by the data distributor. One full frame of LANDSAT TM image data covers approximately 34,225 sq.km.

For areas covered with cloud at the time of the satellite pass, no useful information can be obtained. The season of data recording is critical to the recognition of features of interest. Summer data is generally required for land cover classification. In Southern Ontario, however, data recorded in spring was also required, so that classes could be better defined by a comparison of the two seasons.

LANDSAT images are recorded as digital data which represent intensities of energy reflected from the surface of the earth in various wavelengths of the electromagnetic spectrum. Each set of readings recorded simultaneously in the various wavelengths represents a spatial unit measuring 28.5 metres by 28.5 metres on the ground. This is the resolution cell, or pixel, of the image data. No feature smaller than 28.5 metres by 28.5 metres is individually represented, but joins with all other features in the pixel area to form the Aspectral reflectance \cong of that pixel. (For use of the UTM projection system, LANDSAT TM data is customarily resampled to a pixel size of 25 metres by 25 metres. This practice does not, of course, affect the true resolving power of the data.)

LANDSAT Thematic Mapper (TM) data is recorded in seven bands of electromagnetic energy, three in the range of visible light, three reflected (non-thermal) infrared bands, and one thermal infrared band. Bands 2 (green), 3 (red) and 4, 5, or 7 (different infrared ranges) provide the most useful information on vegetation cover.

The LANDSAT TM image data frames from which the Ontario land cover classification was derived were recorded between 1986 and 1997, with the majority of frames recorded in the early 1990s. The forest cutovers and burns were updated from 1996 TM coverage for all of the Great Lakes forest region and most of the Boreal forest region of the province.

2.4. Satellite Data Analysis

Skilled satellite image interpreters understand the nature of features on the ground and know how these features appear, in all their variety, from a remote vertical perspective. They have extensive experience in identifying features from their brightness or darkness in individual wavelength bands and combinations of these bands, together with additional clues of texture and pattern.

The *visual interpretation* of LANDSAT TM imagery is customarily performed on a false-colour composite of the image data, on which dense deciduous foliage appears bright red, conifer foliage appears darker red, mixed deciduous/conifer forest has subtle intermediate variations, areas bare of vegetation appear almost white, clear waterbodies appear black, and wetlands appear in a range of shades, depending on the density and nature of the surface vegetation and the degree of open water.

Digital analysis of the satellite image data is based on visual interpretation skills. This is true whether the spectral differences in the image frame are interpreted prior to the automated classification process (that is, when a "supervised" classification technique is used) or after the automated classification has identified a range of spectral differences (in the case of an "unsupervised" classification technique). With either approach, the classification results must finally be edited to avoid confusions which spectral discrimination alone cannot prevent.

2.4.1 Interpretation of Forest Density

In the Ontario provincial land cover classification, dense and sparse forest classes are distinguished in both coniferous and deciduous forests. Density signifies continuity in the vegetation canopy, as viewed from the vertical perspective of the satellite sensor system. If gaps in the canopy are prevalent, they allow light to be reflected upward from the ground surface. At the relatively coarse resolution of the LANDSAT TM sensor, this light is combined with the light reflected from the forest canopy to change the nature of the light recorded for the forest as a whole.

2.5 The Land Cover Classification Method

The classification process used to produce the Ontario land cover data consisted of the following steps: geocoding the image data to basemap coordinates, establishing criteria for classification, processing the data, editing the classification results, and filtering the final data.

2.5.1 Geocoding

For each frame of satellite data, numerous control points were selected on NTS basemaps, then corresponding points on the satellite data display were selected and identified with the UTM coordinates on the map. These points were then used to resample the satellite image data so that the geometry of the image matched the geometry of the map. In all areas but the Hudson Bay-James Bay Lowlands (Tile 4), 1:50,000-scale NTS basemaps were used for this purpose; in Tile 4, 1:250,000-scale basemaps were used. Geometric correction was accomplished using a polynomial transform algorithm provided by the image analysis software. During the same process, the image data were resampled to a pixel size of 25 metres by 25 metres, so that distances could be computed in even hundreds of metres.

Care was taken to keep the positional error within two pixels. This error means a ground referencing error of 50 metres in all parts of the province except the Hudson Bay-James Bay Lowlands, where the same error equates to more than 100 metres because of the smaller (1:250,000) scale of basemaps used for georeferencing. When the data tiles were joined, however, their positional errors may have been compounded in some areas. If the geometry of the data base is a critical factor for a given application, then a second geocoding procedure is recommended within the study area. This task can be carried out using either an image analysis system or the geometric correction functions in a GIS system.

2.5.2 Setting the Criteria for Classification

The satellite data were classified one frame at a time. An initial formulation of the land cover classes was made by visual inspection of the frame. Numerous representative samples of each class were then selected on the image data display and delineated by cursor. These samples (termed "training sites") provided spectral criteria (termed a "spectral signature") for the automated recognition of similar areas across the image frame. A large number of classes were initially defined in this way, far more than would remain in the final classification. The spectral signatures were compared to eliminate avoidable confusions among classes.

2.5.3 Controlling the Automated Classification Process

A preliminary automated classification of the entire image frame was performed on the basis of the spectral signatures, through the use of an image analysis program based on a maximum-likelihood selection rule. The classes were examined for accuracy against a visual interpretation of the colour-composite image data display. Some themes which represented subtypes of the same class were combined. In some cases, classes were split further to represent useful differences. As noted above, the program under which the Hudson Bay-James Bay Lowlands (Tile 4) was classified included limited aerial sketching and ground sampling of wildlife habitat types. These data sources were used in defining and mapping the classes of that tile. The land cover of Southern Ontario was classified using two sets of satellite data,

recorded in summer and spring, respectively. Both dates were classified for each scene, then the land cover classes were identified and mapped through a comparison of the two seasons.

2.5.4 Classification Editing

Interactive editing was used extensively to map certain classes which could not be positively identified without taking pattern and/or context into account, in addition to spectral values. Through visual interpretation, regenerating old cutovers were differentiated from deciduous forest, wetlands occurring within cutovers were differentiated from their surroundings, and densely treed wetlands were differentiated from coniferous forest. On the basis of context alone, certain areas that appeared by spectral values to be sparse forest were identified as settlements. Using editing software functions, the misclassified features were identified and assigned to the correct class. Some degree of confusion among certain classes is expected to have survived the editing process. Those are confusions that could not be detected by visual interpretation, which must be accepted as an inherent limitation of the methodology. Nevertheless, the knowledgeable use of editing techniques improved the overall accuracy of the land cover data significantly.

2.5.5 Final Filtering

When the classification was finalized, a minimum-area filter was applied to the data to absorb very small features into surrounding larger features. This process streamlined the classification data for transfer to GIS data bases. The smallest ground feature mapped across the data base ranges from 1.2 hectare (in the Great Lakes and eastern Boreal forest regions, the former Tiles 1, 2, 3, and 5) to 0.6 hectare (in the remainder of the data base).

2.6 Estimated Classification Accuracy

Satellite image analysis was used to produce the Ontario land cover data because the vast area to be mapped (1 million km²) made the use of more detailed mapping methods impractical. The resulting database has not been subjected to standard techniques of accuracy assessment, for two reasons. First, the land cover classes are broad and thus subject to broad interpretation. Secondly, gathering sufficient ground truth data to provide a meaningful assessment of accuracy over so vast an area has not been financially feasible.

Practical experience suggests that the accuracy of the original, high-resolution land cover data is 95 percent or better for waterbodies; approximately 90 percent for the forest classes, with exception of some degree of unavoidable confusion between treed wetlands and sparse forest classes; and approximately 85 percent for agricultural land cover, taking into account the presence of widespread, unavoidable confusion with small towns and roads. Mine tailings, quarries, bedrock outcrops, and coastal mudflats along Hudson Bay and James Bay were mapped as a single class of minimal vegetation cover with an overall accuracy of approximately 90 percent, although some quarries may have been indistinguishable amid agricultural land cover. Major settlements and roads were spectrally distinguished with less confidence than all other classes.

3.0 OVERVIEW OF THE LINEAGE OF THE ONTARIO LAND COVER DATA BASE

3.1 Regional Land Cover Mapping: The Classification of Nine Tiles

The Ontario land cover data base was produced in nine segments (termed "tiles") under three separate programs of the Ontario Ministry of Natural Resources (OMNR) between 1991 and 1996 (Figure 1). The tiles are numbered according to the order in which they were completed, not according to geographic location. In general terms, the relative location of each tile is as follows:

- Tile 1: eastern portion of the Great Lakes forest region;
- Tile 2: western portion of the Great Lakes forest region;
- Tile 3: southeastern portion of the Great Lakes forest region;
- Tile 4: Hudson Bay-James Bay Lowlands;
- Tile 5: eastern portion of the Boreal forest region;
- Tile 6: western portion of the Boreal forest region;
- Tile 7: Southern Ontario;
- Tile 8: central portion of the Boreal forest region; and
- Tile 9: the northernmost tile.



Figure 1. Geographic Tiles for Producing the Ontario Land Cover Classification

In 1991, the Forest Landscape Ecology Program (FLEP) of the Ontario Forest Research Institute in OMNR initiated satellite land cover classification for part of the province under the Ministry's Forest Fragmentation and Biodiversity Project. The focus of this project was to produce digital spatial information on the land cover and forest types of the managed forest region of the province (Tiles 1, 2, 3 and 5). The project was initiated and conducted by Dr. Ajith Perera, the Provincial Landscape Ecologist. Technical consultation in remote sensing was provided by Andrew Jano of the Provincial Remote Sensing Office, OMNR.

The primary purpose of the FLEP project was landscape ecological analyses of forest types, and the initial focus was on forests containing a ten-percent component of white pine and/or red pine. Victor Zsilinszky of V.Z. and Associates in Vineland, Ontario interpreted the pine species distribution from Forest Resources Inventory (FRI) airphotos. The pine stands were incorporated into the satellite data classification, and a GIS data base was produced of the integrated land cover data. The principal private sector contractor for the classification of these tiles was SPECTRANALYSIS Inc. of Oakville, Ontario (Dr. Simsek Pala, President).

The land cover classification of the Hudson Bay-James Bay Lowland (Tile 4) was completed under a separate program of wildlife habitat mapping. A number of organizations contributed to that program, but overall direction and coordination was provided by the Moosonee District office of OMNR. Some aerial sketching and limited field sampling were conducted to provide greater detail for habitat identification. The satellite data classification for Tile 4 was carried out by Andrew Jano of the OMNR staff.

Building on the foundation laid by the FLEP program, the Natural Resources Information Branch of OMNR launched a project to complete land cover classification derived from LANDSAT Thematic Mapper satellite data for both Southern Ontario and the far north of the province (Tiles 6, 7, 8 and 9). The project was directed and coordinated by Andrew Jano, with assistance from Tracey Ellis and David White, also OMNR staff members. SPECTRANALYSIS Inc. was again successful in competing for the series of contracts issued to the private sector under this phase of land cover data base preparation. All classification work was completed by Dr. Simsek Pala, President of SPECTRANALYSIS Inc.

3.2 Aggregation of the Tile Classifications to Form Province-Wide Coverage

As noted above, when the land cover classifications generated by all three programs were complete, they were integrated into a single data base covering the province. To accomplish this integration, a single set of 48 land cover classes was compiled, which represented all of the classes distinguished in the individual tiles of the province. This classification scheme had the virtue of avoiding the loss of distinctions made in any individual tile, but overlap and inconsistency existed among some of the classes. Such a result was unavoidable, given the slightly different focus of the three programs that produced the data. In 1997, the first user's manual on the land cover data base was prepared, which discussed the correspondence among land cover classes in individual tiles. Appendix I is a table listing the historical land cover classes and indicating the region (i.e., the tile) from which each class was drawn.

3.3 Updating of Forest Depletion Classes

In 1997/98, under the Ministry's Lands for Life Program, forest cutovers and burns within the managed forest region of the province (within both the Great Lakes and Boreal regions) were updated from 1996 TM data. The current data base thus contains information on successional

forest to the summer of 1996. The new forest depletion classes were integrated into the land cover data base, but were also reserved as distinct classes (Classes 47 and 48) containing only those forest areas that had been depleted by cutting or fire since formation of the province-wide data set.

3.4 Rationalization of the Aggregated Data

In 1998/99, OMNR launched a project to rationalize the provincial land cover data; that is, to create one single, consistent land cover classification at the provincial level by merging certain classes and subdividing others. The rationalization effort concentrated on bringing greater province-wide consistency to certain classes of wetlands, forest, minimally vegetated cover types, agricultural land cover, and settlement features.

No attempt was made to make the land cover classification of the Hudson Bay-James Bay Lowlands region of the province correspond to the classes mapped in the remainder of the province. The decision to leave the classification of this region as a separate entity was based on three factors: the intrinsic uniqueness of the land cover and large extent of the area, the fact that the classification scheme for this region was designed specifically for wildlife habitat studies, and the more limited use likely to be made of this data, in comparison to data for many other parts of the province.

The specific modifications made to the aggregated land cover classification are as follows:

- (a) A single, undifferentiated "wetlands" class mapped in Tiles 1, 2 and 3 was subdivided into its component wetland types, whether open or treed bogs, or open or treed fens.
- (b) An "open wetland" class mapped in Tile 5 was subdivided into open bogs and open fens, and a "treed wetland" class distinguished in the same area was likewise subdivided into "treed bogs" and "treed fens".
- (c) Areas of sparse deciduous forest included in the "old cutovers and burns" class in Tiles 1, 2, 3, 5 and 6 were transferred to the "sparse deciduous forest" class (Class 32).
- (d) All of the features originally included in a class identified as "rock barrens/other sparse vegetation" (or, in the initial classifications of individual tiles, as "poorly vegetated areas") were assigned to more specific classes, such as "sparse deciduous forest", "sparse coniferous forest", or one of the treed wetland classes.
- (e) A composite "recent cutovers and burns" class mapped in Tiles 1, 2 and 3 was subdivided into its components, "recent cutovers" and "recent burns".
- (f) A single, undifferentiated "agriculture" class used to represent a range of human land uses in Tiles 1, 2, 3 and 5 was subdivided into the classes of "agriculture" and "urban/settlement/roads".

As noted above, four of the modifications involved subdividing disproportionately broad classes and reclassifying them into their component themes. When that was done, no features remained in the broad classes, so they were effectively eliminated from the classification scheme. However, their class names and position numbers were retained, so that extensive

renumbering of the classes was avoided, and the derivation of the final list of classes was made clear.

Table 1 shows how the rationalized land cover classes were created from the original aggregated land cover classes.

3.5 Formation of the Standard Provincial Land Cover Data Base

The final step in rationalizing the Ontario land cover data base was to process the rationalized 48-class classification scheme (see Table 1) into a set of provincial-scale land cover classes. To achieve this result, some classes were coalesced from several regional variations of the same land cover category, and others were left without change.

The main principle followed in creating the provincial classes was to provide a comparable level of generality among all classes. Notwithstanding that principle, the "conifer plantation" class was retained for its interest to forest managers, and the "alvar" class was retained as a unique biophysical feature. Moreover, the land cover types of the Hudson Bay-James Bay Lowlands were retained without change, in recognition of the distinct nature of that region.

Table 2 identifies how the 48 rationalized classes were compiled to create the final 28 provincial land cover classes.

Table 3 lists the final 28 land cover classes with their definitions.

For quick reference, Table 4 lists the final 28 land cover class with numbers and names alone.

TABLE 1. RATIONALIZED 48-CLASS ONTARIO LAND COVER CLASSIFICATION

CLASS NUMBER	CLASS NAME
1	Water: General class of all waterbodies, mapped in Tiles 1 to 5.
2	Water - deep/clear: Deep or clear water, mapped in Tiles 6 to 9.
3	Water - shallow/sedimented: Coastal shallow or sedimented water, mapped in Tiles 6 to 9.
4	Coastal mudflats: Unvegetated coastal areas, partly submerged at high tide, mapped in Tile 4.
5	Intertidal marsh: Coastal marshes, lying between the coastal mudflats and the supertidal zone, mapped in Tile 4.
6	Supertidal marsh: Coastal marshes, lying inland of the coastal mudflats (Class 4) and intertidal marshes (Class 5) and subject only to exceptionally high tides, mapped in Tile 4.
7	Freshwater marsh: Coastal marshes, lying beyond the area of saltwater influence, mapped in Tile 4.
8	Deep/shallow water marsh: Seasonal marshes mapped in Tile 7.
9	Meadow marsh: Grassy marshes that appear generally drier than deep/shallow water marsh (Class 8) or cattail marsh (Class 10), mapped in Tile 7.
10	Cattail marsh: Marshes that appear generally wetter than meadow marsh (Class 9) but drier than shallow/deep water marsh (Class 8), mapped in Tile 7.
11	Hardwood/thicket swamp: Hardwood swamps occurring along rivers and in old lake beds and other low-lying areas, mapped in Tile 7.
12	Conifer swamp/dense conifer: Swamps with dense conifer tree or shrub cover, mapped mainly in Tile 7.
13	EMPTY: Formerly “wetlands”, mapped in Tiles 1, 2, and 3. Components of this class were distributed among the following, more specific wetland classes: “open bog” (Class 21), “treed bog” (Class 22), “open fen” (Class 16), “treed fen” (Class 18), and the inland freshwater marsh classes (Classes 8 to 10).

TABLE 1. RATIONALIZED 48-CLASS ONTARIO LAND COVER CLASSIFICATION (continued)

CLASS NUMBER	CLASS NAME
14	EMPTY: Formerly "open wetlands", mapped in Tile 5. The features in this class were reassigned to either the "open fen" class (Class 16) or the "open bog" class (Class 21).
15	EMPTY: Formerly "treed wetlands", mapped in Tile 5. The features in this class were reassigned to either the "treed fen" class (Class 18) or the "treed bog" class (Class 22).
16	Open fen: Non-treed grassy wetlands, including some open bogs, mapped in Tiles 4, 6, 8 and 9, but occurring most extensively in Tile 4.
17	Shrub-rich fen (open and treed): Fens with shrubs and some sparse tree cover, mapped in Tiles 4, 6, 8 and 9.
18	Treed fen: Fens with dense shrub cover and tamarack tree cover occurring generally in the province, but most extensively in Tile 4.
19	Fen with pools: Fens having a large proportion of surface water; includes bogs of Tile 4 that have a high proportion of open water surface (termed "string" bogs).
20	Lichen-rich peat plateau/open bog: Non-treed bog occurring generally in the province; lichen-rich plateau mapped only in Tile 4.
21	Shrub-rich peat plateau/open bog: Non-treed bog that may have a partial cover of stunted trees, mapped only in Tile 4.
22	Treed bog: Bog with a low to high density of tree cover, mapped generally in the province; includes some sparse conifer forest.
23	Tundra heath: Areas of ericaceous vegetation occurring on better-drained areas only in the Hudson Bay coastal zone (Tile 4).
24	Dense deciduous forest: Continuous forest canopy composed at least 80 percent of deciduous species occurring generally in the province; includes deciduous shrub cover on old burns and alder thicket swamps in Tile 4.
25	Dense coniferous forest: Largely continuous forest canopy composed at least 80 percent of coniferous species, mapped in Tiles 3 and 7.

TABLE 1. RATIONALIZED 48-CLASS ONTARIO LAND COVER CLASSIFICATION (continued)

CLASS NUMBER	CLASS NAME
26	Dense coniferous forest, mainly pine: Largely continuous forest canopy composed at least 80 percent of coniferous species, with jack pine dominant; mapped where a reliable distinction of species dominance could be made in all parts of the province except Tiles 3, 4 and 7.
27	Dense coniferous forest, mainly spruce: Largely continuous forest canopy composed at least 80 percent of coniferous species, with black spruce dominant; mapped where a reliable distinction of species dominance could be made in all parts of the province except Tiles 3, 4 and 7.
28	Coniferous plantation: Mature coniferous plantations, mostly pine, occurring in evenly spaced rows, only in Tiles 3 and 7. This class does not include artificially regenerated cutovers or burns in Northern Ontario.
29	Mixed forest, mainly deciduous: Largely continuous forest canopy composed of coniferous and deciduous species, with deciduous species dominant (i.e., comprising more than 50 percent of the canopy); mapped in all parts of the province except Tile 4.
30	Mixed forest, mainly coniferous: Largely continuous forest canopy composed of coniferous and deciduous species, with coniferous species dominant (i.e., comprising more than 50 percent of the canopy); mapped in all parts of the province except Tile 4.
31	Sparse conifer: Patchy or sparse forest canopy (i.e., approximately 30 to 40 percent canopy closure) composed approximately 80 percent of coniferous species; mapped in all parts of the province except Tile 4.
32	Sparse/open deciduous: Patchy or sparse forest canopy (i.e., approximately 30 to 40 percent canopy closure) composed approximately 80 percent of deciduous species; mapped in all parts of the province except Tile 4.
33	EMPTY: Formerly "rock barrens/other sparse vegetation" (originally "poorly vegetated areas"). The components of this class were decided among the "sparse forest" class (Class 31) and the "bedrock outcrops" class (Class 37).

TABLE 1. RATIONALIZED 48-CLASS ONTARIO LAND COVER CLASSIFICATION (continued)

CLASS NUMBER	CLASS NAME
34	Recent cutovers: Forest clear-cuts estimated at less than 10 years of age, mapped in all parts of the province except Tile 4. The original composite class, "recent clear-cuts and burns", mapped in Tiles 1, 2 and 3, was subdivided into "recent cuts" (retained in Class 34) and "recent burns" (transferred to Class 35).
35	Recent burns: Forest burns estimated at less than 10 years of age, mapped in all parts of the province.
36	Old burns and cutovers: Forest clear-cuts and burns estimated at more than 10 years of age, mapped generally in the province; formerly included areas of sparse deciduous forest that did not show specific evidence of cutover or burn patterns. The latter areas were transferred to the "sparse hardwood forest" class (Class 32).
37	Bedrock/gravel/sand: Bedrock outcrops, exposed sand, and areas of aggregate extraction.
38	Mine tailings/extraction sites: Clearings for mining activity and aggregate extraction.
39	Urban/settlement/roads: Clearings for human settlement and economic activity in relatively sparsely settled areas. Originally "agriculture/urban/settlement/roads", this class was redefined to represent only human settlement in areas other than Tile 7. The agricultural land cover component was transferred to the "agriculture" class (Class 42).
40	Urban - industrial/commercial/roads/infrastructure: A non-residential zone distinguished only in major cities of Tile 7.
41	Urban - residential: A residential zone distinguished only in major cities of Tile 7.
42	Agriculture: A general class of agricultural land cover mapped in areas other than Tile 7.
43	Row crops and hay/open soil: Cropland in Tile 7; hay or open soil in areas of agricultural land use.

TABLE 1. RATIONALIZED 48-CLASS ONTARIO LAND COVER CLASSIFICATION (continued)

CLASS NUMBER	CLASS NAME
44	Pasture, abandoned fields/savannah/prairie: Open grassland with sparse shrubs, including orchard lands, distinguished in extensive agricultural areas of Tile 7.
45	Alvar: Homogeneous areas of dry grassland growing on thin soils over a limestone substrate, mapped only where they occur in clusters in the central and eastern portions of Tile 7.
46	Unclassified/cloud/shadow: Small local areas for which no classification data could be generated because clouds and their shadows obscured the land surface on the satellite image data.
47	Clear-cut update, 1996: All forest clear-cuts occurring after preparation of the land cover data base, mapped from 1996 LANDSAT TM coverage.
48	Burn update, 1996: All forest burns occurring after preparation of the land cover data base, mapped from 1996 LANDSAT TM coverage.

TABLE 2. COMPILATION OF THE 48 RATIONALIZED LAND COVER CLASSES TO FORM 28 PROVINCIAL-SCALE LAND COVER CLASSES

REGIONAL CLASS NUMBER (1 - 48)	REGIONAL CLASS NAME	PROVINCIAL CLASS NUMBER (1 - 28)	PROVINCIAL CLASS NAME
1	Water	1	Water
2	Water - deep/clear	1	Water
3	Water - shallow/sedimented	1	Water
4	Coastal mudflats	2	Coastal mudflats
5	Intertidal marsh	3	Intertidal marsh
6	Supertidal marsh	4	Supertidal marsh
7	Freshwater marsh	5	Freshwater coastal/inland marsh
8	Deep/shallow water marsh	5	Freshwater coastal/inland marsh
9	Meadow marsh	5	Freshwater coastal/inland marsh
10	Cattail marsh	5	Freshwater coastal/inland marsh
11	Hardwood thicket swamp	6	Deciduous swamp
12	Conifer swamp	7	Conifer swamp
13	Wetlands (EMPTY)	--	--
14	Open wetlands (EMPTY)	--	--
15	Treed wetlands (EMPTY)	--	--
16	Open fen	8	Open fen
17	Shrub-rich fen	9	Treed fen
18	Treed fen	9	Treed fen

**TABLE 2. COMPILATION OF THE 48 RATIONALIZED REGIONAL LAND COVER CLASSES TO FORM 28 PROVINCIAL-SCALE LAND COVER CLASSES
(continued)**

REGIONAL CLASS NUMBER (1 - 48)	REGIONAL CLASS NAME	PROVINCIAL CLASS NUMBER (1 - 28)	PROVINCIAL CLASS NAME
19	Fen with pools	8	Open fen
20	Lichen-rich peat plateau/open bog	10	Open bog
21	Shrub-rich peat plateau/open bog	10	Open bog
22	Treed bog	11	Treed bog
23	Tundra heath	12	Tundra heath
24	Dense deciduous forest	13	Dense deciduous forest
25	Dense coniferous forest	14	Dense coniferous forest
26	Dense coniferous forest, mainly pine	14	Dense coniferous forest
27	Dense coniferous forest, mainly spruce	14	Dense coniferous forest
28	Coniferous plantation	15	Coniferous plantation
29	Mixed forest, mainly deciduous	16	Mixed forest, mainly deciduous
30	Mixed forest, mainly coniferous	17	Mixed forest, mainly coniferous
31	Sparse coniferous forest	18	Sparse coniferous forest
32	Sparse/open deciduous cover	19	Sparse deciduous forest
33	Rock barrens/other sparse vegetation	20	Recent cutovers
34	Recent clear-cuts	20	Recent cutovers

TABLE 2. COMPILATION OF THE 48 RATIONALIZED REGIONAL LAND COVER CLASSES TO FORM 28 PROVINCIAL-SCALE LAND COVER CLASSES (continued)

REGIONAL CLASS NUMBER (1 - 48)	REGIONAL CLASS NAME	PROVINCIAL CLASS NUMBER (1 - 28)	PROVINCIAL CLASS NAME
35	Recent burns	21	Recent burns
36	Old cutovers and burns	22	Old cuts and burns
37	Bedrock, gravel, sand	23	Mine tailings, quarries, and bedrock outcrops
38	Mine tailings/extraction sites	23	Mine tailings, quarries, and bedrock outcrops
39	Urban/settlement/roads	24	Settlement and developed land
40	Urban - industrial, commercial, roads, infrastructure	24	Settlement and developed land
41	Urban - residential	24	Settlement and developed land
42	Agriculture	25	Pasture and abandoned fields
43	Row crops, open soil	26	Cropland
44	Pasture, abandoned fields, savannah, prairie	25	Pasture and abandoned fields
45	Alvar	26	Alvar
46	Unclassified - cloud and shadow	28	Unclassified
47	Clear-cuts update, 1996	20	Recent cutovers
48	Burns update, 1996	21	Recent burns

TABLE 3. THE 28 PROVINCIAL LAND COVER CLASSES WITH DEFINITIONS

PROVINCIAL CLASS NUMBER	PROVINCIAL CLASS NAME AND DEFINITION
1	WATER: All waterbodies, both deep/clear and shallow/sedimented.
2	COASTAL MUDFLATS: Unvegetated coastal areas of the Hudson Bay-James Bay Lowlands, partly submerged at high tide.
3	INTERTIDAL MARSH: Coastal marshes of the Hudson Bay-James Bay Lowlands lying between the coastal mudflats and the supertidal zone.
4	SUPERTIDAL MARSH: Coastal marshes of the Hudson Bay-James Bay Lowlands lying inland of both the coastal mudflats and intertidal marshes, and subject to only exceptionally high tides.
5	FRESHWATER COASTAL MARSH/INLAND MARSH: Coastal marshes of the Hudson Bay-James Bay Lowlands lying beyond the area of saltwater influence; marshes occurring along lakeshores; Southern Ontario inland marshes characterized by a range of moisture conditions, including the following: seasonal marshes, flooded in spring but often dry by fall, which may appear flooded more deeply than other types of inland marsh; cattail marshes, which appear generally drier than the flooded seasonal marshes; and grassy meadow marshes, which appear generally drier than either the seasonal marshes or cattail marshes.
6	DECIDUOUS SWAMP: Hardwood swamps of Southern Ontario occurring along rivers and in old lake beds and other low-lying areas.
7	CONIFER SWAMP: Swamps with dense conifer tree or shrub cover occurring mainly in Southern Ontario.
8	OPEN FEN: Non-treed, grassy fens; fens with open pools occurring most extensively in the Hudson Bay-James Bay Lowlands; bogs of the Hudson Bay-James Bay Lowlands that have a high proportion of open water surface (termed "string bogs").

**TABLE 3. THE 28 PROVINCIAL LAND COVER CLASSES WITH DEFINITIONS
(continued)**

PROVINCIAL CLASS NUMBER	PROVINCIAL CLASS NAME AND DEFINITION
9	TREED FEN: Fens with dense shrub cover and tamarack tree cover occurring generally in the province but most extensively in the Hudson Bay-James Bay Lowlands.
10	OPEN BOG: Non-treed bog that may have a partial cover of stunted trees occurring generally in the province but most extensively in the Hudson Bay-James Bay Lowlands, where it also includes lichen-rich peat plateau.
11	TREED BOG: Bog with a low to high density of tree cover. There is expected to be some degree of overlap between densely treed bog and sparse conifer forest in more northerly parts of the province and especially in the Hudson Bay-James Bay Lowlands.
12	TUNDRA HEATH: Areas of dense, ericaceous vegetation occurring on better-drained areas only in the Hudson Bay coastal zone.
13	DENSE DECIDUOUS FOREST: Largely continuous forest canopy composed at least 80 percent of deciduous species; includes deciduous shrub cover on old burns and alder thick swamps in the Hudson Bay-James Bay Lowlands.
14	DENSE CONIFEROUS FOREST: Largely continuous forest canopy composed at least 80 percent of coniferous species; includes dense conifer swamp in the Hudson Bay-James Bay Lowlands.
15	CONIFEROUS PLANTATION: Mature coniferous plantations, mostly pine, occurring in evenly spaced rows, mainly in Southern Ontario. This class does not include artificially regenerated cutovers or burns in Northern Ontario.
16	MIXED FOREST, MAINLY DECIDUOUS: Largely continuous forest canopy composed of coniferous and deciduous species, with deciduous species dominant (i.e., comprising more than 50 percent of the canopy).

**TABLE 3. THE 28 PROVINCIAL LAND COVER CLASSES WITH DEFINITIONS
(continued)**

PROVINCIAL CLASS NUMBER	PROVINCIAL CLASS NAME AND DEFINITION
17	MIXED FOREST, MAINLY CONIFEROUS: Largely continuous forest canopy composed of coniferous and deciduous species, with coniferous species dominant (i.e., comprising more than 50 percent of the canopy).
18	SPARSE CONIFEROUS FOREST: Patchy or sparse forest canopy (i.e., approximately 30 to 40 percent canopy closure) composed approximately 80 percent of coniferous species.
19	SPARSE DECIDUOUS FOREST: Patchy or sparse forest canopy (i.e., approximately 30 to 40 percent canopy closure) composed approximately 80 percent of deciduous species.
20	RECENT CUTOVERS: Forest clear-cuts estimated at less than 10 years of age.
21	RECENT BURNS: Forest burns estimated at less than 10 years of age.
22	OLD CUTS AND BURNS: Forest clear-cuts and burns estimated at more than 10 years of age.
23	MINE TAILINGS, QUARRIES, AND BEDROCK OUTCROPS: Clearings for mining activity scattered in all parts of the province; aggregate quarries occurring mainly in Southern Ontario; bedrock outcrops.
24	SETTLEMENT AND DEVELOPED LAND: Clearings for human settlement and economic activity; major transportation routes.
25	PASTURE AND ABANDONED FIELDS: Open grassland with sparse shrubs mapped in agricultural areas of Southern Ontario; includes orchard lands.

**TABLE 3. THE 28 PROVINCIAL LAND COVER CLASSES WITH DEFINITIONS
(continued)**

PROVINCIAL CLASS NUMBER	PROVINCIAL CLASS NAME AND DEFINITION
26	CROPLAND: Row crops mapped in Southern Ontario; may or open soil in areas of agricultural land use.
27	ALVAR: Homogeneous areas of dry grassland growing on thin soils over a limestone substrate, mapped only where they occur in clusters in the central and eastern portions of Southern Ontario.
28	UNCLASSIFIED: Small, local areas where no classification data could be generated, because clouds and their shadows obscured the land surface on the satellite image data.

**TABLE 4. OUTLINE OF THE STANDARD ONTARIO PROVINCIAL LAND COVER CLASSIFICATION SCHEME
(Class numbers and names only)**

1. Water
2. Coastal mudflats
3. Intertidal marsh
4. Supertidal marsh
5. Freshwater coastal marsh/inland marsh
6. Deciduous swamp
7. Conifer swamp
8. Open fen
9. Treed fen
10. Open bog
11. Treed bog
12. Tundra heath
13. Dense deciduous forest
14. Dense coniferous forest
15. Coniferous plantation
16. Mixed forest, mainly deciduous
17. Mixed forest, mainly coniferous
18. Sparse coniferous forest
19. Sparse deciduous forest
20. Recent cutovers
21. Recent burns
22. Old cuts and burns
23. Mine tailings, quarries, and bedrock outcrops
24. Settlement and developed land
25. Pasture and abandoned fields
26. Cropland
27. Alvar
28. Unclassified (cloud and shadow)

APPENDIX I

SUMMARY TABLE OF LAND COVER CLASSES AGGREGATED FROM NINE TILES (PRIOR TO RATIONALIZATION)

Provided for historical reference only.

Shading indicates the occurrence of the provincial classes in the individual tiles.

Numbers in the shaded cells indicate the original tile class numbers.

SUMMARY TABLE OF LAND COVER CLASSES AGGREGATED FROM NINE TILES
(with original within-tile reference numbers)

PROVINCIAL CLASS NUMBER AND NAME	TILE NO. 1	TILE NO. 2	TILE NO. 3	TILE NO. 4	TILE NO. 5	TILE NO. 6	TILE NO. 7	TILE NO. 8	TILE NO. 9	COMMENTS
0. Unclassified/ cloud/shadow	17	17	18	14	0	22	17	21	21	Areas where cloud, cloud shadow or smoke hid the land surface.
1. Water	1	1	1	1	1					Single general water class.
2. Water - deep						1	1	1	1	Deep/clear waterbodies appeared distinctively dark.
3. Water- shallow or sedimented						2	2	2	2	Shallow/sedimented waterbodies were distinctly lighter than deep/clear waterbodies.
4. Coastal mudflats				2						Partly covered at high tide.
5. Intertidal marsh				3						Between tidal flats and supertidal zone.
6. Supertidal marsh				4						Subject to exceptionally high tides only.
7. Freshwater marsh				5						Coastal marsh beyond area of saltwater influence.

PROVINCIAL CLASS NUMBER AND NAME	TILE NO. 1	TILE NO. 2	TILE NO. 3	TILE NO. 4	TILE NO. 5	TILE NO. 6	TILE NO. 7	TILE NO. 8	TILE NO. 9	COMMENTS
8. Deep/shallow water marsh							10			Flooded, but may be shallow or seasonal.
9. Meadow marsh							11			Drier than deep/shallow water marsh or cattail marsh; cover of grasses.
10. Cattail marsh							13			Wetter than meadow marsh; drier than shallow/deep water marsh.
11. Hardwood/thicket swamp							9			Along rivers, near lakeshores, in old lake beds.
12. Conifer swamp/dense conifer				14			14	23		Densely treed wetland, conifer species.
13. Wetlands	14	14	14							Single general wetland class (bogs, fens and marshes)
14. Wetlands, open					13					Open general class, mainly bogs and fens.
15. Wetlands, treed					14					Treed general class.
16. Open fen				8		14	12	13	13	Open graminoid wetlands; in Tiles 4 and 7, including open bogs.

PROVINCIAL CLASS NUMBER AND NAME	TILE NO. 1	TILE NO. 2	TILE NO. 3	TILE NO. 4	TILE NO. 5	TILE NO. 6	TILE NO. 7	TILE NO. 8	TILE NO. 9	COMMENTS
17. Shrub-rich fen (open and treed)				9		15		14	14	Fens with shrubs and some sparse tree cover
18. Treed fen				7	15					Characterized by dense tamarack.
19. Fen with pools				10						A fen type with a greater proportion of surface water; includes "string bogs".
20. Lichen-rich peat plateau/open bog				11				15	15, 23	Primarily open bog; lichen-rich peat plateau only in Tile 4.
21. Shrub-rich peat plateau/open bog				12						Like Class 20, but with low shrub cover.
22. Treed bog				13		17		16	16	Low-, medium- and high-density treed bog; some sparse conifer forest.
23. Tundra heath				7						Dense turf on better-drained areas; only occurs in Hudson Bay coastal zone.
24. Dense deciduous forest/shrubs	10	10	10	6	7	8	3	7	7	Estimated 80 percent deciduous species.

PROVINCIAL CLASS NUMBER AND NAME	TILE NO. 1	TILE NO. 2	TILE NO. 3	TILE NO. 4	TILE NO. 5	TILE NO. 6	TILE NO. 7	TILE NO. 8	TILE NO. 9	COMMENTS
25. Dense conifer forest			2				4			Estimated 80 percent coniferous species; dense conifer class without species subgroups.
26. Dense conifer, mainly pine	2	2			2	3		3	3	Pine species (esp. jack pine) dominant.
27. Dense conifer, mainly spruce	3	3			3	4		4	4	Spruce species (esp. black spruce) dominant.
28. Dense conifer, plantations			3				5			Mature plantations, mostly pine.
29. Mixed forest, mainly deciduous	9	9	9		6	7	7	6	6	Dense forest, more than 50 percent deciduous species.
30. Mixed forest, mainly conifer	5, 6, 7, 8	5, 6, 7, 8	5, 6, 7, 8		5	5, 6	6	5, 26	5	Dense forest, more than 50 percent coniferous species. In Tiles 1, 2, and 3, white and red pine subtypes originally mapped are absorbed.
31. Sparse conifer	4	4	4		4, 9	9		8, 25	8	Estimated 80 percent conifer, sparse growth /open canopy.

PROVINCIAL CLASS NUMBER AND NAME	TILE NO. 1	TILE NO. 2	TILE NO. 3	TILE NO. 4	TILE NO. 5	TILE NO. 6	TILE NO. 7	TILE NO. 8	TILE NO. 9	COMMENTS
32. Sparse/open deciduous cover	12	12	12		8	10	8	9	9	Estimated 80 percent deciduous species, sparse growth/ open canopy. The general "sparse forest" type in Tile 7 is included in this class.
33. Rock barrens/other sparse vegetation							19			Generally less densely vegetated than the "sparse/open deciduous" and "sparse/open coniferous" classes; in many areas, distinction between poorly vegetated and sparse deciduous is very slight.
34. Recent clearcuts	12	13	13		10	11		10	10	Estimated less than 10 years old at the date of recording.
35. Recent burns (woodland and lichen)		13		16	12	12		11	11	Disturbance estimated less than 10 years old at the date of recording. The "recent clearcuts and burns" variant occurs in Tiles 1, 2 &3.
36. Old burns and cutovers	11	11	11		11	13		12, 22	12, 22	Estimated over 10 years old at the date of recording.

PROVINCIAL CLASS NUMBER AND NAME	TILE NO. 1	TILE NO. 2	TILE NO. 3	TILE NO. 4	TILE NO. 5	TILE NO. 6	TILE NO. 7	TILE NO. 8	TILE NO. 9	COMMENTS
37. Bedrock/gravel/sand	15	15	15	15	16	20	18	19, 24	19	Bedrock outcrops, exposed sand and aggregate extraction areas.
38. Mine tailings/ extraction sites		16			17	19		18	18	Clearings for mining activity and aggregate extraction.
39. Urban/settlements/ roads		16			17	18		17	17	Clearings for human settlement in sparsely settled areas.
40. Urban: industrial/ commercial/roads/ infrastructure							20			A non-residential zone of major Southern Ontario cities.
41. Urban: residential							21			A residential zone of major Southern Ontario cities.
42. Agriculture	16	16	16		17	21				Although general agriculture classes were included in the original classification schemes of Tiles 6, 8 and 9, no agricultural land cover was mapped in those tiles.
43. Row crops and hay/open soil							15			Specific to extensive agricultural areas in Southern Ontario.

PROVINCIAL CLASS NUMBER AND NAME	TILE NO. 1	TILE NO. 2	TILE NO. 3	TILE NO. 4	TILE NO. 5	TILE NO. 6	TILE NO. 7	TILE NO. 8	TILE NO. 9	COMMENTS
44. Pasture, abandoned fields/savannah/prairie							16			Specific to extensive agricultural areas in Southern Ontario.
45. Alvar							17			Homogeneous, lush grassland over limestone, mapped only in Tile 7. "Other open/non-forested sites" is the bedrock outcrops class in Tile 6.

APPENDIX II

FORMATION OF NATIONAL-SCALE LAND COVER DATA FOR ONTARIO

FOR DISTRIBUTION VIA GEOGRATIS

(NATURAL RESOURCES CANADA)

NATIONAL- SCALE ONTARIO LAND COVER

In 1999/2000, the standard Ontario land cover data base (with 28 land cover classes) was generalized to form a separate, national-scale land cover data set for the province. This data set was prepared for distribution in the GeoGratis system of Natural Resources Canada, in which it formed the basis for the establishment of a new national data category, "Satellite Land Cover".

The data is distributed in 1:250,000-scale National Topographic Series map sheet units, with a pixel size of 100 metres and a ground resolution of approximately 50 hectares. The data is available in two projections: latitude/longitude and UTM.

The national-scale land cover data set contains 15 land cover classes, listed in Table 1. Table 2 provides definitions of these 15 general classes and shows the classes were formed from the standard 28 land cover classes of the provincial data base.

APPENDIX II, TABLE 1.**NATIONAL-SCALE ONTARIO LAND COVER CLASSES
PREPARED FOR GEOGRATIS DATA DISTRIBUTION**

1. Water
2. Marshes
3. Open Wetlands
4. Treed Wetlands
5. Tundra Heath
6. Dense Deciduous Forest
7. Dense Coniferous Forest
8. Mixed Forest
9. Sparse Forest
10. Early Successional Forest
11. Successional Forest
12. Mine Tailings, Quarries, Bedrock Outcrop, Mudflats
13. Settlement and Developed Land
14. Agriculture
15. Unclassified Areas (within the province)

**APPENDIX II, TABLE 2.
DEFINITIONS AND DERIVATION
OF THE 15 NATIONAL-SCALE ONTARIO LAND COVER CLASSES**

NATIONAL CLASS NUMBER (1 - 15)	NATIONAL CLASS NAME	SOURCE PROVINCIAL CLASS(ES) (1 - 28)
1	WATER: The delineation of water bodies is based on the spectral signature of the imagery and is not derived from a secondary map source. Hence the boundaries of water bodies may differ from those on topographic base maps.	#1 - Water
2	MARSHES: Tidal marshes of the Hudson Bay-James Bay lowlands, freshwater coastal marshes, and inland marshes (seasonal marshes, cattail marshes, and grassy meadow marshes).	#3 - Intertidal marsh + #4 - Supertidal marsh + #5 - Freshwater coastal marsh / inland marsh
3	OPEN WETLANDS: Open fens (including grassy fens with open pools occurring most extensively in the Hudson Bay-James Bay lowlands) and open bogs (including bogs with some partial cover of stunted trees occurring generally in the province but most extensively in the Hudson Bay-James Bay lowlands; and "string bogs" of the Hudson Bay-James Bay lowlands which have a high proportion of open water surface).	#8 - Open fen + #10 - Open bog

NATIONAL CLASS NUMBER (1 - 15)	NATIONAL CLASS NAME	SOURCE PROVINCIAL CLASS(ES) (1 - 28)
4	<p>TREED WETLANDS: Fens with dense shrub and tamarack tree cover occurring generally in the province but most extensively in the Hudson Bay-James Bay lowlands; and bogs with low- to high-density tree cover. Some degree of overlap exists between treed bog and sparse conifer forest in more northerly parts of the province, especially in the Hudson Bay-James Bay lowlands.</p>	<p>#9 - Treed fen + #11 - Treed bog + #6 - Deciduous swamp + #7 - Conifer swamp</p>
5	<p>TUNDRA HEATH: Areas of dense ericaceous vegetation occurring on better-drained areas only in the Hudson Bay coastal zone.</p>	<p>#12 - Tundra heath</p>
6	<p>DENSE DECIDUOUS FOREST: Largely continuous forest canopy composed at least 80 percent of deciduous species; includes deciduous shrub cover on old burns and alder thicket swamps in the Hudson Bay-James Bay lowlands.</p>	<p>#13 - Dense deciduous forest</p>
7	<p>DENSE CONIFEROUS FOREST: Largely continuous forest canopy composed at least 80 percent of coniferous species; includes dense conifer swamp in the Hudson Bay-James Bay lowlands; includes mature conifer plantations, mostly pine, growing in evenly spaced rows, mainly in Southern Ontario; does not include artificially regenerated cutovers or burns in Northern Ontario.</p>	<p>#14 - Dense coniferous forest + #15 - Conifer plantations</p>
8	<p>MIXED FOREST: Largely continuous forest canopy of both coniferous and deciduous species.</p>	<p>#16 - Mixed forest, mainly deciduous + #17 Mixed forest, mainly coniferous</p>

NATIONAL CLASS NUMBER (1 - 15)	NATIONAL CLASS NAME	SOURCE PROVINCIAL CLASS(ES) (1 - 28)
9	SPARSE FOREST: Patchy or sparse forest canopy (approximately 30 to 40 percent canopy closure) composed of either coniferous (mainly in northerly regions of Ontario) or deciduous species, or both.	#18 - Sparse coniferous forest + #19 - Sparse deciduous forest
10	EARLY SUCCESSIONAL FOREST: Forest growing on clear-cuts and burns estimated at less than 10 years of age.	#20 - Recent cutovers + #21 - Recent burns
11	SUCCESSIONAL FOREST: Forest growing on clear-cuts and burns estimated at more than 10 years of age.	#22 - Old cutovers and burns
12	MINE TAILINGS, QUARRIES, BEDROCK OUTCROPS, MUDFLATS: Areas of minimal vegetation cover including mine tailings; rock and gravel quarries; rocky Great Lakes shorelines; bedrock outcrops; and mudflats on the Hudson Bay and James Bay coast.	#2 - Coastal mudflats + #23 - Mine tailings, quarries, and bedrock outcrops
13	SETTLEMENT AND DEVELOPED LAND: Clearings for human settlement and economic activity; major transportation routes.	#24 - Settlement and developed land
14	AGRICULTURE: Row crops, hay crops, open soil, open grassland with sparse shrubs, and orchard land.	#25 - Pasture and abandoned fields + #26 - Cropland + #27 - Alvar
15	UNCLASSIFIED: Cloud and shadow areas, within the provincial study area.	#28 - Unclassified