The Muskoka River Watershed Inventory Project
Final Report

The Muskoka Heritage Foundation
The District Municipality of Muskoka
The Ontario Ministry of Natural Resources
The Muskoka Watershed Council

February 2007

Submitted to the Watershed Inventory Collaborative
Submitted by Phung Tran
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Ministry of Natural Resources
Parry Sound District

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Acknowledgements

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Introduction

The development of the Muskoka River Watershed Inventory Project (MRWIP) was overseen by a collaborative initiative of the Muskoka Heritage Foundation, Muskoka Watershed Council, District Municipality of Muskoka, and Ontario Ministry of Natural Resources (Parry Sound District) (The Collaborative). The collaborative members identified a need to undertake a landscape level analysis of the terrestrial ecological systems (ecosystems) within the Muskoka River Watershed in order to facilitate their planning and resource management mandates. Funding was acquired from the Ontario Trillium Foundation and the federal Department of Fisheries and Oceans.

The Muskoka River watershed is located on the Canadian Shield in central Ontario. The watershed contains over 500,000 hectares of forests, wetlands, settlement and agricultural areas, and a large amount of water. The Muskoka River begins in the Algonquin Highlands in Algonquin Provincial Park and travels about 210 km before it flows into Lake Huron at Georgian Bay. The Muskoka River is divided into three branches: North, South and Lower. The North branch starts in the Algonquin Highlands and passes through Rebecca Lake, Lake Vernon, Fairy Lake, and Mary Lake. The South branch has its beginnings from Algonquin Provincial Park, as well as from the Haliburton Highlands, and passes through Kawagama Lake and Lake of Bays. The Lower branch receives inflow from the North and South branches, as well as from Lakes Joseph and Rosseau, and it passes through Lake Muskoka before emptying into Georgian Bay.

Private land makes up 48% of the Muskoka River watershed. There are four upper-tier municipalities and counties covering the watershed. The District Municipality of Muskoka covers 62%, District of Nipissing covers 10%, District of Parry Sound makes up 15%, while the County of Haliburton covers 11% of the watershed. Crown land covers approximately 50% of the watershed and the rest falls under First Nations and other federal lands (2%) (Figures 1 and 2).

At a bird’s eye-view, most of the Muskoka River watershed appears to be covered in forest and other natural vegetation types (about 68%) (Figure 3). About 11% of the watershed consists of wetlands, 15% is water in the form of lakes and ponds, and rock (barrens and outcrops) forms just over 2% of the watershed. Settlement areas (including urban and built areas) make up almost 2% of the watershed, while developed agricultural areas, croplands and open fields (such as golf courses) form over 2% of the landcover types within the watershed.

The Collaborative identified the importance of protected areas as the starting point for developing future natural areas strategies. The level of protection of natural areas within the Muskoka River watershed varies. More than 50% of the natural, land-base portion of the Muskoka River watershed is covered by some level of protection (Figure 4) and those protected areas vary in their degree of protection. Thus, levels of protection were developed for the MRWIP based on the amount of protection provided to natural areas.

National Parks, Provincial Parks, Conservation Reserves, and land trust properties provide the highest level of protection in the watershed (Figure 5). Level 1 protection contains about 85% provincial parks, 14% conservation reserves and 1% land trust properties. These areas provide full protection of natural areas through strictly regulated planning policies and restrictions; they cover about 18% of the watershed's natural land-base.

Level 2 protection areas include Crown Land (making up 90% of level 2 protection), Muskoka Heritage Areas (8%), Muskoka Heritage Trust conservation easement agreements (0.01%), and Provincially Significant Wetlands (2%) (Figure 6). These designations either fully or partially protect natural areas depending on policies and agreements with a variety of users, including private land-owners, industry and/or other agencies. Level 2 protection areas cover 31% of the watershed's natural land-base (excluding those areas in level 1 protection that also fall under level 2 categories).

Level 3 protected areas are confirmed Areas of Natural and Scientific Interest (2% of level 3 protection) and all wetlands (98%) (Figure 7). These areas are protected from incompatible land-use decisions related to development through the municipal official plan policies and comprehensive zoning-by laws. Level 3 protected areas cover about 14% of the watershed's natural land-base.

The objective of the Muskoka River Watershed Inventory was to identify areas of core ecologic significance that are in good condition and other areas of high quality that can enhance the core areas and that can be used to develop a natural areas strategy and inform conservation and protection activities across the watershed.

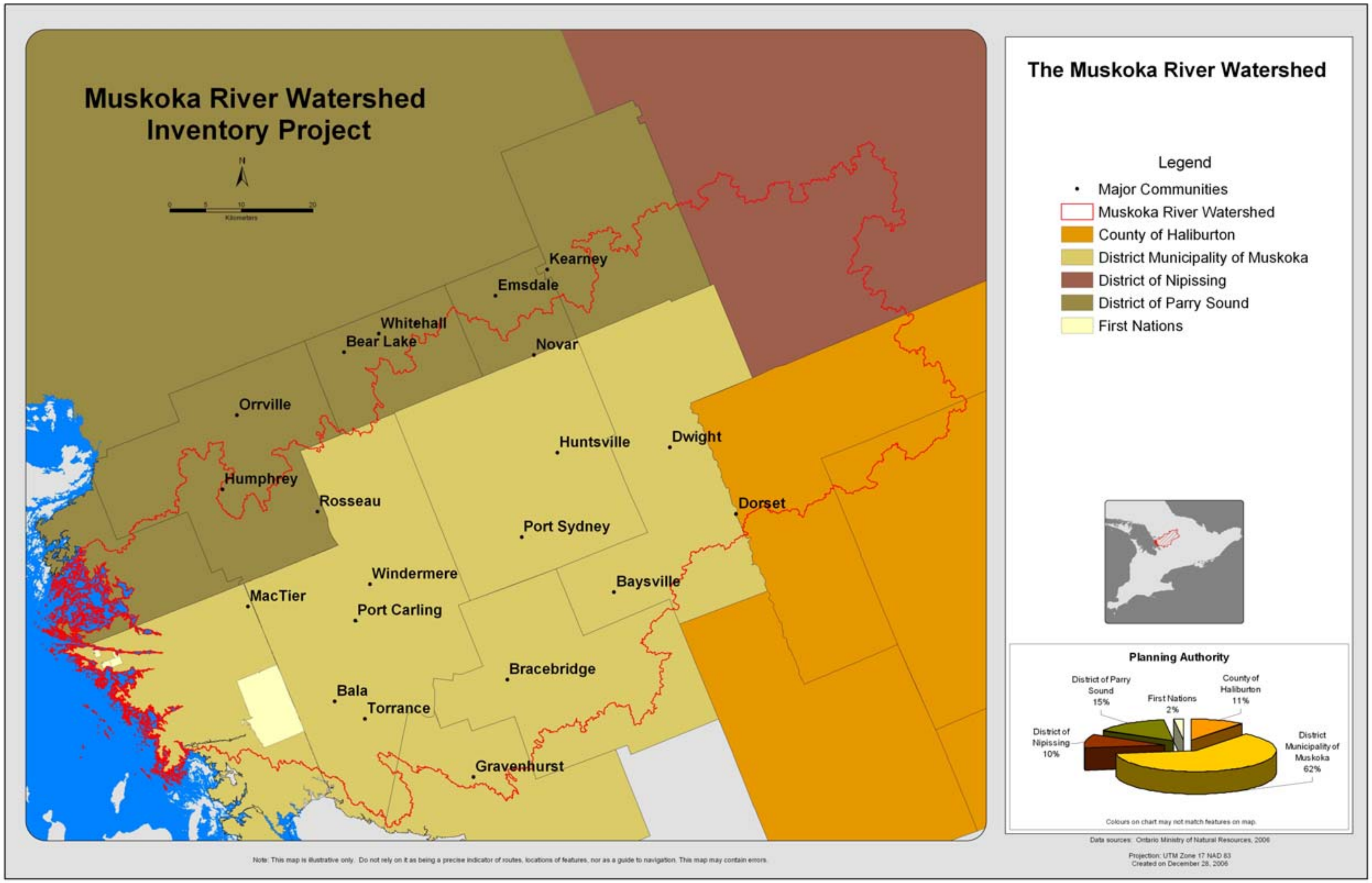


Figure 1. The Muskoka River watershed.

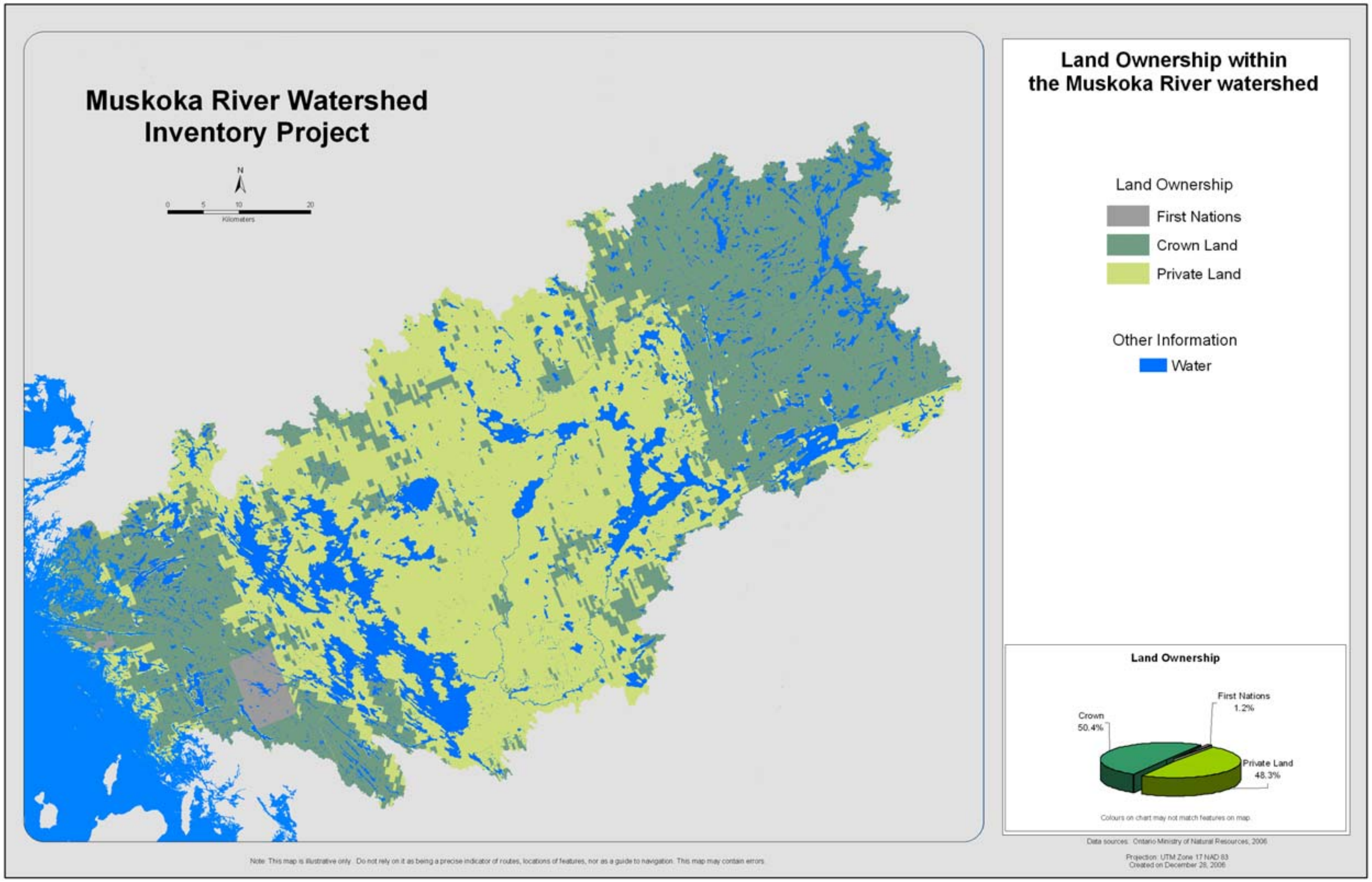


Figure 2. Land ownership within the Muskoka River watershed**.**

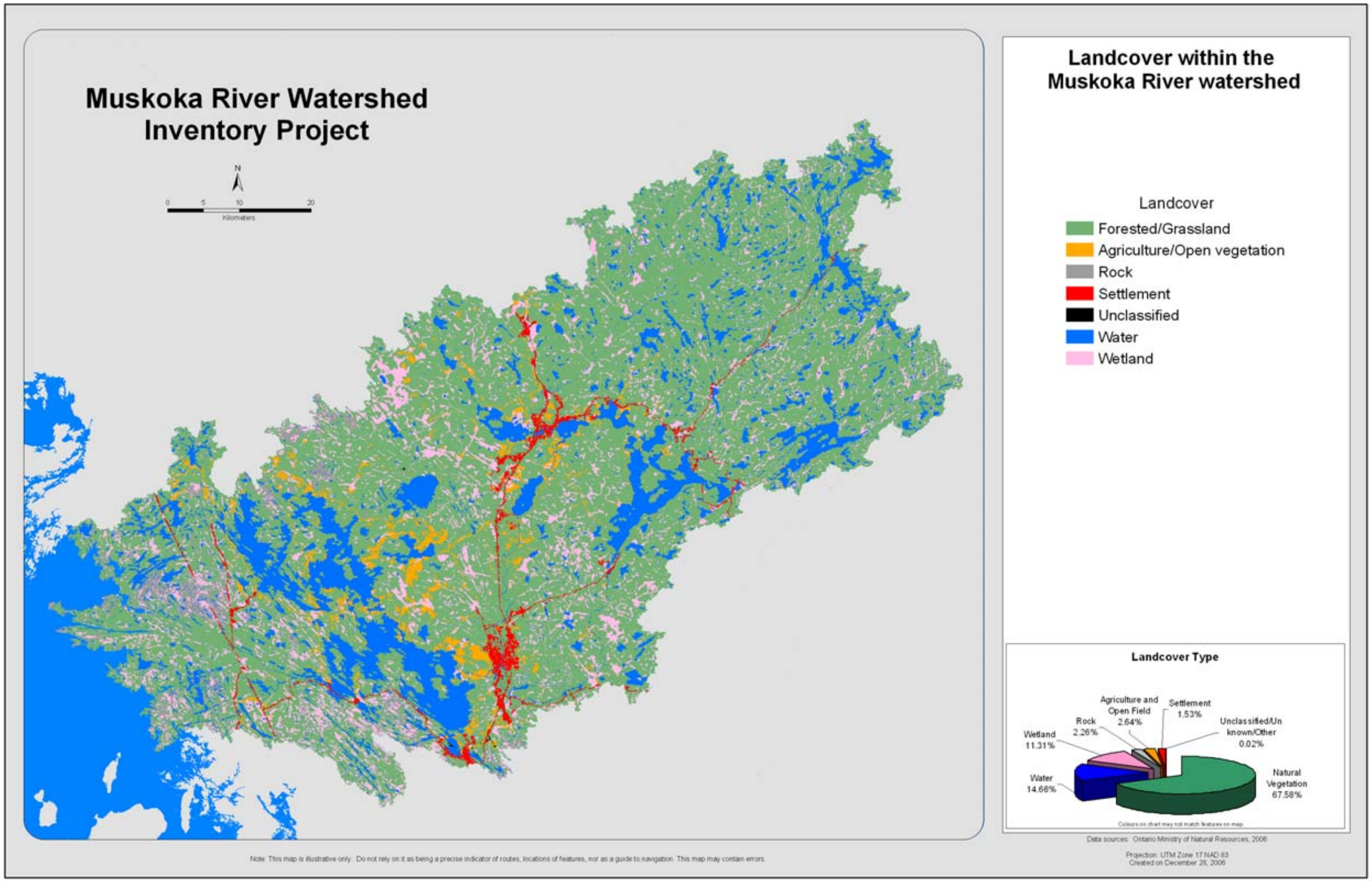


Figure 3. Landcover within the Muskoka River watershed**.**

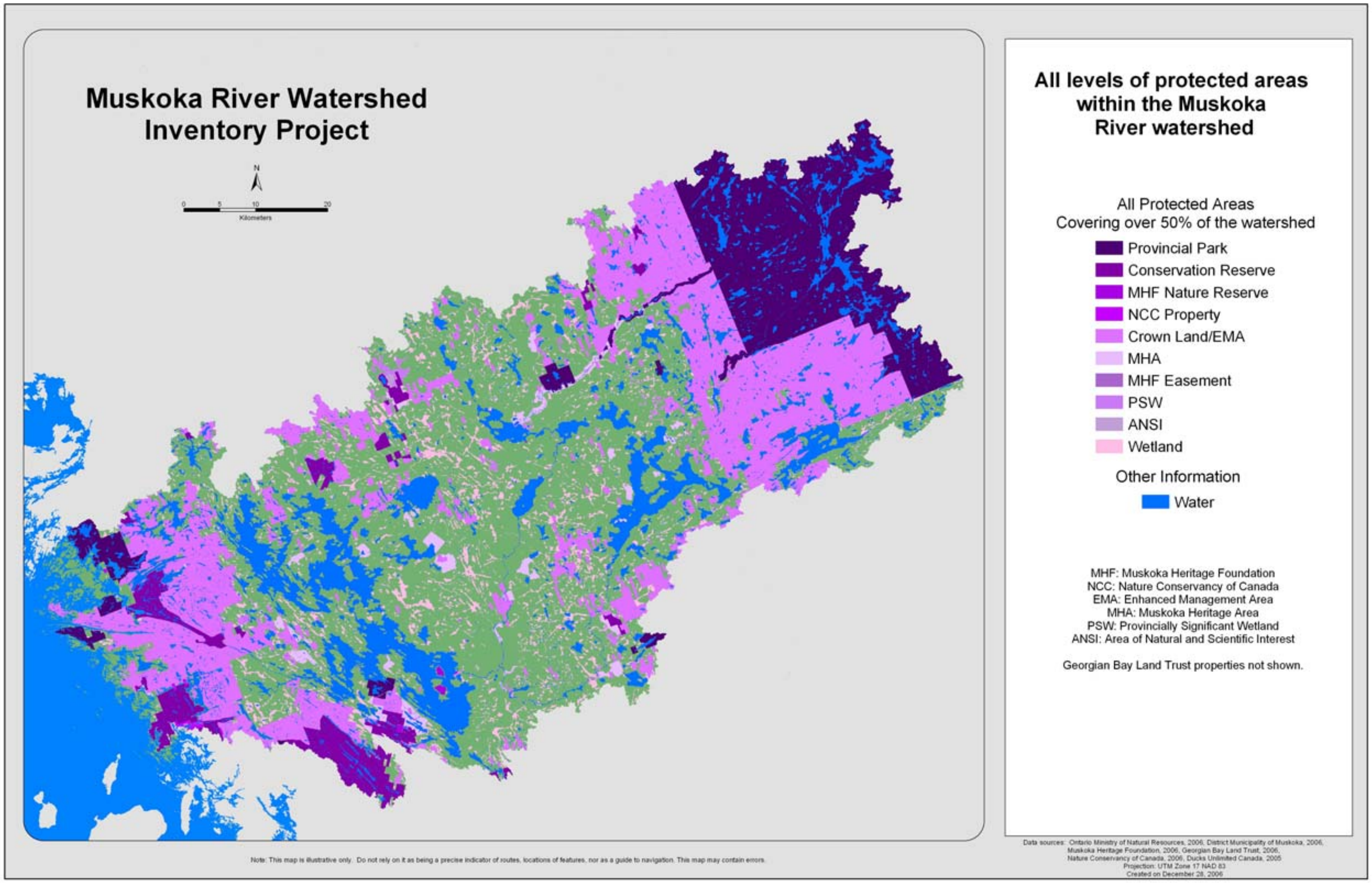


Figure 4. All levels of protected areas within the Muskoka River watershed**.**

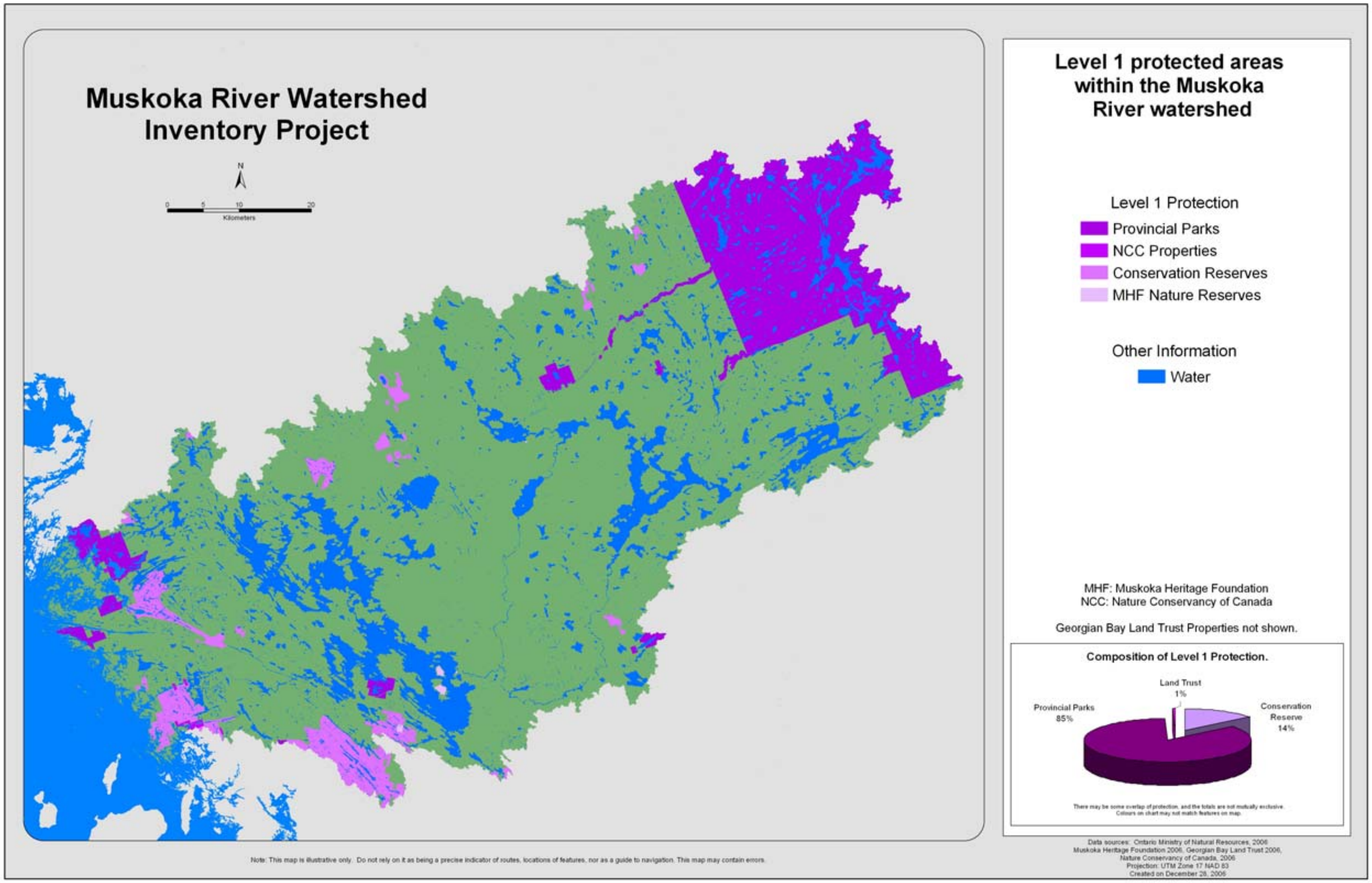


Figure 5. Level 1 protected areas within the Muskoka River watershed.

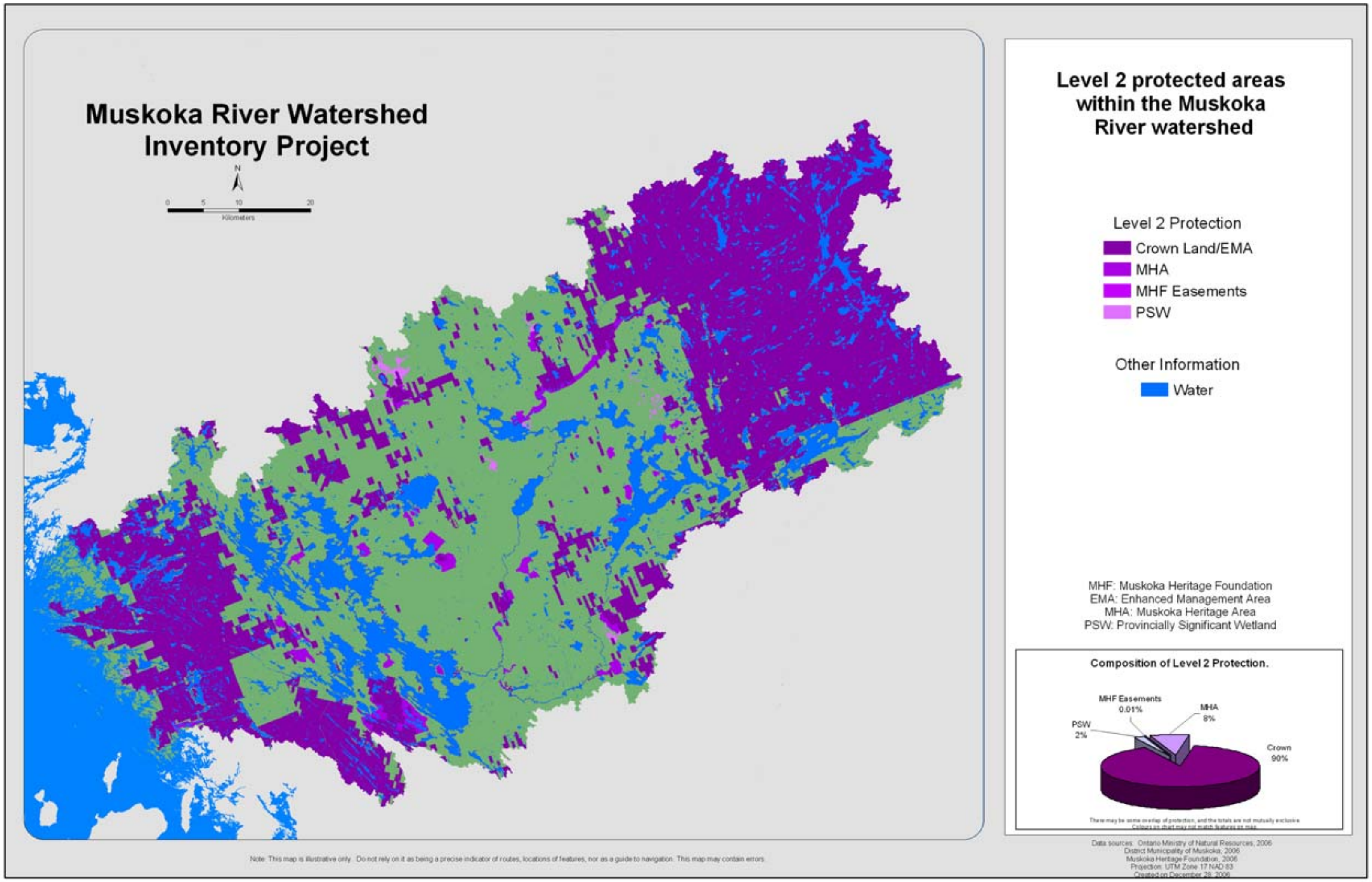


Figure 6. Level 2 protected areas within the Muskoka River watershed.

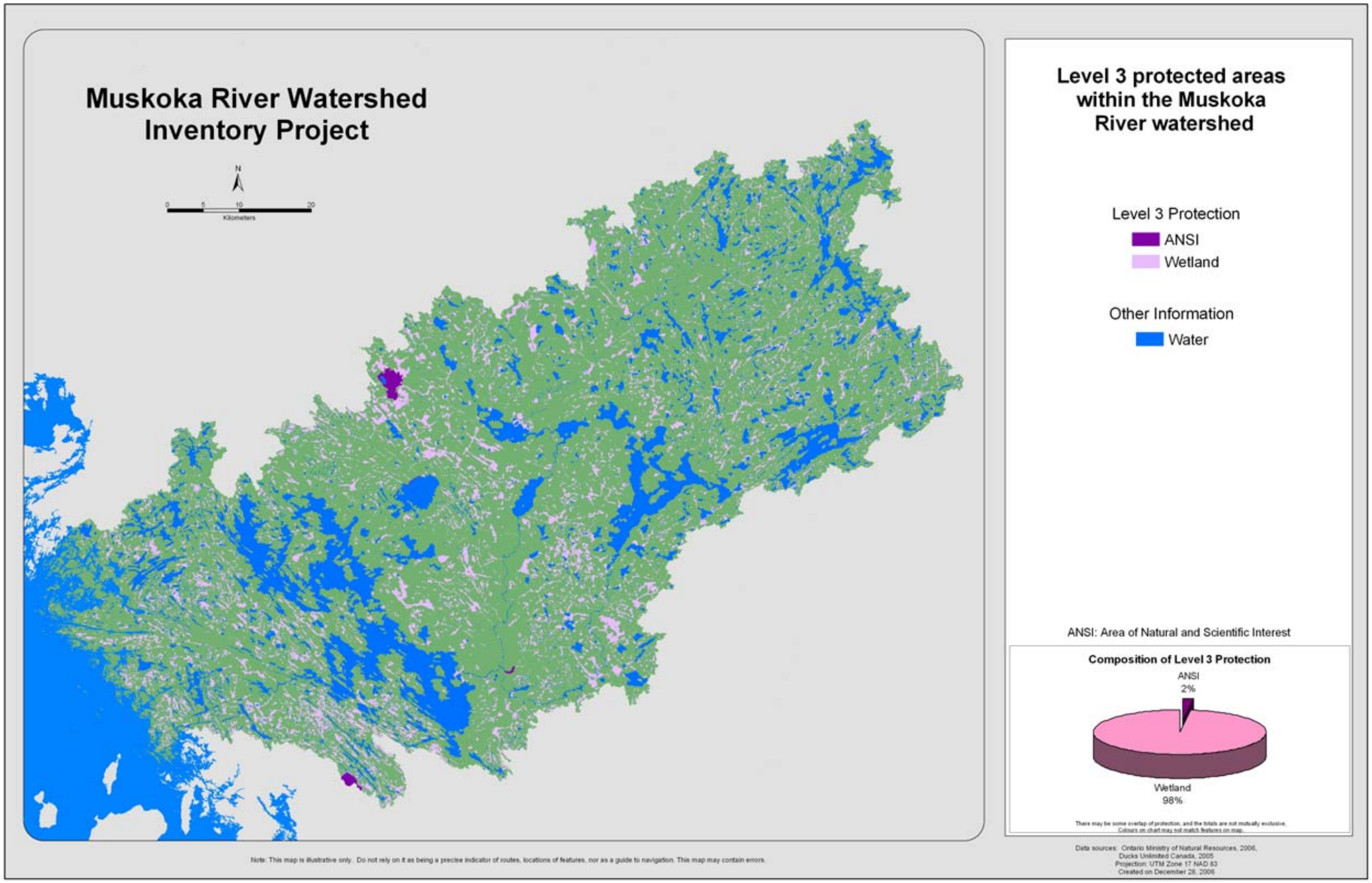


Figure 7. Level 3 protected areas within the Muskoka River watershed.

The Muskoka River Watershed Inventory Project

The development of the Muskoka River Watershed Inventory Project (MRWIP) was overseen by a collaborative initiative of the Muskoka Heritage Foundation, Muskoka Watershed Council, District Municipality of Muskoka, and Ontario Ministry of Natural Resources (Parry Sound District) (The Collaborative). The collaborative members identified a need to undertake a landscape level analysis of the terrestrial ecological systems (ecosystems) within the Muskoka River Watershed in order to facilitate their planning and resource management mandates. Funding was acquired from the Ontario Trillium Foundation and the federal Department of Fisheries and Oceans.

The three goals of the program were to:

1. Identify unique terrestrial ecosystems (page 22)
2. Identify areas of high ecological importance (page 36)
3. Identify stresses on ecosystems and process (page 49)

Based on these analyses, a system of core ecological areas and connecting systems was identified.

The methodology for the Great Lakes Conservation Blueprint, developed by the Nature Conservancy of Canada and Ontario Ministry of Natural Resources, (Henson et al. 2005; Henson and Brodribb, 2004) was adapted for use in the MRWIP. The approach used Geographic Information System (GIS) modeling to assess areas at a watershed scale using a transparent, ecology-based approach. The MRWIP used the best available datasets to identify ecologically important sites in good condition within the Muskoka River Watershed. Using current landscape ecology principles, significant areas were then identified on both Crown and private lands. These significant areas form the base of a sustainable natural ecosystem for the watershed and they should be maintained in an undisturbed state.

The Muskoka River Watershed Inventory is not a site-specific analysis and cannot be used to identify specific features or natural values. Implementation of the Muskoka River Watershed Inventory will be through planning processes undertaken by any one of the collaborative members and will include public consultation as required by any applicable legislation.

The Products of the MRWIP

The following four products were developed through The Muskoka River Watershed Inventory Project and provide a solid base for future natural heritage work of the collaborative members:

1. A gap analysis of unprotected vegetation communities and landforms (page 59);

1. A gap analysis of biological data and site inventories (page 62);
2. A map portraying the significant natural areas and connecting corridors (page 66);
3. Identification of significant degraded sites and areas that may require remediation (page 74).

The results of MRWIP are strategic in nature cannot be applied on a site-specific basis. Collaborative members will be able to use the results for natural heritage planning, conservation, and restoration efforts. In particular:

1. The Muskoka Heritage Foundation, through the Muskoka Heritage Trust, will be able to establish priority areas for potential acquisition or remediation and therefore use limited resources efficiently.
2. The District Municipality of Muskoka will be able to use this information as background to a natural heritage strategy that will identify core natural areas and connecting systems and recommend levels of protection.
3. The Ontario Ministry of Natural Resources will be able to use the findings to assist with natural heritage planning on crown land throughout the watershed and add new information to the provincial database.
4. The Muskoka Watershed Council will be able to report the changes in the sustainability of natural areas to the public and address watershed health through the Muskoka Watershed Report Card.
5. Along with the Muskoka Heritage Foundation, the Watershed Council will be able to use the products generated from MRWIP to develop education and stewardship programs.
6. All four collaborative members will continue to work together to promote the need for protected areas, and to encourage stewardship and education for natural heritage on both Crown and patent land in order to maintain and enhance a logical and continuous natural system.

At a strategic level, the MRWIP identified significant areas that, if conserved, will protect biodiversity and natural heritage values. The MRWIP did not undertake any analysis at a property-specific level and, therefore, does not make any site-specific recommendations with respect to development or protection. Implementation of the MRWIP will occur through the planning processes and specific programs of the collaborative members and may include policy, management, education, stewardship, restoration and remediation activities.

Ecological Concepts Guiding the Methodology

In recent years, organizations concerned with the conservation of natural resources have moved from a site-specific focus to a broader, landscape approach. Focusing conservation effort only on specific communities can create isolated patches that do not protect a whole suite of ecological processes. These protected areas have come to be known as ‘islands of green’ and generally are not large enough to sustain the ecosystems they were designed to protect.

A landscape approach ensures that a healthy, functioning network of protected areas preserves and maintains biodiversity and ecological processes over time, as opposed to individual, independent pieces of protected land that may not be sufficient in supporting a diversity of ecosystem services and function.

The MRWIP is an initial analysis of the Muskoka River Watershed at a landscape level. The analysis not only identified significant natural areas but also correlated those areas to existing protected areas, providing the background required to developing a sustainable system of protected natural areas.

Existing protected areas within the Muskoka River watershed provide different levels of protection for a variety of values. The top level of protection includes provincial and national parks, private land trust lands and conservation reserves. These lands provide the highest level of protection and generally do not permit development activity that would threaten natural systems. The second level of protection includes all other Crown land, Muskoka Heritage Areas, Provincially Significant Wetlands and conservation easements. Largely, these lands are all protected by development policy; however, development may occur on these lands in some situations. The third or lowest level of protection includes all other wetlands and Areas of Natural and Scientific Interest (ANSIs), as defined by the MNR.

Any natural areas strategy will include lands within all levels of protection; however, the most significant sites should be given the highest level of protection through ownership and direct control. Where there are gaps in existing protection, future decisions based on conservation science should ensure that significant natural areas are represented in a sustainable network of protected lands.

Methodology

The MRWIP used a gap analysis process developed in Ontario by Crins and Kor and further refined for use by the Great Lakes Conservation Blueprint, released in 2006. This geographic information system (GIS) model is a science-based methodology supported by agencies with multiple years of experience and expertise in natural heritage planning and conservation science.

In a geographic information system (GIS) environment, the assessment of natural systems requires the use of surrogates, or indicators, to characterize the objectives. An indicator is a digital representation of influences on natural areas that can be mapped, manipulated, and analyzed in a GIS or computer environment. More specifically, the indicators used in this project were the existing digital datasets available through the provincial Natural Resources Values and Information System (NRVIS) and supplemented with local municipal and land trust data where available. For some objectives, indicators were obvious, such as using a dataset of wetlands to identify wetlands, while other indicators required manipulation in order to achieve the objectives of each goal, such as selecting specific sizes of natural sites to represent areas that exhibit degrees of ecological integrity and resiliency.

In developing or modifying a methodology for a large, watershed-scale analysis such as the Muskoka River watershed, a suite of indicators was considered to identify ecologically important areas and evaluate their condition (Table 1).

The MRWIP used a transparent methodology to assess the watershed, which can be updated when science changes or new information becomes available. The MRWIP methodology and results were not meant to be a final, static product for the Muskoka River watershed, but a comprehensive way to look at the complexity of ecosystems within the watershed as they evolve and change.

Table 1 identifies the goals, criteria, objectives, and indicators used for the MRWIP. As previously mentioned, the MRWIP defined three specific goals that guided the production of the final products.

Goal 1: To identify unique terrestrial ecosystems and protected areas (page 22)
Goal 2: To identify areas of high ecological importance (page 36)
Goal 3: To identify stresses on ecosystems and ecosystem processes (page 49)

Each goal consisted of a comprehensive list of criteria. Under each criterion, specific objectives were captured by using indicators, which were weighted and scored based on the influence they had on ecosystems.

Goal 1: Identify unique ecosystems and protected areas

The relationship between landforms and vegetation communities is referred to as ecological systems. Ecological systems (or ecosystems) consist of living and non-living elements of an area and their interactions.

For the Muskoka River watershed study area, ecosystems consist of the dominant vegetation and the landform features on which they occur. The combination of non-living elements (landform) and the response of living features (vegetation) to those enduring elements creates unique ecological units that support a matrix of animal populations and ecological functions. Ecosystems were used as the basic unit in the GIS analysis to measure the value of natural areas for the MRWIP (Comer 2003).

Goal 2: Identify areas of high terrestrial ecological importance

Ecosystems that can maintain ecological processes, as well as sustain evolutionary processes will ensure a healthy, functioning natural system. Several elements can be used as indicators of how well a system can maintain these processes.

Table 1. The goals of the Muskoka River Watershed Inventory Project, and the criteria, objectives, and indicators of these goals.

Goal	Criterion	Objective	Indicator
Identify terrestrial ecosystems and protected areas	1. Representation	(a) Identify all terrestrial ecosystems within the watershed and their protection status	(i) Landform and vegetation associations (terrestrial ecosystems) (ii) Existing protected areas
Identify areas of high terrestrial ecological importance	2. Ecological Function	(a) Identify natural areas that exhibit high degree of integrity and resiliency	(i) Size of discrete terrestrial ecosystems (ii) Presence of old growth forests (iii) Interior size of discrete terrestrial ecosystems
		(b) Identify wetlands	(i) Presence of wetlands
		(c) Identify riparian areas	(i) Riparian of stream/rivers, inland lakes, and Great Lakes shoreline
		(d) Identify recharge areas	(i) Highly permeable areas
	3. Diversity	(a) Identify habitat diversity	(i) Habitat diversity
	4. Special Feature	(a) Identify species element occurrences, vegetation communities, and other significant wildlife habitat	(i) Species and vegetation community occurrences (ii) Important habitat areas
Identify stresses on terrestrial ecosystems and processes	5. Condition	(a) Identify condition/quality of watershed	(i) Percentage natural cover (ii) Influence of settled areas (iii) Influence of open cleared areas such as agricultural lands and golf courses) (iv) Influence of pits and quarries (v) Influence of hydro lines (vi) Influence of railways (vii) Influence of roads (viii) Influence of trails

The following indicators were used to identify areas of high ecological importance (Table 1):

- Size of discrete terrestrial ecosystems;
- Presence of old growth forests;
- Interior size of discrete terrestrial ecosystems;
- Presence of wetlands;
- Riparian of rivers and streams, inland lakes, and the Great Lakes shoreline;
- Highly permeable areas;
- Habitat diversity;
- Species and vegetation community occurrences; and
- Important habitat areas.

Size of Ecosystem: One of the most important factors in maintaining integrity and resiliency of natural areas is size. Size of natural areas is related to species richness, and affects intricate relationships and conditions that are required for successful species survival, such as the ability for species to move between habitat types (Dorp and Opdom 1987), and perform critical evolutionary activities (Burke and Nol 2000). Size also contributes to an ecosystem's ability to recover from natural disturbances, such as fire (Wiersma et al. 2004).

Old Growth Forest: Old growth forests are important features to ecological integrity and resiliency. Old growth forests harbour high species diversity and richness and, since they contain much older than average aged tree species, they consist of a large number of snags (or dead standing trees) and fallen debris. Old growth forests are very different in their structural make-up from younger forest stands. The structural make-up provides opportunities for more specialized species, and is also involved in nutrient cycling, and in maintaining soil stability and water quality (Henry and Quinby 2006). As well, research shows that old growth forests are natural reservoirs of genetic diversity and may be significant in absorbing and storing greenhouse gases (Fredeen et al. 2005).

Interior Size of Ecosystem: The relationship between core areas and edge communities is a factor in maintaining the integrity of natural systems. Interior habitat provides specific environmental elements necessary for the survival of many species. Interior forested patches maintain specific environmental conditions (i.e. moisture, temperature, light) and vegetation compositions. In many instances, these species cannot survive under any other conditions (Daigle and Havinga 1996; Fenton and Frego 2005).

Wetlands: Wetlands play an essential part of healthy, functioning watersheds. Wetlands store, filter, and move water, as well as buffer water supply from harmful effects of adjacent land-uses (Schweiger at al. 2002). Wetlands also provide critical habitat for a number of wildlife species. Many at-risk avian species, insects, reptiles and almost all amphibian species require wetlands for at least part, if not all, of their life cycle (Semlitsch and Bodie 2003).

Riparian Areas: A riparian area is that portion of land that is directly influenced by water. These areas are the interface between land and water. The influence of water on the land produces unique characteristics that create habitat for a variety of plant and animal species, and these habitats are often used by species as critical migration corridors. The Great Lakes shoreline, for instance, is unique because it experiences frequent changes in water level, waves and ice-scour, creating high biological diversity and distinct vegetation types. Many unique vegetation communities are also found along both Great Lakes shoreline and inland lakes such as Atlantic Coastal Plain communities, which is a disjunct vegetation community found in Southern Muskoka (Keddy and Fraser 2000). Riparian areas also play a major role in nutrient cycling, and in buffering natural areas from noise, light and invasive species (Castelle et al. 1994).

Permeable Areas: The areas of land where water can reach aquifers are described as recharge areas. Recharge areas are essential to the hydrological cycle, as well as to the replenishment of drinking wter sources for many of the residents of Muskoka, and therefore is an important element to consider when assessing the ecological importance of the watershed.

Habitat Diversity: Habitat diversity is the number of different habitats in a given area. High diversity of habitat patches is associated with high species richness since more kinds of niches are available for a variety of different organisms, and thus creating complex habitat relationships (Ardron 2002; Riffell et al. 2003).

Significant Areas: The occurrence of species or special habitat areas indicates that an area contains ecological processes that are supporting, or have supported, these elements. Significant habitat is a geographic area that is required for the long-term survival and reproductive success of wildlife species. Many species have evolved to use very specific conditions, and if these conditions are unavailable, these species are unable to continue their existence successfully (Hagen and Hodges 2006; Leon-de-La Luz and Breceda 2006).

Goal 3: Identify stresses on terrestrial ecosystems and processes

A crucial part of identifying a healthy, fully functioning ecosystem is to recognize the stresses on an area's ecological integrity. Stress on an ecosystem can come in a variety of forms and will impact upon the condition of an ecosystem and affect the ability of the ecosystem to maintain ecological functions. The MRWIP assessed the following elements that are currently putting stress upon ecosystems (Table 1):

- Percentage natural cover;
- Influence of settled areas;
- Influence of open cleared areas, including agriculture and golf courses;
- Influence of pits and quarries;
- Influence of hydro lines;
- Influence of railways;
- Influence of roads; and

- Influence of trails.

Identifying the sources of stress on the ecological integrity of systems within the Muskoka River watershed was an essential part of the MRWIP. The condition of ecosystems was evaluated in order to identify the highest quality sites for protection and to assess the need for immediate protection, remediation, and restoration of degraded sites.

GIS Analysis Results and Maps

A Geographical Information System (GIS) is a powerful tool for representing and analyzing features found on the Earth's surface. GIS has the ability to connect spatial data (features on the Earth's surface) and non-spatial data (attributes or information about the features) in one location, for example, roads or lakes, along with their attributes, such as road names or area measurements. As more and more data are collected digitally worldwide, GIS provides the ability to store, maintain, retrieve, update, and display large amounts of information.

GIS relates different datasets and has the ability to define relationships, such as finding the percentage of roads within a defined proximity of a major lake. Many organizations now use GIS in their applications, including land-use planning, natural resource management, real estate, and emergency planning.

For the MRWIP, data were collected from a variety of sources. The Ontario Ministry of Natural Resources provided most data on landscape features. Other data were more specific to the Muskoka River watershed, such as wetland data from Ducks Unlimited Canada, forestry data from Westwind Forest Stewardship, Bancroft and Parry Sound MNR Districts, and Algonquin Provincial Park. Additional protected areas datasets were obtained from The District Municipality of Muskoka, Muskoka Heritage Foundation, Nature Conservancy of Canada, and Georgian Bay Land Trust. The Ministry of Northern Development and Mines provided quaternary and surficial geological information.

The following are the final summary results and maps for the Muskoka River Watershed Inventory Project. For more detailed information on technical methodology and scientific justification of criteria, objectives and indicators, please refer to the Muskoka River Watershed Inventory Project Technical Report.

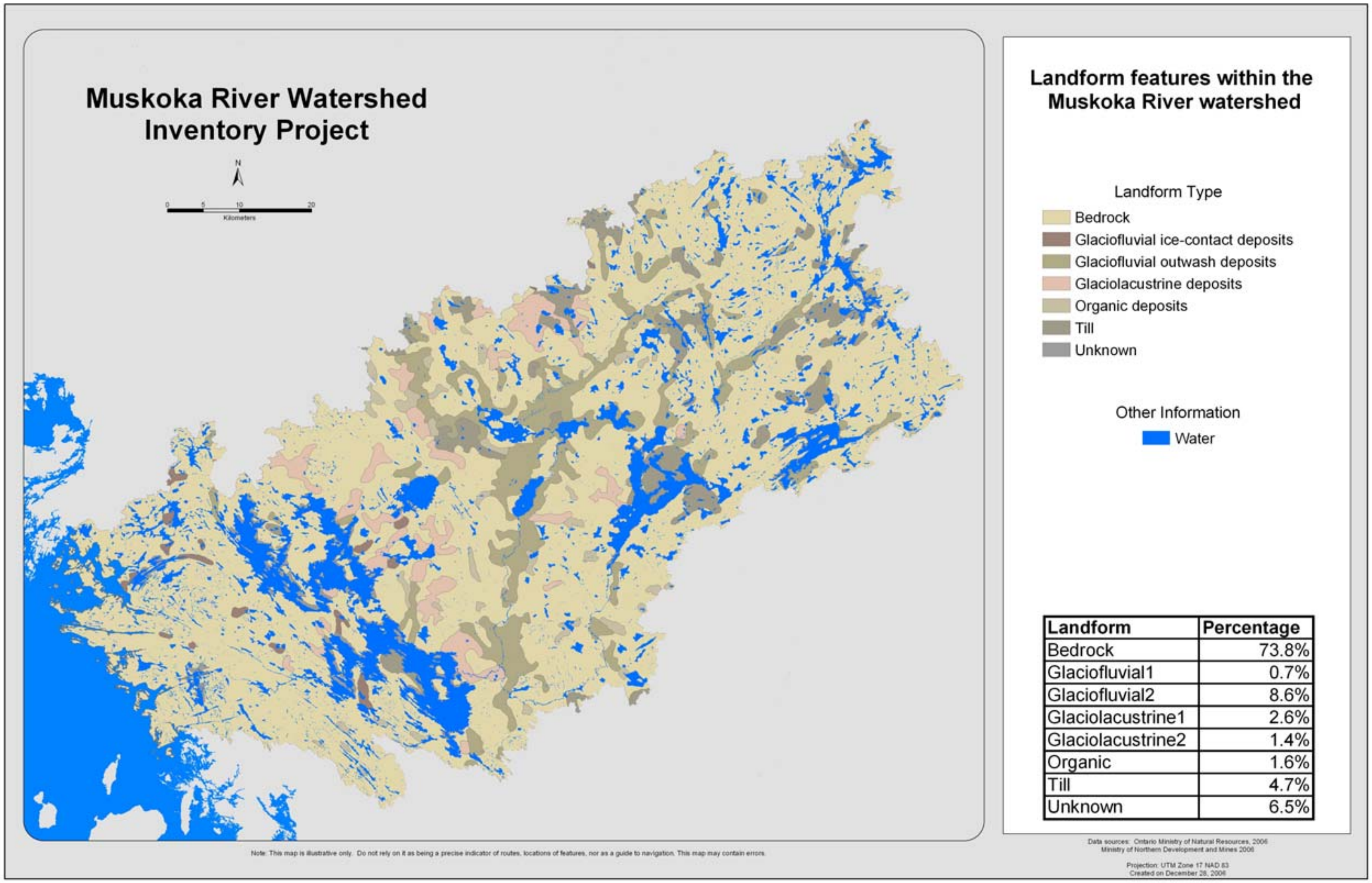
Goals of the Muskoka River Watershed Inventory Project

Goal 1: Identify terrestrial ecosystems and protected areas.

Geological Landforms: Figure 8 illustrates geological deposits that are found within the Muskoka River watershed. These landforms comprise the non-living elements required to identify unique ecosystems. Table 2 explains each landform type and the proportion found within the Muskoka River watershed. Not surprisingly, most of the watershed is made up of bedrock (74%) and much of the material deposits consist of sand and gravel (13%).

Table 2. Landform types and their proportion within the Muskoka River watershed.

MRWIP Name	**Geological Description**	**Material Description**	**Percentage**
Bedrock	Bedrock	Undifferentiated igneous and metamorphic rock, exposed at surface or covered by a discontinuous, thin layer of drift	74%
Glaciofluvial1	Glaciofluvial ice-contact deposits	Gravel and sand, minor till, includes esker, kame, end moraine, ice-marginal delta and subaqueous fan deposits	1%
Glaciofluvial2	Glaciofluvial outwash deposits	Gravel and sand, includes proglacial river and deltaic deposits	9%
Glaciolacustrine1	Glaciolacustrinedeposits	Sand, gravelly sand and gravel, nearshore and beach deposits	3%
Glaciolacustrine2	Glaciolacustrine deposits	Silt and clay, minor sand, basin and quiet water deposits	1%
Organic	Organic deposits	Peat, muck and marl	2%
Till	Till	Undifferentiated, predominantly sand to silty sand matrix, high content of clasts, often low in matrix carbonate content	5%
Uknown	Unknown	Unknown/Undefined/Unclassified	6%



Landform	Percentage
Bedrock	73.8%
Glaciofluvial1	0.7%
Glaciofluvial2	8.6%
Glaciolacustrine1	2.6%
Glaciolacustrine2	1.4%
Organic	1.6%
Till	4.7%
Unknown	6.5%

Figure 8. Landform features within the Muskoka River watershed.

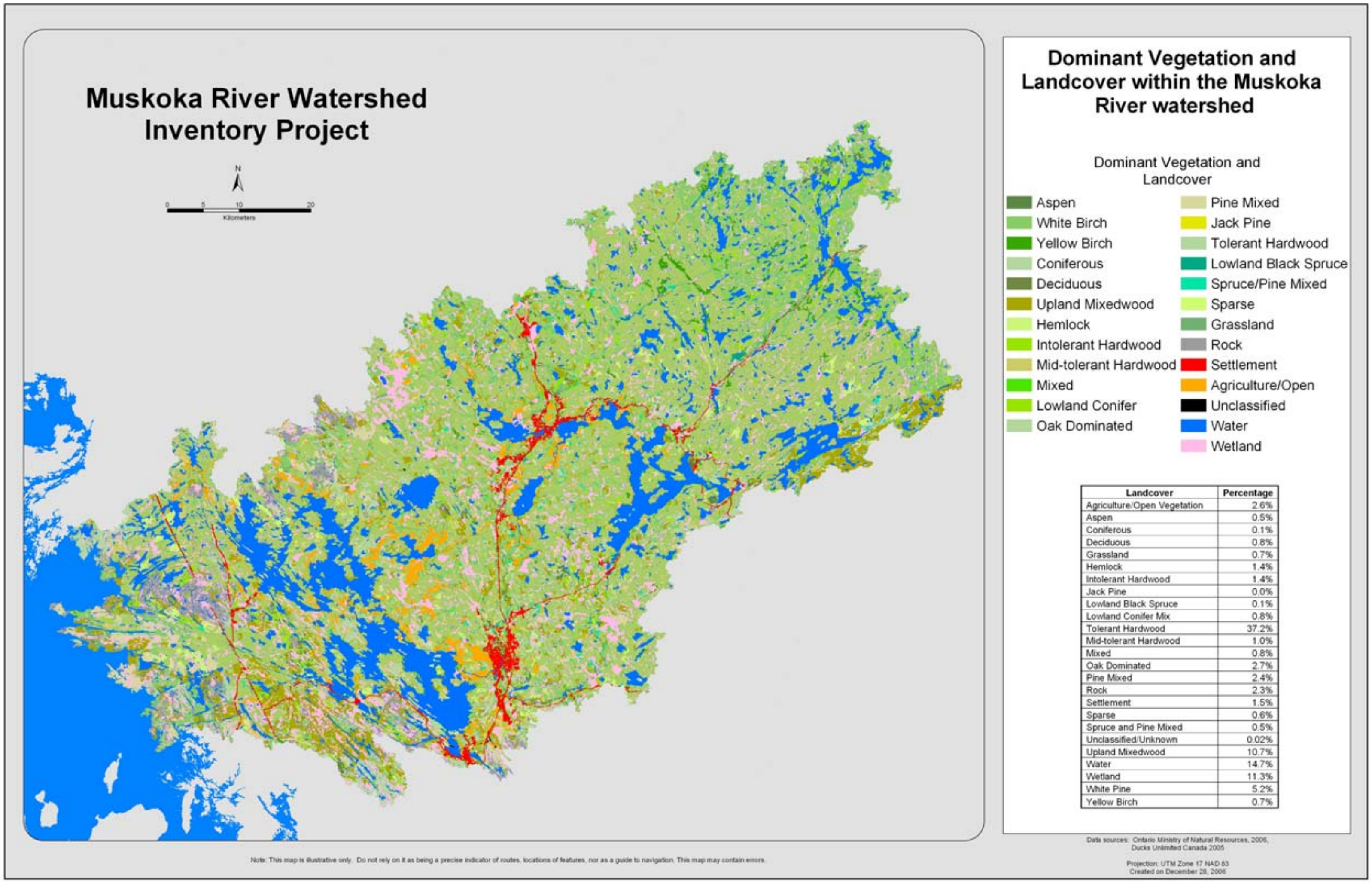
Vegetation Communities: Figure 9 shows the dominant vegetation, natural features and landcover types within the watershed. Dominant vegetation or forest stands are the living elements used to identify unique ecosystems. Table 3 explains the landcover type classifications and Table 4 presents the type of dominant feature and the proportion found within the Muskoka River watershed. Tolerant hardwoods (37.2%), wetlands (11.3%) and upland mixedwood (10.7%) make up most the vegetated landcover types within the watershed.

Table 3. Classification of landcover and vegetation types.

Landcover Types	MRWIP Name	Definition
Forested	PWR	White Pine and Red White mixed
	PJ	Jack Pine Upland
	SbP	Spruce and Pine Mixed
	By	Yellow Birch
	Opine	Oak & Oak/Pine
	MidHd	Midtolerant Hardwood
	TolHd	Tolerant Hardwood
	Asp	Poplar Upland
	IntHd	Intolerant Hardwood
	OCLow	Lowland Conifer mixed
	SbLow	Lowland Black Spruce
	HdCon	Upland mixed
	He	Hemlock
	Bw	White Birch
	Mixed	Largely continuous forest canopy composed of both deciduous and coniferous forests
	Coniferous	Largely continuous forest canopy composed primarily of coniferous species
	Deciduous	Largely continuous forest canopy composed primarily of deciduous species
	Sparse	Patchy or sparse forest canopy composed of coniferous or deciduous species or a combination of the two
Non-Forested	DAL	Agricultural land
		Pasture: Open grassland with sparse shrubs in rural land
		Cropland: Areas of row crops and fallow fields
	GRS	Grass and meadow
	Rock	Rock
		Bedrock: exposed bedrock, lacking vegetation cover
	Settlement	Settlement/Infrastructure: clearings for human settlement and economic activity
	Tailings	Mines and mine tailings
Water	Water	Water
Wetland	Wetland	Open muskeg
		Treed muskeg
		Brush and Alder
		Marsh
		Swamp
		Fen
		Bog
		DUC identified wetlands
		Wetlands
		Permanent Wetland
Unknown	UCL	Unclassified, undefined, cloud and shadow

Table 4. Proportion of landcover and vegetation types within the Muskoka River watershed.

Landcover	Percentage
Agriculture/Open Vegetation	2.6%
Aspen	0.5%
Coniferous	0.1%
Deciduous	0.8%
Grassland	0.7%
Hemlock	1.4%
Intolerant Hardwood	1.4%
Jack Pine	<0.01%
Lowland Black Spruce	0.1%
Lowland Conifer Mix	0.8%
Tolerant Hardwood	**37.2%**
Mid-tolerant Hardwood	1.0%
Mixed	0.8%
Oak Dominated	2.7%
Pine Mixed	2.4%
Rock	2.3%
Settlement	1.5%
Sparse	0.6%
Spruce and Pine Mixed	0.5%
Unclassified/Unknown	0.02%
Upland Mixed	**10.7%**
Water	14.7%
Wetland	**11.3%**
White Pine	5.2%
Yellow Birch	0.7%



Landcover	Percentage
Agriculture/Open Vegetation	2.6%
Aspen	0.5%
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Deciduous	0.8%
Grassland	0.7%
Hemlock	1.4%
Intolerant Hardwood	1.4%
Jack Pine	0.0%
Lowland Black Spruce	0.1%
Lowland Conifer Mix	0.8%
Tolerant Hardwood	37.2%
Mid-tolerant Hardwood	1.0%
Mixed	0.8%
Oak Dominated	2.7%
Pine Mixed	2.4%
Rock	2.3%
Settlement	1.5%
Sparse	0.6%
Spruce and Pine Mixed	0.5%
Unclassified/Unknown	0.02%
Upland Mixedwood	10.7%
Water	14.7%
Wetland	11.3%
White Pine	5.2%
Yellow Birch	0.7%

Figure 9. Dominant vegetation and landcover within the Muskoka River watershed

Unique Terrestrial Ecosystems: Figure 10 shows the unique terrestrial ecosystems found within the Muskoka River watershed. This is the result of combining the landform (Figure 8) and landcover/vegetation (Figure 9) information. Table 5 shows the proportion of each unique ecosystem within the watershed. As expected, tolerant hardwood forests influenced by bedrock make up a large proportion of the terrestrial ecosystems within the watershed (28.56%).

Table 5. Proportion of each unique ecosystem found within the Muskoka River watershed as a result of combining landform and land-cover data.

Landcover	Percentage
Asp\Bedrock	0.40%
Asp\Glaciofluvial2	0.06%
Asp\Glaciolacustrine1	0.04%
Asp\Glaciolacustrine2	< 0.01%
Asp\Organic	0.01%
Asp\Till	0.03%
Asp\Unknown	0.01%
Bw\Bedrock	4.47%
Bw\Glaciofluvial1	0.01%
Bw\Glaciofluvial2	0.33%
Bw\Glaciolacustrine1	0.08%
Bw\Glaciolacustrine2	0.05%
Bw\Organic	0.08%
Bw\Till	0.07%
Bw\Unknown	0.08%
By\Bedrock	0.49%
By\Glaciofluvial1	< 0.01%
By\Glaciofluvial2	0.10%
By\Glaciolacustrine1	< 0.01%
By\Glaciolacustrine2	0.01%
By\Organic	< 0.01%
By\Till	0.08%
By\Unknown	< 0.01%
Coniferous\Bedrock	0.04%
Coniferous\Glaciofluvial1	< 0.01%
Coniferous\Glaciofluvial2	0.02%
Coniferous\Glaciolacustrine1	< 0.01%
Coniferous\Glaciolacustrine2	< 0.01%
Coniferous\Organic	< 0.01%
Coniferous\Till	< 0.01%
Coniferous\Unknown	< 0.01%
DAL	2.64%
Deciduous\Bedrock	0.50%
Deciduous\Glaciofluvial1	0.01%
Deciduous\Glaciofluvial2	0.10%
Deciduous\Glaciolacustrine1	0.02%
Deciduous\Glaciolacustrine2	0.01%
Deciduous\Organic	0.01%
Deciduous\Till	0.06%
Deciduous\Unknown	0.05%
GRS	0.69%
HdConU\Bedrock	8.58%
HdConU\Glaciofluvial1	0.03%
HdConU\Glaciofluvial2	0.88%
HdConU\Glaciolacustrine1	0.26%
HdConU\Glaciolacustrine2	0.10%
HdConU\Organic	0.18%
HdConU\Till	0.58%
HdConU\Unknown	0.09%
He\Bedrock	1.06%
He\Glaciofluvial1	0.04%
He\Glaciofluvial2	0.08%
He\Glaciolacustrine1	0.02%
He\Glaciolacustrine2	0.01%
He\Organic	0.02%
He\Till	0.08%
He\Unknown	0.06%
IntHd\Bedrock	1.22%
IntHd\Glaciofluvial1	< 0.01%
IntHd\Glaciofluvial2	0.10%
IntHd\Glaciolacustrine1	0.03%
IntHd\Glaciolacustrine2	< 0.01%
IntHd\Organic	0.01%
IntHd\Till	0.02%
IntHd\Unknown	0.01%
MidHd\Bedrock	0.82%
MidHd\Glaciofluvial1	0.03%
MidHd\Glaciofluvial2	0.08%
MidHd\Glaciolacustrine1	0.04%
MidHd\Glaciolacustrine2	< 0.01%
MidHd\Organic	< 0.01%
MidHd\Till	0.02%
MidHd\Unknown	0.02%
Mixed\Bedrock	0.50%
Mixed\Glaciofluvial1	0.01%
Mixed\Glaciofluvial2	0.16%
Mixed\Glaciolacustrine1	0.02%
Mixed\Glaciolacustrine2	0.01%
Mixed\Organic	0.01%
Mixed\Till	0.06%
Mixed\Unknown	0.05%
OCLow\Bedrock	0.65%
OCLow\Glaciofluvial1	< 0.01%
OCLow\Glaciofluvial2	0.06%
OCLow\Glaciolacustrine1	0.02%
OCLow\Glaciolacustrine2	0.02%
OCLow\Organic	0.01%
OCLow\Till	0.06%
OCLow\Unknown	0.01%
OPine\Bedrock	2.12%
OPine\Glaciofluvial1	0.07%
OPine\Glaciofluvial2	0.20%
OPine\Glaciolacustrine1	0.03%
OPine\Glaciolacustrine2	0.06%
OPine\Organic	0.02%
OPine\Till	0.07%
OPine\Unknown	0.15%
Pj\Bedrock	0.02%
Pj\Glaciofluvial2	0.01%
Pj\Glaciolacustrine1	< 0.01%
Pj\Organic	< 0.01%
Pj\Till	< 0.01%
PWR\Bedrock	1.85%
PWR\Glaciofluvial1	0.01%
PWR\Glaciofluvial2	0.27%
PWR\Glaciolacustrine1	0.03%
PWR\Glaciolacustrine2	0.05%
PWR\Organic	0.03%
PWR\Till	0.02%
PWR\Unknown	0.13%
Rock	2.26%
SbLow\Bedrock	0.07%
SbLow\Glaciofluvial2	0.03%
SbLow\Glaciolacustrine1	< 0.01%
SbLow\Glaciolacustrine2	< 0.01%
SbLow\Organic	< 0.01%
SbLow\Till	0.01%
SbP\Bedrock	0.32%
SbP\Glaciofluvial1	< 0.01%
SbP\Glaciofluvial2	0.12%
SbP\Glaciolacustrine1	0.02%
SbP\Glaciolacustrine2	< 0.01%
SbP\Organic	0.01%
SbP\Till	0.04%
SbP\Unknown	< 0.01%
Settlement	1.53%
Sparse\Bedrock	0.36%
Sparse\Glaciofluvial1	0.01%
Sparse\Glaciofluvial2	0.08%
Sparse\Glaciolacustrine1	0.01%
Sparse\Glaciolacustrine2	0.01%
Sparse\Organic	0.01%
Sparse\Till	0.04%
Sparse\Unknown	0.03%
Tailings	0.01%
TolHd\Bedrock	**28.56%**
TolHd\Glaciofluvial1	0.27%
TolHd\Glaciofluvial2	3.25%
TolHd\Glaciolacustrine1	0.92%
TolHd\Glaciolacustrine2	0.68%
TolHd\Organic	0.65%
TolHd\Till	2.37%
TolHd\Unknown	0.50%
UCL	0.01%
Water	14.66%
Wetland	11.31%

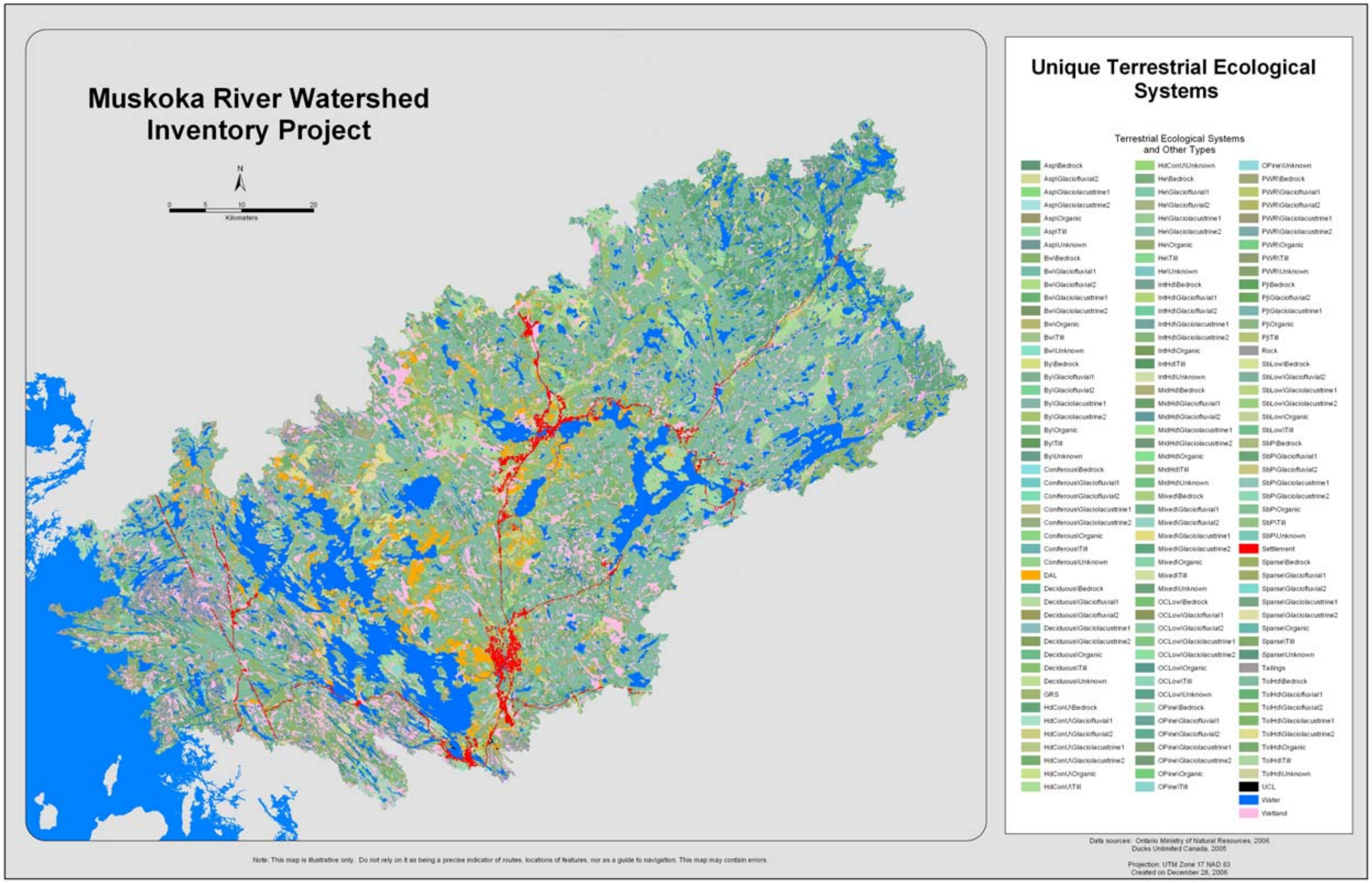


Figure 10. Unique ecosystems within the Muskoka River watershed.

Unique Terrestrial Ecosystems and Level of Protection: Figure 11 shows unique terrestrial ecosystems and all levels of protected areas. Table 6 shows each terrestrial ecosystem and the proportion of area protected under each level of protection, as well as the proportion not represented in any level of protection.

There are several ecosystems that are well represented in some level of protection, including wetlands and yellow birch stands on glaciofluvial ice-contact deposits. Other well represented ecosystems included aspen stands influenced by organic and till deposits, and lowland conifer stands on bedrock. Ecosystem types that had little to no representation in protected areas included aspen and yellow birch stands on glaciofluvial ice-contact deposits (Table 7, Figure 33).

Table 6. Unique terrestrial ecosystems and their representation in protected areas.

	Total within Watershed	**Within Level 1 Protection**	**Within Level 2 Protection**	**Within Level 3 Protection**	**Proportion not within protection**
Landcover	**Area (ha)**	**Percentage**			
Asp\Bedrock	2210.9	26.9%	23.4%	0.0%	49.8%
Asp\Glaciofluvial2	360.2	10.1%	20.8%	2.0%	76.5%
Asp\Glaciolacustrine1	219.9	0.0%	0.3%	0.0%	99.7%
Asp\Glaciolacustrine2	21.1	0.0%	0.3%	0.0%	99.7%
Asp\Organic	31.5	68.0%	20.5%	0.0%	11.6%
Asp\Till	144.9	21.1%	65.6%	0.0%	13.3%
Asp\Unknown	43.8	72.9%	0.3%	0.0%	26.9%
Bw\Bedrock	24985.5	14.1%	30.6%	0.2%	56.3%
Bw\Glaciofluvial1	48.9	0.0%	5.7%	0.0%	94.3%
Bw\Glaciofluvial2	1830.4	8.5%	15.4%	0.5%	78.6%
Bw\Glaciolacustrine1	442.2	0.0%	24.0%	0.0%	76.0%
Bw\Glaciolacustrine2	254.2	0.0%	16.0%	0.0%	84.0%
Bw\Organic	468.7	30.1%	19.3%	0.0%	59.3%
Bw\Till	369.9	5.9%	17.5%	0.0%	76.6%
Bw\Unknown	465.5	13.6%	34.0%	0.0%	52.3%
By\Bedrock	2723.8	59.9%	33.3%	0.0%	9.5%
By\Glaciofluvial1	2.3	100.0%	0.0%	0.0%	0.0%
By\Glaciofluvial2	570.6	16.0%	66.3%	0.0%	17.7%
By\Glaciolacustrine1	13.8	0.0%	0.0%	0.0%	100.0%
By\Glaciolacustrine2	41.1	0.8%	0.0%	0.0%	99.2%
By\Organic	23.5	0.0%	95.6%	0.0%	4.4%
By\Till	430.5	40.0%	45.3%	0.0%	14.7%
By\Unknown	27.3	100.0%	0.0%	0.0%	0.0%
Coniferous\Bedrock	209.5	8.9%	16.6%	0.0%	75.1%
Coniferous\Glaciofluvial1	0.9	0.0%	78.6%	0.0%	21.4%
Coniferous\Glaciofluvial2	119.6	5.2%	12.1%	0.1%	82.8%
Coniferous\Glaciolacustrine1	24.6	0.0%	17.5%	0.0%	82.5%
Coniferous\Glaciolacustrine2	3.4	0.0%	14.1%	0.0%	85.9%
Coniferous\Organic	12.2	0.0%	27.4%	0.0%	72.6%
Coniferous\Till	25.0	0.0%	24.4%	0.0%	75.6%
Coniferous\Unknown	17.5	0.7%	6.1%	0.0%	93.2%
Deciduous\Bedrock	2770.1	1.9%	25.9%	0.0%	72.5%
Deciduous\Glaciofluvial1	73.6	0.8%	27.3%	0.0%	71.9%
Deciduous\Glaciofluvial2	545.6	1.4%	13.8%	0.5%	84.6%
Deciduous\Glaciolacustrine1	102.7	0.0%	4.3%	0.0%	95.7%

	Total within Watershed	Within Level 1 Protection	Within Level 2 Protection	Within Level 3 Protection	Proportion not within protection
Landcover	Area (ha)	Percentage			
Deciduous\Glaciolacustrine2	71.8	0.1%	1.3%	0.0%	98.6%
Deciduous\Organic	35.6	0.0%	11.5%	0.0%	88.5%
Deciduous\Till	335.4	1.0%	17.8%	0.0%	81.1%
Deciduous\Unknown	258.8	1.1%	7.3%	0.0%	91.8%
GRS	3862.0	4.0%	7.0%	0.6%	89.0%
HdConU\Bedrock	47980.1	59.3%	16.0%	0.0%	26.0%
HdConU\Glaciofluvial1	151.2	26.0%	34.9%	0.0%	39.2%
HdConU\Glaciofluvial2	4944.4	20.9%	15.6%	0.0%	64.4%
HdConU\Glaciolacustrine1	1448.9	0.1%	6.9%	0.1%	93.0%
HdConU\Glaciolacustrine2	577.3	5.2%	6.8%	0.0%	87.9%
HdConU\Organic	1023.3	12.7%	27.3%	0.0%	61.7%
HdConU\Till	3240.0	59.4%	12.2%	0.0%	29.0%
HdConU\Unknown	524.6	44.6%	9.6%	0.0%	45.6%
He\Bedrock	5939.0	5.9%	39.2%	0.0%	58.0%
He\Glaciofluvial1	239.4	0.5%	17.4%	0.0%	82.1%
He\Glaciofluvial2	454.1	0.0%	19.7%	0.0%	80.3%
He\Glaciolacustrine1	89.7	0.0%	3.4%	0.0%	96.6%
He\Glaciolacustrine2	62.4	0.0%	0.5%	0.0%	99.5%
He\Organic	125.4	0.0%	5.2%	0.0%	94.8%
He\Till	421.5	0.1%	20.1%	0.0%	79.8%
He\Unknown	332.2	3.2%	38.2%	0.0%	61.6%
IntHd\Bedrock	6840.1	34.1%	37.3%	0.3%	34.3%
IntHd\Glaciofluvial1	11.0	0.0%	0.0%	0.0%	100.0%
IntHd\Glaciofluvial2	586.5	14.4%	42.4%	0.0%	48.9%
IntHd\Glaciolacustrine1	151.4	0.0%	16.1%	0.0%	83.9%
IntHd\Glaciolacustrine2	21.6	0.0%	8.7%	0.0%	91.3%
IntHd\Organic	34.5	35.3%	23.4%	0.0%	64.5%
IntHd\Till	85.6	44.6%	4.2%	0.0%	51.2%
IntHd\Unknown	59.6	42.2%	21.7%	0.0%	36.0%
MidHd\Bedrock	4572.4	8.1%	29.0%	0.0%	63.1%
MidHd\Glaciofluvial1	142.9	0.0%	43.7%	0.0%	56.3%
MidHd\Glaciofluvial2	450.8	0.3%	14.2%	0.0%	85.5%
MidHd\Glaciolacustrine1	197.9	0.0%	19.3%	0.0%	80.7%
MidHd\Glaciolacustrine2	2.0	0.0%	16.6%	0.0%	83.4%
MidHd\Organic	23.6	0.0%	0.0%	0.0%	100.0%
MidHd\Till	125.0	0.0%	30.8%	0.0%	69.2%
MidHd\Unknown	88.8	0.0%	20.3%	0.0%	79.7%
Mixed\Bedrock	2801.7	3.2%	17.3%	0.0%	79.7%
Mixed\Glaciofluvial1	45.1	0.6%	23.4%	0.0%	76.0%
Mixed\Glaciofluvial2	891.2	2.6%	12.8%	0.1%	84.9%
Mixed\Glaciolacustrine1	121.3	0.0%	7.2%	0.0%	92.8%
Mixed\Glaciolacustrine2	58.6	0.0%	2.5%	0.0%	97.5%
Mixed\Organic	58.0	0.0%	8.8%	0.0%	91.2%
Mixed\Till	314.8	1.0%	13.7%	0.0%	85.3%
Mixed\Unknown	255.1	0.7%	3.9%	0.0%	95.5%
OCLow\Bedrock	3651.3	71.9%	10.8%	0.5%	17.0%
OCLow\Glaciofluvial1	13.6	37.2%	0.0%	0.0%	62.8%
OCLow\Glaciofluvial2	311.9	15.8%	21.7%	0.0%	62.5%
OCLow\Glaciolacustrine1	112.2	0.0%	3.0%	0.1%	96.9%
OCLow\Glaciolacustrine2	135.0	34.7%	0.2%	0.0%	65.2%
OCLow\Organic	41.8	22.4%	26.5%	0.0%	51.0%

Landcover	Total within Watershed Area (ha)	Within Level 1 Protection	Within Level 2 Protection	Within Level 3 Protection	Proportion not within protection
		Percentage			
OCLow\Till	308.0	63.5%	10.2%	0.0%	26.3%
OCLow\Unknown	74.3	92.4%	0.0%	0.0%	7.6%
OPine\Bedrock	11853.0	22.3%	23.3%	0.4%	54.8%
OPine\Glaciofluvial1	390.8	0.0%	27.9%	0.0%	72.1%
OPine\Glaciofluvial2	1140.0	0.0%	16.5%	0.0%	83.5%
OPine\Glaciolacustrine1	156.7	0.0%	2.3%	0.0%	97.7%
OPine\Glaciolacustrine2	349.6	0.0%	3.6%	0.0%	96.4%
OPine\Organic	110.0	53.7%	12.0%	0.0%	34.6%
OPine\Till	395.7	0.0%	6.3%	0.0%	93.7%
OPine\Unknown	819.2	23.7%	13.6%	0.3%	65.2%
PWR\Bedrock	10324.9	9.7%	36.8%	0.6%	55.3%
PWR\Glaciofluvial1	83.6	0.0%	59.1%	0.0%	40.9%
PWR\Glaciofluvial2	1489.9	0.0%	9.0%	0.5%	91.0%
PWR\Glaciolacustrine1	191.1	0.0%	10.5%	0.0%	89.5%
PWR\Glaciolacustrine2	279.7	1.8%	18.9%	0.0%	79.3%
PWR\Organic	192.0	2.7%	18.8%	0.0%	78.5%
PWR\Till	130.0	0.0%	19.9%	0.0%	80.1%
PWR\Unknown	727.5	12.3%	23.1%	0.0%	66.3%
Pj\Bedrock	108.7	6.7%	37.1%	0.0%	61.2%
Pj\Glaciofluvial2	42.6	0.0%	0.4%	0.0%	99.6%
Pj\Glaciolacustrine1	3.6	0.0%	0.0%	0.0%	100.0%
Pj\Organic	2.9	0.0%	0.0%	0.0%	100.0%
Pj\Till	12.7	0.0%	0.0%	0.0%	100.0%
Rock	12652.3	28.7%	57.3%	0.0%	18.4%
SbLow\Bedrock	391.5	32.1%	44.0%	0.0%	25.6%
SbLow\Glaciofluvial2	160.3	25.2%	48.0%	0.0%	30.1%
SbLow\Glaciolacustrine1	11.0	0.0%	0.0%	0.0%	100.0%
SbLow\Glaciolacustrine2	2.7	0.0%	0.0%	0.0%	100.0%
SbLow\Organic	15.3	12.0%	17.8%	0.0%	82.2%
SbLow\Till	30.6	9.0%	72.9%	0.0%	16.7%
SbP\Bedrock	1802.8	2.2%	14.0%	0.0%	84.6%
SbP\Glaciofluvial1	6.6	0.0%	0.0%	0.0%	100.0%
SbP\Glaciofluvial2	684.6	0.1%	5.3%	0.0%	94.6%
SbP\Glaciolacustrine1	96.0	0.0%	0.0%	0.0%	100.0%
SbP\Glaciolacustrine2	9.8	0.0%	0.0%	0.0%	100.0%
SbP\Organic	51.5	0.0%	12.6%	0.0%	87.4%
SbP\Till	234.7	1.2%	10.6%	0.0%	88.3%
SbP\Unknown	5.0	0.0%	2.5%	0.0%	97.5%
Sparse\Bedrock	2025.6	2.3%	14.2%	0.0%	83.7%
Sparse\Glaciofluvial1	56.0	0.0%	36.9%	0.0%	63.1%
Sparse\Glaciofluvial2	425.5	0.7%	7.9%	0.5%	91.1%
Sparse\Glaciolacustrine1	76.1	0.0%	6.6%	0.0%	93.4%
Sparse\Glaciolacustrine2	75.4	0.1%	5.0%	0.0%	95.1%
Sparse\Organic	32.3	0.0%	4.5%	0.0%	94.6%
Sparse\Till	216.4	0.0%	5.1%	0.0%	94.9%
Sparse\Unknown	184.9	1.1%	6.9%	0.0%	91.9%
TolHd\Bedrock	159633.3	10.6%	36.2%	0.1%	53.5%
TolHd\Glaciofluvial1	1530.1	0.4%	37.2%	0.0%	62.4%
TolHd\Glaciofluvial2	18183.6	4.4%	25.8%	0.0%	70.1%
TolHd\Glaciolacustrine1	5116.7	0.2%	6.0%	0.1%	93.8%
TolHd\Glaciolacustrine2	3780.4	4.4%	11.5%	0.0%	84.1%

	Total within Watershed	Within Level 1 Protection	Within Level 2 Protection	Within Level 3 Protection	Proportion not within protection
Landcover	**Area (ha)**	**Percentage**			
TolHd\Organic	3636.6	1.4%	24.6%	0.0%	74.3%
TolHd\Till	13268.0	8.0%	36.4%	0.0%	55.6%
TolHd\Unknown	2807.0	4.3%	8.2%	0.1%	87.9%
Wetland	63234.6	18.5%	38.0%	100.0%	0.0%
	453581.7	18.5%	30.7%	14.0%	45.5%

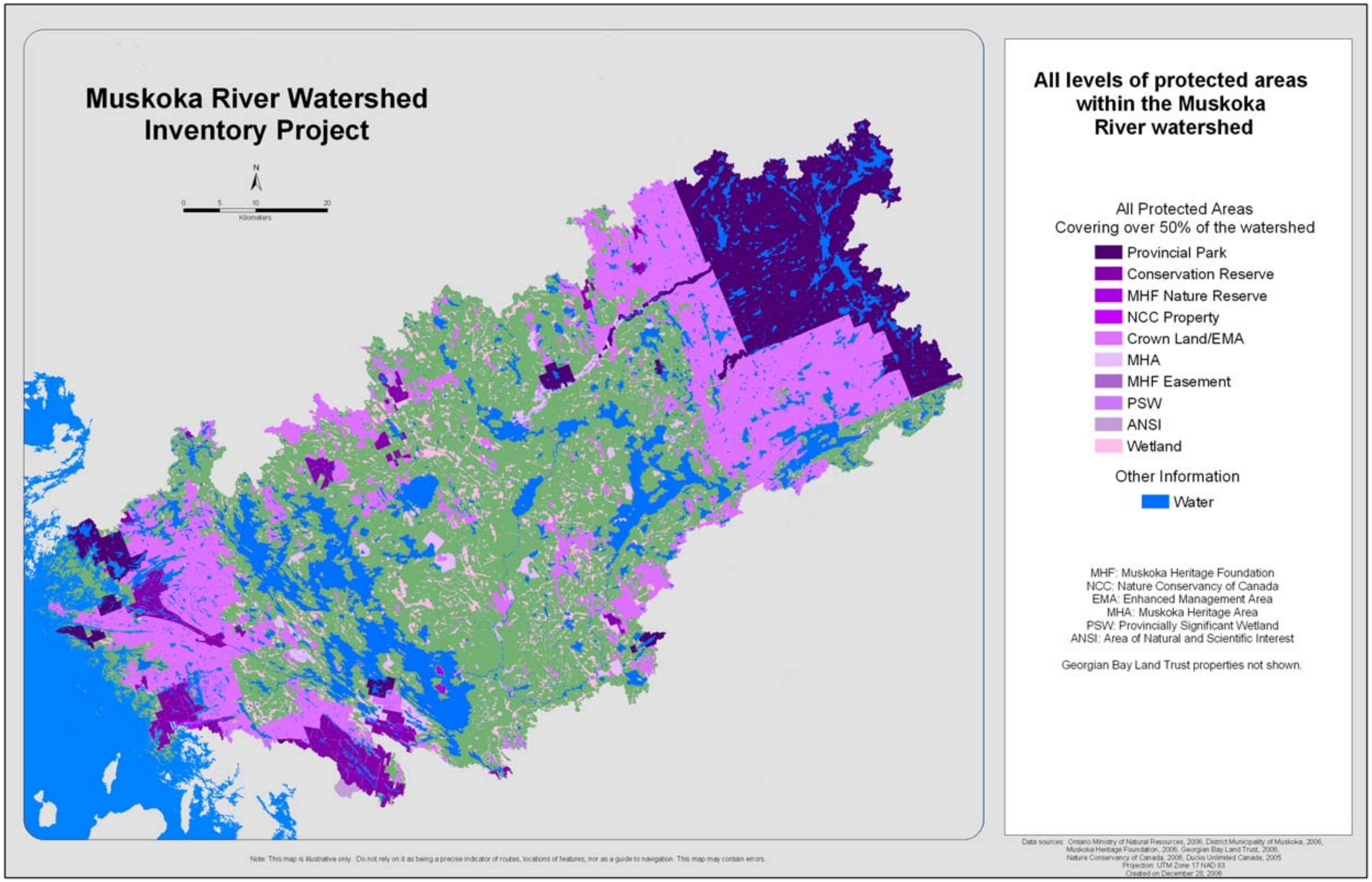


Figure 11. All levels of protected areas and terrestrial ecosystems.

Goal 2: Identify areas of high potential for sustaining ecological processes.

Figure 23 shows ecologically important areas based on the indicators detailed in Table 1. The higher the ecological score, the more valuable the site is for ecological functions, maintaining diversity, and supporting special features, such as species occurrences and critical habitat.

Final scores were classified into five classes:

1. Very High – Areas with the best potential for sustaining ecological processes
2. High – Areas with good potential for sustaining ecological processes
3. Medium – Areas with some potential for sustaining ecological processes
4. Low – Areas with limited potential for sustaining ecological processes
5. Very Low – Area with very limited potential for sustaining ecological processes

Classification of scores was accomplished using a statistical formula that divides the values into classes by looking for groups and patterns that are found in the data, thus minimizing the variation in each class. The breaks between each class are identified where there is a statistical difference in the scores from one class to the next (Jenks 1967).

Figures 12-22 show the scored datasets used to create the final scored map for this goal. These scored indicators include the following datasets:

1. Size of discrete terrestrial ecosystems (Figure 12);
2. Influence of old growth forests (Figure 13);
3. Interior size of discrete terrestrial ecosystems (Figure 14);
4. Presence of wetlands (Figure 15);
5. Riparian of rivers and streams (Figure 16);
6. Buffer of inland lakes (Figure 17);
7. Buffer of the Great Lakes shoreline (Figure 18);
8. Highly permeable areas (Figure 19);
9. Habitat diversity (Figure 20);
10. Species and vegetation community occurrences (Figure 21); and
11. Important habitat areas (Figure 22).

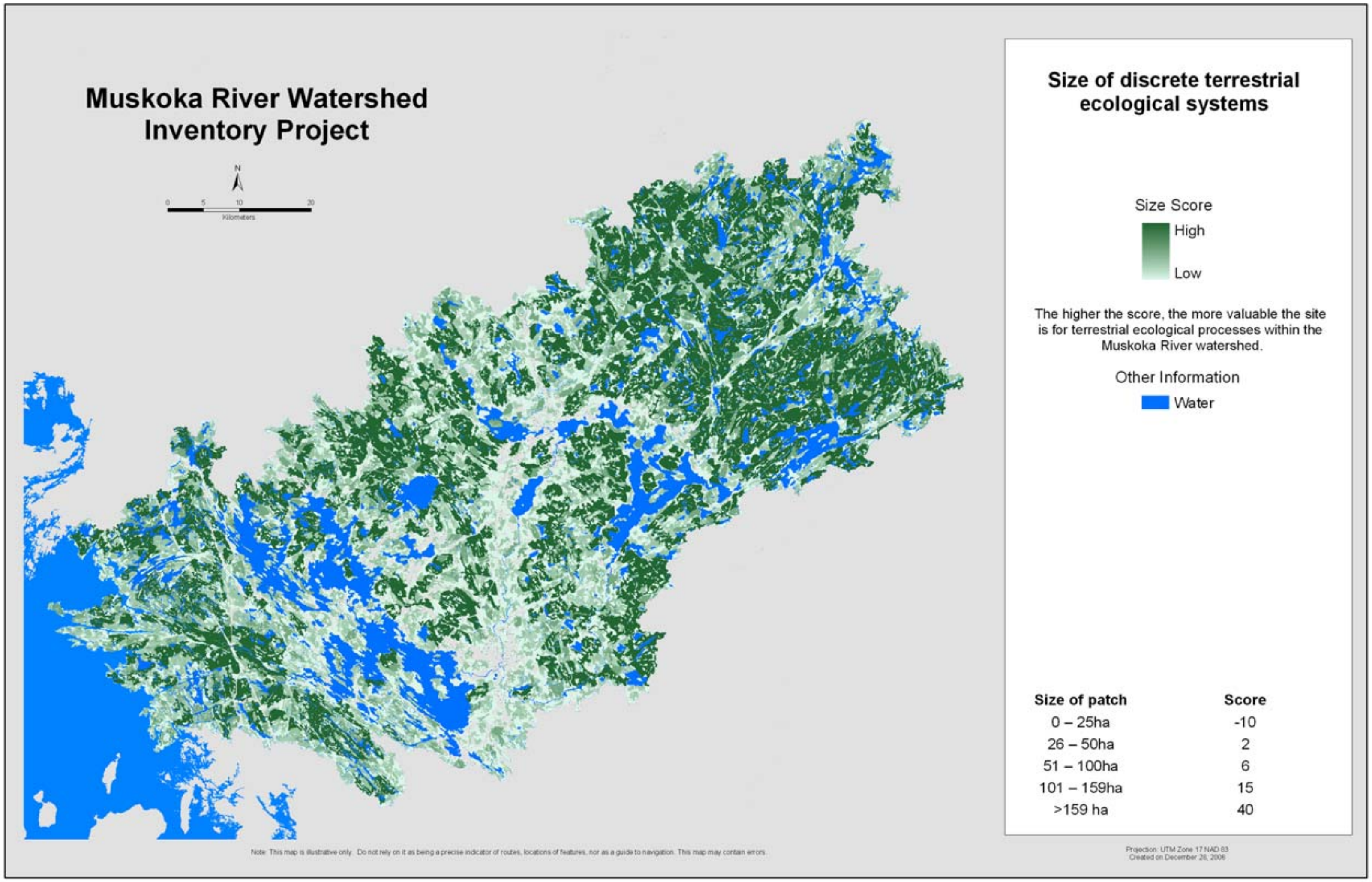


Figure 12. Size of discrete terrestrial ecosystems.

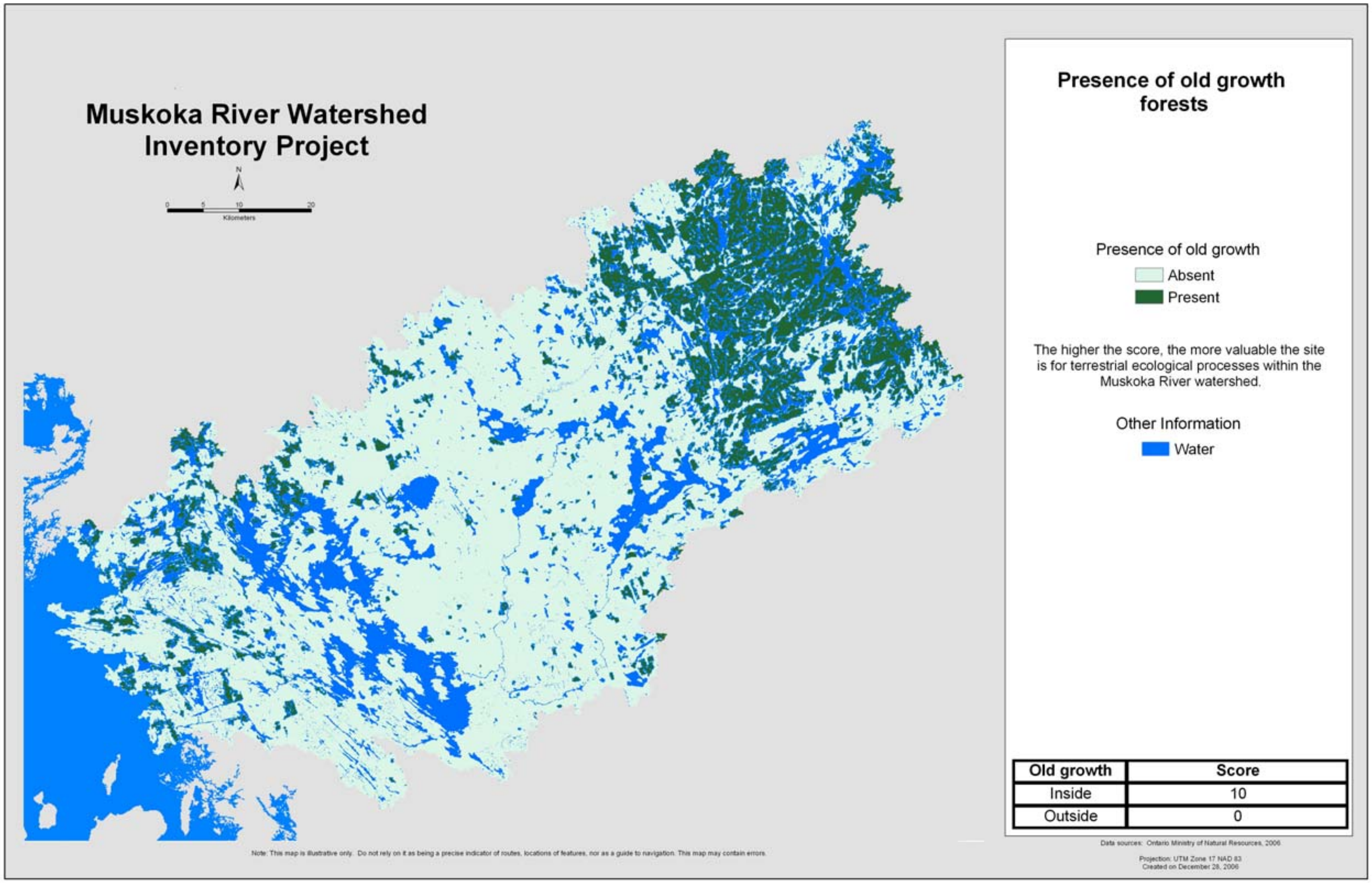


Figure 13. Presence of old growth forests.

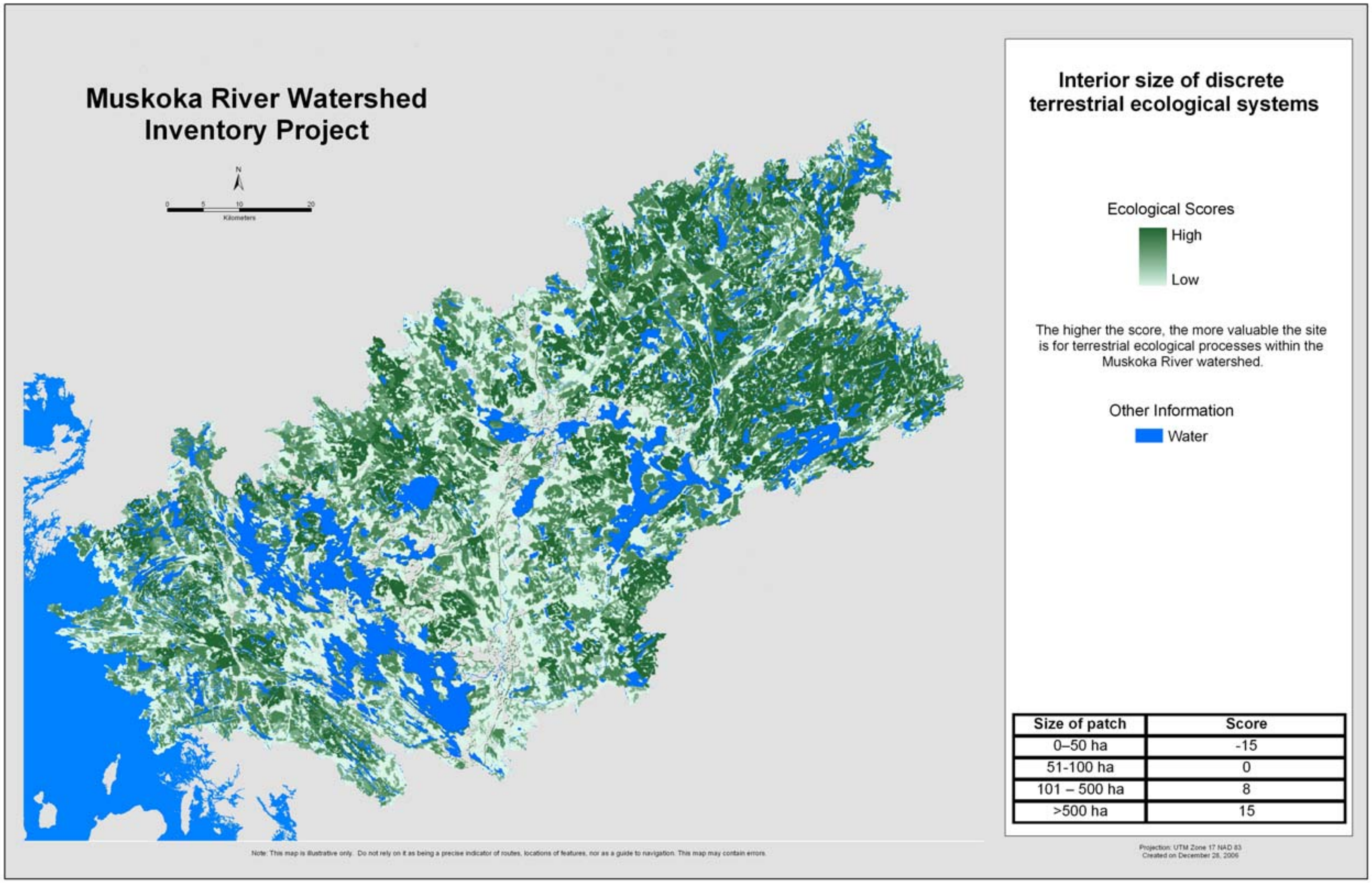


Figure 14. Interior size of discrete terrestrial ecosystems.

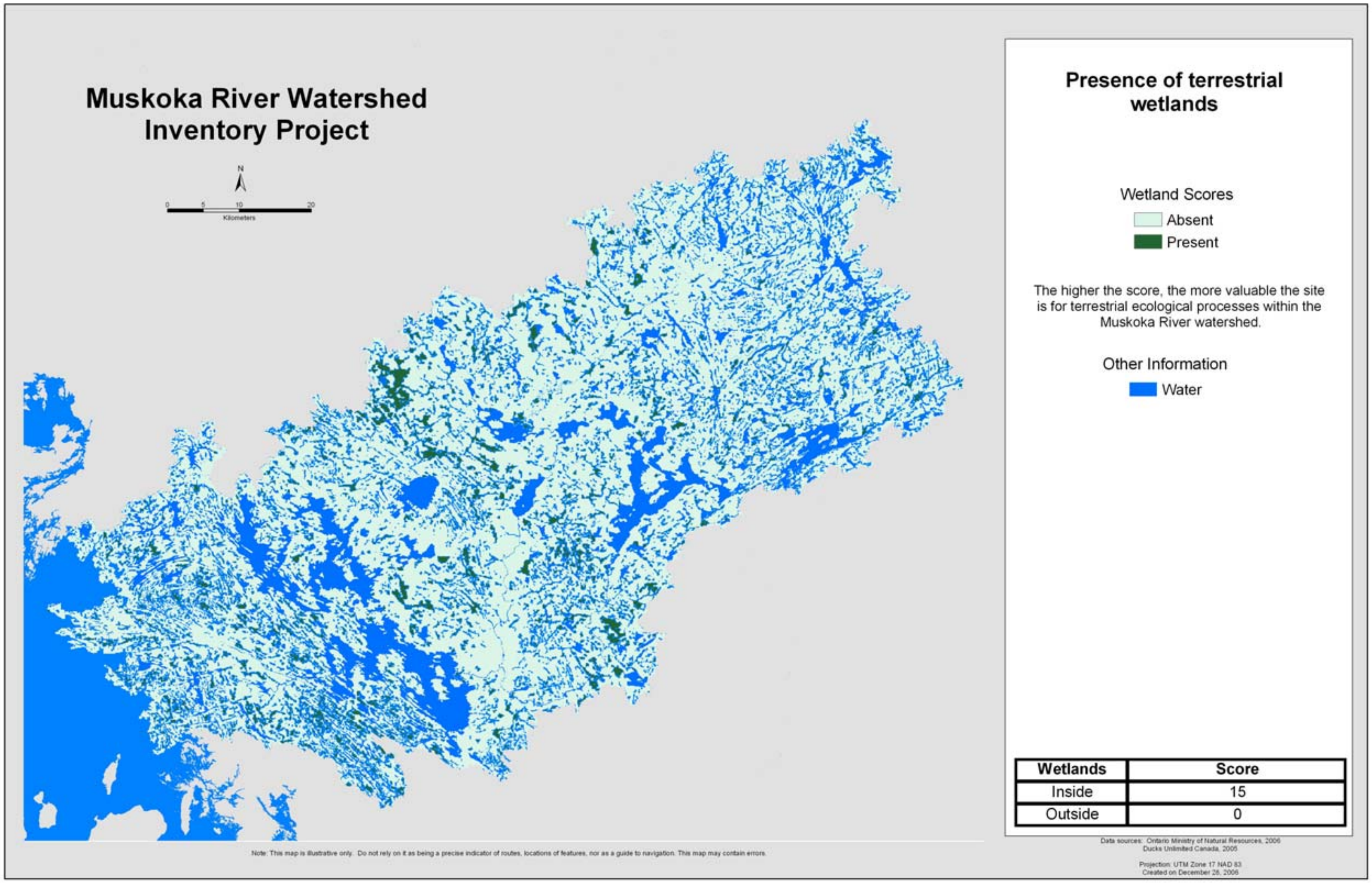


Figure 15. Presence of terrestrial wetlands.

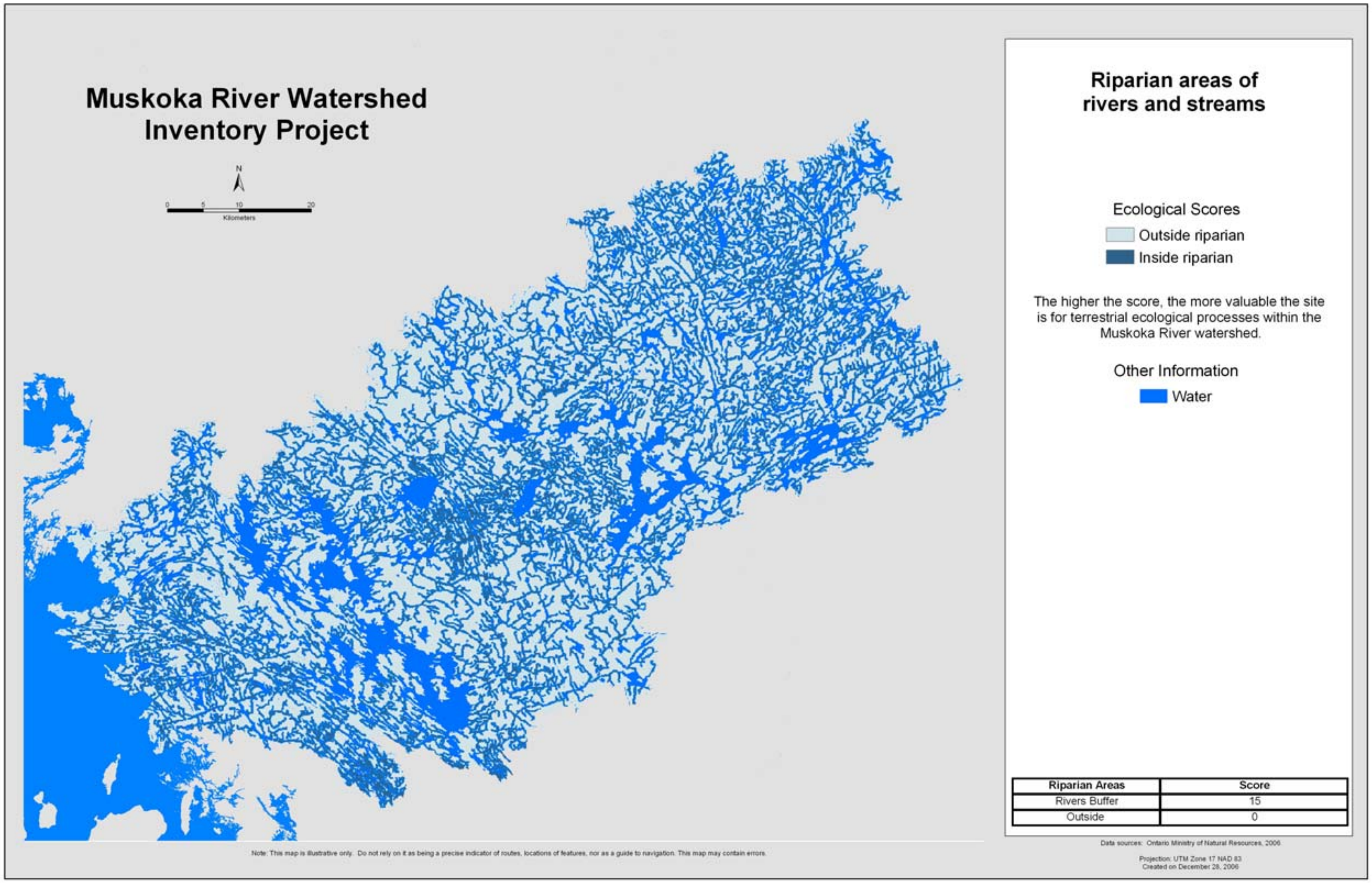


Figure 16. Riparian areas of rivers and streams.

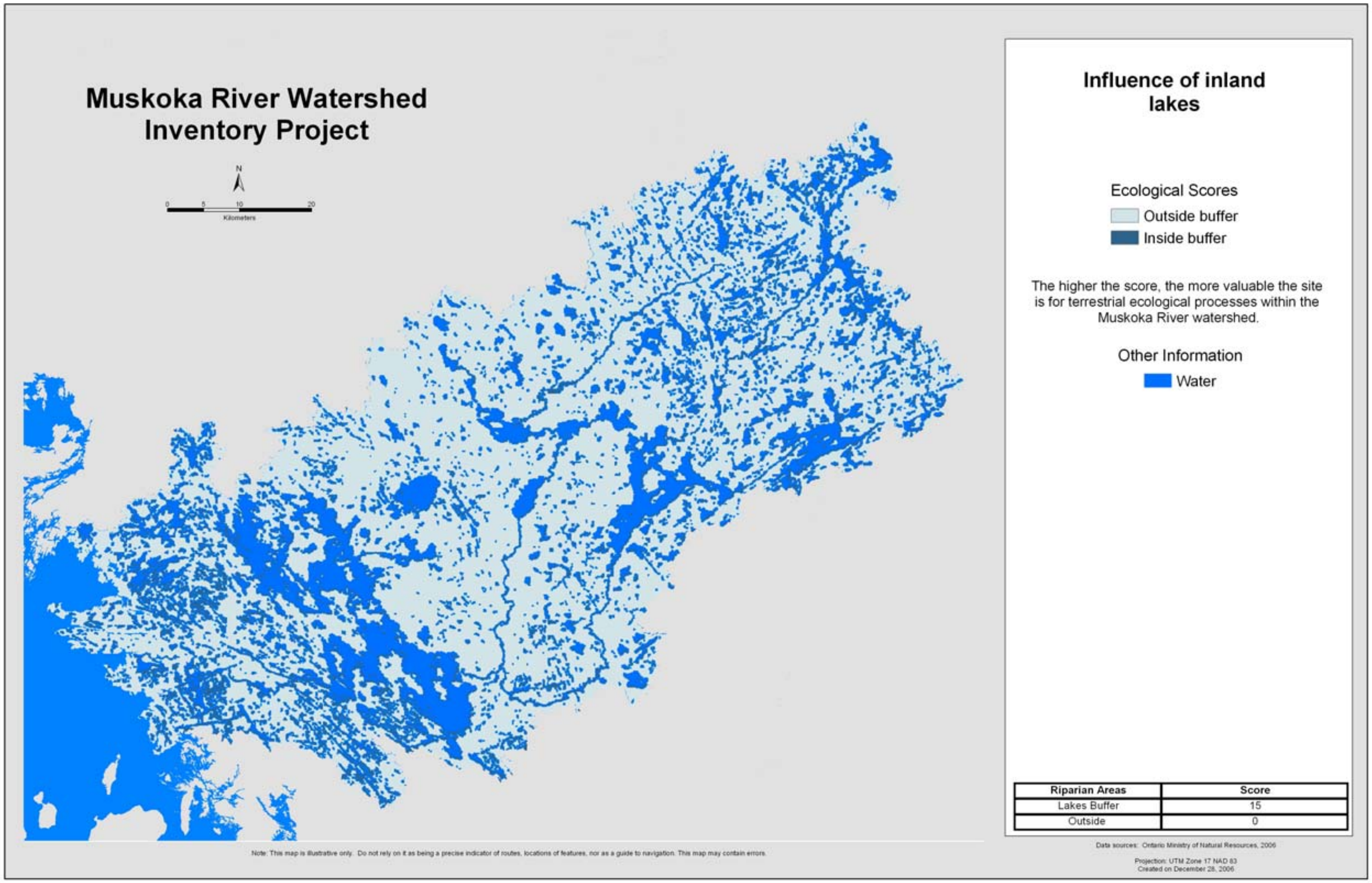


Figure 17. Influence of inland lakes.

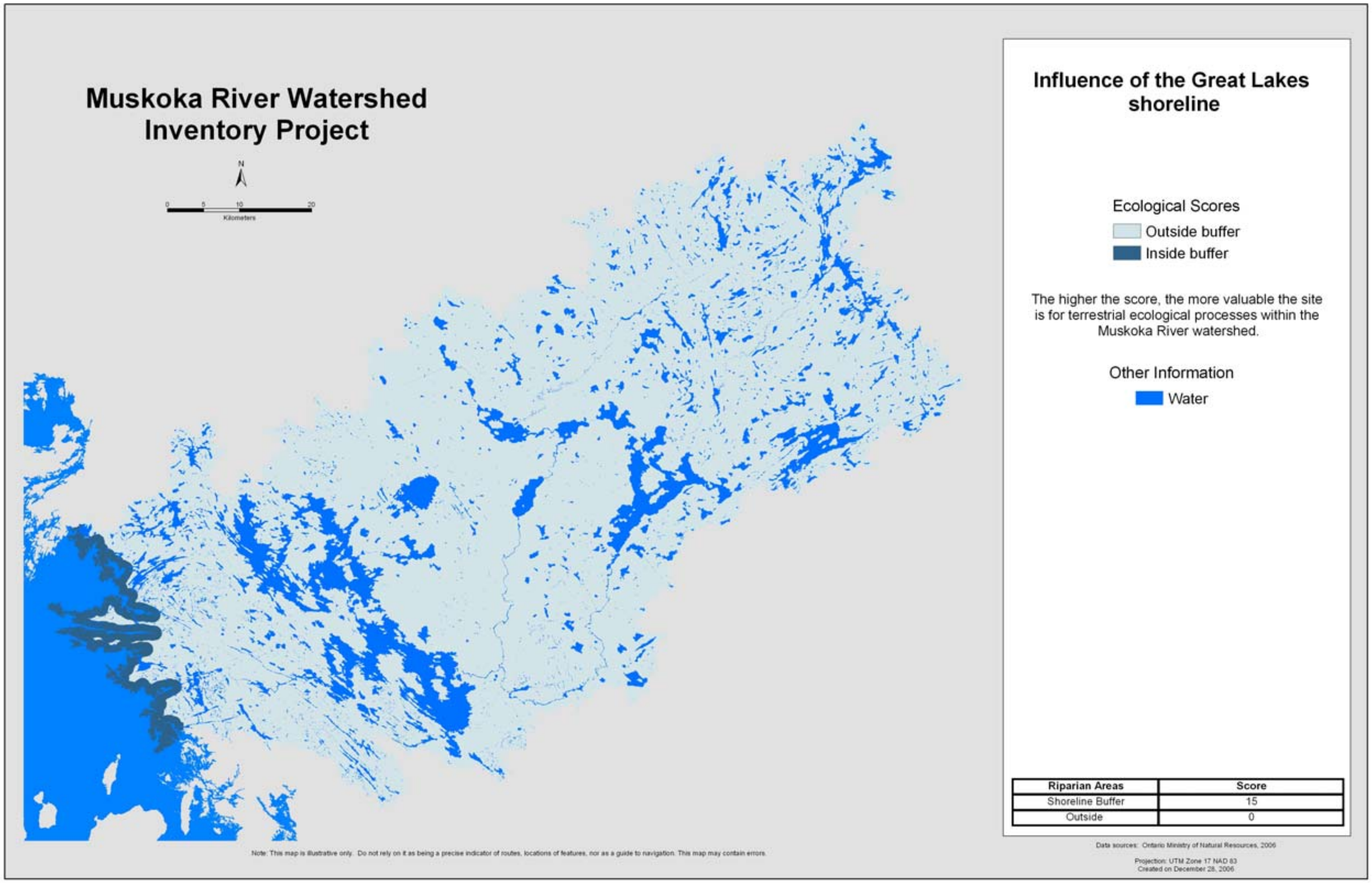


Figure 18. Influence of the Great Lakes shoreline.

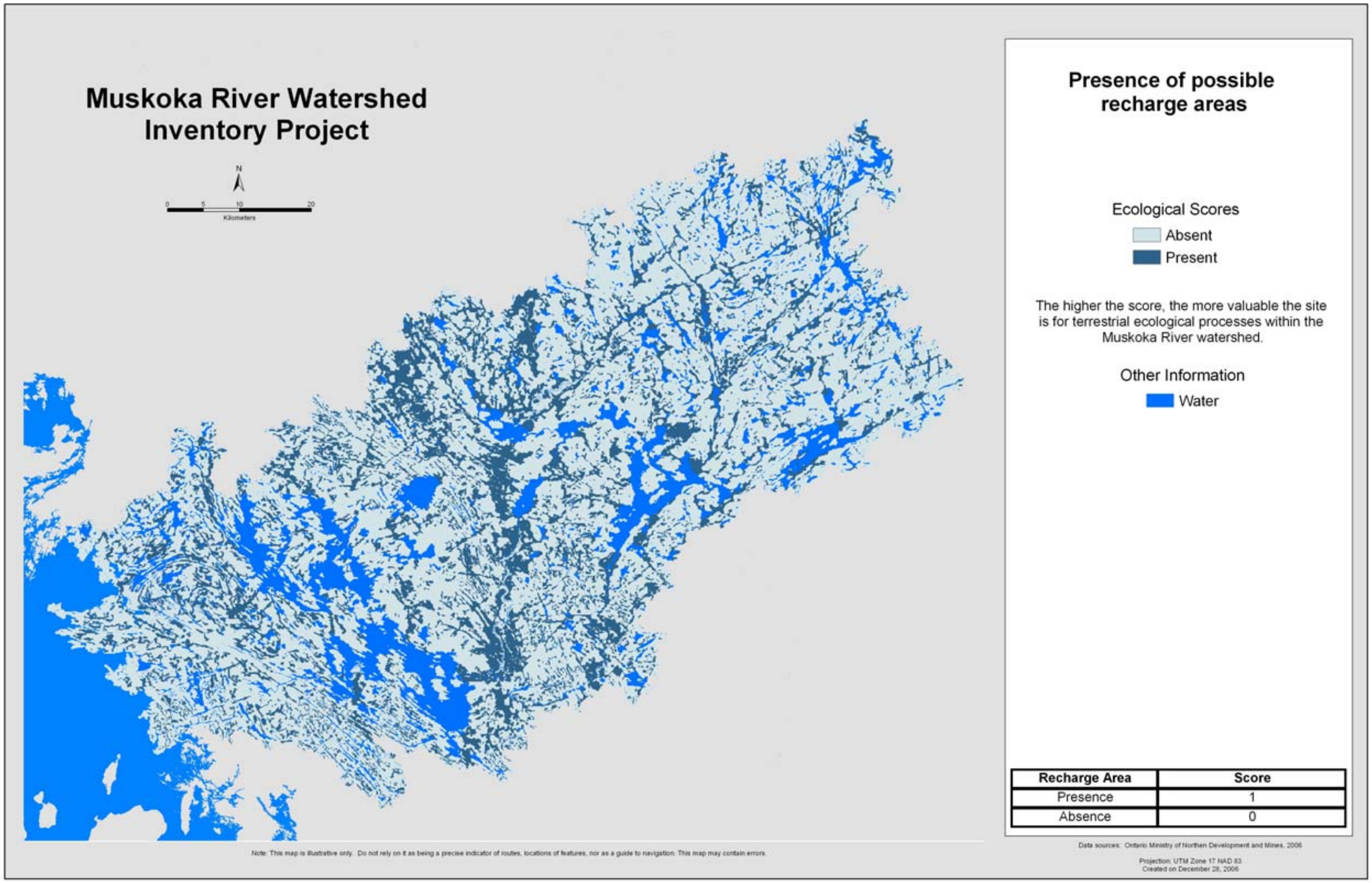


Figure 19. Highly permeable areas (possible recharge areas).

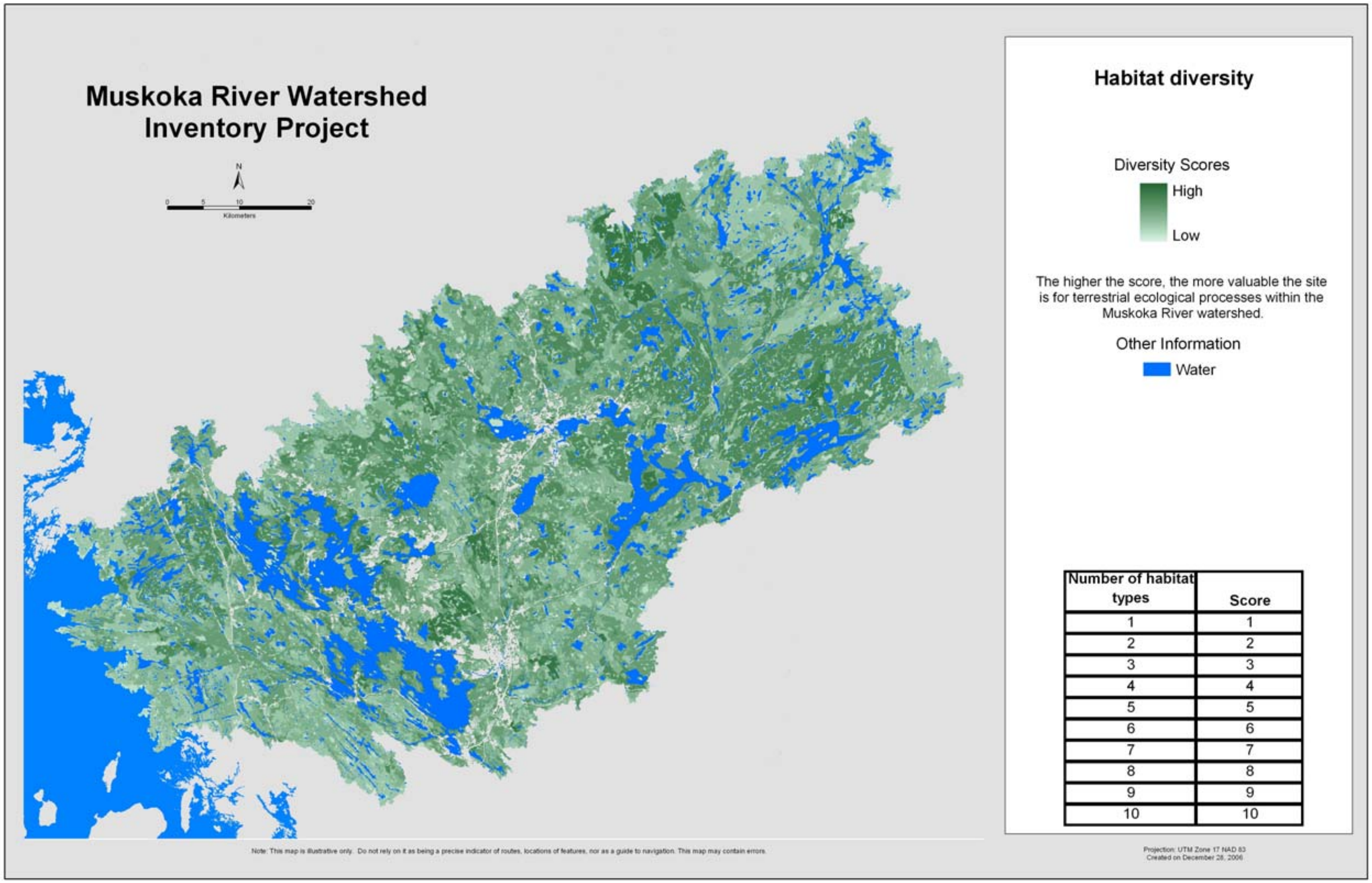


Figure 20. Habitat diversity.

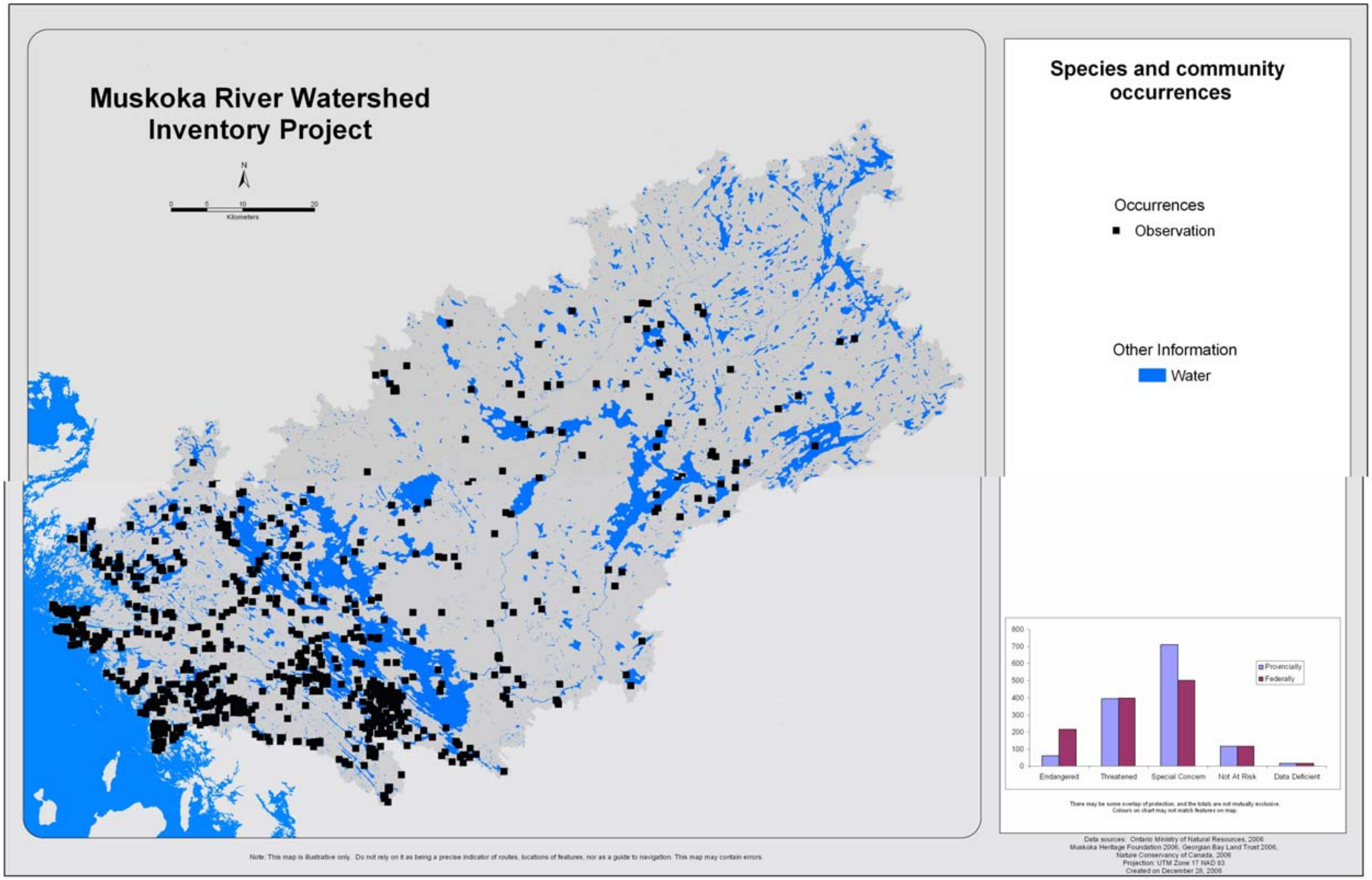


Figure 21. Species and vegetation community occurrences**.**

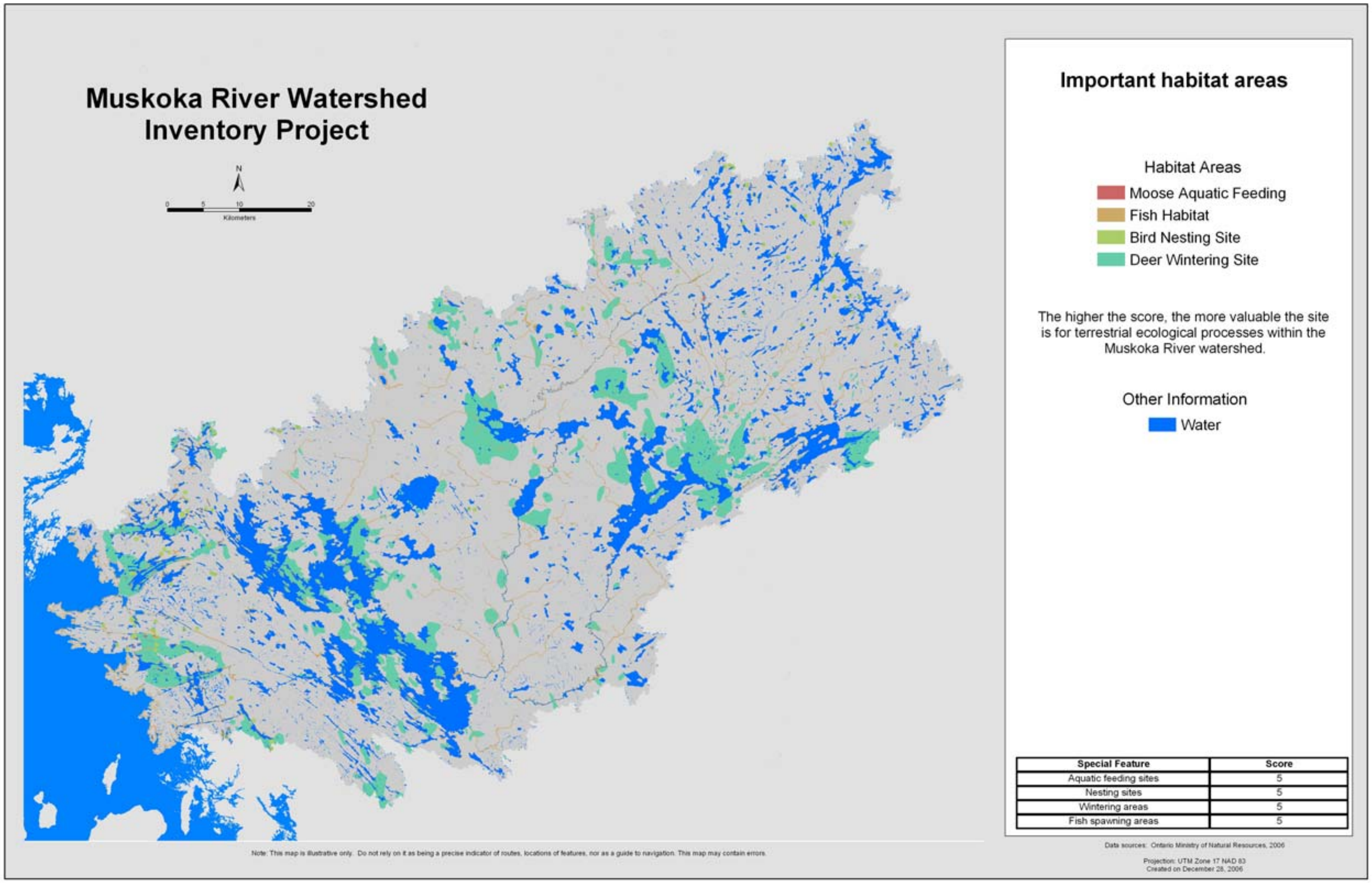


Figure 22. Important habitat areas.

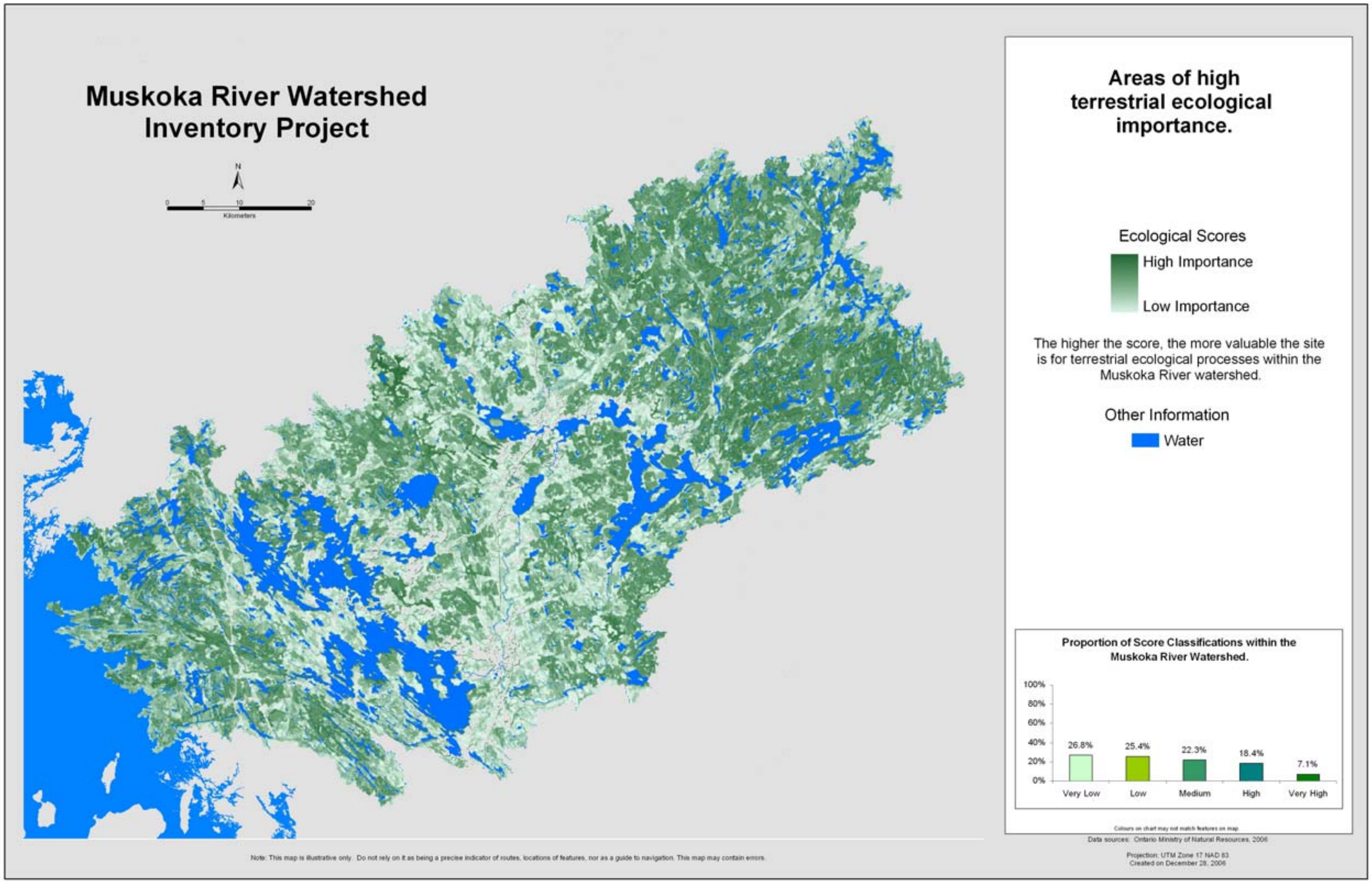


Figure 23. Areas of high potential for sustaining ecological processes

Goal 3: Identify stresses on terrestrial ecosystem processes.

Figure 32 shows the final scored dataset for the condition criteria. The lower the score, the more stress is affecting the site. Again, the final scores were classified into five classes:

1. Very High – Areas with no or very limited stress impacting the site
2. High – Areas with limited stress impacting the site
3. Medium – Areas with moderate stress impacting the site
4. Low – Areas with significant stress impacting the site
5. Very Low – Areas that are highly degraded

The same statistical formula was used to establish these categories and minimize the variation in each classification group (Jenks 1967).

Figures 24-31 show the scored datasets used to create the final scored map for this goal. These scored indicators included the following datasets:

1. Percent natural cover (Figure 24);
2. Influence of settlement areas (Figure 25);
3. Influence of cleared open space (Figure 26);
4. Influence of pits and quarries (Figure 27);
5. Influence of hydro lines (Figure 28);
6. Influence of railways (Figure 29);
7. Influence of roads (Figure 30); and
8. Influence of trails (Figure 31).

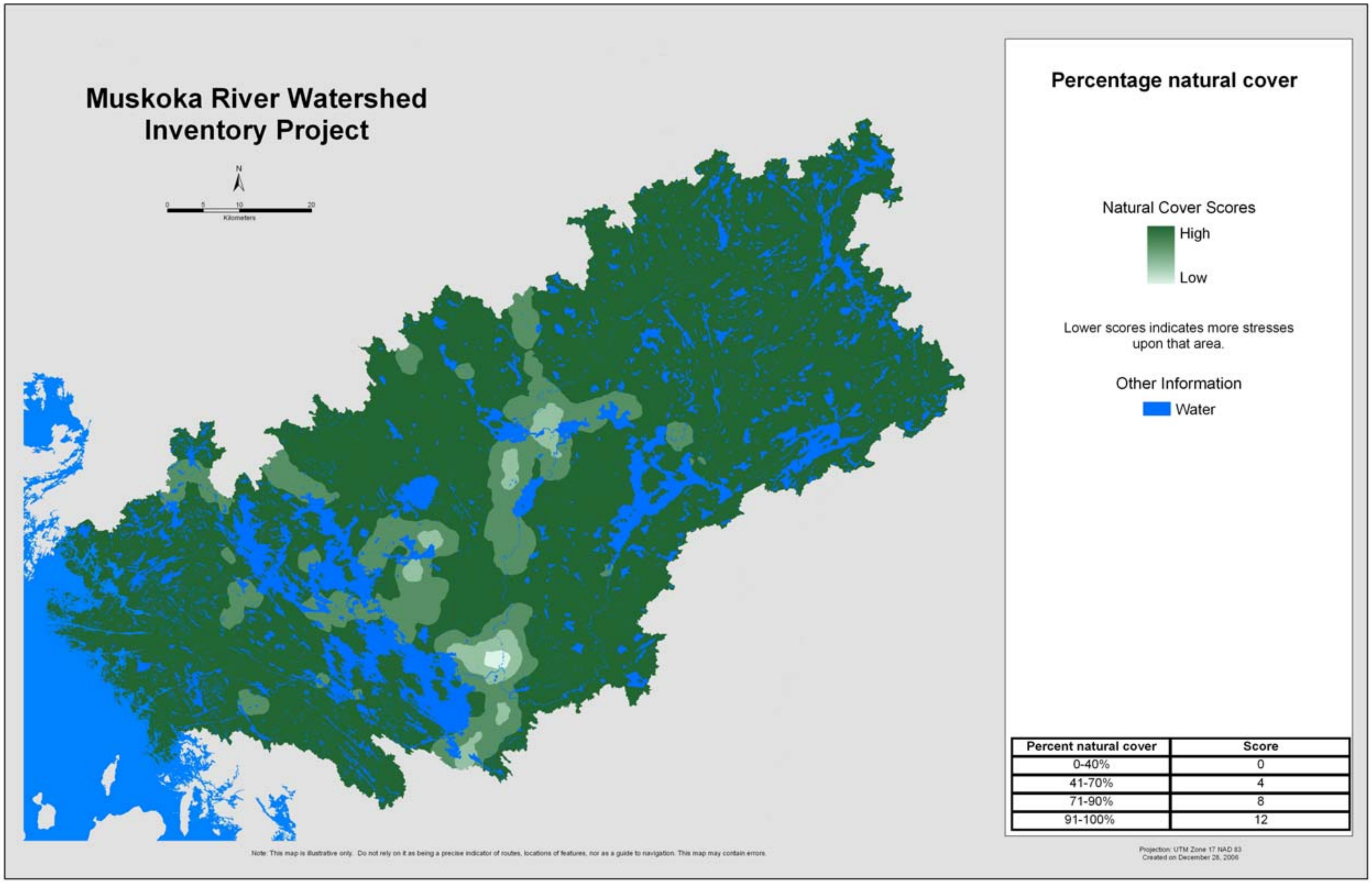
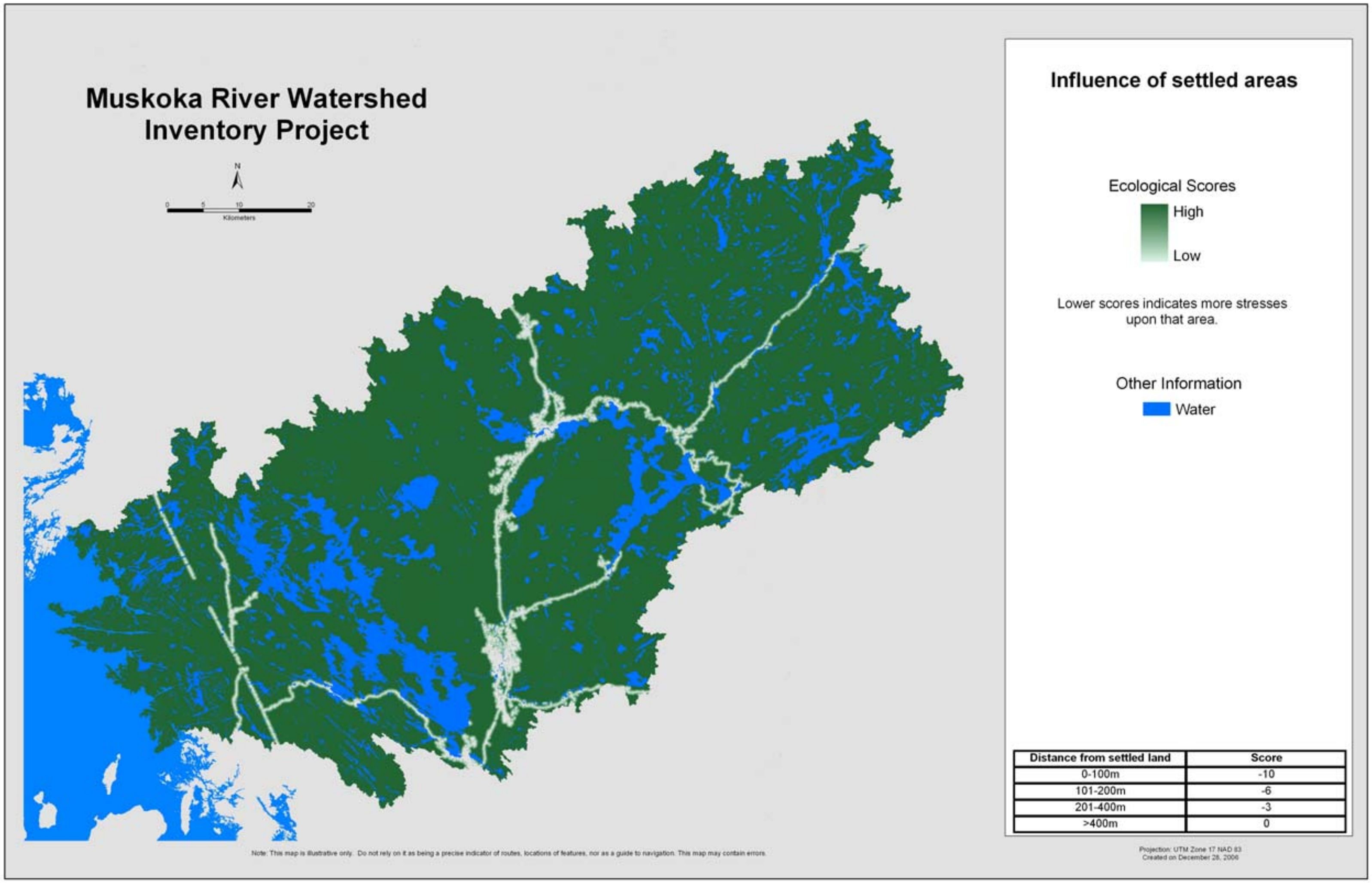


Figure 24. Percentage natural cover.



Distance from settled land	Score
0-100m	-10
101-200m	-6
201-400m	-3
>400m	0

Figure 25. Influence of settled areas.

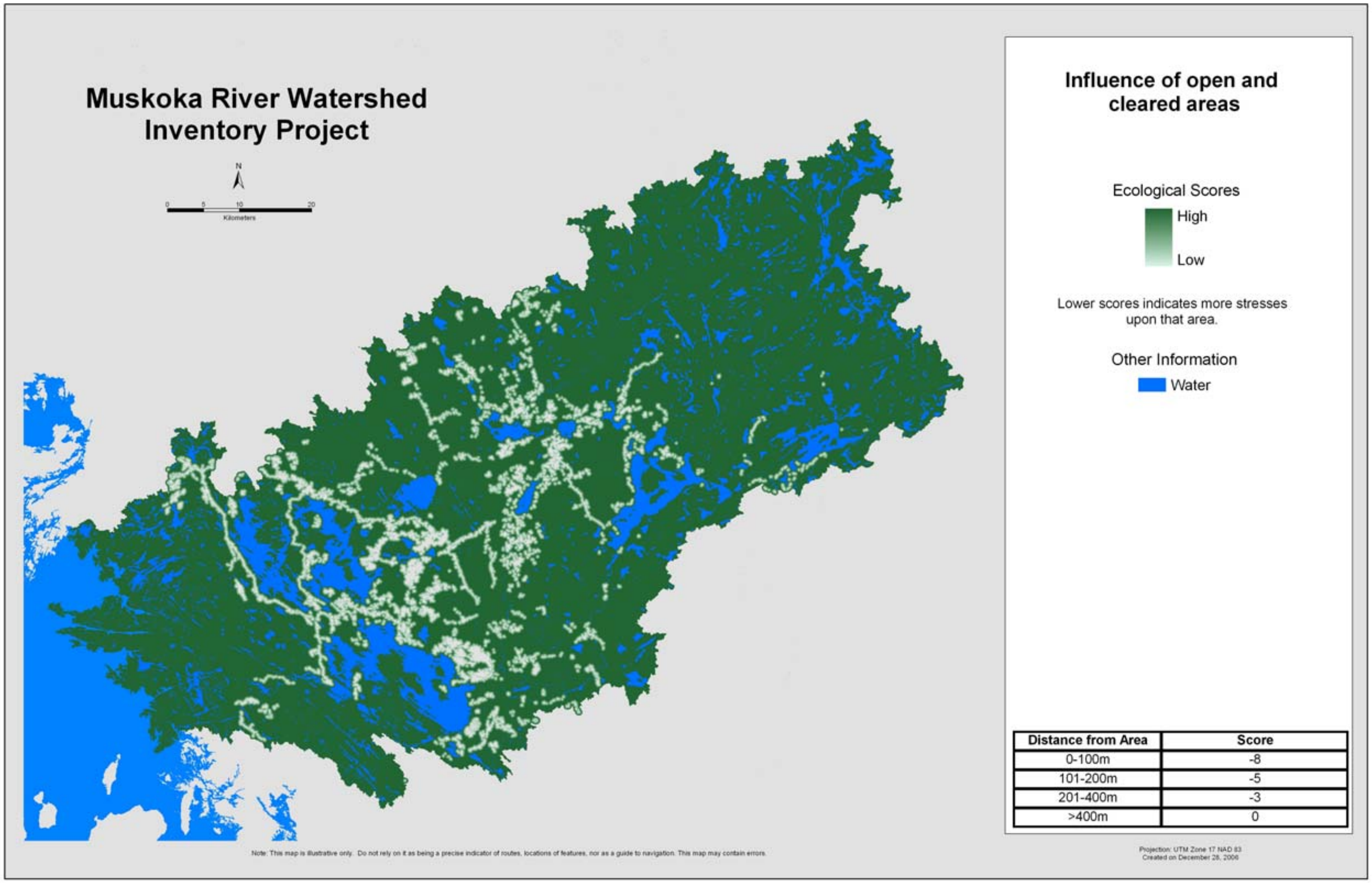


Figure 26. Influence of open and cleared areas (i.e. agricultural lands, golf courses).

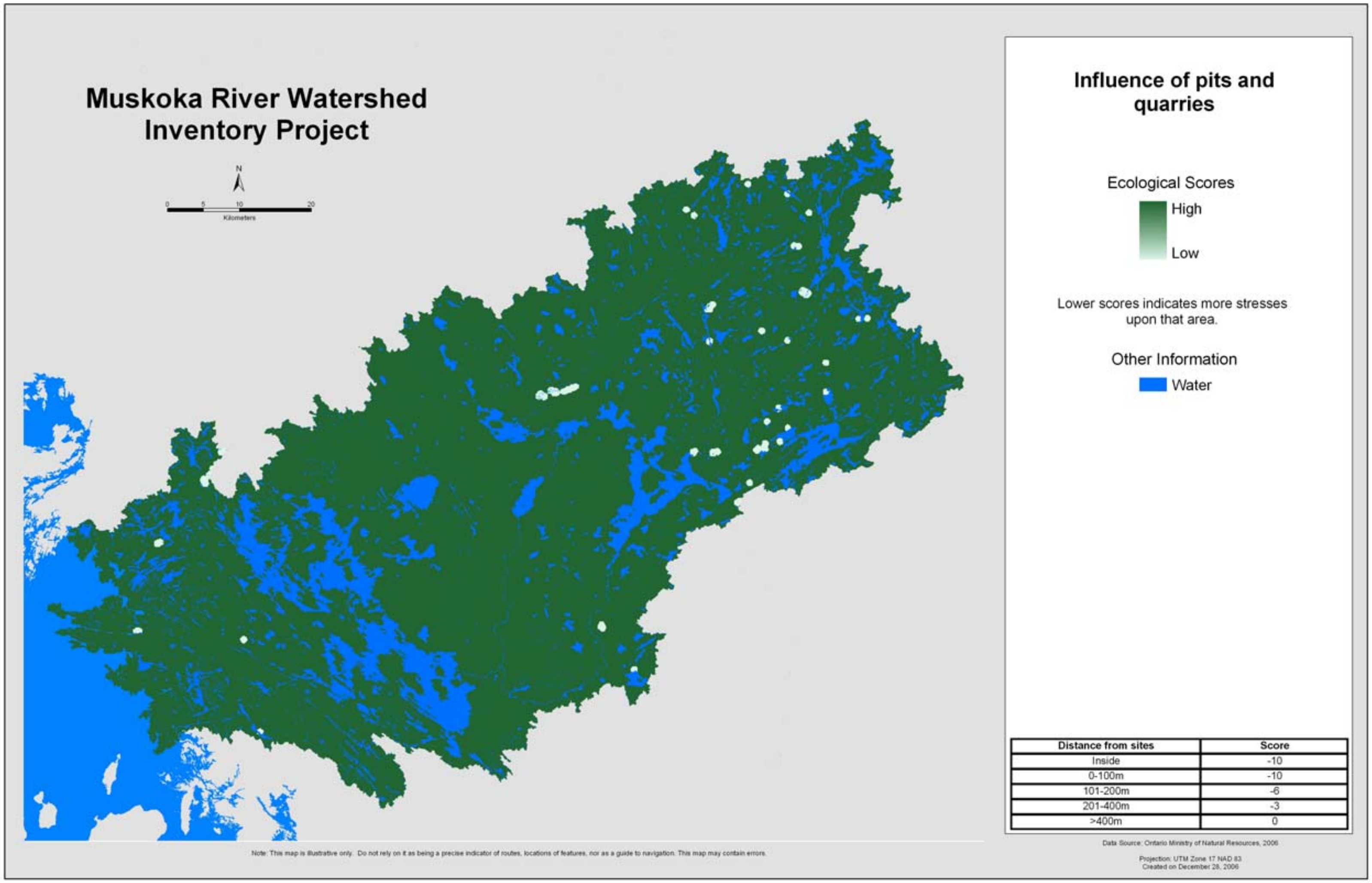


Figure 27. Influence of pits and quarries.

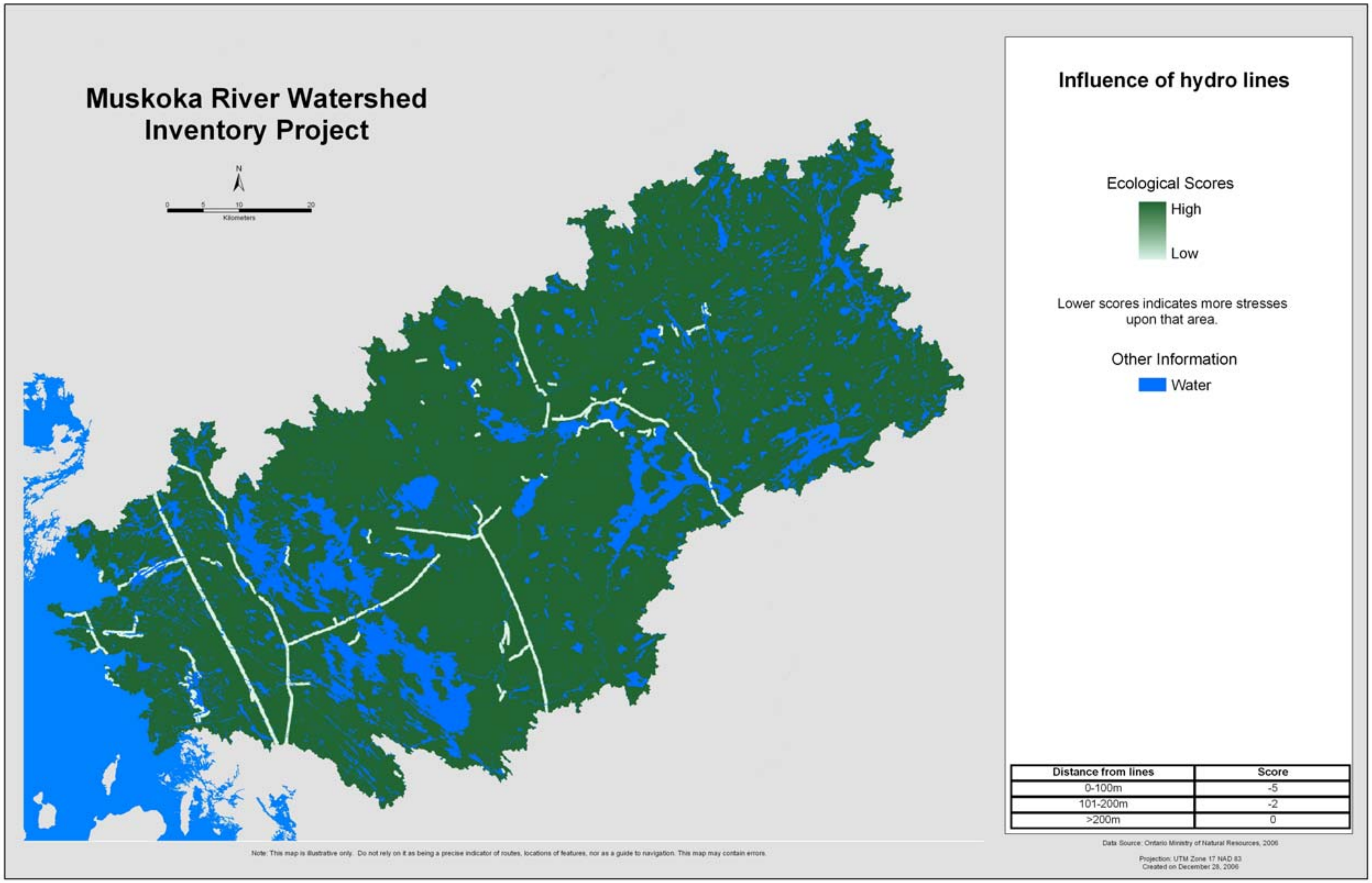


Figure 28. Influence of hydro lines.

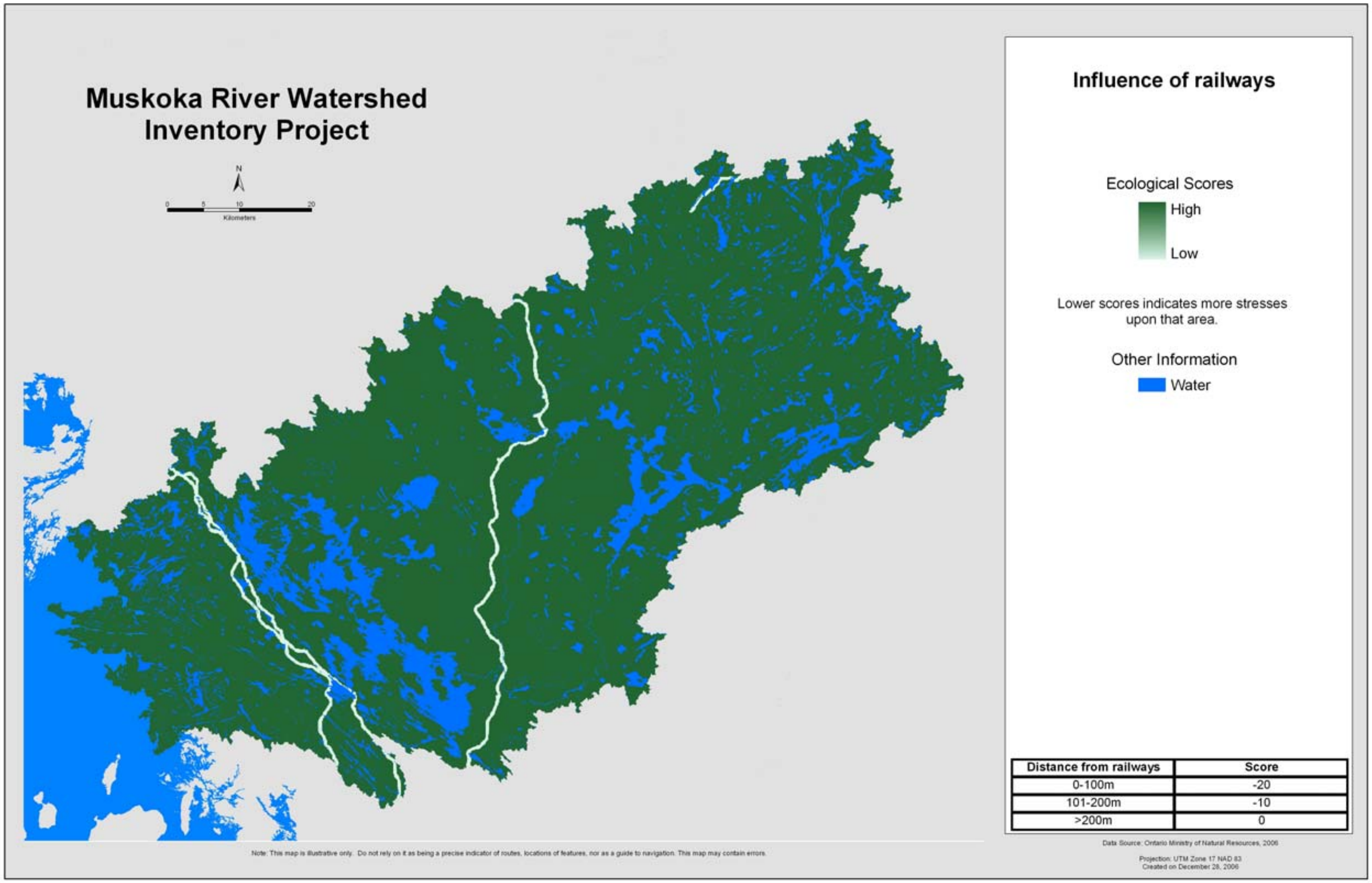


Figure 29. Influence of railways.

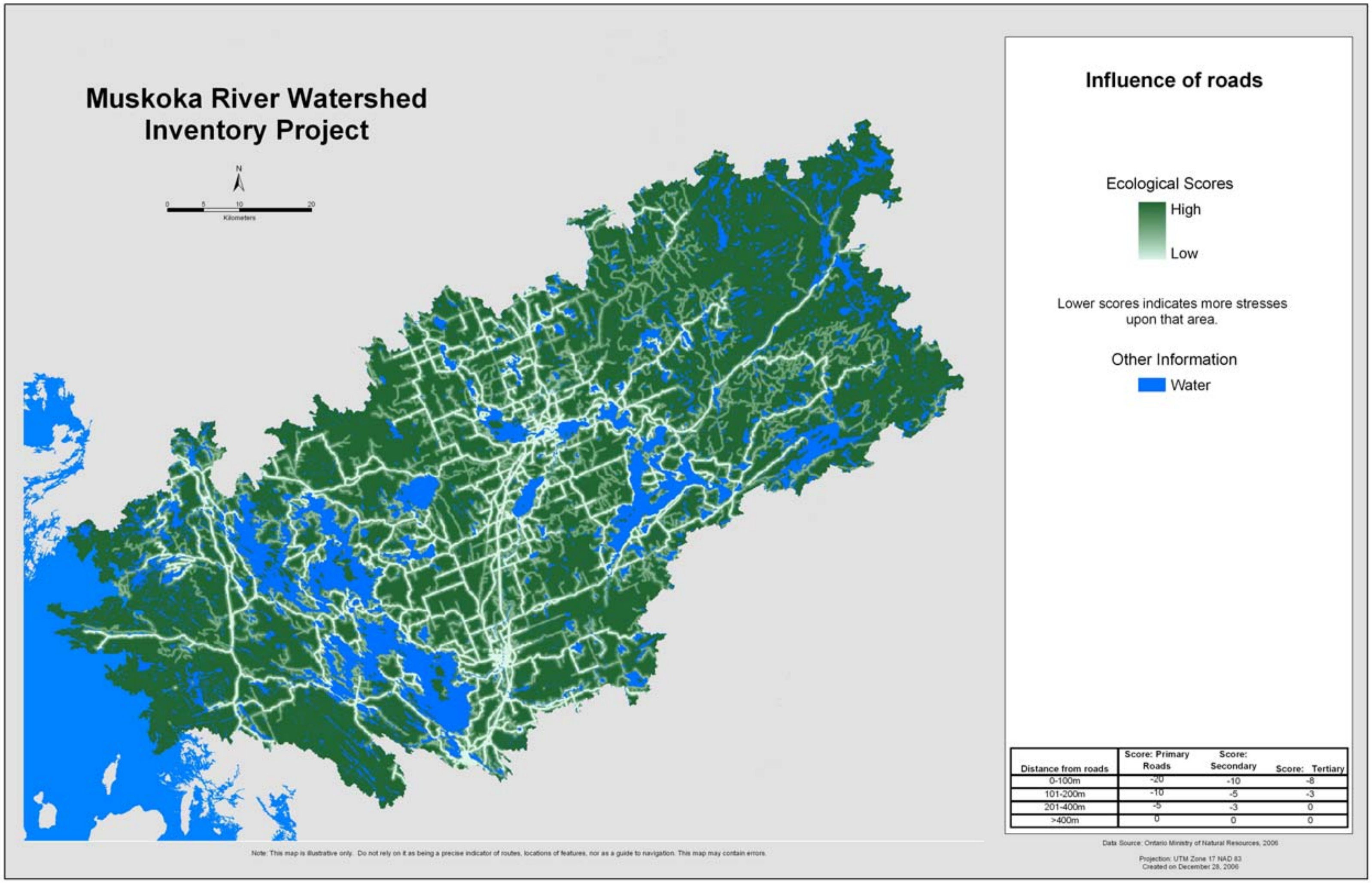


Figure 30. Influence of roads.

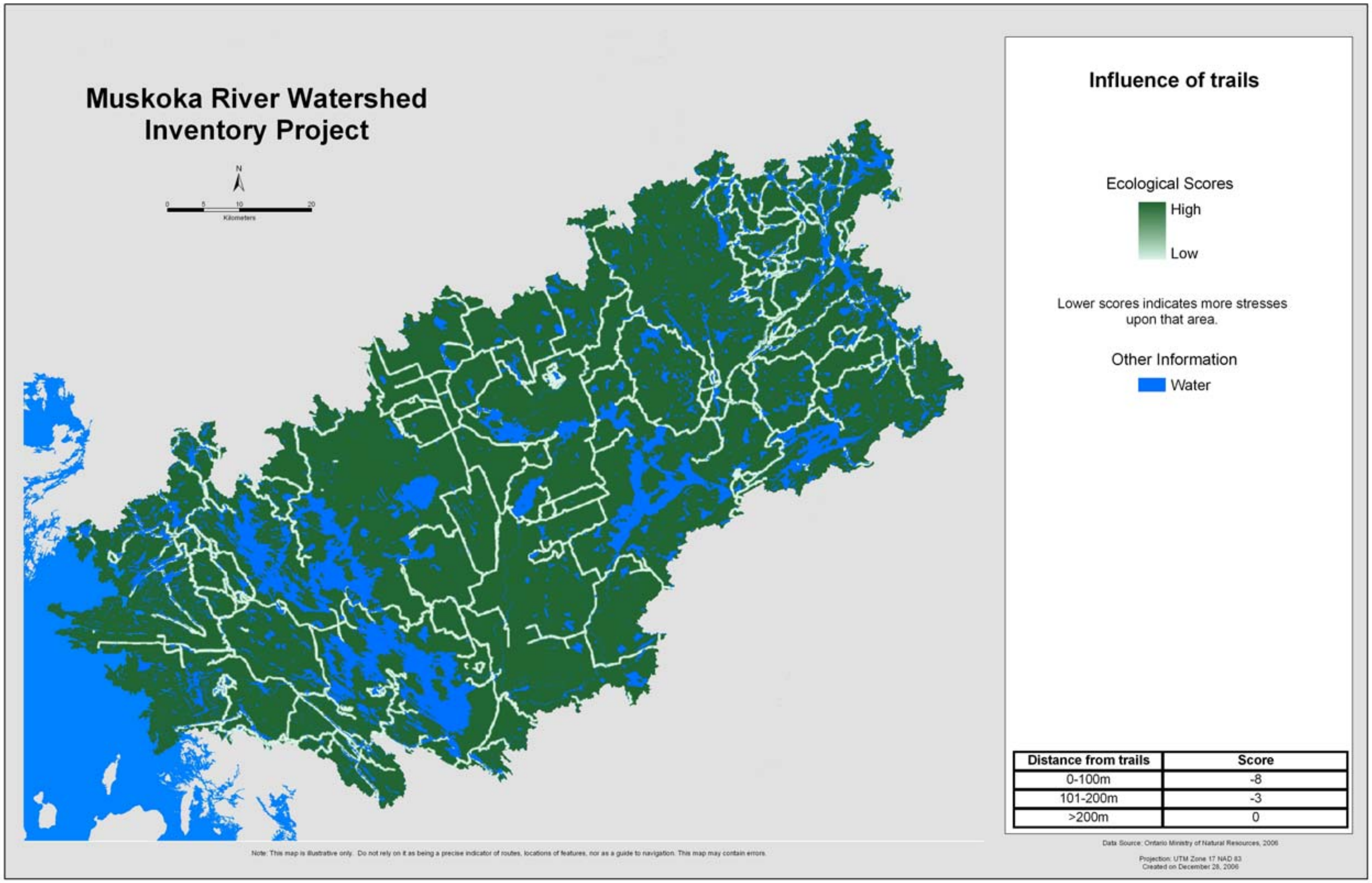


Figure 31. Influence of trails.

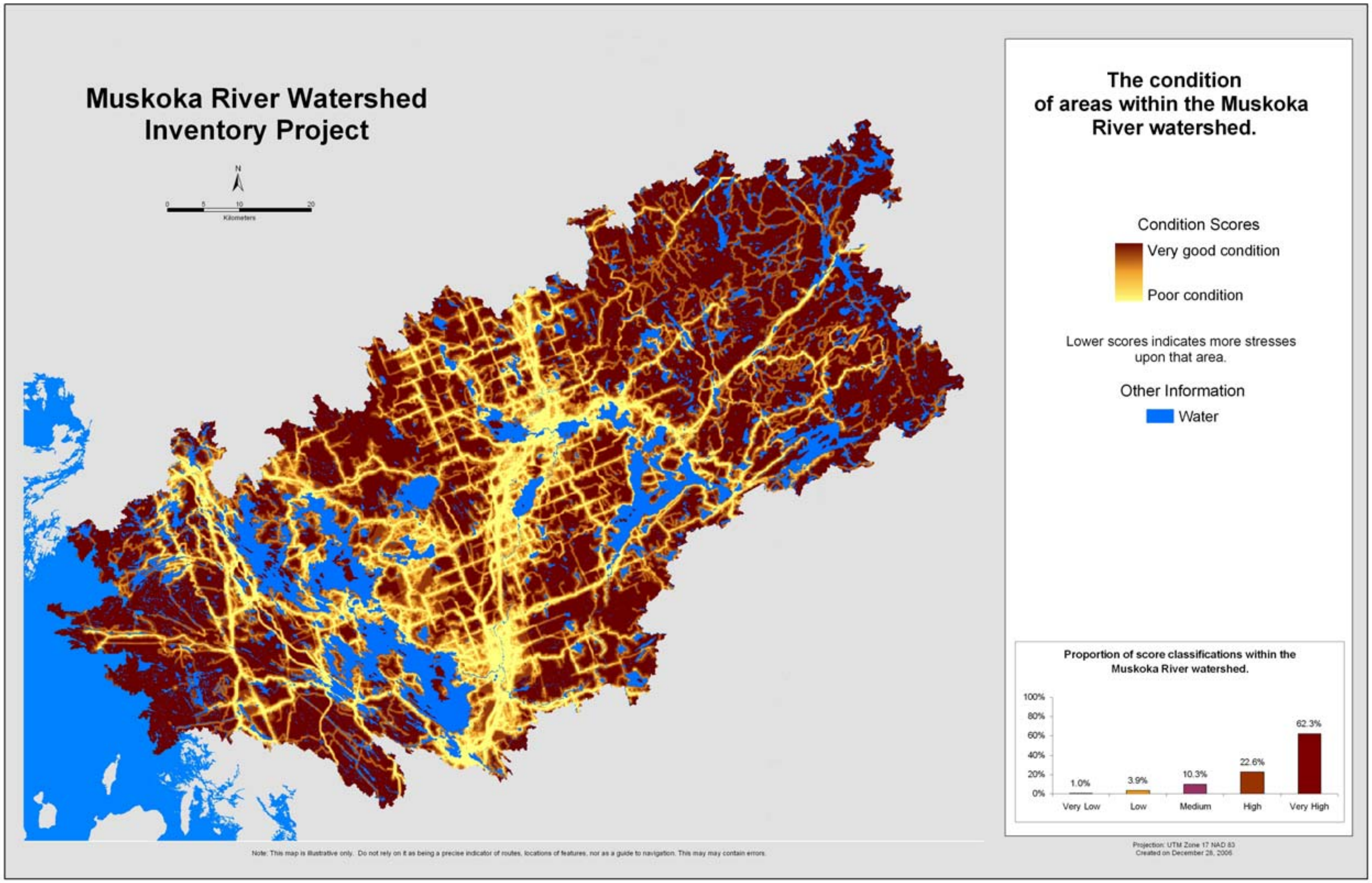


Figure 32. The condition of areas within the Muskoka River watershed

Muskoka River Watershed Inventory Project Products

After identifying the unique terrestrial ecosystems of the watershed, areas with the highest potential to sustain natural processes, and areas in the best ecological condition the following products were created:

1. A gap analysis of unprotected vegetation communities and landforms;
2. A gap analysis of biological data and site inventories;
3. A map portraying the significant natural areas and connecting systems;
4. Identification of significant degraded sites and areas that may require remediation.

Product 1: A gap analysis of unprotected vegetation communities and landforms.

Figure 11 (page 35) shows terrestrial ecosystems that are not represented in protected areas. Although over 50% of the natural land-base within the watershed is under some level of protection, not all ecosystems are represented in protected areas and many have very low representation within protected areas. In addition, protected areas are geographically skewed to the far eastern and western portions of the watershed with far less protection in the central portion of the watershed. The location and amount of protected areas coincides with areas of Crown land and is influenced by Algonquin Provincial Park and the roadless area of the Township of Algonquin Highlands which cover a large proportion of the eastern part of the watershed. Table 7 and Figure 33 highlight ecosystems that have an area of 10% or less located in protected areas.

Table 7. Ecosystems with and area of less than 10% located within protection (see Figure 33).

	Total within Watershed	Within Level 1 Protection	Within Level 2 Protection	Within Level 3 Protection	Proportion not within protection
Landcover	Area (ha)	Percentage			
By\Glaciolacustrine1	13.8	0.0%	0.0%	0.0%	100.0%
IntHd\Glaciofluvial1	11.0	0.0%	0.0%	0.0%	100.0%
MidHd\Organic	23.6	0.0%	0.0%	0.0%	100.0%
Pj\Glaciolacustrine1	3.6	0.0%	0.0%	0.0%	100.0%
Pj\Organic	2.9	0.0%	0.0%	0.0%	100.0%
Pj\Till	12.7	0.0%	0.0%	0.0%	100.0%
SbLow\Glaciolacustrine1	11.0	0.0%	0.0%	0.0%	100.0%
SbLow\Glaciolacustrine2	2.7	0.0%	0.0%	0.0%	100.0%
SbP\Glaciofluvial1	6.6	0.0%	0.0%	0.0%	100.0%
SbP\Glaciolacustrine1	96.0	0.0%	0.0%	0.0%	100.0%
SbP\Glaciolacustrine2	9.8	0.0%	0.0%	0.0%	100.0%
Asp\Glaciolacustrine1	219.9	0.0%	0.3%	0.0%	99.7%
Asp\Glaciolacustrine2	21.1	0.0%	0.3%	0.0%	99.7%
Pj\Glaciofluvial2	42.6	0.0%	0.4%	0.0%	99.6%
He\Glaciolacustrine2	62.4	0.0%	0.5%	0.0%	99.5%
By\Glaciolacustrine2	41.1	0.8%	0.0%	0.0%	99.2%
Deciduous\Glaciolacustrine2	71.8	0.1%	1.3%	0.0%	98.6%
OPine\Glaciolacustrine1	156.7	0.0%	2.3%	0.0%	97.7%
Mixed\Glaciolacustrine2	58.6	0.0%	2.5%	0.0%	97.5%
SbP\Unknown	5.0	0.0%	2.5%	0.0%	97.5%
OCLow\Glaciolacustrine1	112.2	0.0%	3.0%	0.1%	96.9%
He\Glaciolacustrine1	89.7	0.0%	3.4%	0.0%	96.6%
OPine\Glaciolacustrine2	349.6	0.0%	3.6%	0.0%	96.4%
Deciduous\Glaciolacustrine1	102.7	0.0%	4.3%	0.0%	95.7%
Mixed\Unknown	255.1	0.7%	3.9%	0.0%	95.5%
Sparse\Glaciolacustrine2	75.4	0.1%	5.0%	0.0%	95.1%
Sparse\Till	216.4	0.0%	5.1%	0.0%	94.9%
He\Organic	125.4	0.0%	5.2%	0.0%	94.8%
SbP\Glaciofluvial2	684.6	0.1%	5.3%	0.0%	94.6%
Sparse\Organic	32.3	0.0%	4.5%	0.0%	94.6%
Bw\Glaciofluvial1	48.9	0.0%	5.7%	0.0%	94.3%
TolHd\Glaciolacustrine1	5116.7	0.2%	6.0%	0.1%	93.8%
OPine\Till	395.7	0.0%	6.3%	0.0%	93.7%
Sparse\Glaciolacustrine1	76.1	0.0%	6.6%	0.0%	93.4%
Coniferous\Unknown	17.5	0.7%	6.1%	0.0%	93.2%
HdConU\Glaciolacustrine1	1448.9	0.1%	6.9%	0.1%	93.0%
Mixed\Glaciolacustrine1	121.3	0.0%	7.2%	0.0%	92.8%
Sparse\Unknown	184.9	1.1%	6.9%	0.0%	91.9%
Deciduous\Unknown	258.8	1.1%	7.3%	0.0%	91.8%
IntHd\Glaciolacustrine2	21.6	0.0%	8.7%	0.0%	91.3%
Mixed\Organic	58.0	0.0%	8.8%	0.0%	91.2%
Sparse\Glaciofluvial2	425.5	0.7%	7.9%	0.5%	91.1%
PWR\Glaciofluvial2	1489.9	0.0%	9.0%	0.5%	91.0%

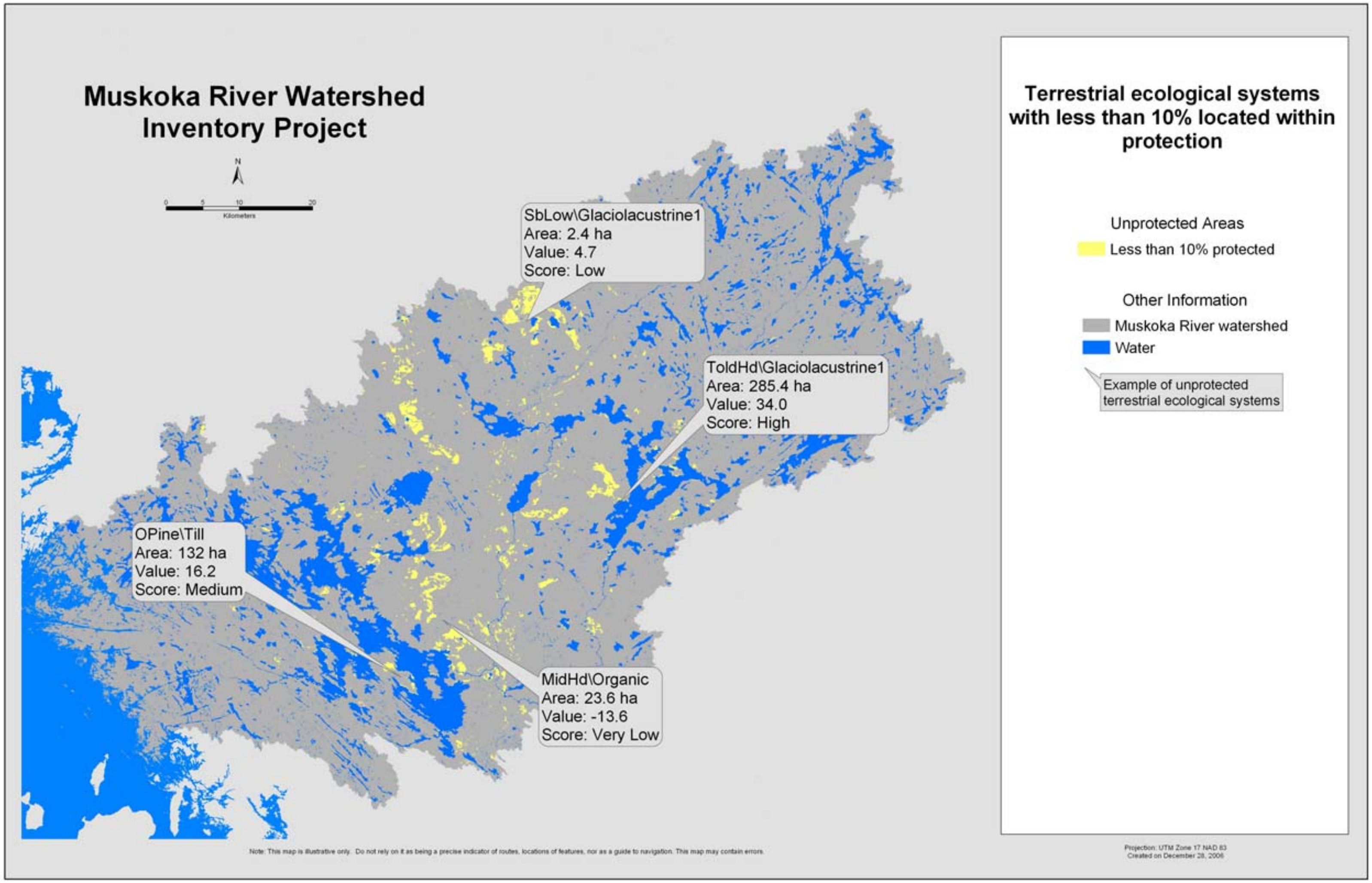


Figure 33. Ecosystems with an area of less than 10% located within protection (see Table 7).

Product 2: A gap analysis of biological data and site inventories

There were several limitations to the datasets used in MRWIP that should be addressed. As datasets are updated, they should be incorporated into the MRWIP to provide resource managers with a more complete and comprehensive analysis of watershed features.

Since the first Ontario effort to systematically record natural areas was undertaken in the late 1960s, Ontario has dedicated significant resources to the surveying of life and earth science features. This has resulted in a comprehensive system of protected areas and parks and includes provincial parks, conservation reserves, and Areas of Natural and Scientific Interest. However, the Conservation Blueprint project and others have recognized that survey and monitoring protocols have not been consistent or undertaken on a routine basis. For example, forest resource inventories vary greatly from one MNR district to the next. Before these data can be used to undertake a landscape level analysis, such as MRWIP, considerable time and resources are required to standardize these datasets.

The MRWIP found most data to be out-of-date for Muskoka. For natural area planning to occur at a meaningful level, current and accurate data are required. Updating and maintaining datasets will be critical to keep tools such as MRWIP current and useful. Muskoka is beginning to experience increased development pressure. Lessons learned from southern Ontario indicate that maintenance of natural systems is considerably less expensive than restoring damaged ecosystems. In undertaking the MRWIP it became evident that many datasets needed to be updated or they were only available for portions of Southern Ontario that were off the Canadian Shield. As development pressures increase northward into communities on the Canadian Shield, the need for updated information in this area will grow.

Even given the shortcomings of these datasets, the data were still useful at a strategic level in undertaking the initial analysis of ecosystems for the watershed as a whole. The MRWIP used all available datasets; however, the weighting of specific datasets that were known to be older or imprecise was reduced so as to not skew results.

In attempting to compile a list of available datasets, several agencies whose data were unavailable or out-of-date were contacted. Several of these agencies now recognize the need to concentrate effort in this area, which should result in better data in the future (Table 8). In general, there appears to be an increasing effort to update information and develop protocols to keep surveys and data management consistent across the province.

Table 8 summarizes data gaps found during the MRWIP. Notes on the future availability of these data are provided.

Table 8. Summary of data gaps and information for addressing them.

Data/Information Gaps	Description	Notes
Unclassified/Unknown data in landcover mapping	Incomplete or non-surveyed areas from FRI datasets and landcover satellite mapping that were undefined, or covered in cloud and shadow. The use of both FRI and Landcover 2000 datasets was to classify as much of the landscape as possible. Unclassified or unknown data covers less than 1% of the landcover mapping within the Muskoka River watershed.	If resources are available, these areas should be investigated, either through site-specific surveys, or using future updated satellite landcover mapping techniques. The latest technology in high resolution satellite imagery is currently being discussed for the province, including areas where no coverage presently exists. Contacts for these data: Ontario Ministry of Natural Resources (MNR), Parry Sound District.
Soils and Agriculture mapping	Lacking current datasets on soils and agricultural use within the Muskoka River watershed. The Inventory used surficial geology from the Ministry of Northern Development and Mines, which was a collection of data and surveys dating from 1950 to 2003. Agricultural areas were identified using out-dated surveys from FRI and satellite photo interpretation from Landcover 2000, which may not be accurate.	Updated field surveys and mapping methodology is currently planned by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) for 2007/08, which will encompass the Muskoka River watershed. Contact for these data: OMAFRA Other updated information for soils and geological data is being completed by the Ministry of Northern Development and Mines (MNDM). Contact for these data: MNDM.
Forest Resource Inventory database	Some data are out-dated and databases are somewhat inconsistent between MNR districts of Parry Sound, Algonquin Provincial Park and Bancroft. The Inventory used all three datasets available, and dedicated time to retrieve and organize necessary information. Also, forest stands calculated for old growth forests were taken from FRI data and should be updated for future iterations of the Inventory. As well, FRI data is not detailed, up-to-date or was lacking all together for forested areas on private land.	Within the next five years, new and updated Forest Management Plans are slated for completion. Effort is being made to organize and update FRI data into a more consistent format across the province. Contacts for these data: Each MNR District.
Pits and Quarries	The best available dataset available at the time of the MRWIP analysis for location of pits and quarries was the provincial database (from NRVIS). The database does not include pits and quarries on private land.	At the time of the project analysis, effort was being made by the MNR to update pits and quarries information on crown land in the Parry Sound MNR district with on-the-ground surveys. Pits and quarries on private land were not yet released digitally. Contacts for these data: Parry Sound MNR District and The District Municipality of Muskoka. With the expansion of the Aggregate Resources Act to the Muskoka area, pits and quarry information on private land could soon be available.
Roads	There were two separate datasets available for the Inventory. A provincial database with information on most roads at a more strategic level, and includes roads on crown land (forestry access roads). The Ontario Roads Network database is complete and more accurate at a site-specific level, with more consistent road information within urban and settled areas; however it is missing data on roads that are not within urban areas. Since the Inventory assessed the watershed at a strategic level, the provincial roads data were used for analyses.	Presently, there is discussion to combine the Ontario Roads Network with the provincial roads database by MNR districts, especially for use in Forest Management Plans. Contacts for these data: GIS specialists from each MNR District.

Data/Information Gaps	Description	Notes
Recharge areas	The Inventory looked at some elements of the watershed that would represent the interface between terrrestrial and aquatic areas. There was no comprehensive dataset for the Muskoka River watershed on location of recharge areas. Instead, the Inventory used highly permeable areas from surficial geology data to indicate possible recharge areas.	As mentioned for other datasets, there will be updates for soils data from OMAFRA and MNDM. These updates may still not be able to identify locations of actual recharge areas. Resources and partnerships need to be developed if these areas are to be identified within the Muskoka River watershed. Environment Canada will be releasing a Water Use and Supply Project report in 2006/07. Although the Muskoka River watershed may not be within the scope of the project, the methodology and results may be of interest for future iterations of the Inventory. Contact for Water Use and Supply Project: Environment Canada.
Natural Heritage Information Centre Species Occurrence database	The Inventory used NHIC database for assessing species and vegetation community occurrences. The database follows strict standards used by an international network of conservation data centres. However, there were a few issues about the database for the Inventory to discuss, including the positional accuracy of observations. Some records were old and taken before GPS (geographic positioning system) units were used widely for field inventories. The Inventory used the Conservation Blueprint method for scoring historical and more current observations (high scores for more current data), thus taking into account some questionable positional accuracy of historical data. Whether extant or historical, all data were considered to have value.	The NHIC is constantly confirming and updating observations. There is current effort being made to improve the accuracy of observations and to move point data into polygons. Contact: Natural Heritage Information Centre or the Parry Sound District MNR. Muskoka has been acquiring data through inventories completed by naturalists, ecologists, municipalities, and consulting companies as a result of development applications. Some of this information may not be appropriate for input into the NHIC, however, locally these data are very important. The Inventory should move toward developing an inventory database based on these past and current works and have this database available to all stakeholders.
Important wildlife habitat	The Inventory used the best available datasets to capture important wildlife habitat. The habitat types included moose aquatic feeding areas, bird nesting sites, deer wintering areas and fish habitat type (including spawning areas).	Clearly, there are many other types of important wildlife habitat areas. However, the Inventory used the digital datasets that were available at the time of analysis from provincial data sources. We also acknowledge that the bird nesting site dataset only includes observations for raptor and heron nesting sites. Future iterations of the Inventory would benefit from searching out local information about other habitat areas of interest.
Settlement and built areas	The Inventory used a combination of FRI and landcover satellite mapping data to identify areas of settlement. As mentioned, FRI data for settled areas may be out of date and satellite mapping may not accurately capture the boundaries of settled areas.	Updated and accurate data of built and settled areas within the District Municipality of Muskoka were completed in 2006. However, the data were not available in time for use in the Inventory analyses. Future iterations of the Inventory will consider this local information. Assessment of the dataset will be necessary to ensure that data are appropriate for use at this strategic level, especially if they are not available for the entire watershed. Contacts for these data: The District Municipality of Muskoka.

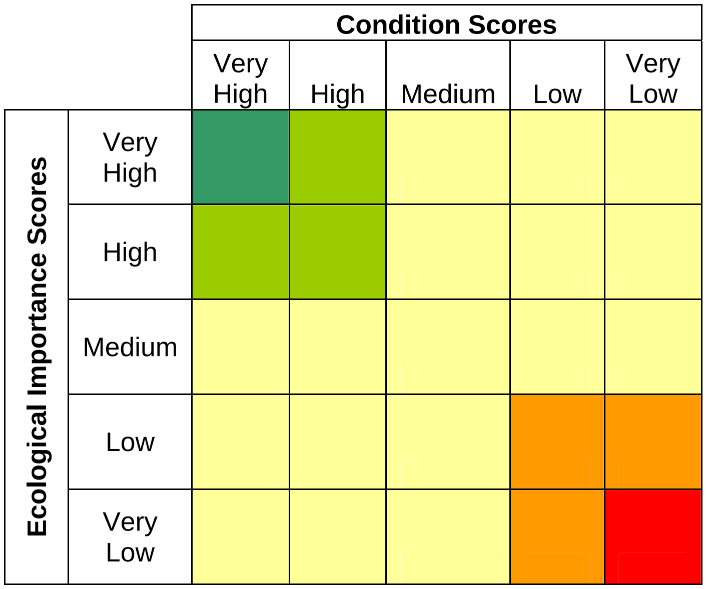
Data/Information Gaps	Description	Notes
Peer-reviewed literature and research	There was a lack of current peer-reviewed literature related to ecological processes as it occurs on the Canadian Shield. Although, much literature has been published on landscape-scale ecological interactions and planning, more specific scientific support for unique processes occurring on the Canadian Shield in central/northern Ontario would be useful.	More effort to encourage and initiate research and monitoring projects within the Muskoka River watershed would help address the gaps in information and literature. As well, projects and information must be shared or made known to communities, agencies and organizations within the watershed to ensure that efforts are not being duplicated, that resources are used efficiently, and that local knowledge is considered.

Product 3: A map portraying the significant natural areas and connecting systems

The MRWIP produced a model that identifies areas with the potential for sustaining ecological processes as well as areas in poor condition and subject to ecological stressors. When the two datasets are combined, the result of the final analysis shows how some stressors affect ecologically important areas. The result is an indication of where the least stressed and most ecologically significant areas are located within the watershed.

Figure 35 is the final scored watershed dataset, which combines the ecological significance scores with the condition scores. As with previous scored datasets, the final scores are classified into five classes: very high, high, medium, low, and very low using a statistical formula to minimize the variation in each classification group (Jenks 1967). Figure 34 is a matrix that describes these five classifications. As noted in the matrix, the higher the score classification, the higher the ecological significance and the better the quality or condition of that site.

Within the entire watershed, 20% and 25% of the land-base fall into the class of very high and high, respectively. About 15% of the watershed scored medium and the rest scored low (18%) and very low (23%).



	Very high ecological importance and very high condition. These sites are the most ecologically important and least stressed. These sites should be the top priority for protection or acquisition and they should form the core of a natural areas strategy that will support and sustain the ecosystems of Muskoka.	
	High ecological importance and high condition.	Some of these sites have the potential to increase the value of other sites either by increasing the size of an adjacent significant area or by connecting significant areas to other valuable sites. These sites could have potential for restoration to restore highly significant sites to a higher quality. As well, these sites have potential for creating ecologically significant sites, i.e. creating a wetland, in a relatively undisturbed area.
	Medium ecological importance and medium condition.	
	Low ecological importance and low condition.	
	Very low ecological importance and very poor condition. These sites do not appear to contribute greatly to the ecological processes of the landscape and are highly disturbed.	

Figure 34. Matrix of the final MRWIP scores

Figure 36 shows the final scored watershed (the combined ecological importance and condition scores) with all levels of protected areas superimposed. About 22% of the ‘very high’ scored sites and 52% of the ‘high’ scored sites were not under any level of protection.

Significant natural core areas and linkages

For the Muskoka River Watershed Inventory Project, significant natural core areas were identified as the sites that scored very high for the final combined score (Figure 35). These areas scored very high for maintaining and sustaining important ecological processes, as well as for having scores that indicated high quality or condition.

Significant natural linkage areas were identified as those areas that scored high and medium for the combined scores. These areas have a value in connecting or enlarging the natural core areas. If conserved or restored to a better condition, where necessary, these areas could form the basis of a linked, healthy, functioning and continuous natural system.

Connecting the natural areas in most of Southern Ontario involves identifying remnant natural areas and suitable corridors to connect them. The image of significant natural core areas and linkages would be “islands” of natural areas connected with “bands of green” surrounded by non-natural areas (McMurtry et al. 2002).

Unlike Southern Ontario, the Muskoka River watershed has a large proportion of high quality natural landcover. There is a tremendous opportunity to maintain areas that can adequately support important ecological processes and connect them with other valuable natural areas. In contrast to Southern Ontario, the Muskoka River watershed can be described as “islands of green within a sea of green”. The MRWIP has identified the highest quality significant areas and identified remaining natural areas that would contribute to and enhance the overall terrestrial ecological quality of the Muskoka River watershed.

Figure 37 shows the ‘very high’ scored sites from the combined score dataset (significant natural core areas). Tolerant hardwoods on bedrock appeared to account for the majority of the highest scored sites (59%), although upland hardwood conifers on bedrock (15%) and wetlands (11%) also had high representation within core areas.

Linkage areas connect core sites to each other and to other highly scored sites. For the MRWIP, linkage areas were identified as high and medium scored sites. Figure 38 shows core areas and linkages, where linkage priority 1 areas were the ‘high’ scored sites and linkage priority 2 areas were the ‘medium’ scored sites. Within the watershed, core areas represented 20% of the land-base, linkage priority 1 areas covered 25% of the land-base, and linkage priority 2 areas covered 15%.

Figure 39 shows core and linkage areas with existing protected areas. About 22% of identified core areas were not under protection. As well, approximately 52% of linkage priority 1 areas and 33% of linkage priority 2 areas are not currently under any level of protection.

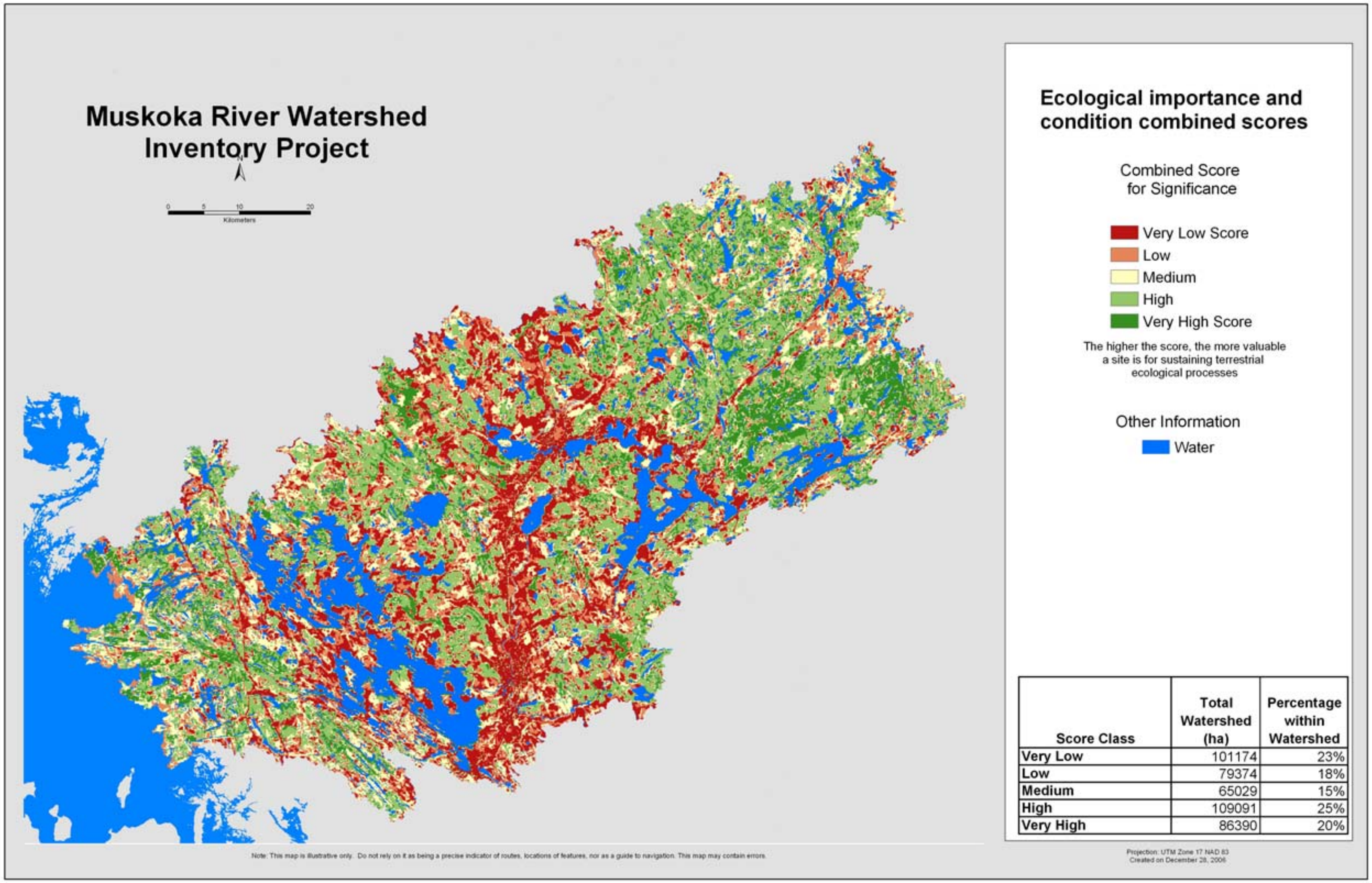
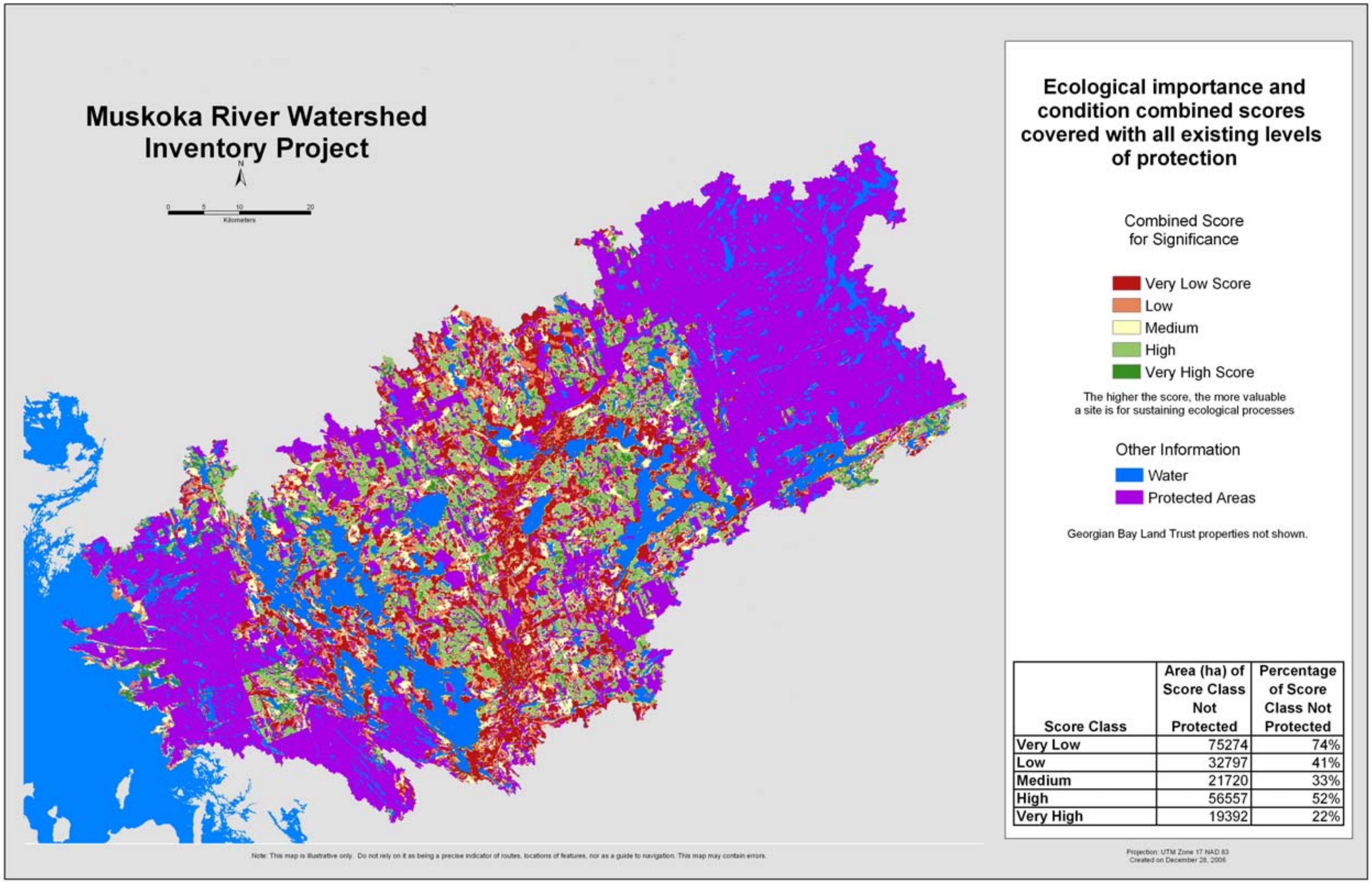
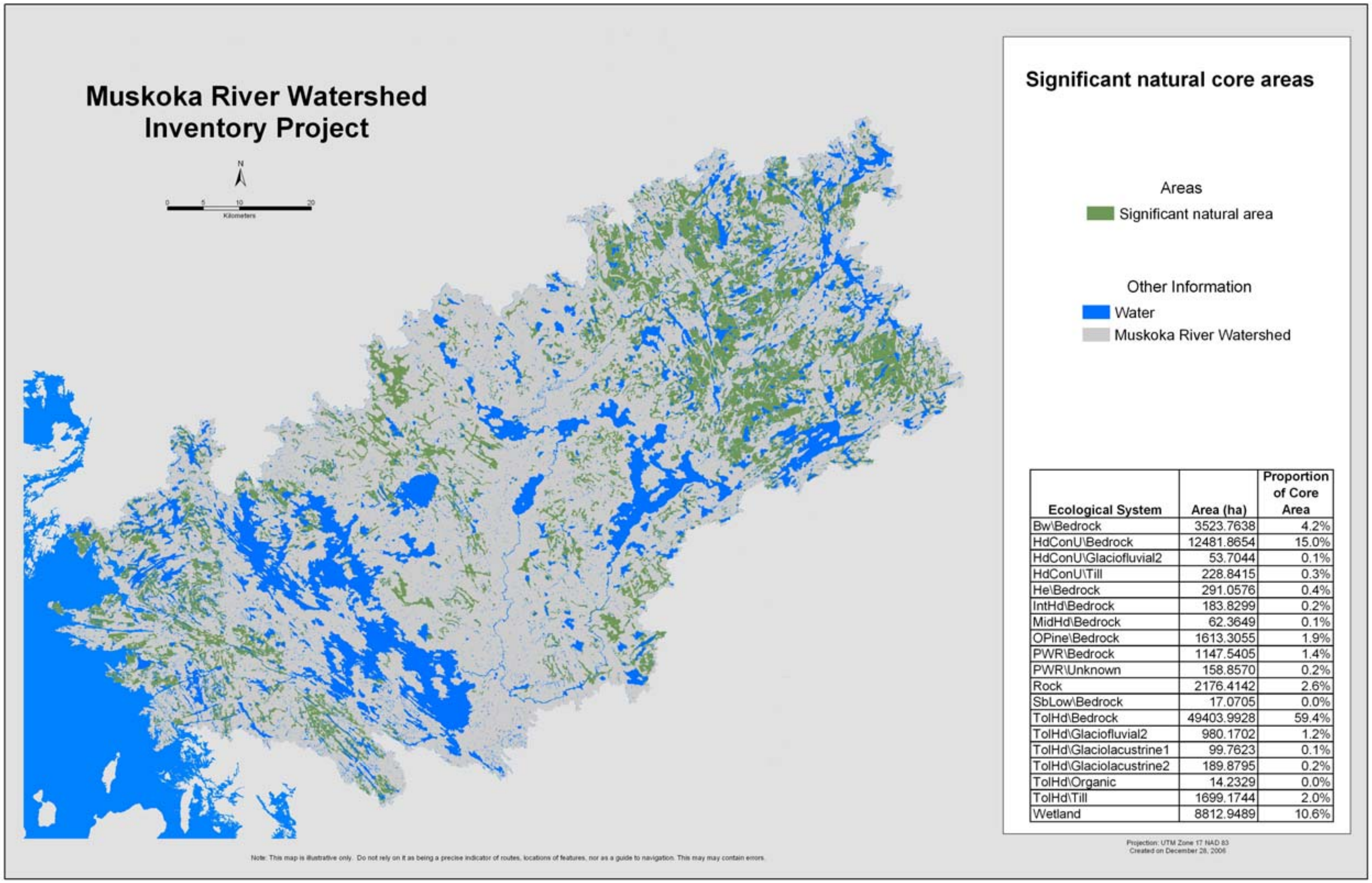


Figure 35. Ecological importance and condition combined scores.



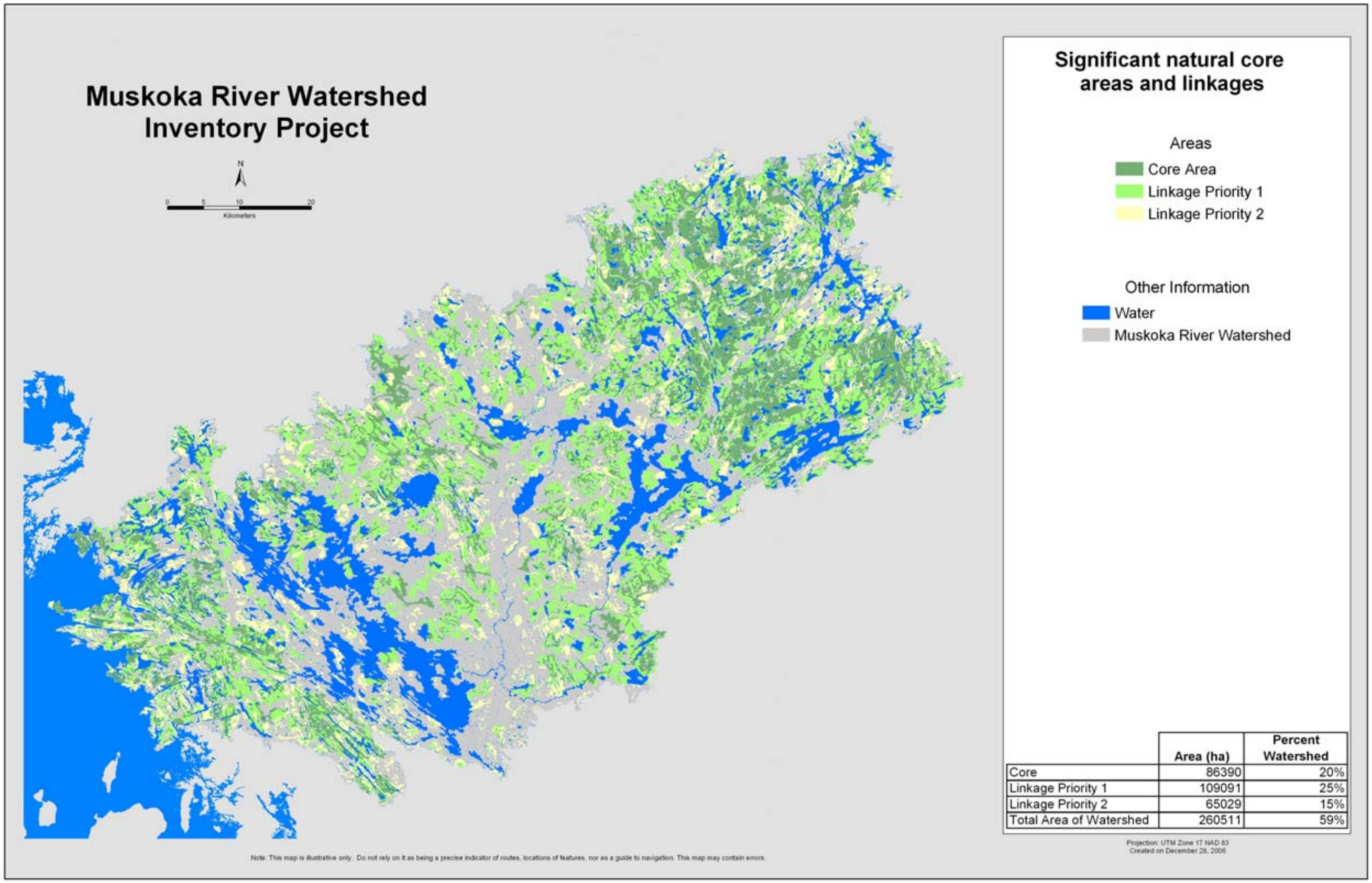
Score Class	Area (ha) of Score Class Not Protected	Percentage of Score Class Not Protected
Very Low	75274	74%
Low	32797	41%
Medium	21720	33%
High	56557	52%
Very High	19392	22%

Figure 36. Ecological importance and condition combined scores covered by all existing levels of protection.



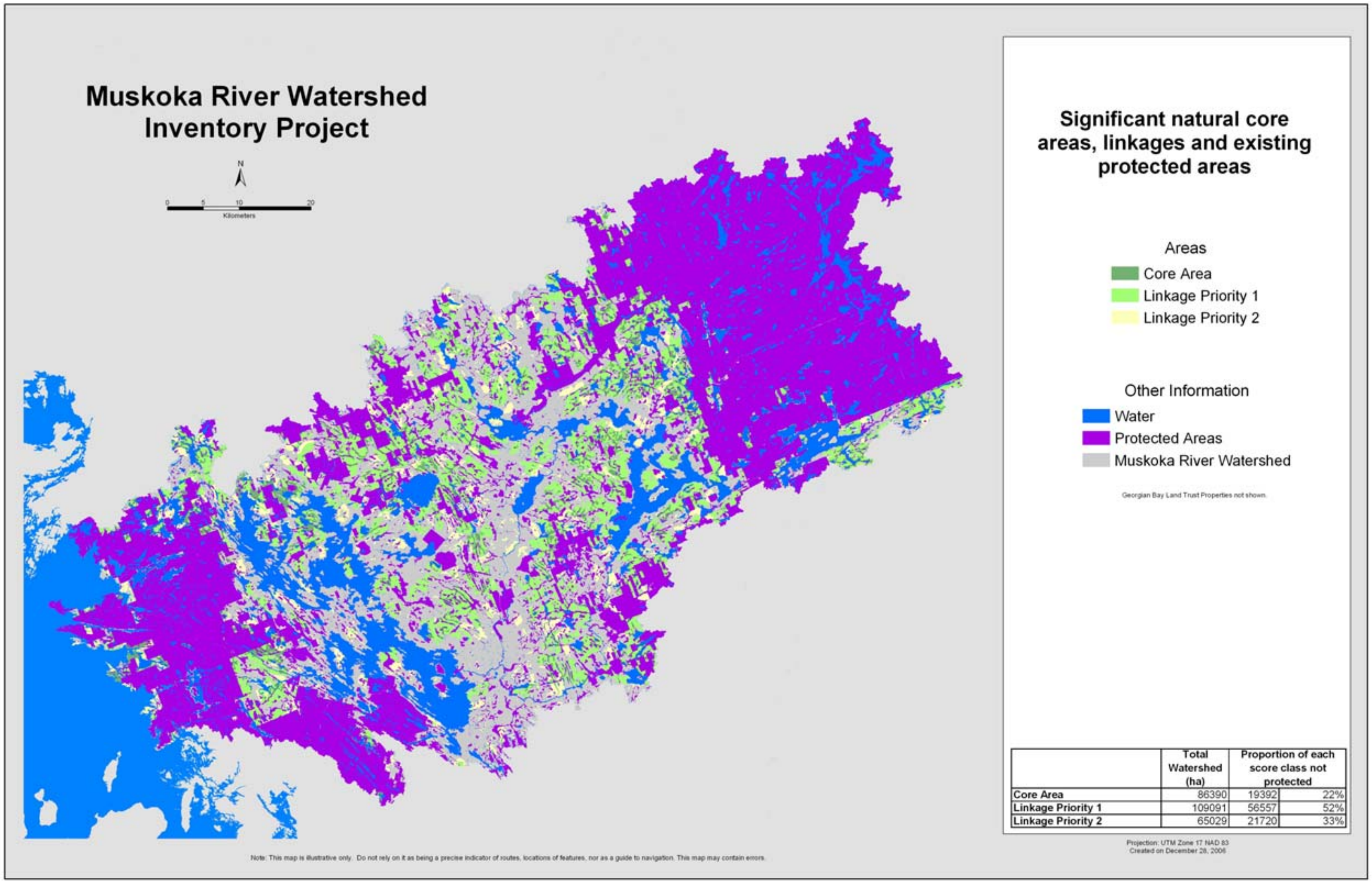
Ecological System	Area (ha)	Proportion of Core Area
Bw\Bedrock	3523.7638	4.2%
HdConU\Bedrock	12481.8654	15.0%
HdConU\Glaciofluvial2	53.7044	0.1%
HdConU\Till	228.8415	0.3%
He\Bedrock	291.0576	0.4%
IntHd\Bedrock	183.8299	0.2%
MidHd\Bedrock	62.3649	0.1%
OPine\Bedrock	1613.3055	1.9%
PWR\Bedrock	1147.5405	1.4%
PWR\Unknown	158.8570	0.2%
Rock	2176.4142	2.6%
SbLow\Bedrock	17.0705	0.0%
TolHd\Bedrock	49403.9928	59.4%
TolHd\Glaciofluvial2	980.1702	1.2%
TolHd\Glaciolacustrine1	99.7623	0.1%
TolHd\Glaciolacustrine2	189.8795	0.2%
TolHd\Organic	14.2329	0.0%
TolHd\Till	1699.1744	2.0%
Wetland	8812.9489	10.6%

Figure 37. Significant natural core areas (the very high scored sites).



	Area (ha)	Percent Watershed
Core	86390	20%
Linkage Priority 1	109091	25%
Linkage Priority 2	65029	15%
Total Area of Watershed	260511	59%

Figure 38. Significant natural core areas and linkages (the very high scored sites linked with high and medium scored sites).



	Total Watershed (ha)	Proportion of each score class not protected	
Core Area	86390	19392	22%
Linkage Priority 1	109091	56557	52%
Linkage Priority 2	65029	21720	33%

Figure 39. Significant natural core areas, linkages and protected areas.

Product 4: Identification of significant degraded sites and areas that may require remediation.

Figure 32 shows the condition scores within the watershed. Many of these areas are urban and settled areas. By focusing future development in these areas, areas with higher ecological value can be maintained.

In some situations, it may be important to remediate degraded areas in order to enhance nearby areas of higher ecological value. For instance, a ‘low’ scored site may be suitable for a constructed wetland that would enhance a ‘medium’ or ‘high’ scored area. However, sites must be investigated to evaluate how reversible the stressors or impacts are to ensure that resources are used efficiently and in a cost-effective manner.

Figure 34 describes the influence of condition scores on the scores for ecological importance. The ‘very high’ scored sites indicate that the area is ecologically important and not greatly stressed. The ‘Very low’ scored sites indicate that the areas have very limited ecological value and are greatly stressed. The scores in between may have potential for restoration or remediation efforts. For instance, an area could score very high in ecological importance, but very low in condition. The condition of this area could be improved, thus increasing the condition score and raising the overall value of the area.

Figure 11 identifies ecosystems that have no to very little representation within protected areas. Current conservation science and ecological principles suggest that protecting the whole suite of ecosystems found within an area is important. Ecologists believe that it is one of the best strategies for ensuring the conservation of ecological processes and intricate species interactions for the long term. Many of the ecosystems that are not represented in protected areas scored low to very low for ecological significance. Some of these sites scored low because of their proximity to roads, settlement areas, and other non-natural features. As size of the system is a significant factor in scoring, restoration and remediation of these sites may increase their ecological significance. Organizations undertaking restoration projects may need to consider restoring these areas of low condition, as well as restoring areas to connect these systems to prevent further fragmentation and isolation.

Recommendations and Next Steps

The Muskoka River Watershed Inventory Project was a systematic, landscape-scale analysis of ecological significance and condition of the terrestrial ecosystems within the Muskoka River watershed. The methodology used can be replicated and enhanced as new data become available. In order to continue to be relevant and useful, methods for identifying significant areas need to be iterative and incorporate new data and technology as they become available.

The Muskoka River Watershed Inventory is a living and evolving analysis of the ecosystems within the Muskoka River watershed. The project fostered discussion, created new and strengthened previous relationships, and provided a better visualization of the concept of large-scale ecological planning that crosses private and public lands, and political borders. The MRWIP strived to collect the best-available data and scientific support for measuring and modeling the present and future integrity of terrestrial natural areas. The products produced provide guidance and direction for collaborative members to further the resource management and planning mandates of each agency represented.

Table 9 provides a detailed list of recommendations for the Muskoka River Inventory Project. In summary, it is recommended that Collaborative members:

1. Develop and implement a natural areas strategy based on protecting and enhancing areas that scored very high for ecological importance and very high for condition, and that includes representation of all ecosystems within protected areas.

2. Work together to develop and maintain standardized datasets.

3. Work with appropriate agencies to ensure that Muskoka-based datasets are updated on a regular and ongoing basis.

4. Remediate areas of very low to low ecological significance where:
    a. They would add to the value of an adjacent site of higher ecological significance.
    b. Remediation would result in the restoration of an area with high ecological importance but is currently in poor condition.

5. Develop an aquatic-based inventory of the Muskoka River Watershed to complement and enhance the terrestrial component.

The diversity of expertise of the MRWIP collaborative group will assist in ensuring that the results of the MRWIP project are interpreted using a variety of strategies to protect and restore significant natural areas. Collaborative members represent agencies that are active in ensuring the conservation of unique features within the Muskoka River watershed. The results of the MRWIP provide many opportunities for attaining the conservation objectives of each collaborative member.

Table 9. Strategies and recommendations for the Muskoka River Watershed Inventory results.

Strategy	Recommendations
Planning and Policy	Develop a Natural Heritage Strategy - Natural heritage system planning is increasingly important for ensuring that significant areas are shielded from incompatible land-use. Natural heritage systems are defined in the Provincial Policy Statement (PPS) as systems "made up of natural heritage features and areas, linked by natural corridors which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species and ecosystems." The MRWIP model was developed with natural features, ecological function, and long term ecological processes as high priority factors in identifying significant natural areas and connecting corridors. Thus, the MRWIP identified significant natural areas and connecting corridors that should be considered in the development of planning policies and any future natural heritage planning strategies.
Resource Management	Protect areas of high ecological importance on crown land from incompatible uses - Appropriate management of the natural resources is in the best interest of all stakeholders. Resource management plans are developed based on current scientific data and local information. The MRWIP model was developed using the most current concepts in ecology and conservation science of natural ecosystems; thus, MRWIP findings should be considered in the development of future resource management plans. As well, land-use planning on crown land can identify highly valuable areas when considering land dispositions, aggregate and logging activities, and other crown land uses.
Land Securement	Acquire areas of high ecological importance - The priority for land trusts is to focus effort on securement of properties found to comprise highly significant sites. As well, quality sites that have been identified as potential linkages to significant areas should be considered for purchase or easements.
Restoration and Remediation	Restore or remediate appropriate sites - Selection of appropriate sites for restoration should focus on areas that are degraded, but not isolated from other significant sites. Restoring an area should ensure that upgrading that degraded site will improve the connectedness of the entire landscape. Agencies should work with partners to increase the ecological values of lower quality sites that will provide potential linkages to significant and/or protected areas.
Enhanced Protection	Enhance protection of unique sites - Although high scored areas are considered significant, there are low scored sites that need to be considered significant as well. Many rare to uncommon terrestrial ecosystems within the Muskoka River watershed identified in the analysis came out as low quality sites. There are many reasons for their low scores, including their size and their proximity to non-natural features. However, the fact that they are uncommon systems within the watershed should flag them as being significant and prevent them from becoming further isolated and disturbed through enhanced protection.

Strategy	Recommendations
Research and Data Collection	Improve datasets and encourage research projects - There are many opportunities within the Muskoka River watershed for research efforts. During the MRWIP process, it became evident that peer-reviewed scientific studies specific to the Muskoka River watershed, or similar regions were lacking. Most literature concentrated on Southern Ontario. As well, many of the various datasets used in the MRWIP were collected and assessed using protocols developed for areas in Southern Ontario, off the Canadian Shield. There should be continued support of wetland evaluations within Muskoka. As well, partnerships should be developed with First Nations, non-profit organizations such as cottage associations and nature groups, and other agencies, including universities and colleges for new inventories, and innovative projects and studies specific to the interactions within the Muskoka River watershed.
Monitoring and Evaluation	Continue to monitor and evaluate natural areas - The Muskoka River watershed is considered a naturally intact area, compared to other areas in Southern Ontario. Thus, the opportunity exists to monitor our healthy, functioning natural areas and evaluate them against other areas within the watershed and across the province.
Stewardship and Community Engagement	Develop education and stewardship programs that engage the community - The results of the MRWIP should be shared with municipalities and the community, increasing the local awareness of natural heritage values within the watershed. Information from the MRWIP should be used in presentations, reports and plans to inform and support communities.
Information Sharing	Continue to share information - The collaborative group should continue working together to create a database to monitor identified significant natural areas, and share this important information with other interested agencies of similar conservation mandates, especially if it leads to the enhancement of current data and knowledge of the Muskoka River watershed.
Data Quality	Work toward improving the quality of data -The quality of data greatly influences the results of the analyses. The MRWIP identified some issues related to data accuracy and currency (Table 8). Presently, there is significant lag time between data collection to GIS useable digital datasets, but also a lag time between updating local information into provincial databases. As well, one dataset can be used for several different purposes. As a consequence, there are many versions of similar datasets, all of which were updated at different times for different purposes. It is the responsibility of the data custodians to ensure that data are managed appropriately and issues with the data are communicated to the user.

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