A Natural Heritage Plan for the Land Conservancy of Kingston, Frontenac Lennox and Addington

Prepared for LC-KFLA

Date: January 2018

North-South Environmental Inc.

35 Crawford Crescent, Suite U5
P.O. Box 518
Campbellville, Ontario
L0P 1B0

Project Team

North-South Environmental Inc.
Sarah Mainguy: reporting
Richard Czok: mapping review

LC-KFLA
Mapping Committee
Land Conservancy for Kingston, Frontenac, Lennox and Addington
Dr. Kathleen Laird, Chair
Adam Clow, GIS Specialist
Dale Dilamarter
Paul Mackenzie
Vicki Schmolka
Lesley Rudy; project management support, report review and editing, Appendix 4

Nanor Momjian, maps, Appendix 5

The project administrators thank the reviewers who reviewed drafts of the Plan.

Acknowledgement
The project administrators gratefully acknowledge financial support from the Ontario Trillium Foundation.

Ontario Trillium Foundation
Fondation Trillium de l'Ontario
An agency of the Government of Ontario
Un organisme du gouvernement de l'Ontario

Cover photo: a stormy wetland (top) and a rapid in the Salmon River (bottom), Natural Heritage Plan area. Photo credits: Mary Alice Snetsinger, Paul Mackenzie

Executive Summary

This is the Natural Heritage Plan (the Plan) of the Land Conservancy for Kingston, Frontenac, Lennox and Addington (LC-KFLA): a strategy for land acquisition and stewardship activities in the County of Frontenac, the County of Lennox and Addington, and the rural part of the City of Kingston.

The Plan presented here provides guidance for identification of core areas and primary landscape connections throughout the LC-KFLA study area. The focus is on habitats south of Provincial Highway 7, as the Land Conservancy works collaboratively with the Mississippi Madawaska Land Conservancy which is active in the area north of Highway 7. The purpose of the Plan is to guide Land Conservancy habitat protection activities as well as to provide information that may be useful to other conservation partners.

The Plan covers an area rich in habitats and species. The study area includes two major geological regions, the Limestone Plain and the Canadian Shield. Four watersheds, as defined by Conservation Authority boundaries, drain this area. Specialized habitats such as coastal wetlands and forests, alvars, the Frontenac Arch, and the contact zone between the Canadian Shield and the Limestone Plain add to the biodiversity. Non-governmental organizations that have an interest in protection and stewardship of the region include the Nature Conservancy of Canada (NCC), The Land Between, and stewardship groups associated with Lennox & Addington County, Frontenac County, and several watershed-based groups, such as the Friends of the Salmon and Napanee Rivers.

Guidance from Environment Canada and the Ontario Ministry of Natural Resources and Forestry (MNRF) has been the principal reference informing priorities for habitat protection. Size criteria for identifying core areas was different between the Limestone Plain and the Canadian Shield because of the differences in the amount of habitat: the Canadian Shield is heavily forested, with highly connected wetlands and waterbodies and fewer roads and built-up areas. The Limestone Plain is much more sparsely forested, with habitats more isolated by farmland and roads. Criteria for core areas included provincially significant wetlands in both areas, large wetlands, waterbodies, lake trout lakes, and forests (with the size criterion higher in the Canadian Shield, taking into account the differences in landscape), interior forests, and watercourses. Criteria also focused on connectivity and expansion of protected lands as the building blocks of the plan. Other features were identified that may eventually help inform priorities within the region: alvars, priority areas identified by the NCC and The Land Between, and coastal habitats. In time, other sources of information may help refine priorities, such as additional identification of significant habitats, areas where density of roads is lowest, and identification of priority areas on a watershed scale.

Criteria were weighted, because when weighting was not applied, mapping did not discriminate sufficiently to distinguish priorities. In the Canadian Shield, the highest weighting was applied to significant wetlands, interior forests, and areas within 100 m of protected lands. On the Limestone Plain, the highest weighting was applied to significant wetlands and lands adjacent to protected lands.

The preliminary criteria were presented at a series of meetings to twenty-two area organizations, involving 40 individuals, who have an interest in conservation within Kingston, Frontenac, Lennox and Addington. The consultation resulted in some changes to the mapping and the Plan: for example, it led to the increase in weighting of lake trout lakes, delineation of headwater areas and mapping of interior forest criteria and changes to their weighting. Many of the organizations were interested in sharing data and potentially identifying ways to partner in stewardship.

The resulting cumulative scores were divided into three categories based on the standard deviation around the raster score: Low (with scores of 0 to 4), Medium (with scores of >4 to 9) and High (with scores of >9 to 25). The final mapping indicated that priority areas in the Canadian Shield were concentrated in headwater areas: highlighting connections between Frontenac Provincial Park and the Cataraqui Region Conservation Authority lands. On the Limestone Plain, high priorities were indicated around provincially significant wetlands; identifying a broad area in a band approximately 2-3 km south of the Canadian Shield boundary. On the Canadian Shield, without headwater areas, a band along the eastern part of the Canadian Shield boundary was highlighted. Additional studies that may inform priorities in the future were developed by two Queen's University graduate students in the CREATE program, including a study on using remote sensing techniques to identify additional features, and a study that looked at land cover change in the past and future as a result of climate change.

Ultimately, prioritization for acquisition will be on three levels: areas indicated by the Plan, areas that best meet the objectives of LC-KFLA and its partners, and a focus on areas that are at high risk may be considered. Areas of exclusion were identified near built up areas, and major roads and quarries that may be of lower priority for acquisition.

Table of Contents

List of Tables

List of Figures

List of Appendices

1.0 Introduction

The Natural Heritage Plan (the Plan) of the Land Conservancy for Kingston, Frontenac, Lennox and Addington (LC-KFLA) sets a strategy for land acquisition and stewardship activities in the County of Frontenac, the County of Lennox and Addington, and the rural part of the City of Kingston. The Plan presented here provides guidance for identification of core areas and primary landscape connections throughout the LC-KFLA study area. The focus is on habitats south of Provincial Highway 7, as the Land Conservancy works collaboratively with the Mississippi Madawaska Land Conservancy which is active in the area north of Highway 7, and also overlaps with the Rideau Watershed Land Trust in the east. The boundaries of the Plan are also influenced by watershed boundaries of the Cataraqui, Quinte, Rideau Valley, and Mississippi Valley Conservation Authorities.

The purpose of the Plan is to guide Land Conservancy habitat protection activities as well as to provide information that may be useful to other conservation partners – municipalities, conservation authorities, conservation organizations, lake associations, and other groups and individuals concerned with ecosystem health in this part of southeastern Ontario.

The Plan covers an area rich in biodiversity. The UNESCO designated Frontenac Arch Biosphere runs through the counties and some of the area incorporates "The Land Between", land where the habitats of the Canadian Shield blend with the habitats of the Limestone Plain. The Nature Conservancy of Canada has a priority protection plan for the southeastern portion of Frontenac County, and the Algonquin to Adirondack (A2A) Collaborative is working with partners on conservation projects through the A2A corridor. The Nature Conservancy of Canada is also working to identify, protect, and monitor globally, nationally and provincially rare alvar, karst, and wetland communities in the Limestone Plain as well as focus on Coastal areas along Lake Ontario. The NCC also incorporates measures of connectivity into property prioritization. The NCC is continually adding to this network of conserved lands. Both Frontenac County and Lennox and Addington County have active stewardship groups.

The Plan identifies key habitat attributes from available source data and from natural heritage plans that cover the Land Conservancy region of focus (LC-KFLA 2015, pers. comm.). These other natural heritage plans are summarized in Appendix 1. Methods used to compile other natural heritage plans are summarized in Appendix 2.

The Plan is guided by the Province of Ontario's Natural Heritage Reference Manual (MNRF 2010) and Environment Canada's "How Much Habitat is Enough?" (Environment Canada 2013). The Plan was developed in consultation with conservation partners in the region, to get feedback on the selected priorities and to strengthen connections with other organizations with an interest in stewardship and protection of natural heritage.

After compiling and analyzing the available data and maps and considering the areas covered by acquisition strategies of other organizations, the Land Conservancy has identified several areas as critical for conservation activity to conserve vital habitat.

This document describes the process and the analysis that led to this conclusion. The Plan should be regarded as a living document, as it is intended to be fluid within the context of the availability of additional information, analyses and interests of future partnerships.

1.1 Land Conservancy for Kingston, Frontenac, Lennox and Addington

The mission of the LC-KFLA is "to preserve natural sites and landscapes" in the Ontario counties of Frontenac and Lennox and Addington, providing vital habitat for the diverse plant and animal species here. The LC-KFLA's region is based on county boundaries; however, in the Natural Heritage Plan watersheds are the basis for analysis, with the focus area primarily south of Highway 7.

The LC-KFLA is an all-volunteer, not-for-profit charity established in 2004. It currently protects eight properties, six owned and two through conservation easement agreements, conserving a total area of 220 hectares (540 acres) and providing habitats for 19 species at risk. To preserve these habitats, most Land Conservancy properties are not open to the public. They are nature reserves for the purpose of conservation. The Land Conservancy has one public access property, the Depot Creek Nature Reserve, near Bellrock, Ontario.

To cover the ongoing costs of property ownership and conservation easement management, the LC-KFLA invests donations in its Natural Areas Protection Fund, a fund endowed with the Community Foundation for Kingston & Area. The Fund and a stewardship account generate annual income to cover property taxes, property insurance, and other expenses related to property responsibilities.

2.0 Approach

The purpose of a Natural Heritage Plan, and LC-KFLA's goal, is to identify priority areas for conservation and potential land acquisition or partnership with other groups. Part of LC's approach is 1) to identify valuable habitat for conservation and 2) to focus on areas where other groups are not 'on the ground as much' - thus filling in gaps.

The Plan identifies core areas, both those with provincially significant natural heritage features (see below) and those with other features that provide important functions in the landscape although they do not carry a provincial significance designation.

> *Natural heritage features and areas: means features and areas, including significant wetlands, significant coastal wetlands, fish habitat, significant woodlands south and east of the Canadian Shield, significant valleylands south and east of the Canadian Shield, significant habitat of endangered species and threatened species, significant wildlife habitat, and significant areas of natural and scientific interest, which are important for their environmental and social values as a legacy of the natural landscapes of an area.* (Provincial Policy Statement 2014)

The NHS is important in the case of landscape change: it ensures that features do not become isolated by development. A NHP should provide priorities that are relevant in the current and future landscape. This project focuses on the natural features and areas identified by the Province of Ontario as those that are most important for its natural heritage. It also focuses on their surrounding areas, as the so-called "Adjacent Lands" are areas within which development has the greatest potential to have negative impacts on the feature.

The Plan also identifies connections (also called corridors or linkages) between core areas so that the core areas' functions are not eroded through isolation. However, connections are identified according to existing features (i.e. rather than, for example, identifying areas of intervening farmed landscape that could be modified to restore connections between features), as this is more in keeping with the LC-KFLA's approach to conservation. The Plan has followed the Provincial Policy Statement and supporting materials that guide which features are considered significant, but goes beyond this to protect features that are considered worthy of protection in a regional context.

The Plan focuses on identifying additional areas that are most likely to support high biodiversity, for instance, areas adjacent to watercourses and wetlands, or lands that provide critical habitat for some species, such as large interior woodlands.

Two types of criteria serve the purpose of this Plan:

- Those that specify features that should be included in the Plan so that it would be a functioning natural heritage system in the face of landscape change; and
- Those that add weight to individual patches of land to indicate which patches should be prioritized for acquisition or stewardship.

The application of the criteria to a Geographic Information System analysis has provided the foundation that led to the conclusions in this Plan. The criteria and weighting used in the Plan were developed as a preliminary draft (see Appendix 3) and then refined through consultation, which is described in Section 7.

3.0 Study Area Context

The study area boundary shows the LC-KFLA focus area for the Plan (Figure 1). The study area south of Highway 7 is based primarily on the boundaries of Kingston, Frontenac County, Lennox & Addington County, but excludes the area where Mississippi Madawaska Land Trust (MMLT) is active. North of Highway 7 the study area includes the upper reaches of the Salmon River watershed (which is excluded by the MMLT). Figure 1 provides an aerial photograph that shows the broad differences between the northern and southern parts of the study area. The northern part of the study area lies within the Canadian Shield, an area of granite bedrock. The southern part lies within the Limestone Plain, where the bedrock is composed of limestone. The way vegetation responds to interacting substrate type, climate, and terrain has been classified in Ontario through its delineations of different Ecoregions (subdivided into finer classifications of Ecodistricts). Ontario is divided into eight Ecoregions (Crins et al. 2009). Figure 2 shows that Ecoregions 5 and 6 straddle the study area (with sub-divided boundaries representing finer Ecodistricts within each Ecoregion).

Differences between the northern and southern parts of the study area are reflected in differences in climate and vegetation as well as bedrock. In Ecoregion 6E, the climate is mild and moist. The annual mean temperature range is 4.9 to 7.8°C, the length of the mean growing season is 205 to 230 days, the annual mean precipitation is 759 to 1,087 mm, and the summer mean rainfall is 198 to 281 mm (Crins et al. 2009). The vegetation is relatively diverse. Hardwood forests dominated by sugar maple, American beech, white ash, eastern hemlock, and numerous other species are found where substrates are well developed on upland sites. Lowlands, including rich floodplain forests, contain green ash, silver maple, red maple, eastern white cedar, yellow birch, balsam fir, and black ash. Peatlands (some quite large) occur along the northern edge and in the eastern portion of the ecoregion, and these contain fens, and rare bogs, with black spruce and tamarack. Some of the best examples of North American alvar vegetation (a globally, nationally and provincially rare community) are located in this ecoregion (Crins et al. 2009).

Contrasting with this are the climate and vegetation within Ecoregion 5E (as summarized from Crins et al. 2009). The climate is cool-temperate and humid. The annual mean temperature range is 2.8 to 6.2˚C, and the length of the mean growing season is between 183 and 219 days. Annual mean precipitation ranges between 771 and 1,134 mm, and the summer mean rainfall is between 204 and 304 mm. Vegetation is characterized by a mixture of elements from both the south and the north, but Great Lakes–St. Lawrence forest species such as eastern white pine, red pine, eastern hemlock, and yellow birch are frequent throughout. On sites with intermediate or somewhat-dry soils, sugar maple is a dominant species, with other hardwoods such as American beech, wild black cherry, American basswood, and white ash. Boreal species such as black spruce, white spruce, balsam fir, jack pine, and tamarack are more localized and grow on moist or cooler-than-normal sites. Balsam fir often is found in the understories, or as a lesser component in the canopies, of many forest stands (Crins et al. 2009).

There is one important exception to the "north versus south" division in bedrock and vegetation. The Frontenac Axis is an area of special interest in Ecodistrict 6E-10 (Westport) as shown in Figure 2. The Frontenac Axis is the only area in Ecoregion 6E where the granitic bedrock of the Canadian Shield extends into southern Ontario (it is mapped as part of the Canadian Shield in Figure 1). It is mapped by MNRF as part of Ecoregion 6E (which is generally dominated by limestone bedrock) because it is within the climatic zone of the southern ecoregion, and local pockets of moderate to low lime loam, silt and clay are interspersed with areas of shallow soil over the bedrock.

Table 1 provides statistics on the differences between land cover in the Canadian Shield and on the Limestone Plain within the Plan area. Farming was difficult on the Canadian Shield because of the close proximity of bedrock to the surface, and the cooler climate, so less of the land was developed for agriculture. Farming was more prevalent on the Limestone Plain, and the warmer climate meant that more of this area could be developed for agriculture, so less of the original forest vegetation remains than in the north. The statistics show that more than 60% of the north is wooded (including woodlands and wooded wetlands), whereas woodlands occupy a much lower percentage in the south. Wetlands occupy about the same proportion of the landscape on the Canadian Shield as they do in the Limestone Plain, but they are generally more isolated within the landscape. Built up areas make up nearly 4% of the land base in the Limestone Plains, and less than half a percent in the north. Natural areas of the Canadian Shield region are generally well-connected with few barriers to animal and plant dispersal, and large woodlands and wetlands, while in the south, the landscape is less connected, and animals and plants would be able to disperse less readily. With the exception of the City of Kingston, much of the landscape matrix in between patches of habitat in the southern part of the study area consists of "working landscapes": cropland, pasture, and abandoned farmland that are altered by human activity but may allow dispersal to some extent. However, these working landscapes are interrupted by extensive road networks in the south, and to a lesser extent in the north. Road networks create hazardous conditions for animals that need to disperse to complete their life cycles.

Table 1. Proportion of woodland, wetland, and human activities: Canadian Shield and Limestone Plain within the LC-KFLA Plan area. Areas do not add up to 100% because LIO does not classify some community types.

	Canadian Shield (Total Area 225,451)		Limestone Plain (Total Area 205,442)	
	Area	**Percent**	**Area**	**Percent**
Wetlands and Water Bodies	42,777	19%	39,630	20%
Woodlands	146,468	65%	64,004	31%
Pits and Quarries	1,623	0.7%	2,200	1.0%
Built-up Areas	417	0.2%	7,829	3.8%
Roadways (length)	1,494	0.6 km per ha	2,867	1.4 km per ha

4.0 Natural Heritage Plan Criteria

Criteria for mapping in the second draft of the Plan, and a summary of the changes from the preliminary criteria as a result of consultation (described in Section 7), are shown in Table 2.

The general philosophy for constructing the Plan was first, to identify features that should be included based on their significance to the natural heritage of the region. Second, the Plan identified a certain width of lands adjacent to the feature: the most appropriate place to identify building blocks on protected areas that would be most likely to improve their size, configuration, and connectivity, and thus increase their viability. These areas were then weighted according to their significance to the feature. These were called "buffers" in this report. The word buffer tends to have multiple meanings in ecological and Geographical Information System (GIS) parlance. However, there are no other words that would describe the areas adjacent to features so succinctly or specifically (for example words such as "adjacent lands" have very specific meanings in Ontario because they are regulated by the Provincial Policy Statement). The ecological buffer is the area which should not be developed or disturbed around a feature; whereas the GIS buffer gives higher weight to properties that are within a specific distance of the feature.

The philosophy for map weighting is to give more weight to properties (areas) that are adjacent or within a certain distance (called a buffer in this report) of protected lands, Provincially Significant Wetlands (PSWs), Areas of Natural and Scientific Interest (ANSIs), and other features outlined Table 2. Buffers are discussed by Environment Canada's "How Much Habitat is Enough?" (2013) as providing a protective function between the feature and adjacent development, but also as incorporating the "Critical Function Zone" of the feature, on which many of the species that inhabit the feature rely for additional habitat. The land adjacent to a significant feature would therefore have the highest potential to support functions critical to the feature. The mapping of buffers is based on a width that captures most important areas adjacent to the feature based on ecological and protective functions. For example, buffers adjacent to PSWs correspond with the width of adjacent lands recommended by the Natural Heritage Reference Manual (MNRF 2010), which notes that 120 metres is the area within which development has the potential to affect wetland function.

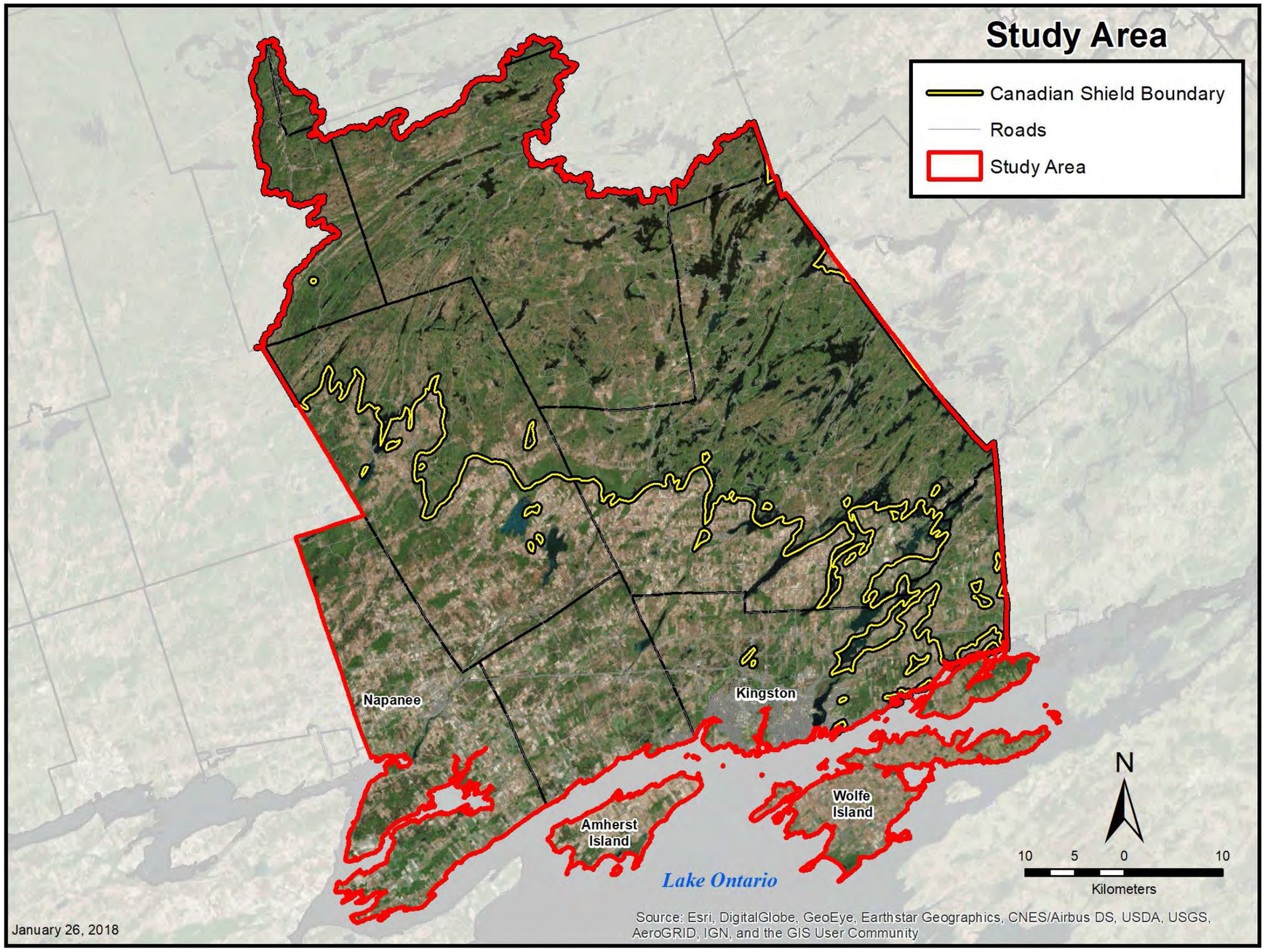


Figure 1. Aerial photograph of the LC-KFLA Study Area

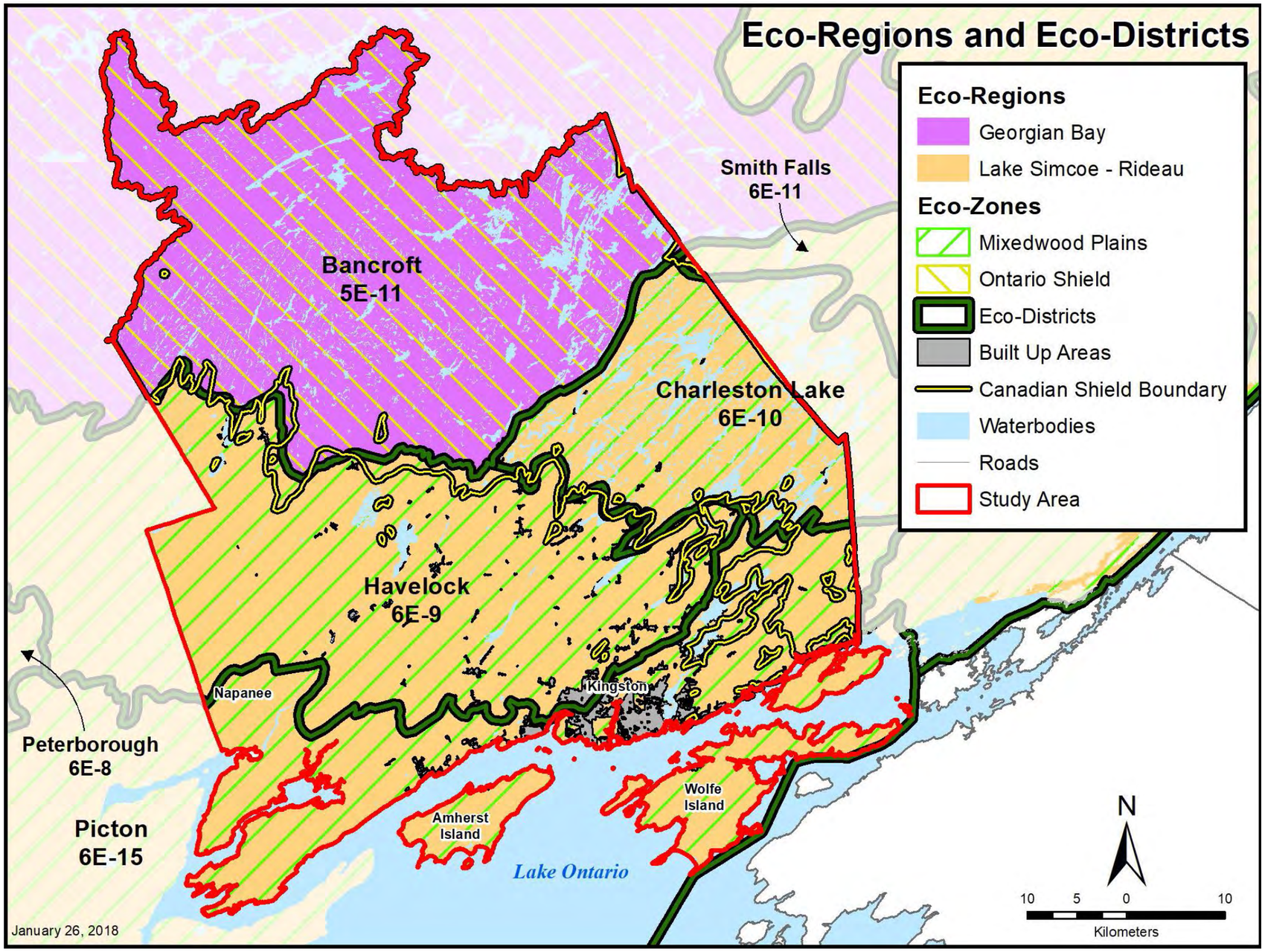


Figure 2. Ecoregions and Ecodistricts mapped by MNRF within the Study Area.
Note that Ecodistrict 6E-10 (Charleston Lake) is the Frontenac Axis: an area where granitic bedrock extends to Lake Ontario.

This width was also selected because the ecological buffers defined in Ministry's Natural Heritage Manual are the minimum buffers deemed needed. There is a section in the Manual that clearly outlines that other specific studies suggest that some of the defined ecological buffers should be wider. This is true for riparian areas around watercourses, for example, where 30 m is defined as the minimum, but in order to maintain habitat and ecosystem functions, it has been suggested in specific studies (a number are outlined in the Ministry's manual) that it should be increased to 50, 60, or even 100m or greater depending on the species or ecosystem function the feature must maintain. For example, 50 m along watercourses was used to incorporate a broader ecological focus, as these areas are often under great threat and are highly important for many species and for connectivity across the landscape.

Finally, LC-KFLA's Plan is a tool to be used mainly to focus a limited volunteer base and funds on the areas where the highest conservation value can be achieved for the effort and funds. Thus, the weights and buffers are based on the consensus provided by the group, by consultations with other groups, and consultation with experts, on what should be of high conservation priority.

Table 2. List of Criteria used in the Plan: Bold type indicates change due to consultation

Criterion	Buffer
Canadian Shield	
Significant Wetland	50m **increase to 120m**
Wetland >30ha	50m
Wooded Area > 60 ha	None
Interior forest - top 20% in size	None
ANSI **+ Candidate ANSIs**	100m **increase to 120m**
Headwater Lake Areas - top 20% in elevation	50m **increase to 1km**
Lake Trout Lakes	50m; **may increase to 300 m in future**
Protected Lands	100m
Watercourse	50m
Waterbody	50m
Limestone Plain	
Significant Wetland	50m **increase to 120m**
Wetland – > 30 ha	50m
Wooded Area – top 20% in Size	None
ANSI **+ Candidate ANSIs**	100m **increase to 120m**
Headwater Lake Areas – top 20% in elevation	50m **increase to 1 km**
Lake Trout Lakes	50m
Protected Lands	100m

Criterion	Buffer
Canadian Shield	
Watercourse	50m
Waterbody	50m

The most important database available for completion of the Plan was Land Information Ontario (LIO), a spatial database that incorporates the information on topographic mapping (Spectranalysis 2004). Information on woodlands, wetlands, and watercourses was initially based on interpretation of aerial imagery (used in development of topographic maps by cartographers), but many layers have been refined. The database is based primarily on aerial photographs and different layers are updated at different times, with some layers more frequently updated than others. It includes (dates in brackets are dates when information was updated in mapping within the Plan area, if available):

- roads, railways and trails (2001-2013)
- urban areas (2007)
- lakes, rivers, streams and wetlands (1998-2016)
- wooded areas (2003-2014)
- active and inactive quarries (2006-2014; with active quarries being updated more recently than inactive quarries)
- elevations
- official names and boundaries
- management and classification information

Some information is refined through further investigation, which may include ground-truthing. For example, boundaries of evaluated wetlands, including Provincially Significant Wetlands (PSWs), and some wetlands that have been evaluated and found to be non-provincially significant are updated relatively frequently. However, LIO mapping may have inaccuracies at the higher resolution, small spatial scale.

Mapping criteria focused on inclusion of core features (woodlands and wetlands of appropriate size and shape, previously identified significant wetlands, and other significant areas) and connections or 'linkages' (generally associated with watercourses). As discussed in Section 3, the mapping criteria were different for the Canadian Shield and Limestone Plain, to respond to the differences in landscape context associated with the differences in landscape cover.

4.1 Core Areas

4.1.1 Wetlands

> *Wetlands are habitats forming the interface between aquatic and terrestrial systems. The ecological, social and economic benefits that can be ascribed to wetlands are substantial. They are among the most productive and biologically diverse habitats on the planet* (Natural Heritage Reference Manual 2010).

A high priority has been set on identifying and mapping significant wetlands and other water-based features for this Plan. Throughout the Plan area, wetlands are some of the most important features in the landscape, since they tend to support a disproportionately high biodiversity (for their size) of flora and fauna, are important for connectivity, and have a large number of ecological functions. As can be seen in the illustration below, wetlands are often composed of many diverse communities in a small area, because different plant species thrive in different water depths, microclimatic conditions, sediments, and flows.

Figure 3. Google Earth image example of a wetland in Frontenac County, showing multiple vegetation communities that foster diversity, and forested neighbouring upland habitat that provides adjunct habitat for wetland-dependent wildlife

Land Information Ontario provides a publicly available source of wetland mapping. The Ontario Wetland Evaluation System (OWES) provides guidance for finer mapping of wetlands, and an assessment of wetlands' significance. The evaluation is based on their biology (which includes size and diversity), hydrology, social value, and special features of a wetland. For wetlands that have been evaluated, these attributes have been determined through detailed aerial photo interpretation and field surveys. However, many wetlands have not been evaluated by the Ontario Ministry of Natural Resources and Forestry, especially those in regions where there is little development and where wetland and forest cover are very high.

Some of these attributes (such as hydrology, size, and diversity) can be determined through GIS analysis which, in OWES methods, is accompanied by aerial photo interpretation. In addition, some ecological functions can be inferred through GIS. The mapping approach used by LC-KFLA incorporates all GIS information on wetlands: it includes provincial mapping of PSWs and evaluated wetlands, as well as mapping in LIO. In general, large wetlands, which can be determined through GIS analysis, are likely to have more ecological functions than small wetlands: they will support more diversity of vegetation communities and therefore more species.

The wetlands mapped for this project are shown in Figures 4 and 5.

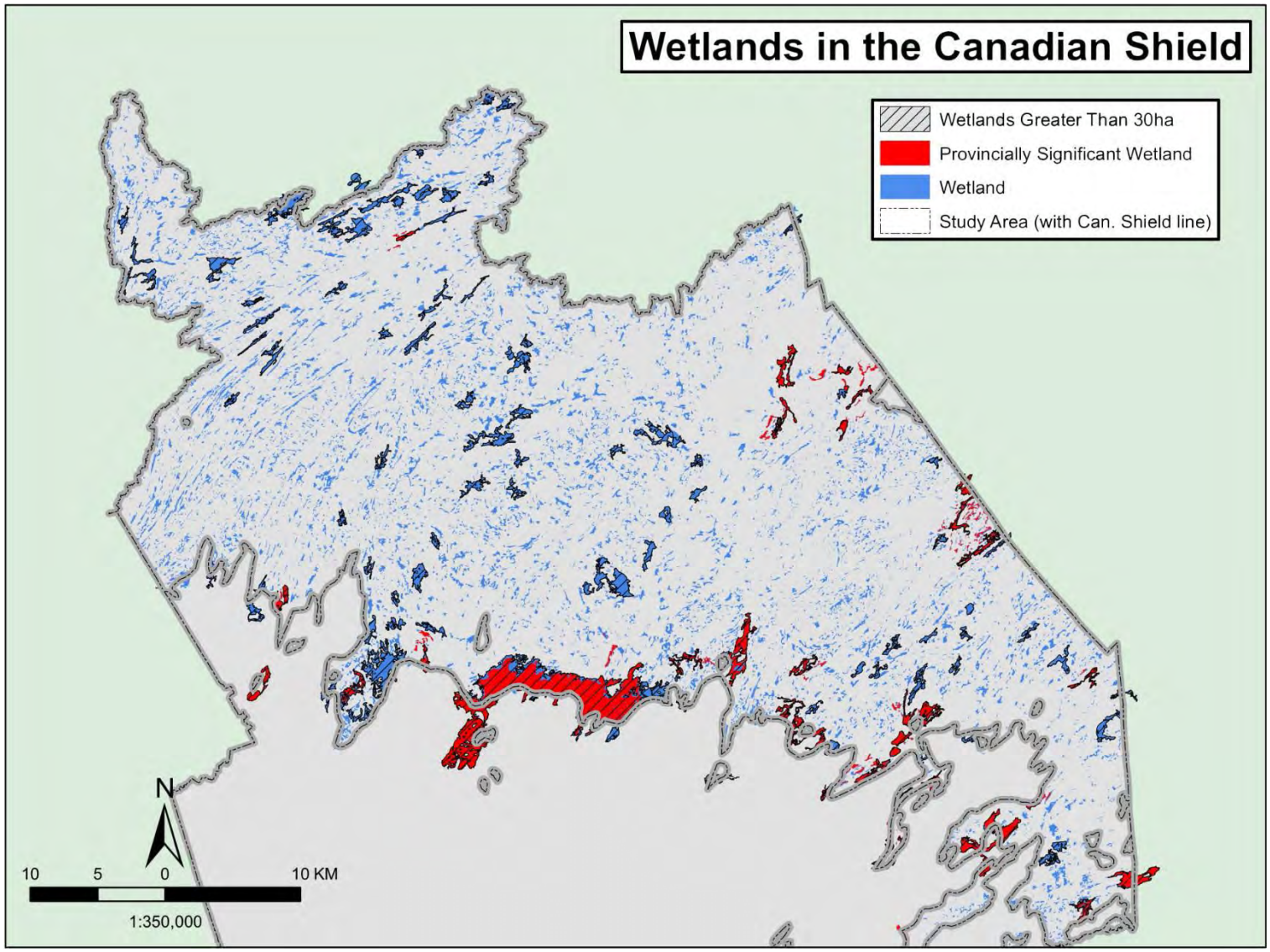


Figure 4. PSWs and Wetlands 30 ha or greater on the Canadian Shield.
Note that wetlands that extend across both regions are shown in their entirety.

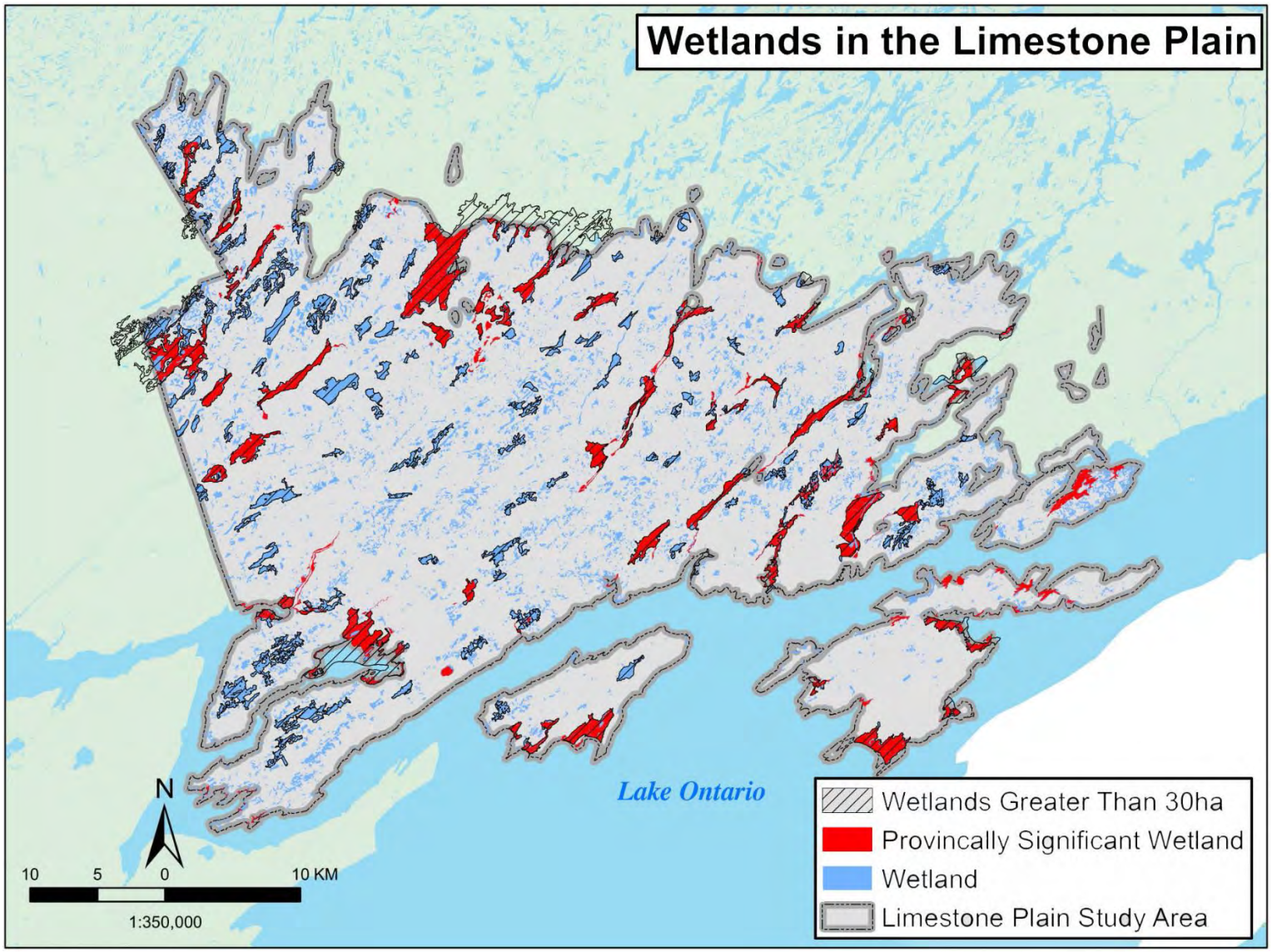


Figure 5. Wetlands over 30 ha and PSWs on the Limestone Plain.
Note that wetlands that extend over both regions are shown in their entirety.

The main limitations of mapping wetlands in this study area were:

- Wetland boundaries are not always evident in aerial photography, particularly boundaries between forests and forested wetlands that can resemble forests very closely. Where wetlands have been evaluated with ground-truthing, the boundaries are more accurate.
- There are four types of wetlands: open wetlands include marsh, bog, and fen and closed wetlands are classified as swamp, whether dominated by shrubs or trees. Habitats are different within each wetland type. The wetland type can be important for determining which species are found in the wetland; especially Species at Risk which are highly specific in their habitat needs. For example, least bittern, considered Threatened in Ontario, occurs only in certain marshes dominated by cattail and other robust emergent plants. Wetland type can be difficult to determine from aerial photography; for example, marsh can be difficult to separate from bog and fen. Interspersion (the amount of vegetation in relation to water) is extremely important to a wetland's ability to support breeding waterfowl, but the finer points of interspersion may not be reflected in mapping. Many open wetlands have several communities visible in aerial photography. These details may not be reflected in Land Information Ontario mapping although they should be picked up in wetland evaluations.
- Provincially Significant Wetlands are occasionally evaluated through aerial photo interpretation, with less intensive (or no) ground-truthing. Nonetheless, the wetlands evaluated through OWES likely have had a higher level of scrutiny than many unevaluated wetlands. In addition, conservation authorities may undertake wetland evaluations and aerial interpretation to map wetlands more accurately.

Approach to Mapping and Modifications Through Consultation

Provincially Significant Wetlands are mapped as core areas. Core areas also include other wetlands 30 ha and larger, as significance of many wetlands has not yet been evaluated and, as noted above, larger wetlands are an important measure of high function. This was based on the recommendation of Environment Canada's How Much Habitat is Enough? (2013) that wetlands over 30 ha be protected. The approach to mapping wetlands was not modified through consultation.

4.1.2 Lands Adjacent to Wetlands

The Plan maps the 120 m of upland habitat adjacent to wetlands because it has particular significance to the wetlands that form core features within the Plan. Adjacent lands have been defined in the Natural Heritage Reference Manual (MNR 2010) as the lands within 120 m of a Provincially Significant Wetland boundary. This is because many wetland-dependent species use neighbouring uplands as adjunct habitat where they find, for example, nest sites, foraging areas, song perches, and overwintering habitat. The functional area adjacent to a wetland is called the Critical Function Zone. Though many species use habitat more than 120 m from the edge of a

> *Adjacent lands are defined in the PPS as "those lands contiguous to a specific natural heritage feature or area where it is likely that development or site alteration would have a negative impact on the feature or area."* PPS, 2014

wetland (for example turtles in search of nesting areas), 120 m captures the upland habitat most often used by wetland-dependent species. It also captures the area within which a wetland tends to fluctuate depending on yearly fluctuations in moisture. In addition, 120 m is the area adjacent to a wetland where there is the highest probability of impacts from surrounding development: such as impacts from contaminants, surface runoff, noise, light and excess heat, and drying winds created by pavements and other hard surfaces.

Figure 6. Google Earth example of an open wetland in Lennox and Addington County where forested adjacent uplands provide habitat for foraging and overwintering frogs that breed in the wetland

The PPS policies only partially protect adjacent lands. Development can (and frequently does) occur within lands 120 m from wetlands if the ecological function of the adjacent lands has been evaluated and it has been demonstrated that there will be no negative impacts on the natural features or on their ecological functions. But many of the functions of adjacent lands are hard to measure, and studies may overlook their importance. Environment Canada (2013) notes that the most important upland area adjacent to a wetland in terms of the Critical Function Zone is within 50 m. In practice, as land uses change from rural to urban, buffers put in place to protect Provincially Significant Wetlands from development extend approximately 30 m (or less) from the wetland boundary, often largely based on the zone within which water quality impacts are attenuated, and on protection of wetland tree rooting zones. Buffers from non-provincially significant wetlands are frequently less than 30 m.

Approach to Mapping and Modifications Through Consultation

The Plan includes the entire adjacent land boundary (120 m) in its core areas. The Plan thus prioritizes acquisition of properties with a high level of function adjacent to wetlands. Acquisition of land within 120 m allows protection of a large portion of land within the Critical Function Zone and focuses on the area where the wetland is most likely to be affected by development should the land use change. This boundary was modified as a result of communications received during consultation from the previous boundary of 50 m.

4.1.3 Woodlands

Woodland habitats are particularly important environments as they provide habitat for a high diversity of animal and plant life, as well as being some of the most important areas

for carbon storage and other ecosystem services. Environment Canada (2013) and the Ontario Ministry of Natural Resources and Forestry (2010) evaluate the importance of woodlands based on size, condition, shape (blocky or round shapes are more functional than narrow linear shapes), diversity of communities and species, and special features. Special features can include locally, regionally, and provincially rare species, as well as so-called conservative species that are dependent on a few, specialized habitats. Woodland size and shape, which are discernable through GIS analysis, correlate with many attributes of significance: diversity of microclimates created by topographic and soil variations, which foster a high diversity of vegetation communities and species, including conservative species. The Plan uses criteria for including woodlands related to attributes that could be measured by GIS: particularly their size and configuration.

Figure 7. Google Earth example of a large, contiguous woodland and wooded wetland complex in Lennox and Addington County that would include large areas of forest interior habitat, contrasting with smaller fragmented woodlands to the east and southeast

On the Canadian Shield, the woodland cover is so high (65 % of the Plan area on the Canadian Shield) that woodlands over 60 ha are included but given a moderate weighting (see Section 6 for a discussion of weighting). On the Limestone Plain, the Plan gives woodlands that are the top 20% in size of the remaining woodlands the highest weighting. On the Limestone Plain, the size of these woodlands range from ~5 to 690 ha, with just 16% of these over 60 ha in size. The mean size of woodland in the top 20% is ~ 40 ha, but the median size is only ~15 ha.

GIS analysis assessed the optimal shape of woodlands by measuring so-called "forest interior": the sheltered area within the depths of a forest that is protected by the forest edge. Forest-interior is often moist and sheltered, and supports higher numbers of invertebrates that provide prey for a variety of wildlife. The Ontario Ministry of Natural Resources and Forestry (MNRF 2015a) notes that forests with areas 200 m from the forest edge are candidate significant wildlife habitat, and this provided the focus for the mapping (Figure 7).

One of the most recent findings in research related to landscape ecology is that the number and type of species that inhabit woodlands is influenced as much by the woodlands' surroundings as by their size and shape. Woodland size and shape are highly significant in the Limestone Plain where forest cover is less than approximately 60%. In areas where forest cover is greater than 60%, such as the Canadian Shield (where forest cover is 65%), the size and shape of individual woodland patches is less important. In the Canadian

Shield, only woodlands larger than 60 ha adjacent to a waterbody or watercourse were included as core areas in the Plan.

Approach to Mapping and Modifications Through Consultation

Figures 8 and 9 provide an illustration of woodlands included in the mapping. These include:

- Woodlands on the Canadian Shield that are greater than 60 ha in size and within 60 m of a waterbody or watercourse
- Woodlands with the top 20% of forest interior (200 m from the forest edge) in the Canadian Shield
- The top 20% in size of woodlands in the Limestone Plain

Forest interior areas were included as a result of comments received during consultation.

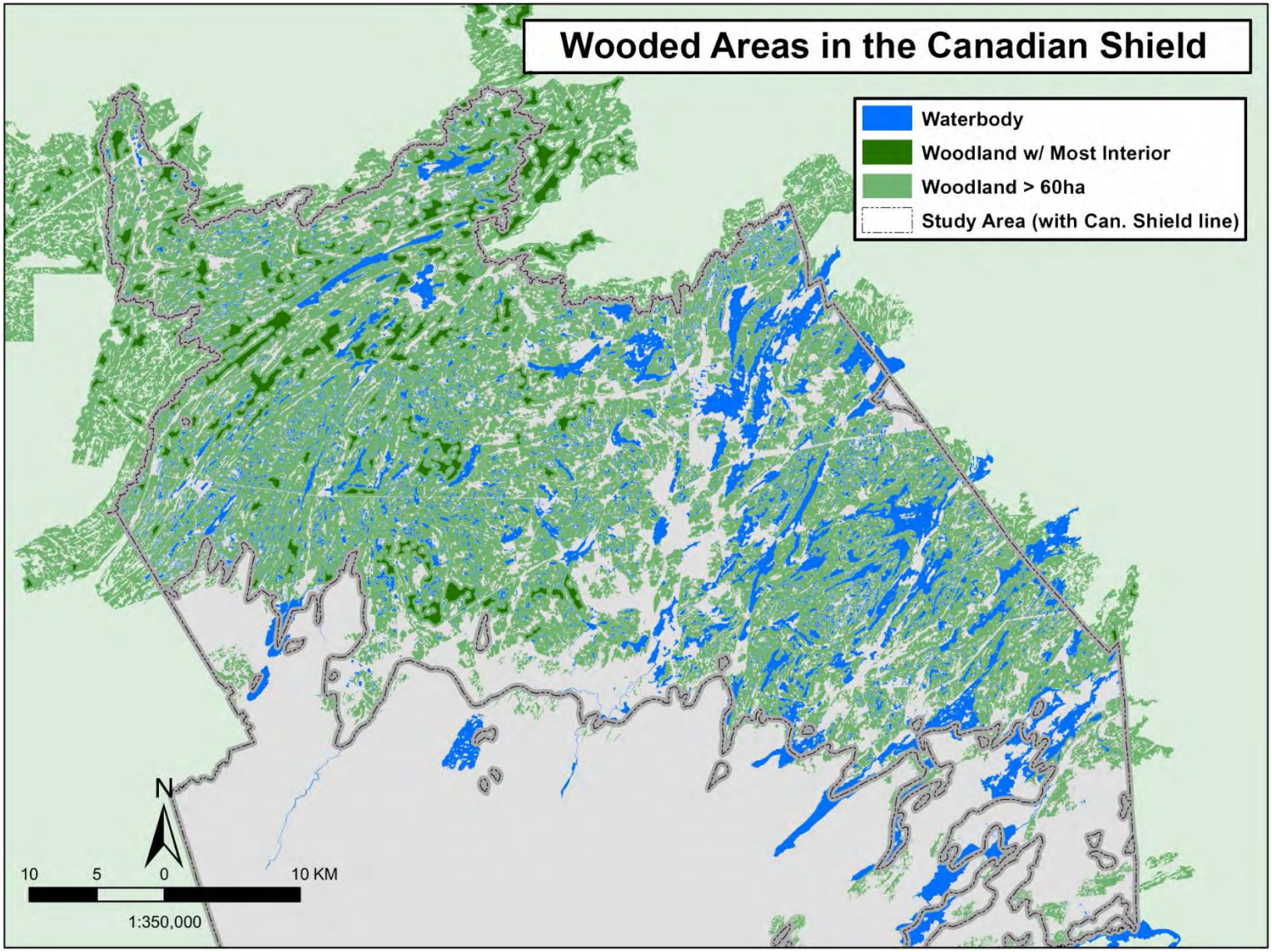


Figure 8. Forests over 60 ha, forest interior areas, and water bodies on the Canadian Shield.
Note that wooded areas that extend over both regions are shown in their entirety.

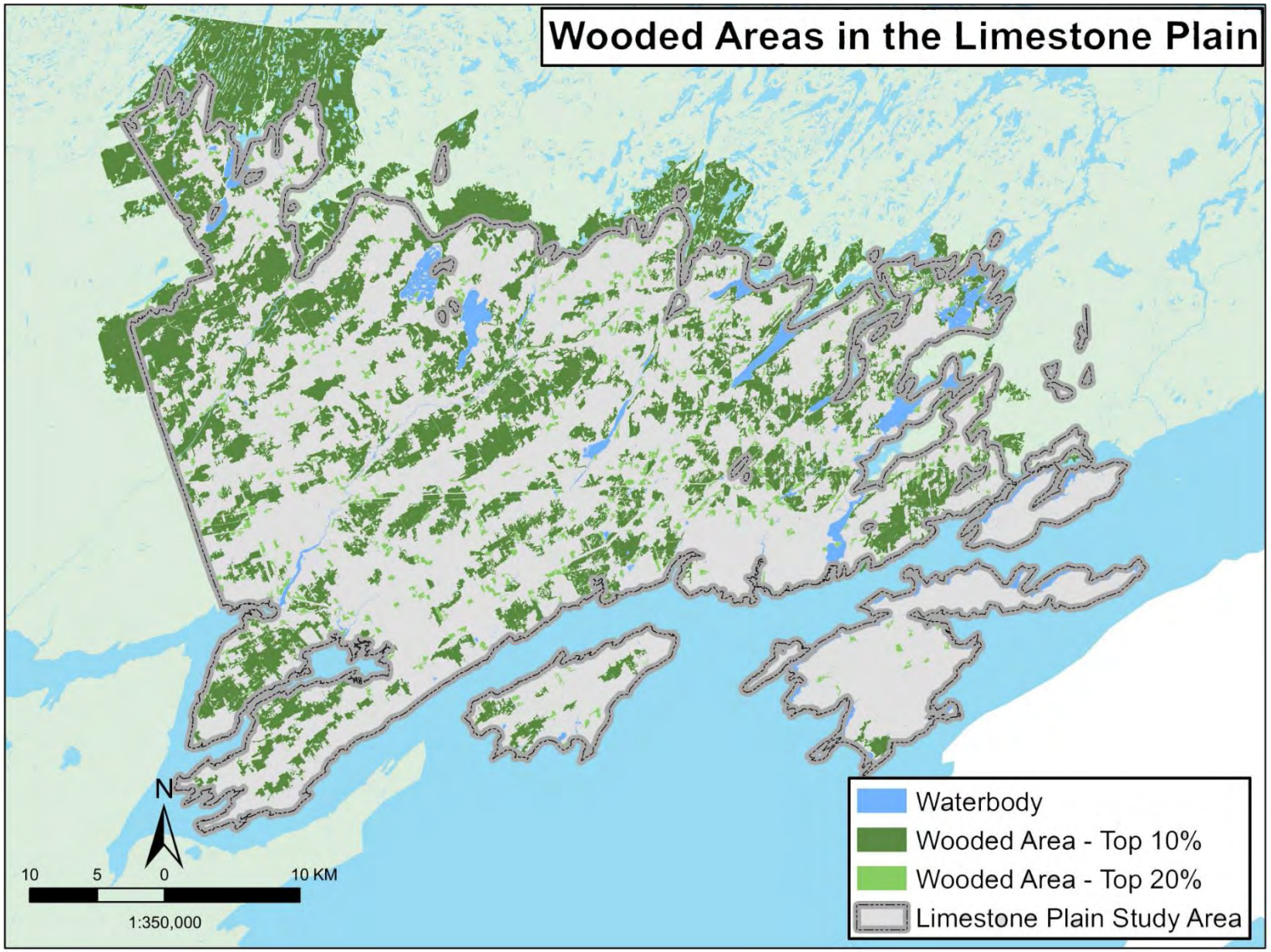


Figure 9. Forests in the top 10% and 20% in size, showing adjacent waterbodies, on the Limestone Plain.
Note that wooded areas that extend over both regions are shown in their entirety

4.1.4 Life Science and Earth Science Areas of Natural and Scientific Interest (ANSIs)

> *Areas of natural and scientific interest (ANSI): means areas of land and water containing natural landscapes or features that have been identified as having life science or earth science values related to protection, scientific study or education.* (PPS, 2014)

The Ontario Ministry of Natural Resources and Forestry selects Life Science ANSIs to represent "the best" of each representative landform / vegetation units within each Ecodistrict in Ontario (Ecodistricts in Ontario are illustrated in Figure 2: the study area contains portions of Ecodistricts 6E-8, 9, 11, 15, and 18, and 5E-11). They select these areas through a gap analysis for each Ecodistrict that indicates, through satellite imagery, the landform/vegetation units within the Ecodistrict, and whether there are landform/vegetation units that do not occur in protected areas and are therefore considered under-represented. The best areas of representation are then selected through more detailed investigations on the basis of size, condition, diversity, ecological functions, and special features. These ANSIs are shown in Figure 10.

The Natural Heritage Plan identifies ANSIs as core features. ANSIs are protected to a large extent by the Provincial Policy Statement, which does not permit development in a significant ANSI unless it has been demonstrated that there will be no negative impacts on the feature or its ecological functions, but some portions of ANSIs can be developed under this criterion. The importance of land adjacent to ANSIs is also considered in the Natural Heritage Plan. For example, development is not permitted on adjacent lands (defined by the Natural Heritage Reference Manual (2010) as lands within 120 m of an ANSI boundary) unless the ecological function has been evaluated and it is demonstrated that there will be no negative impacts on the feature or its ecological functions.

<u>Approach to Mapping and Modifications Through Consultation</u>

- The Plan includes all provincially significant Life Science and Earth Science ANSIs as core areas.
- The Plan also includes Candidate provincially significant Life Science and Earth Science features as the ANSI program has received a lower priority in recent years.
- The Plan includes a higher weight to lands within a 120 m buffer area adjacent to Earth Science and Life Science ANSIs (Table 2). The Natural Heritage Reference Manual (2010) stipulates that a 120 m Adjacent Lands boundary should be investigated adjacent to Life Science ANSIs if development is proposed as this is the area within which development is most likely to affect the feature; a 50 m buffer will be most likely to include any features that are present within the ANSI. The NHRM advises that a 50 m Adjacent Lands boundary should be investigated adjacent to Earth Science ANSIs should development be proposed within this area.
- Confirmed, provincially significant Life Science and Earth Science ANSIs were included in the initial Plan as core areas. On the basis of the comments received during consultation, Candidate Life Science and Earth Science ANSIs were also

added to the core area of the Plan. Candidate ANSIs are those for which preliminary gap analysis has been undertaken and the evaluation (which includes ground-truthing) has been conducted, but where the evaluation has not been reviewed by MNRF. The review might ultimately conclude that the candidate ANSI is not "the best", but the "second best", and would thus be more appropriately classified as a regionally significant ANSI, rather than a provincially significant ANSI. However, the inclusion of regionally significant ANSIs within the Plan is valuable in protecting important features specific to the Plan area. Figure 10 shows the provincially significant and candidate Life Science and Earth Science ANSIs mapped within the study area.

4.1.5 Headwater Lake Areas

The Ontario Headwaters Institute (2017) defines headwater areas as surface drainage features, including ephemeral and intermittent streams; groundwater recharge areas and aquifers; areas of groundwater discharge and upwelling; vernal pools, spring-fed ponds, and off-line wetlands (i.e. wetlands that are not fed by watercourses); and first and second-order streams (i.e. streams with no tributaries or streams that result from convergence of two first order streams, respectively).

Headwater areas serve important functions (Ontario Headwaters Institute 2017). For example, headwaters and their catchment areas (land area drained by small headwater streams) have the following important attributes:

- They comprise the majority of both the total surface area and stream length in most watercourses;
- They contribute the majority of flow to most watercourses;
- They help regulate that flow – through natural cover, soil type, and surface geology – to both surface and groundwater, thereby reducing both flooding and erosion;
- They furnish key habitat types for the breeding, feeding, and sheltering of upstream species, thereby harbouring a large portion of these species, and in many ways the base of a watershed's biodiversity; and,
- Nurture downstream ecosystems by providing significant portions of a stream's nutrients, organic material, and sediment.

In addition:

- Headwater streams and catchments are as important to terrestrial insects, a key element of the food chain, as they are to aquatic species;
- Forest cover in headwater areas and along small streams protects local waters, and their biodiversity, from thermal heating;
- Headwaters may be sensitive to small volumes of pollutants; and,
- Headwater areas may become both less resilient and increasingly important to watershed integrity in a changing climate.

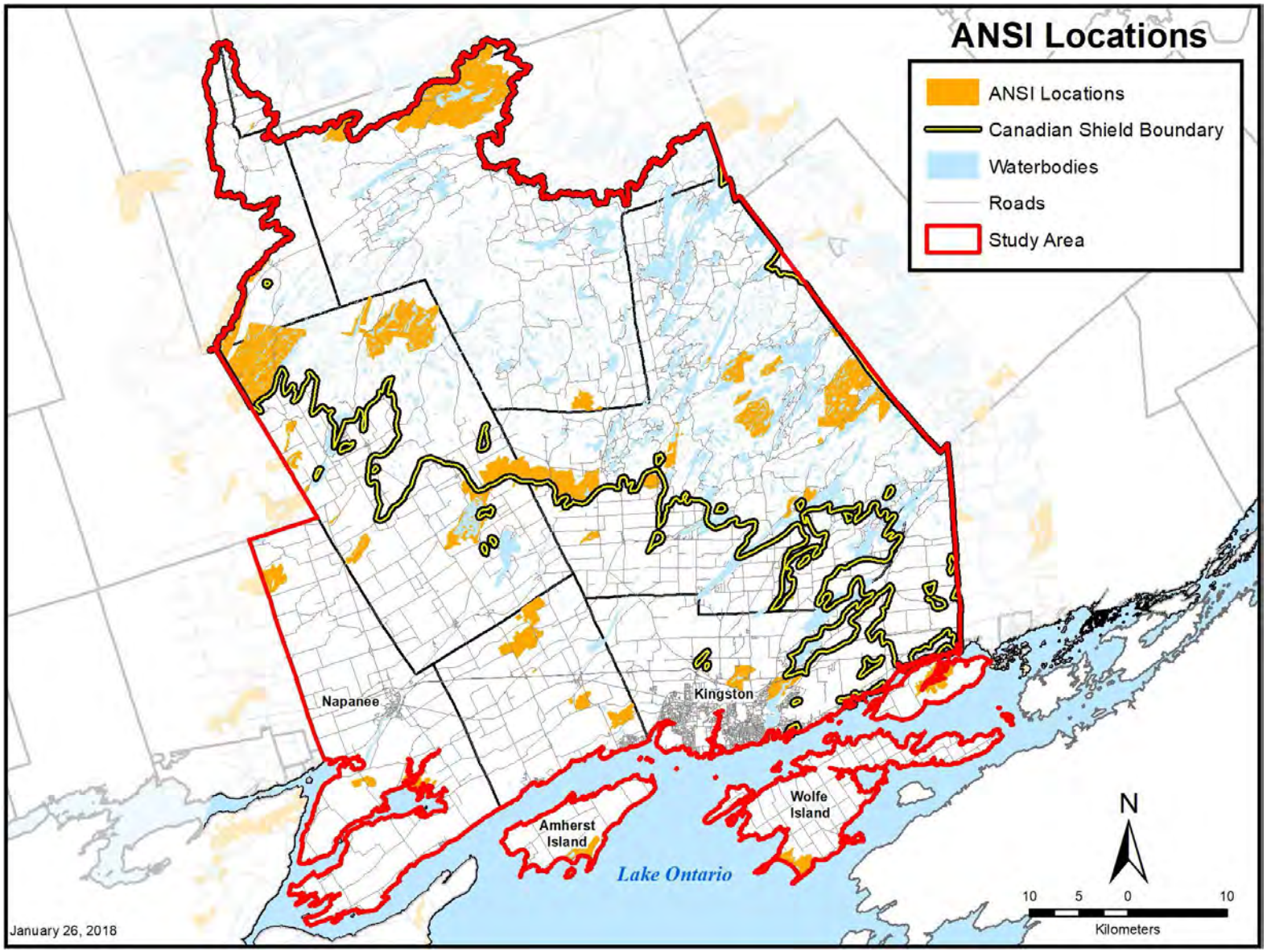


Figure 10. Provincially significant and Candidate ANSIs in the LC-KFLA study area.

Headwater areas are of particular interest to LC-KFLA because they are important to many of the functions in downstream lakes, streams, and wetlands. Headwater areas have not previously been mapped in the Plan area, and techniques for deriving boundaries for headwater areas are computer intensive. For this reason,contour mapping was used to identify the highest elevations to give a general location for headwaters. The top 20% in elevation of waterbodies within each watershed was used as an approximation of high density of headwater streams, wetlands, and ponds. Figures 11 and 12 show the headwater areas that were included as core areas in the Canadian Shield and Limestone Plain respectively.

Approach to Mapping and Modifications Through Consultation

Headwater lakes were included conceptually in the first draft of the Plan, but were not mapped. Through consultation, techniques for determining headwater lake areas were further investigated, and at the suggestion of the Cataraqui Region Conservation Authority, mapped. The Mapping Committee used a 1 km buffer; headwater lake areas themselves constituted only a small proportion of the headwater area, and the larger area was included to capture the extensive network of small streams and adjacent uplands which feed into the headwaters and provide diverse habitats.

Lake Trout Lakes

The lake trout is the only major, indigenous sport fish species in Ontario that is adapted to oligotrophic lakes (i.e. lakes with low levels of nutrients, high dissolved oxygen levels, and typically deep areas with very cold water) (MNRF 2015b). lake trout lakes are rare (MNRF 2015b). Only about one percent of Ontario's lakes contain lake trout, but this represents 20-25% of all lake trout lakes in the world. In the Plan area, all but two of the lakes are considered "natural" Lake Trout lakes (i.e. they naturally support lake trout or have the capacity to be restored to support lake trout). Two lakes are considered "put-grow-take" lakes that are stocked to provide a recreational fishery, but may not have originally supported lake trout. The Frontenac County Official Plan lists 33 lake trout lakes with only 8 not-yet-at-capacity (an "at-capacity" lake is defined by the Lakeshore Capacity Assessment Handbook as one that cannot accommodate additional development without degrading water quality past a defined point). There are 8 lake trout lakes in Lennox and Addington County. Lake trout lakes (which are confined almost entirely to the Canadian Shield) are shown in Figure 13.

Lakes that support lake trout are indicative of an unusual microclimate, as they are cold and deep. Lake trout lakes were included in the Plan for their rare quality as cold-water fish habitat and for their potential to contribute to unusual, cold microclimatic conditions. In addition, these lakes may be some of the most vulnerable to climate change and so require greater protection.

Approach to Mapping and Modifications Through Consultation

The Plan included lake trout lakes and a 50 m buffer as a core area in the draft Plan, but increased their weighting on the basis of comments received through consultations with Frontenac County. The Ministry of the Environment and Climate Change (2016) notes that

the area within 300 metres of a lake or permanently flowing stream is the area of influence for phosphorus loading, (i.e. the area within which phosphorus from septic systems may move to the lake or stream). In future mapping updates to the Plan the buffer can be increased from 50 m to 300 m.

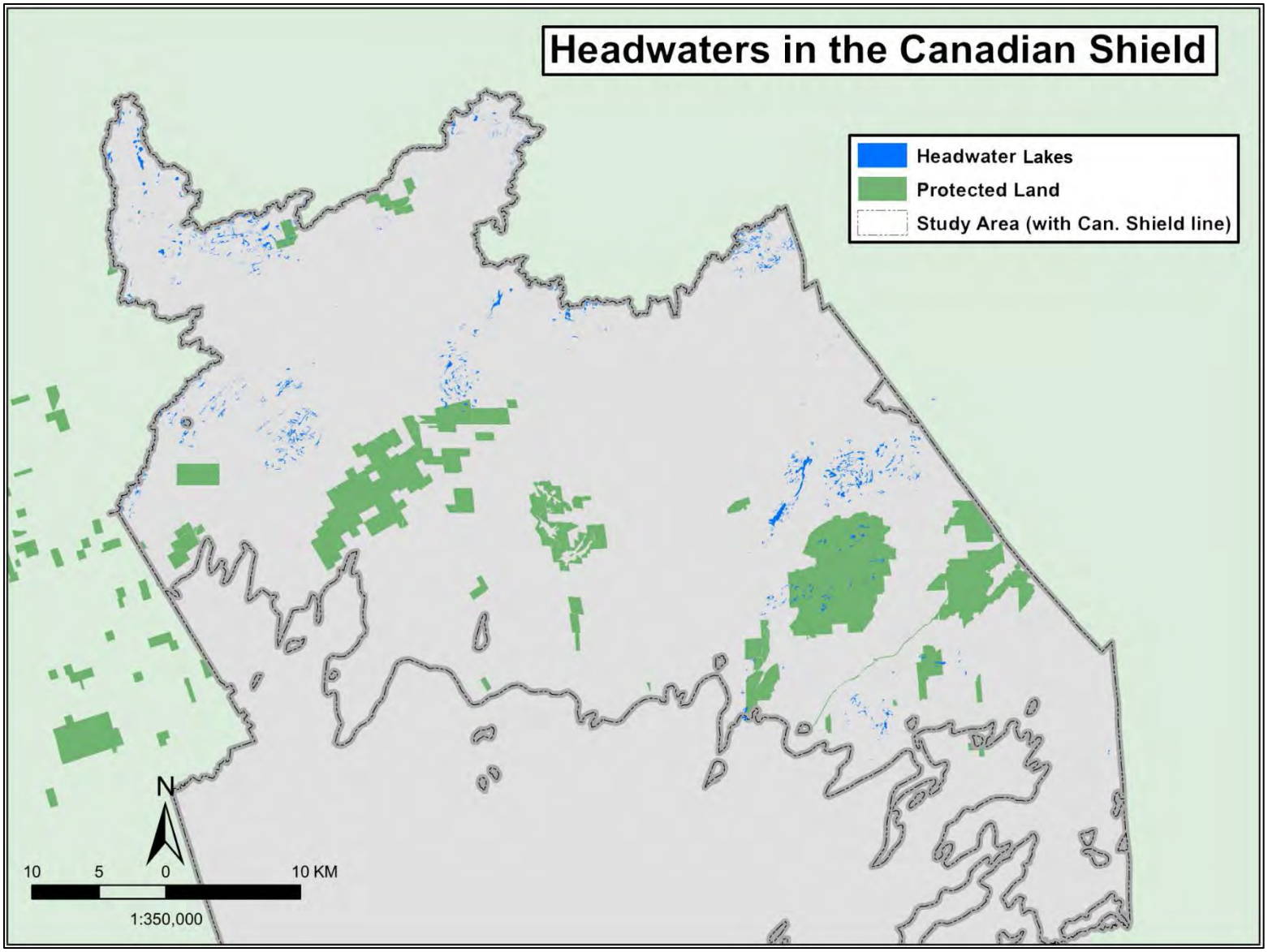


Figure 11. Headwater Lake areas on the Canadian Shield

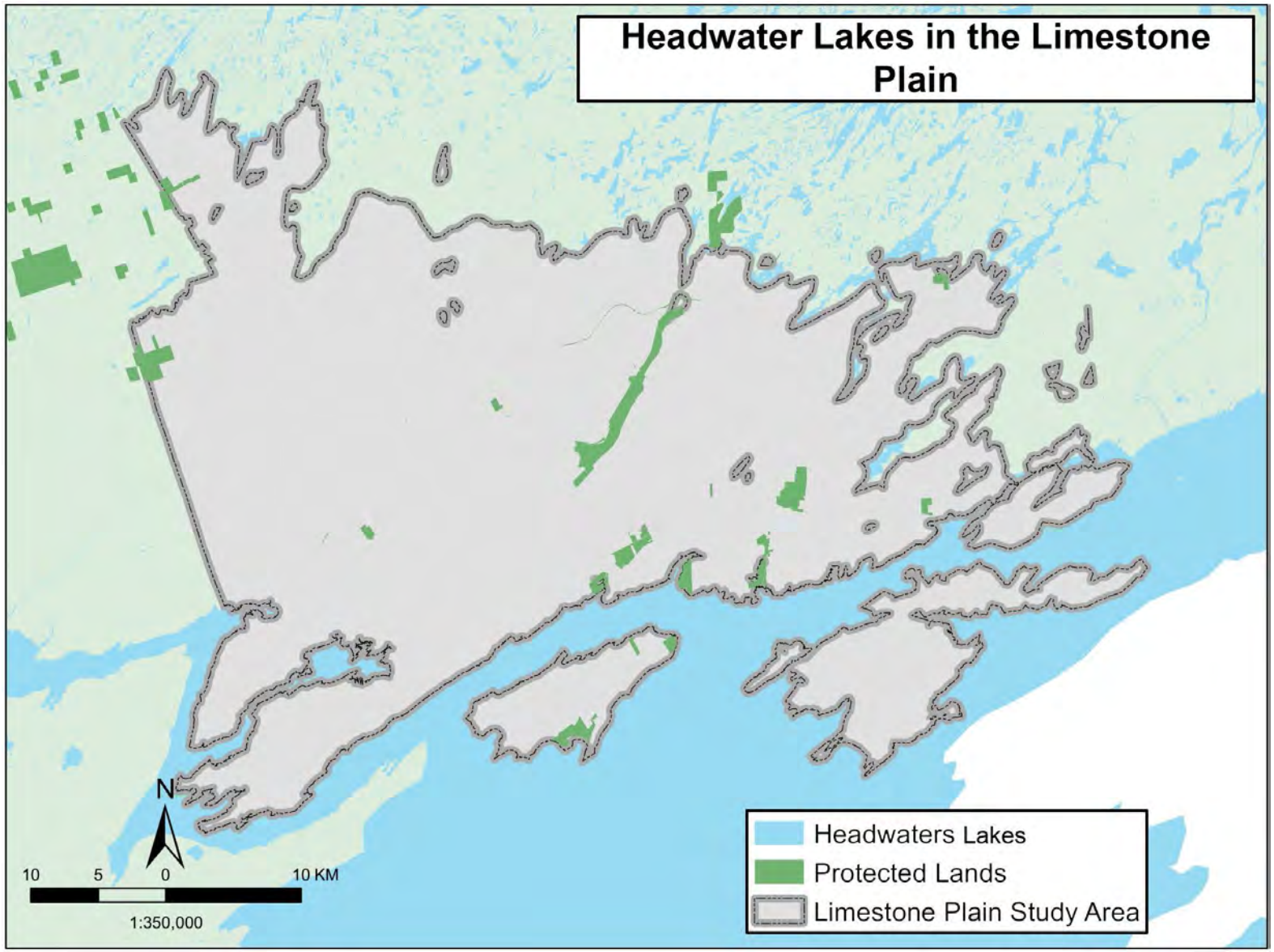


Figure 12. Headwater Lake areas on the Limestone Plain

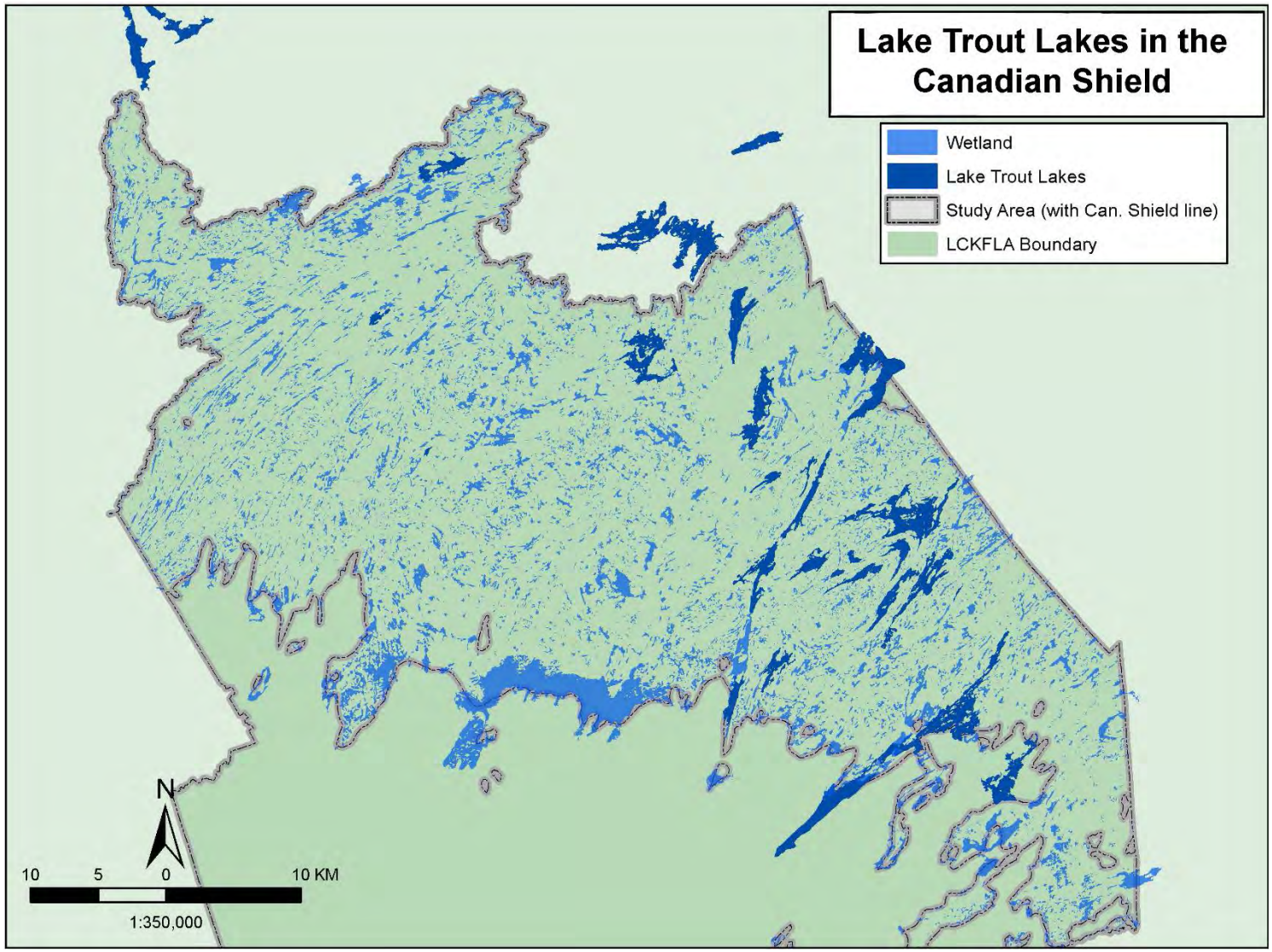


Figure 13. Lake Trout Lakes on the Canadian Shield.
Note that lakes that extend over both regions are shown in their entirety.

4.1.6 Protected Areas

Protected areas were included as core areas in the mapping (Figure 14); they are part of the 'base' natural areas that LC-KFLA will continue to build on and connect in the landscape. The LIO database includes areas under conservation easements and areas owned by the province (provincial parks and nature reserves), conservation authorities (conservation areas), or other land trusts. Since these lands were likely (though not always) purchased for their value as conservation lands, and since the intention is to preserve them as natural heritage features in the long term, they were considered important building blocks for the Plan. Protected areas shown in Figure 14 do not include all of the Nature Conservancy of Canada lands at this time: this is addressed in section 4.3.2.

Approach to Mapping and Modifications Through Consultation

Protected lands are shown in Figure14. They include the provincial parks and lands owned by land trusts, conservation authorities, Queen's University, and some of the lands owned by the Nature Conservancy of Canada. They were not weighted, as they are already protected and considered to be the 'base' natural areas as important building blocks for the Plan. However, the 100 m buffer adjacent to the protected area boundary was weighted as it is considered important to the functions of protected areas and is the area within which surrounding development is most likely to affect the feature. Protection of adjacent areas to protected lands would build on landscape connectivity of important habitat.

4.2 Connectivity and Linkages

There is an extensive discussion of the science behind the need for connectivity in the Natural Heritage Reference Manual (2010). Ideally, connections between patches of habitat should be designed specifically to meet the dispersal requirements of the species within core areas, and wide enough to provide linkage through inhospitable urban landscapes. However, when dealing with the limitations of available data, the most effective strategy is to map prospective linkages along watercourses. On the Canadian Shield, the extensive wetlands, watercourses, and forests within the landscape afford connectivity at a broad scale. Local connections may be important, but they cannot be discerned with the sources available.

4.2.1 Watercourses

Watercourses (Figure 15, 16, and 17) provide the most continuous connections available, particularly within the southern part of the study area. Watercourses with wider riparian corridors are of more value than those with narrow riparian corridors. Environment Canada (2013), based on their literature review, recommends a minimum of 30 metres of naturally vegetated habitat on both sides of streams.

Figure 15. Google Earth image from Lennox & Addington County as an example of the importance of watercourses for connecting patches of habitat in fragmented landscapes

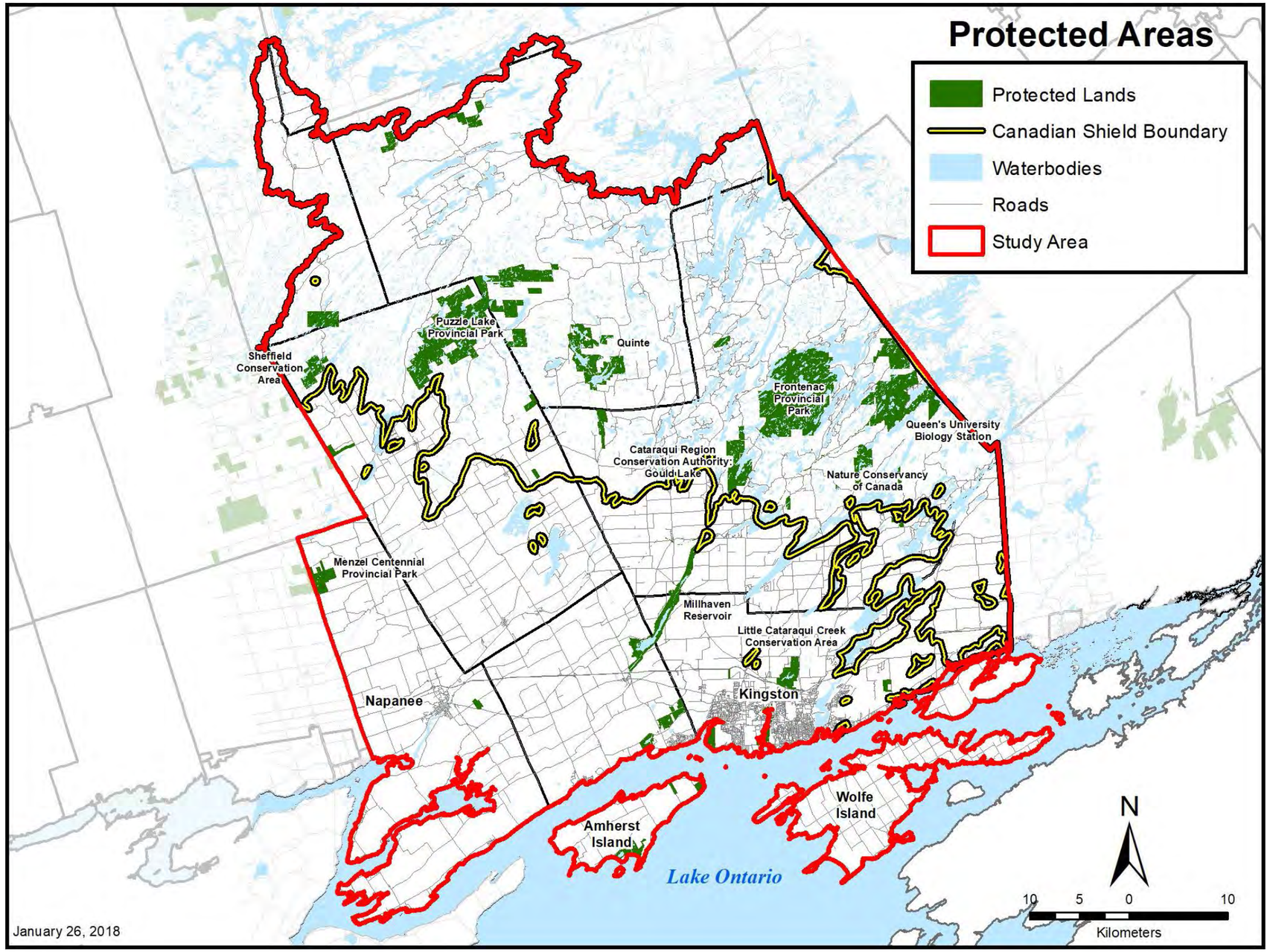


Figure 14. Protected areas within the LC-KFLA study area

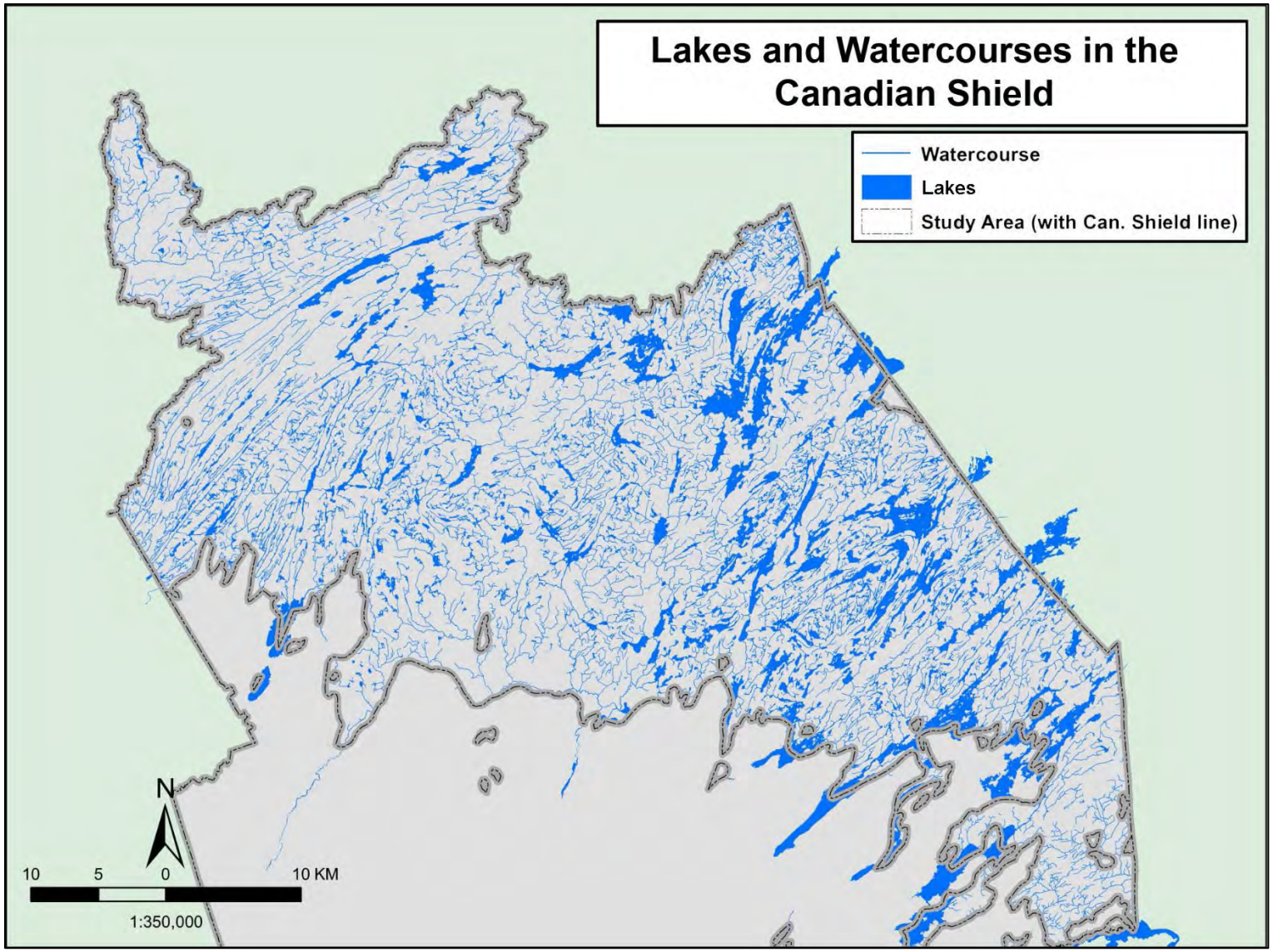


Figure 16. Watercourses and Waterbodies on the Canadian Shield.
Note that wooded areas that extend over both regions are shown in their entirety.

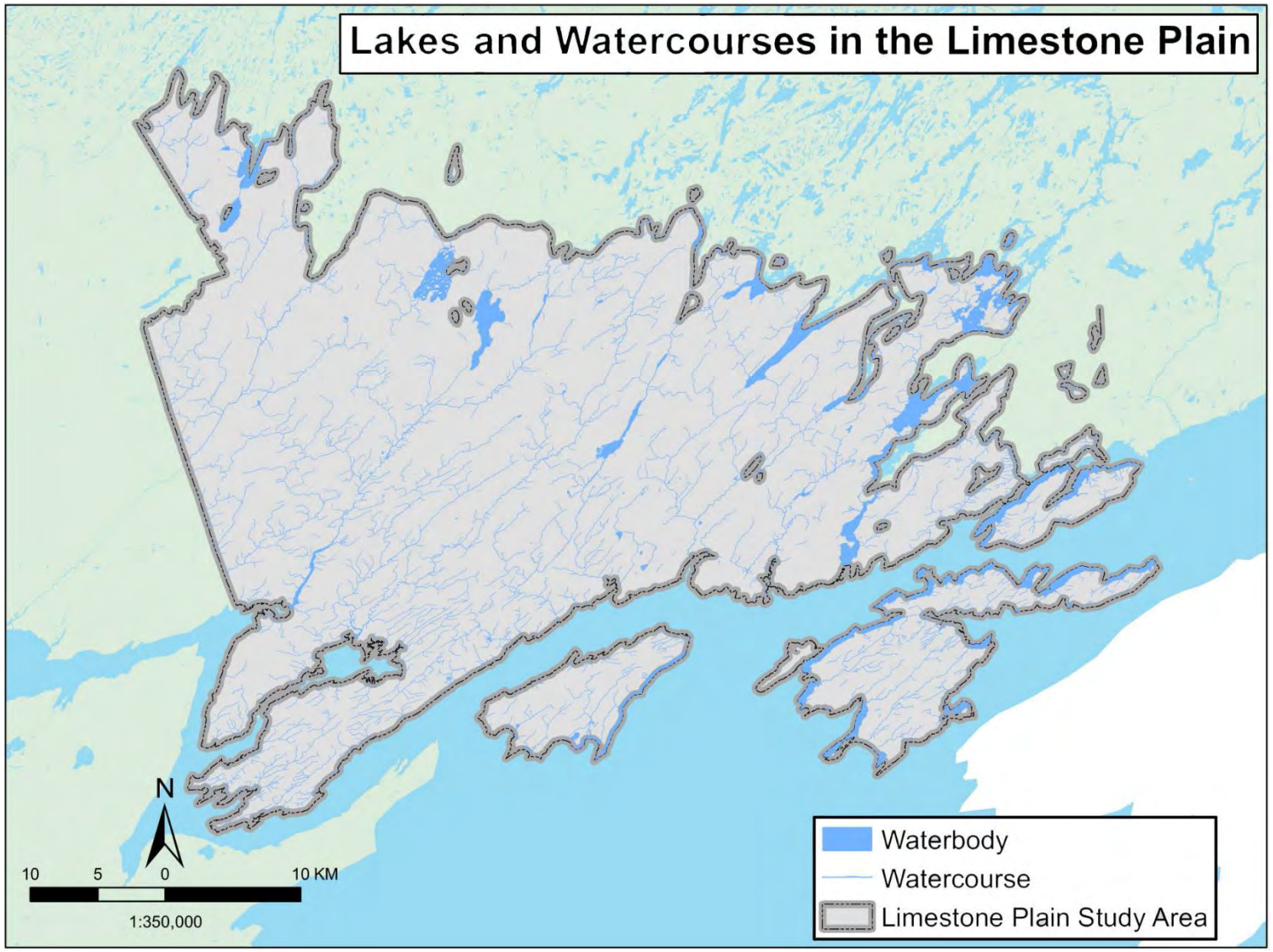


Figure 17. Watercourses and Waterbodies on the Limestone Plain.
Note that wooded areas that extend over both regions are shown in their entirety.

Approach to Mapping and Modifications Through Consultation
Watercourses were included as features that provide connection within the Plan. A 50 m area of riparian vegetation was included as a buffer on either side of the watercourse. As noted in Section 4, 30 m is defined as the minimum buffer to watercourses by the Natural Heritage Reference Manual (MNR 2010) but in order to maintain habitat for many species, or other ecosystem functions, specific studies have suggested that the buffer should be increased to between 50 and 100 m depending on the function that needs to be maintained.

Comments received during the consultations supported this approach to watercourse mapping. Environment Canada (2013; How Much Habitat is Enough?) notes that the provision of highly functional wildlife habitat may require total vegetated riparian widths greater than 30 metres.

4.2.2 Other Natural Heritage Systems

Natural Heritage System studies which overlap the LC-KFLA focus area have been conducted by the, County of Frontenac and the Cataraqui Region Conservation Authority. The linkages and priority areas shown by these municipalities were studied as an overlay to inform the connections and potential priority areas for the LC-KFLA Plan. The Cataraqui Region Conservation Authority completed a table that lists other natural heritage systems identified within the LC-KFLA area (Appendix 1). A summary of methods used to compile natural heritage systems in the LC-KFLA area is provided in Appendix 2.

The following additional layers from other groups are available:

- Nature Conservancy of Canada (priority areas),
- Adirondack to Algonquin (priority areas and connectivity data, mainly in the south),
- The Land Between (priority areas),
- The Cataraqui Region Conservation Authority's Natural Heritage corridors; and
- Linkage data from Frontenac County Natural Heritage Plan.

Approach to Mapping and Modifications Through Consultation
Some areas in the Plan study area are not covered by these priority areas and identified linkages, so there are gaps in the overall coverage. For this reason, these layers will be used as overlays and not additively in the raster mapping. These layers are considered qualitatively on top of other criteria mapping and weighting, and provide a further qualitative means of assessing and evaluating the LC-KFLA's priority areas of conservation effort.

4.3 Overlays that Add Landscape Context to the Plan

The following overlays were assessed to determine if they could be used as 'landscape context', additional features that can be taken into account when setting overall priorities. Some would be included in the other natural heritage systems discussed above, but they are discussed individually here because of their importance, and because new information on these features may become available outside the organizations discussed above. Overlays will be used qualitatively in the future to determine where LC-KFLA priority areas

overlap with priority areas identified by other groups, such as the Nature Conservancy of Canada and The Land Between. Overlays from other groups may be used when evaluating individual properties at a smaller scale. When a higher resolution analysis is required for particular areas, for example high-density regions of headwater lake areas or between other protected areas such as Puzzle Lake and Depot Lake and Frontenac Provincial Park, landscape context will be used. Future analyses will include analyses of this type of smaller spatial scale.

4.3.1 Alvars

Alvars are areas of thin soil over limestone bedrock where drought and extreme soil conditions have fostered a specialized plant community that is considered globally, nationally, and provincially rare. Alvars frequently support provincially rare flora and fauna species. The Plan area within the Limestone Plain is a particularly important site in Ontario for alvar communities (Figure 18).

Alvars were initially not included in the Plan because other groups, particularly the NCC (the Napanee Plain Natural Area Conservation Plan), are focusing on alvars in the Limestone Plain. However, it was apparent during the consultation that because of their importance to biodiversity, alvars need to be included in the mapping and the possibility of partnering with other groups for their protection considered.

Approach to Mapping and Modifications Through Consultation

The inclusion of alvars was strongly recommended during consultation. Alvars were therefore included in the Plan as an overlay to help inform priorities. While acquisition priorities need not necessarily include these areas, it may be possible to partner with other organizations to contribute to stewardship or management of adjacent lands.

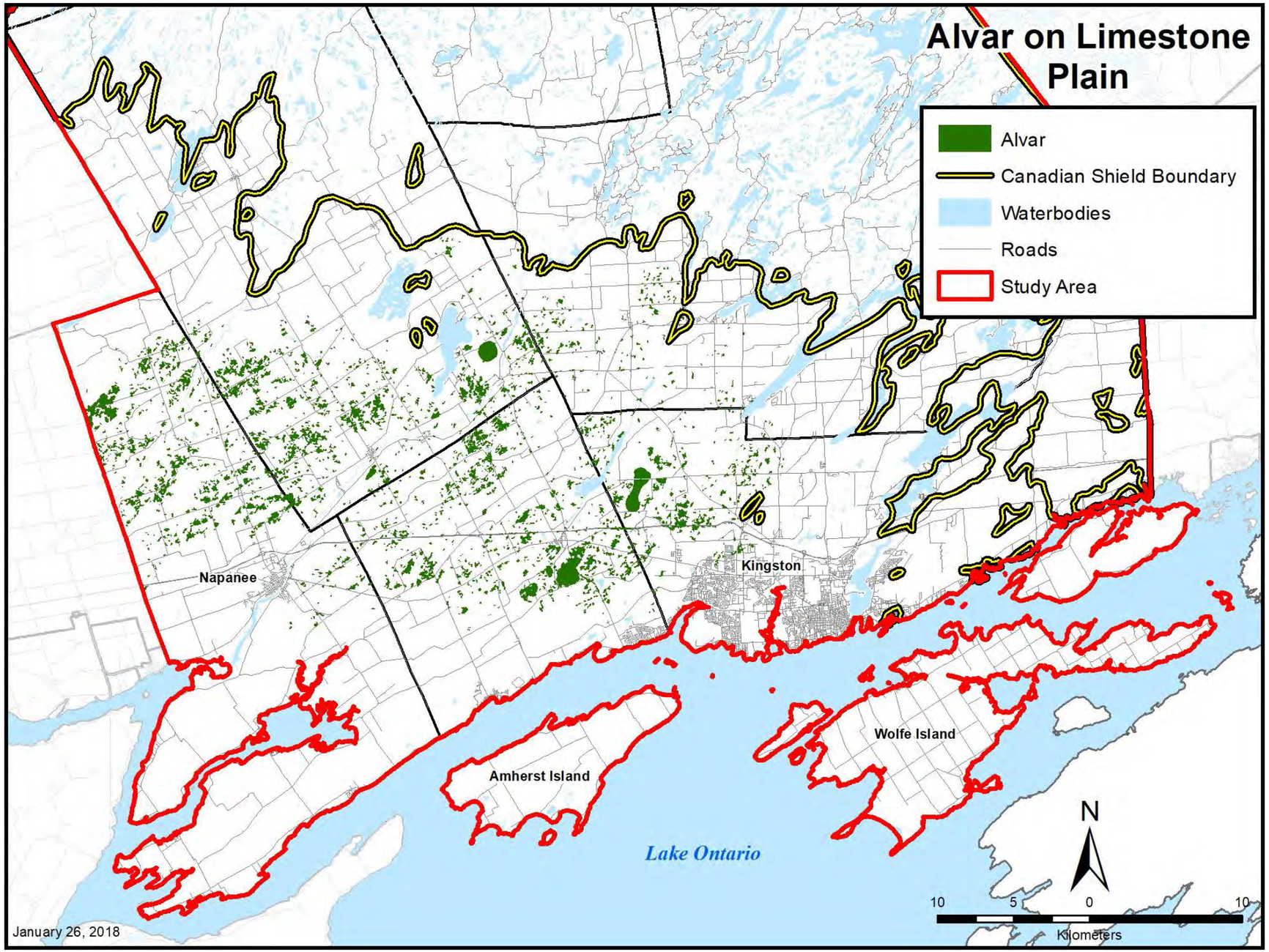


Figure 18. Alvars within the LC-KFLA Study Area

4.3.2 Nature Conservancy of Canada and The Land Between Priority Habitat

The Nature Conservancy of Canada (NCC) has identified areas of priority habitat that can be used to add weight to the scoring for patches within the Plan (Figure 19). The NCC assesses "conservation blueprints" within Canada's southern ecoregions; those areas where the biodiversity is greatest, but so is the threat. Each conservation blueprint seeks to prioritize a set of areas that, if conserved, could collectively sustain the biodiversity of the ecoregion.

The NCC works with local experts and academics to identify the rare or endangered species and habitats that are representative of an ecoregion, along with the threats to them. The NCC's priority areas in Eastern Ontario include Frontenac Arch, Eastern Lake Ontario Coast, and the Napanee Plain Area - natural areas for which the NCC has developed Strategic Plans. The Napanee Plain Natural Area Conservation Plan targets alvar, karst, and wetland systems and incorporates measures of connectivity into property prioritization.

The Land Between is a charitable organization devoted to stewardship of the land encompassing the transition between the Canadian Shield and Limestone Plain in Ontario. It promotes research that identifies areas of biodiversity for conservation and stewardship. It has identified priority areas for stewardship that include alvars, wetlands, and rock barrens (Figure 20).

<u>Approach to Mapping and Modifications Through Consultation</u>

Priority areas of other organizations will be studied to determine where they overlap with LC-KFLA priority maps and whether partnership relationship might be warranted. Furthermore, in areas where priorities overlap, the priority mapping of other organizations can strengthen justifications to funding sources or fundraising campaigns. Note that Figure 19 does not include all of the priority area mapping for the NCC, as the newest acquisitions and priority area mapping has not been updated from the NCC. These updates are hoped to be received for more detailed analyses and for future raster analyses.

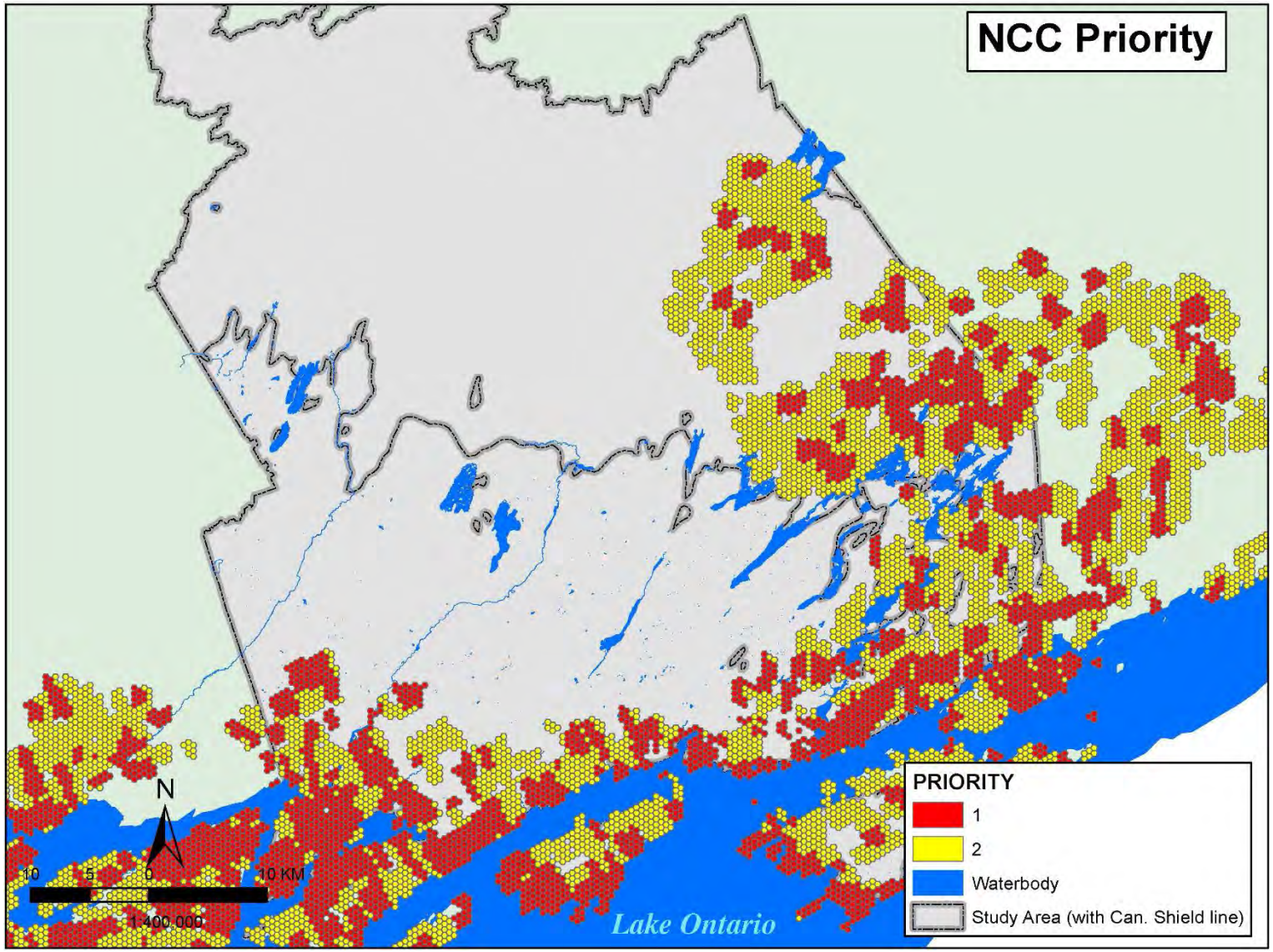


Figure 19. Some Areas of NCC habitat priority, note: this does not include recent updates in NCC plans.

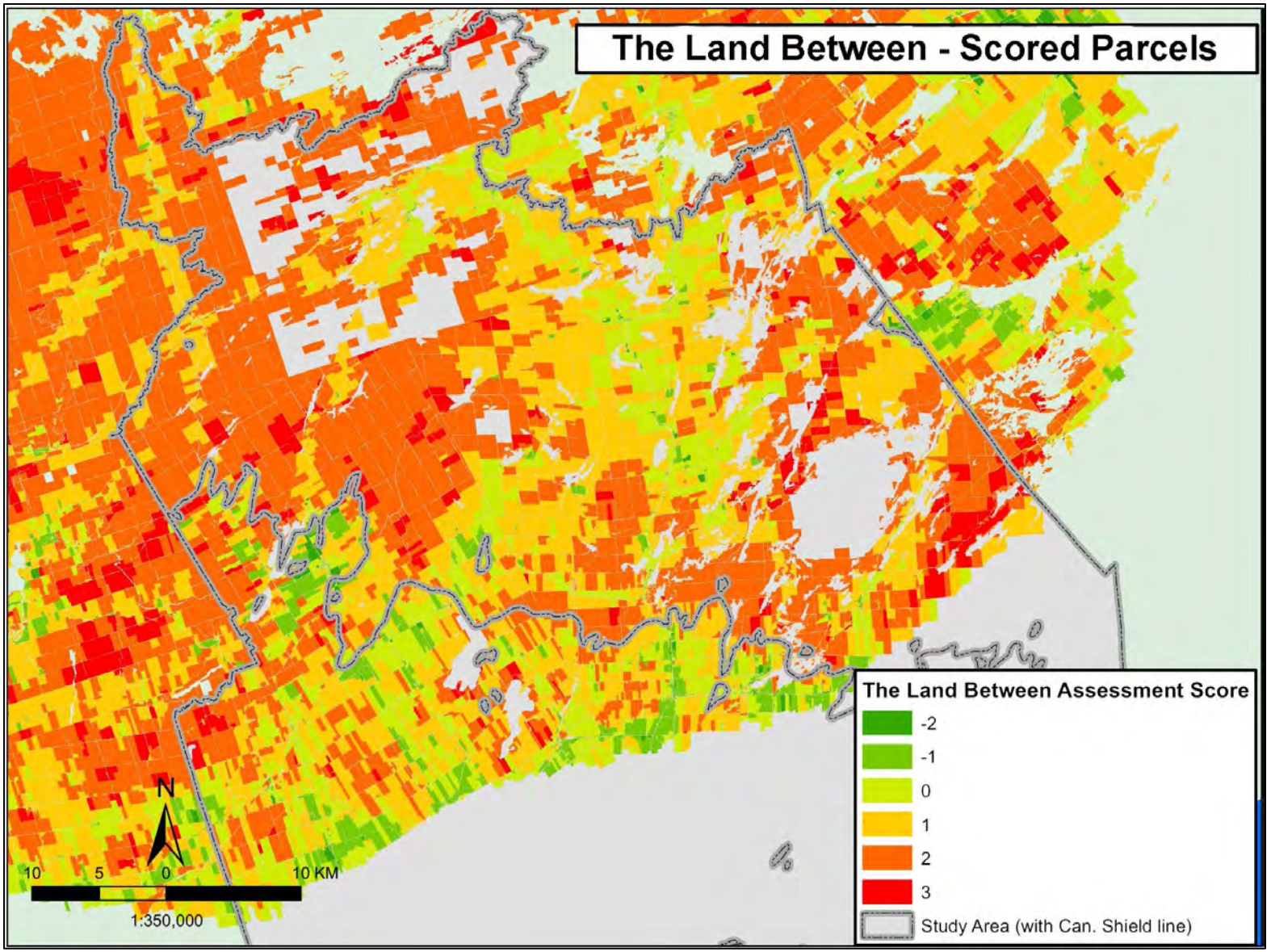


Figure 20. Priority Mapping for The Land Between

5.0 Consideration of Additional Data for Inclusion

The following section explores data that have been considered for inclusion to inform the Plan, or have been recommended during consultations. These data have not been used in the present Plan, but may be considered as the Plan evolves in the future.

5.1 Species at Risk Habitat Information

Species at Risk habitat mapping requires very detailed information on habitat availability and on locations and movements of the species themselves. It is also very sensitive information, as many Species at Risk are of high value to poachers. This information has been collected by a variety of sources such as the Ontario Ministry of Natural Resources and Forestry, the Breeding Bird Atlas of Ontario and the Ontario Herpetofaunal Atlas but the accurate locations of species are rarely divulged, though general locations may be provided. Even general information is never divulged for highly sensitive species such as Spotted Turtle and American Ginseng. There are many areas that have not received the level of study that would allow Species at Risk to be detected.

Approach to Mapping and Modifications Through Consultation
Species at Risk information was not used to inform mapping. However, the feature-based approach to mapping, which included features with high diversity, size, and ecological function, will mean that many of the habitats identified have a high probability of high biodiversity supporting Species at Risk.

5.2 Habitat within the Vicinity of Lake Ontario

The Lake Ontario shoreline has particular significance for many plant and animal species. Forest areas over 10 ha, within 5 km of the Lake Ontario shoreline, are considered candidate Significant Wildlife Habitat for migrating landbirds (MNRF 2015a). Figure 21 illustrates these forests (wetlands in coastal areas can be seen in Figure 5). Similarly, coastal wetland habitat is considered highly significant in Ontario. Most coastal wetlands have been evaluated as provincially significant. The significance of coastal areas has been captured in part by including Provincially Significant Wetlands and priority areas from the Nature Conservancy of Canada's coastal strategic plan (Eastern Lake Ontario Coast) that can help to highlight the importance of the remaining undeveloped areas in this region.

Approach to Mapping and Modifications Through Consultation
People consulted noted that coastal communities were highly significant. The LC-KFLA Mapping Committee is discussing what data to include, and the distance from Lake Ontario within which communities will be considered; this information may be included in future iterations of the Plan.

5.3 Parcel Data

Parcel data (digital boundaries of individual properties or "parcels" of land in Ontario) would be a practical layer for guiding land acquisition. However, parcel data must be purchased from municipalities, and is generally of high cost, or investigated as part of a labour-intensive search of tax rolls at the municipal office. This is beyond the scope of a small organization such as LC-KFLA. Lot and concession boundaries are available within LIO, but there may be subdivided parcels within lots and concessions for which the boundaries would have to be requested from the municipality. The actual landowner information must be requested from the municipality as well.

Several municipalities were prepared to share some elements of parcel data (not property owner information). Information on parcels for mapping purposes could be explored as part of a partnership with LC-KFLA. Parcel data would provide a practical basis on which land acquisitions could be prioritized.

Approach to Mapping and Modifications Through Consultation
Lot and concession boundary information is available at a coarse level. In addition, several organizations indicated that they may be able to provide some parcel data. Larger properties may provide greater opportunities for protection than smaller properties, so inclusion of this information will be considered in future iterations of the Plan.

5.4 Additional Aerial Photo Interpretation

Aerial photo interpretation could provide information on vegetation communities that are a high priority for protection, such as habitats for Species at Risk, and communities that are not identified in LIO, for example thickets and grasslands.

Aerial photos could also provide more information on wetlands within forested areas if the photos were scrutinized in more detail than may have been conducted for LIO. Aerial photo interpretation can be conducted by an expert in identifying vegetation polygons through scrutiny of aerial photography, using stereo pairs and photos taken at different times of the year, or by computer analysis to determine vegetation communities. However, both techniques require detailed aerial imagery, which is costly. (Computer analysis is generally conducted with satellite imagery.) Manual aerial photo interpretation is highly labour-intensive. In addition, there is a high margin of error in both types of aerial photo interpretation, and ground-truthing by an expert is required.

Approach to Mapping and Modifications Through Consultation
Aerial photo interpretation is likely not feasible at this stage, as it is beyond the scope of LC-KFLA to conduct aerial photo interpretation for the entire Plan area.

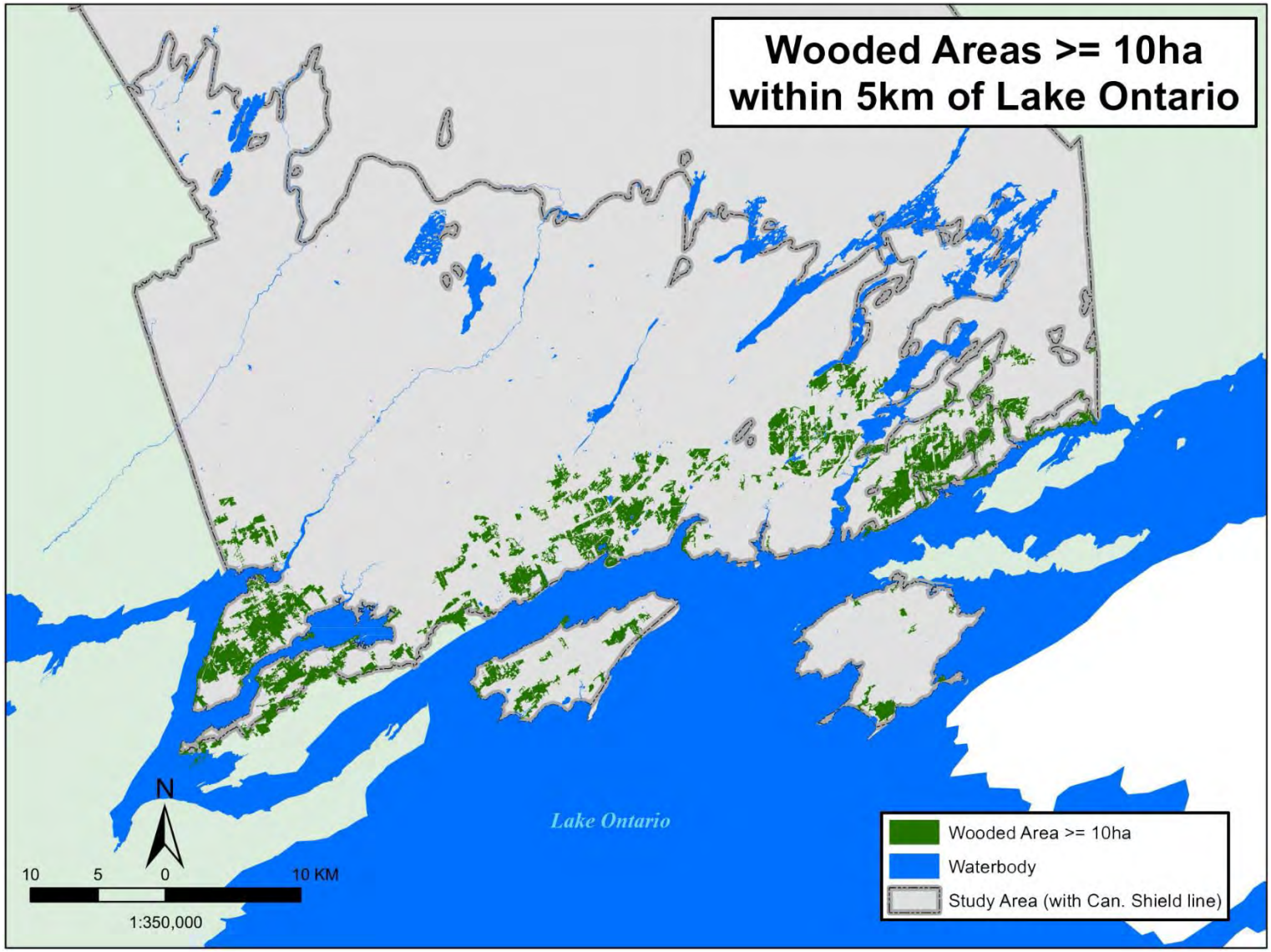


Figure 21. Woodlands 10 ha or greater, within 5 km of the Lake Ontario shoreline (candidate migratory landbird stopover habitat)

5.5 Canadian Wildlife Service Biodiversity Atlas Data

Environment Canada published the report: "A landscape assessment for the Ontario Mixedwood Plains: terrestrial biodiversity of federal interest in the Mixedwood Plains ecozone of Ontario: 2015". The purpose of the report and accompanying maps is to identify landscapes or regions in the Ontario Mixedwood Plains Ecozone that have multiple and overlapping federal biodiversity elements, and to identify areas where conservation actions may have the greatest impact. The mapping is the basis of Canadian Wildlife Service's biodiversity mapping. At a coarse level, the relative importance of each physiographic region was assessed based on the terrestrial elements of biodiversity that exist within its boundary. Finer resolution maps for each physiographic region were produced to illustrate the distribution and abundance of priority migratory bird species and their potential stopover habitat. This study identified the Napanee Plain and Lake Iroquois Plain as top priorities for federal conservation and action.

The mapping that accompanies this report shows areas of high biodiversity, based on 14 biodiversity elements mapped and scored for each ecoregion (Environment Canada 2015):

- SAR (species at risk) richness
- SAR count
- SAR irreplaceability
- Globally rare species locations
- Coastal wetland locations
- Colonial nesting waterbird locations
- Landbird stopover locations
- Shorebird stopover locations
- Waterfowl stopover locations
- Forest bird density
- Open-country bird density
- Shorebird density
- Waterbird density
- Waterfowl density

The resulting mapping shows many attributes that may be highly compatible with the objectives of LC-KFLA but is at a very coarse level (Figure 22).

<u>Approach to Mapping and Modifications Through Consultation</u>
Analysis determined that these layers were too coarse to add weight to priority areas within the Plan. The "High Biodiversity" layer comprises a very large area, such that it would not discriminate between properties that would be of most value for protection. Modifications were not suggested through consultation. While the grasslands layer was considered, as several consultations suggested grasslands be included in the Plan, it was found that the data were too coarse for the purposes of the Plan. It also appeared that grasslands may have included cropland and other more intensive agricultural areas. A2A suggested incorporating Canadian Wildlife Service's Human Impact Analysis to look at

which of the High Value Biodiversity Areas are affected. This type of analysis could be considered as LC-KFLA develops higher detailed analysis and maps for priority areas.

5.6 Modelling of Connectivity in the Great Lakes Basin

During their review of the first draft of this Plan, A2A provided suggestions on the use of modelling to inform connectivity within the Plan. An example they suggested was "The landscape connectivity in the Great Lakes Basin" (Bowman and Cordes 2015). The modelling approach used by Bowman and Cordes (2015) used a GIS-circuit theory approach to model the landscape as a large circuit board where pixels reflect resistance to wildlife movement, then simulate an omnidirectional electrical current. Pixels were assigned value according to the connectivity of features in the landscape: for example wetlands, forests and cutovers were assigned a low resistance value, while urban areas and water bodies were assigned the highest resistance values.

Approach to Mapping and Modifications Through Consultation

This approach differed from LC-KFLA's approach in that in Bowman and Cordes' work, "water" (which probably included many larger waterbodies and watercourses) was not considered to have a high connectivity, whereas in the Plan, watercourses are included because they provide connection. However, the approach may provide insights into other types of land cover and this analysis could be examined in future.

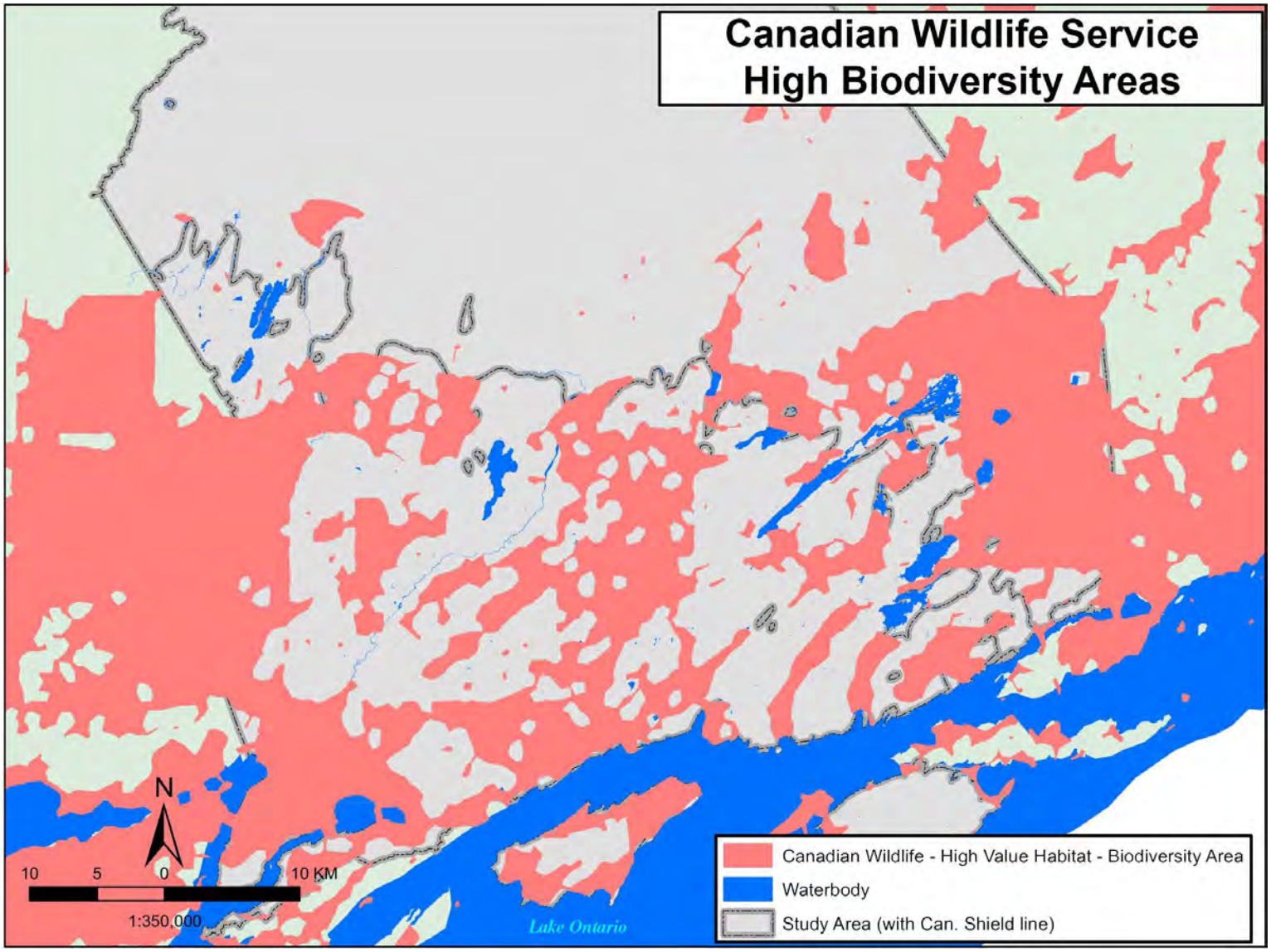


Figure 22. Areas of high value wildlife habitat from the Canadian Biodiversity Atlas

5.7 Areas of Low Road Density

An analysis of road densities (Figure 23) indicated that there are areas on the Canadian Shield that have relatively few roads within the study area. These areas may provide attributes that are not available elsewhere – they may be less disturbed (less fragmented), with fewer sources of light, contaminants, and noise associated with roads. These areas could be used as an overlay to contribute weight to core areas. However, road development is regulated by the Environmental Assessment Act, which involves consideration of alternatives. Though it would be desirable to protect properties in relatively roadless areas there is no guarantee that they would remain roadless. There is a high density of roads running north-south in the east-central part of the Plan area, which is associated with a main arterial: Highway 38. Another area, in the northwest portion of the Plan area, is associated with another main arterial: Highway 7.

Approach to Mapping and Modifications Through Consultation

Weighting of areas with fewest roads was discussed. However, the long-term potential for persistence of areas of low road density would need to be evaluated to use this criterion to inform priorities for the Plan.

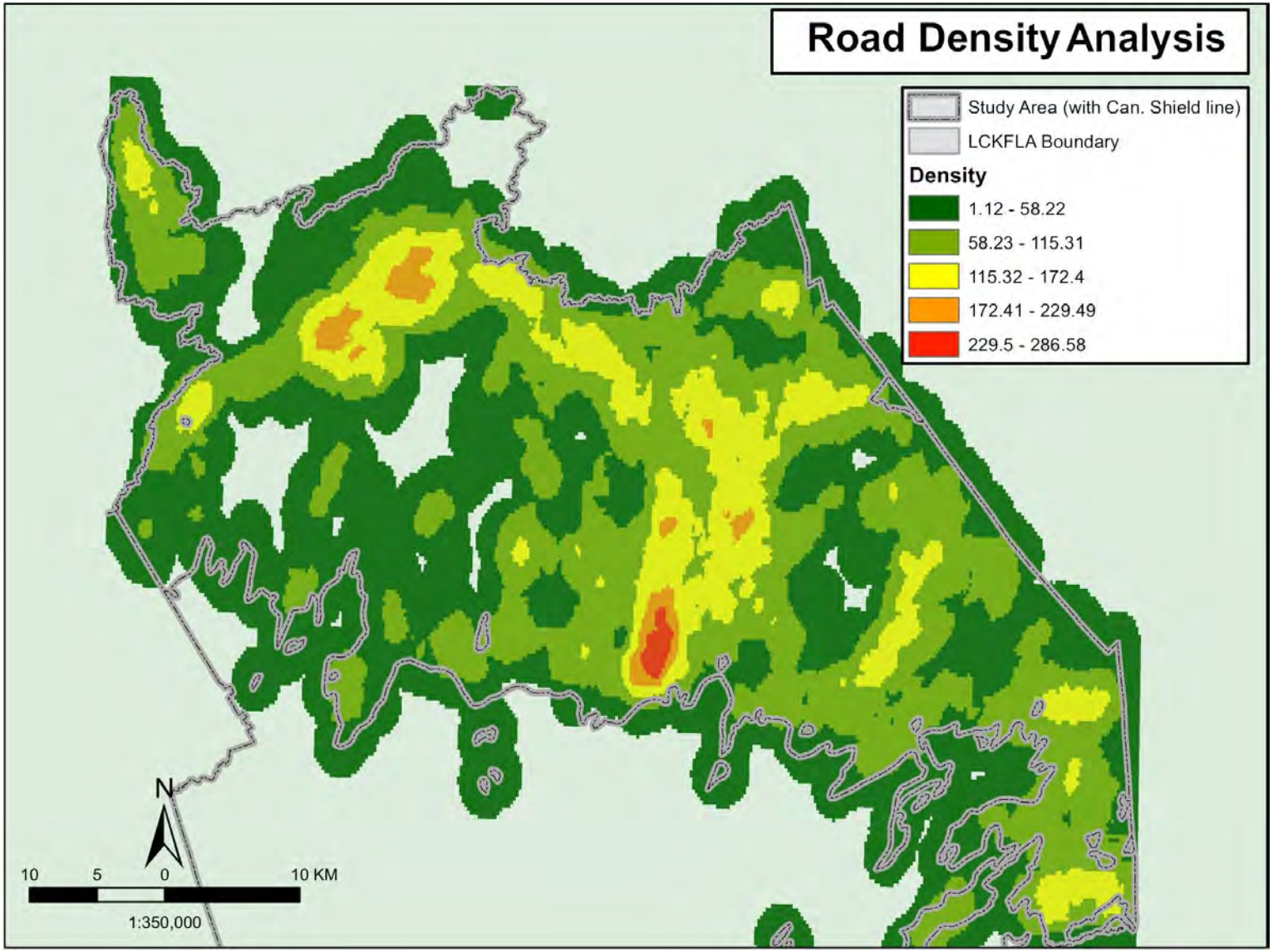


Figure 23. Road density analysis on the Canadian Shield

5.8 Consideration of Modifying the Plan to Assess Priorities on a Watershed Scale

Comments from the consultations indicated that priorities could be explored at the scale of the watershed. Woodlands and wetlands that might be of low priority on the scale of the study area might be a higher priority on a watershed scale if they were the largest or most diverse in the watershed. Watershed scale assessment would be explored at both the Tertiary and Quaternary level of watershed.

This approach could be narrowed in scope to investigations of, for example, the largest patches of woodland and wetland in each watershed, to determine if they have been "picked up" by the analysis already or should receive higher weight. Figure 24 shows watershed boundaries in relation to features within the LC-KFLA study area.

5.9 Including Grasslands and Other Successional Areas

Large grasslands (i.e. those over 30 ha) are reservoirs for Species at Risk, for example Eastern Meadowlark and Bobolink, two species considered Threatened in Ontario and Canada. They also support a high diversity of species that have narrow habitat requirements and are declining in Ontario. Other successional areas such as thickets also support high biodiversity of birds that are declining in Ontario. Therefore, inclusion of grasslands within the Plan could be a strategy for protecting high biodiversity of bird species.

However, grasslands and other successional areas are difficult to identify in aerial photography. They are not accurately identified by landcover identification computer technology, and they are difficult to recognize during scrutiny of aerial photos unless ground-truthing is undertaken. In addition, they are likely not a good priority for conservation for an organization such as LC-KFLA, as the presence of successional birds depends on the persistence of successional vegetation cover. This cover must be managed by human intervention because the factors that originally controlled woody vegetation in pre-settlement times, such as fire, are usually controlled. In addition, the persistence of the surrounding open landscape is an important factor in successional species' persistence in an individual habitat patch.

<u>Approach to Mapping and Modifications Through Consultation</u>
Inclusion of grasslands in the Plan was not considered at this point, unless they are alvars. Grasslands and other successional areas are likely not appropriate candidate areas to include in the Plan because the information would require a high level of expertise (with aerial photography interpretation and ground-truthing) and be highly labour-intensive to acquire. Protection of successional areas would require management of the individual patch of habitat as well as a large surrounding area, and is likely not feasible.

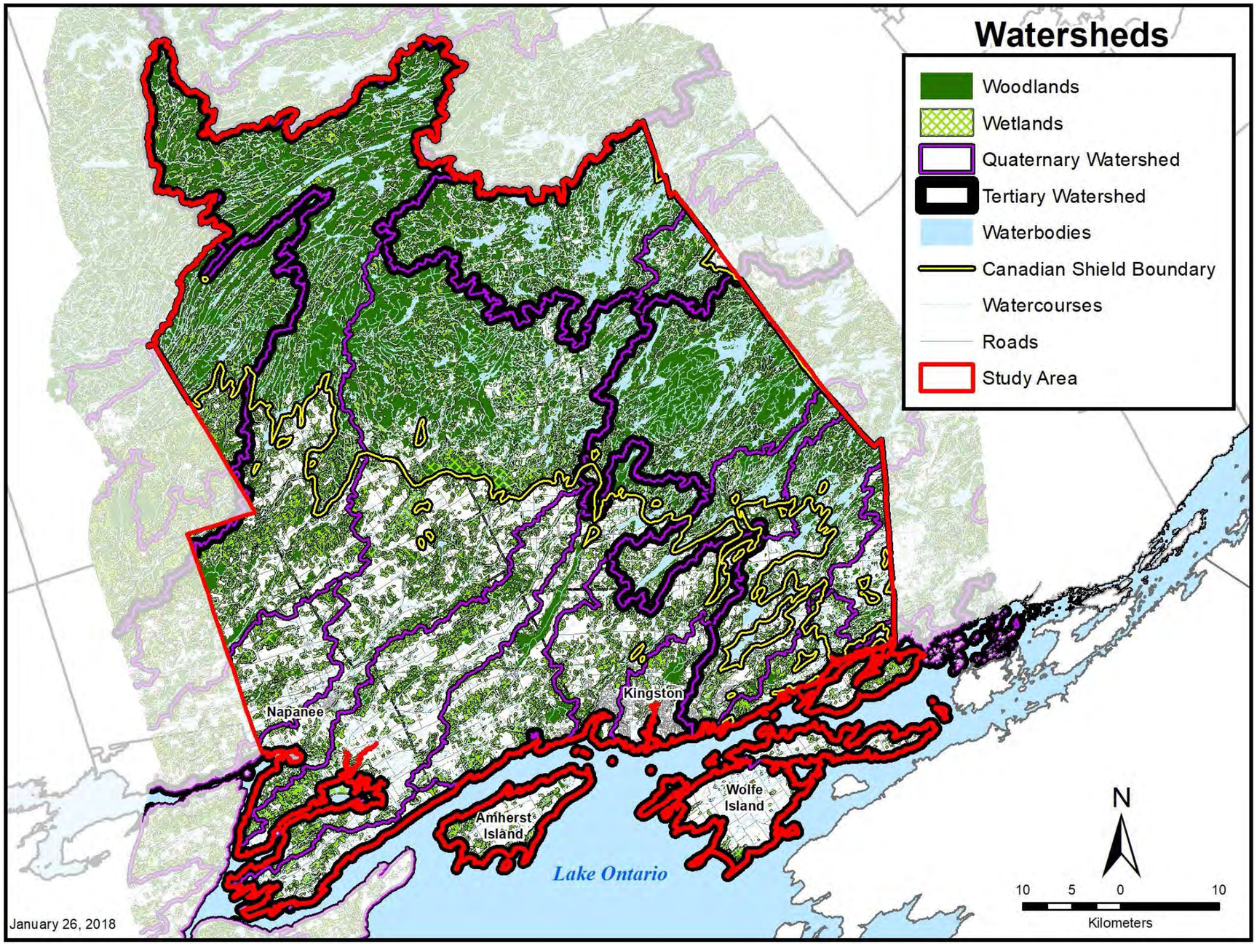


Figure 24. Watershed Boundaries Illustrating woodlands, wetlands, and water bodies in each watershed within the LC-KFLA study area

5.10 Crown Lands

Crown lands are lands owned by the province that provide opportunities for economic development, tourism, and recreation. Crown lands are shown in Figure 25. Each area of Crown land is assigned a primary land use designation with provincial land use policy associated with it. Most primary land use designations allow for a range of area-specific planning considerations. Crown land planning:

- assigns to a specific area a primary land use designation, which can include:
    - provincial park
    - conservation reserve
    - forest reserve
    - provincial wildlife area
    - enhanced management area
    - wilderness area
    - general use area; and

- establishes permitted land uses for a specific area, such as: ◦
    - recreational hiking
    - ATV use
    - commercial fur harvesting, hunting, fishing;
    - power generation;
    - forestry
    - aggregate production.

Crown lands in the LC-KFLA fall within a wide variety of uses.

Approach to Mapping and Modifications Through Consultation

As Crown lands are not strictly protected, they were not included in the protected layer for the Plan. The layer of protected lands was obtained through the Province's Land Information Ontario, so this likely represents all crown lands for which protection is certain. The future use of crown lands is set out in the Crown Land Use Policy Atlas (MNRF 2018), so any other crown lands that may have landuse plans that are compatible with LC-KFLA's objectives can be identified and added to the Plan. Many crown lands remain undeveloped. The distribution of Crown lands will be considered further and may be used to refine future considerations of priority.

6.0 Final Weighting Criteria

Weighting received very careful consideration, with weighting of each variable considered and discussed by the Mapping Committee. A weighting scale of 1 to 5 was considered, as shown in the Table 3 below, with 1 indicating a low score (i.e. the importance of this variable was considered low on the scale of priorities), and 5 indicating the variable was high on the scale of priorities. Weighting was not applied to protected lands and ANSIs themselves because they are already protected: however, the area within 100 m of

protected lands was considered a high priority as this is an area within which the likelihood of impacts from adjacent development is highest. Section 4 provides a discussion of the principles used to establish the width of "buffers" to include as a core feature in this Plan.

Table 3. Weighting applied to criteria

Criterion	Buffer	Weighting
Canadian Shield		
Significant Wetland	50m **increase to 120m**	5
Wetland >30ha	50m	4
Wooded Area 60 ha	None	3
Interior forest - top 20% in size	None	5
ANSI **+ Candidate ANSIs**	100m **increase to 120m**	3 (applied to buffer only)
Headwater Lake Areas - top 20% in elevation	50m **increase to 1km**	4
Lake Trout Lakes	50m	2 **change to 3**
Protected Lands	100m	5 (applied to buffer only)
Watercourse	50m	4
Waterbody	50m	3
Limestone Plain		
Significant Wetland	50m **increase to 120m**	5
Wetland – > 30 ha	50m	4
Wooded Area – top 20% in Size	None	3
ANSI **+ Candidate ANSIs**	100m **increase to 120m**	3 (applied to buffer only)
Headwater Lake Areas – top 20% in elevation	50m **increase to 1 km**	3 **change to 4**
Lake Trout Lakes	50m	2 **change to 3**
Protected Lands	100m	5 (applied to buffer only)
Watercourse	50m	4
Waterbody	50m	3

Consideration was given to showing the Plan with different weighting criteria applied to individual features. Without weighting, the Plan did not discriminate sufficiently to inform priorities for acquisition. Removal of headwater areas was investigated, as discussed in Section 9. Investigation of other changes in weighting may be considered in a future stage of the Plan.

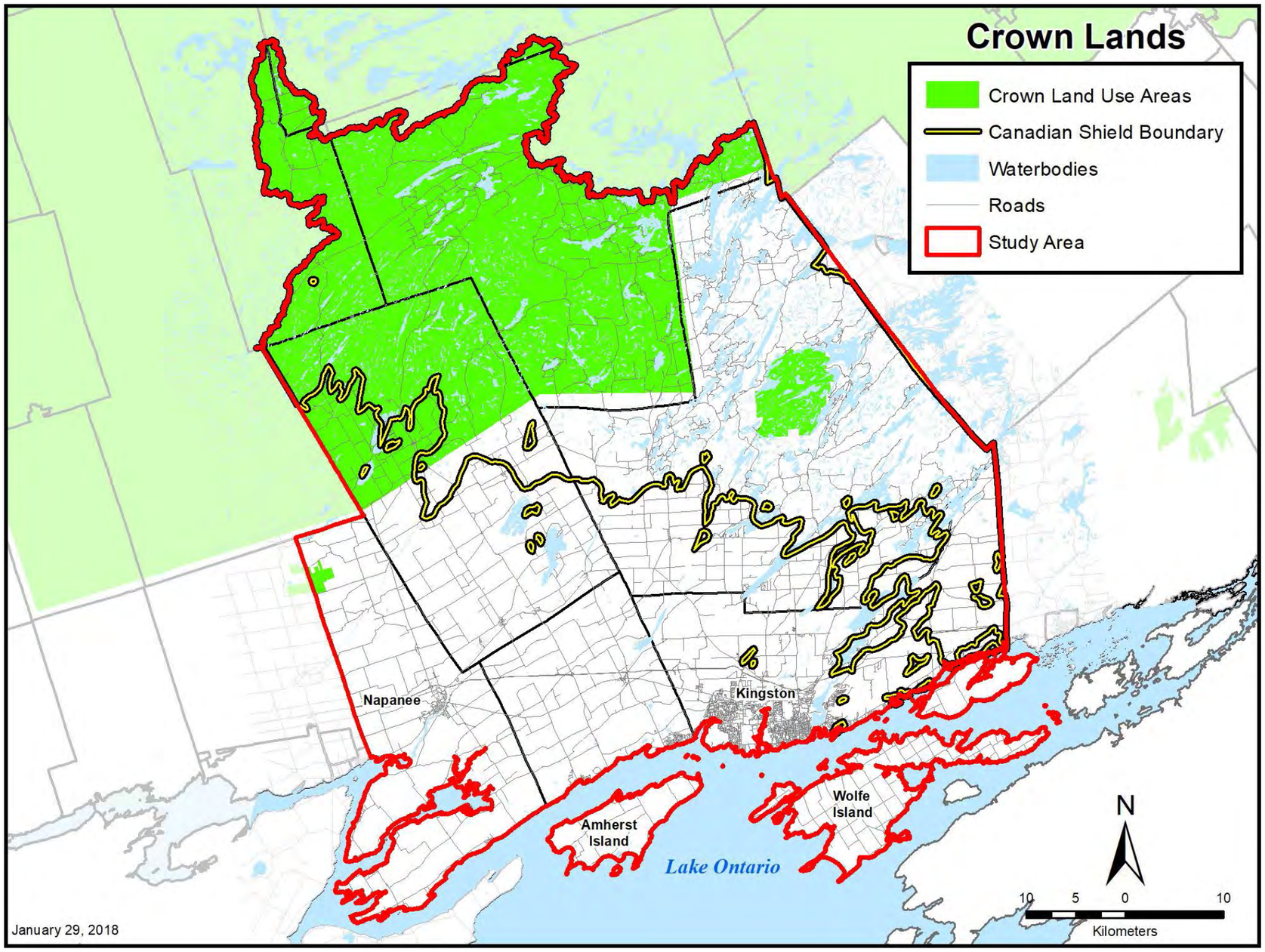


Figure 25. Crown land use policy areas. Source: Matawa First Nation Open Data, 2017.
Note: land use policy areas within the northern part of the study area include some private land.

7.0 Consultation process

The Land Conservancy's Mapping Committee collected natural heritage plans and GIS maps for the area, see Appendix 1 for a list of these documents. With this material, the Mapping Committee developed a series of maps showing overlapping areas of potential conservation interest. It also ranked a list of criteria to guide its priority setting, as shown in Table 4. With this as a basis, members of the committee met with municipal government and conservation organization representatives to receive feedback on the Plan approach and hear about areas of local concern.

Table 4. Preliminary criteria and ranking used prior to consultation process

File	Buffer	Weighting
Canadian Shield		
Protected Lands	100m	5
Significant Wetland	50m	5
Lake Trout Lakes	50m	2
ANSI	100m	3
Watercourse	50m	4
Waterbody	50m	3
Wetland >30ha	50m	4
Wooded Area	None	3
Headwaters*	50m	4
Limestone Plain		
Protected Lands	100m	5
Significant Wetland	50m	5
Lake Trout Lakes	50m	2
ANSI	100m	3
Watercourse	50m	4
Waterbody	50m	3
Wetland >30ha	50m	4
Wooded Area – top 20% in Size	None	3
Headwaters*	50m	3

*note: while headwaters were planned to be included, headwaters were not factored into the preliminary mapping because no mapping source had been identified

The consultation set out to build both awareness and potential partnerships. The consultation resulted in some changes: for example, it led to the increase in weighting of lake trout lakes, to delineating and mapping headwater areas, to including interior forest criteria, and to changes in some weightings. These changes are described in Section 6.

7.1 Participation

Twenty organizations were consulted, involving 40 people in the consultation process (Appendix 4):

Municipalities

- City of Kingston
- County of Frontenac
- Lennox and Addington County
- Town of Greater Napanee
- Loyalist Township
- Township of South Frontenac
- Township of Stone Mills

Conservation Authorities

- Cataraqui Region Conservation Authority
- Mississippi Valley Conservation Authority
- Quinte Conservation
- Rideau Valley Conservation Foundation

Ontario Ministry of Natural Resources and Forestry

- Partnership Specialist, Ministry of Natural Resources and Forestry

Conservation Organizations

- Ducks Unlimited
- Friends of the Napanee River
- Friends of the Salmon River,
- Frontenac Stewardship Foundation
- Lennox and Addington Stewardship Council
- Mississippi Madawaska Land Trust
- Nature Conservancy of Canada
- Ontario Woodlot Association

Individuals

- Tim Yearington, Algonquin Anishinaabe

Following these consultations changes were made to the draft Plan. Information about the Plan and draft maps (see Appendix 5) were presented at two community meetings:

- Roblin, October 23, 2017, with guest speaker Mark Stabb, Nature Conservancy of Canada, on alvars and grassland communities
- Sydenham, October 29, 2017, with guest speaker Oliver Reichl, arborist, on what is happening to trees.

7.2 Summary of Comments

The following summarizes recommendations and other comments and suggestions that stemmed from consultation. This input was used to support and inform the development of the final version of the Plan. More detail on the organizations and individuals involved in consultation can be found in Appendix 4.

7.2.1 Providing Opportunities for Sharing with Other Groups

- Several participating organizations noted they were interested in LC-KFLA's approach to land acquisition: noting that responding to willing donors or looking for willing sellers were both workable. Many organizations noted their willingness to assist with identifying lands that could be high priority for purchasing but might not be identified by the current criteria. Additional priority areas could be identified, for example, through public meetings.

- Several organizations offered to read the draft Plan.

- Several organizations noted they had a similar approach to identifying properties for land acquisition and that they would be willing to share information with LC-KFLA that could help to facilitate shared ownership or stewardship. Organizations also noted their willingness to share data that could help to prioritize property.

- The Land Conservancy's work could also benefit municipalities through a working relationship: increasing municipal awareness of habitat preservation issues, assisting with protection of easements, contributing to support for their Natural Heritage System approach, and enhancing their ability to defend natural heritage.

- Organizations expressed interest in the extent to which the Plan would serve the municipal approach to Natural Heritage Systems, while acknowledging that they might be looking through the different lens of satisfying provincial policies. However, the Plan could help to inform areas of development, for example broad-scale development scenarios such as solar farms. They noted that the Plan has a high value because it aggregates and documents data from a wide variety of groups. This will be valuable for townships and anyone wanting to purchase land or plan for conservation.

7.2.2 Focusing on Water-based Features

There was a general agreement with the focus on water-based features, but the following suggestions were made on this approach:

- Use of headwater data. While it was always the intention to include headwater data, it was acknowledged that there was no existing mapping. There were suggestions for methods by which headwater lakes could be added to the mapping, for example using contour lines to pick up the highest lakes in each watershed, to derive headwater lake areas.

- Focus on other water bodies instead of Provincially Significant Wetlands (PSWs) as PSWs have protection and other water-based features do not.

- Consider including areas of peat mosses as they sequester large amounts of carbon;

- Focus on imperfectly drained areas that are highly productive.

- Include additional areas mapped by Conservation Authorities, who noted they would be willing to share data wherever possible.

- Give lake trout lakes higher ranking. Even though the MNRF and some municipal plans impose restrictions on lake trout lakes there is evidence of considerable pressure on these areas by an increase in the number of cottages in the past 60 years. Frontenac County Official Plan, for instance, lists 23 lake trout lakes that require a 300 m buffer as they are "at capacity" (i.e. the development of the shoreline has reached the maximum allowed limit) and only 8 that are not yet at capacity (i.e. they have not reached the maximum shoreline development allowed).

7.2.3 Refining Watershed Boundaries

- Organizations agreed on the current focus on watershed boundaries but suggested considering a more local scale: for example, refining the approach to reflect what habitat is left in each watershed (ie: a smaller woodland might not seem important on a large scale, but if it is the only one left in a particular watershed, it would be very important.).

7.2.4 Adding Additional Buffers

- Consider buffers for wooded areas as well as wetlands, water bodies, ANSIs etc.

7.2.5 Adding Other Potential Mapping Criteria

- Add alvars, as these are globally, nationally and provincially rare communities that have been mapped.
- Consider including interior forest as a criterion (i.e. forest with a configuration that provides a substantial edge and a sheltered interior).
- Include habitat for Species at Risk as a criterion.
- Use the information from the Canadian Wildlife Service's biodiversity atlas.
- Add other areas that are covered by provincial policies such as adjacent lands, Significant Wildlife Habitat, Significant Valleylands.
- Add Algonquin Land Claim lands.
- Use aerial photo interpretation to identify additional areas worthy of protection, such as grasslands and thickets, and add these.
- Consider other approaches to developing priority mapping, for example map riparian areas 30 m from the shoreline.
- Consider the shoreline of Lake Ontario as a special feature.
- Look at areas of high waterfowl potential mapped by Ducks Unlimited,

- Include areas mapped by the Bay of Quinte Remedial Action Plan.
- Consider adding parcel data as a layer; with larger parcels being higher priority.
- Consider using Quinte Conservation's Watershed Report Card data.
- Consider factoring in the condition of the area; for example, areas with high recreational use could be less of a priority.

7.2.6 Considering Additional Criteria for Linkages

- Linkages may be too heavily based on a "path of least resistance" rather than ecological criteria; other analyses could be used to identify linkages.
- Consider using the NCC "least cost path" approach.
- Linkages should be selected based on juxtaposition of features rather than arbitrary connections.
- Set specific priority for connecting the existing protected lands. For example, consider linking the area that extends between Frontenac Provincial Park and Puzzle Lake Provincial Park, and consider connecting the Bayview Wetland area with the Parrott's Bay property of the Cataraqui Region Conservation Authority.

7.2.7 Adding Individual Areas of Concern

- Consider adding individual areas of concern where justification is provided based on ecological principles, particularly if it is based on knowledge that is not available through current mapping. For example, consider including additional wetlands, particularly smaller wetlands that are not provincially significant.
- Include Crown lands.
- Fifteen additional areas were suggested by participants that were of particular significance to them.

7.2.8 Considering Additional Analyses

- Consider cluster or density analysis as a substitute for parcel data; this would mean choosing a polygon as a priority area when it reaches a certain density of medium to high priority pieces of the landscape.
- Sensitivity analyses. Develop "what if" scenarios prior to settling on final priority criteria. That is, choose a variety of criteria and change their weighting to see what the priority areas look like under each set of conditions. For example, what impact would weighting forest cover much higher than water-related features have on the mapping?
- Consider the Ontario Ministry of Natural Resources climate change maps that indicate the impact on habitat of climate change under varying scenarios.
- Focus on expanding patches to enable natural processes to continue and get away from a "beads on a string" approach – i.e. bigger conserved spaces with less worry about connectivity

7.2.9 Refining Weighting

- Consider giving more weighting to features that are rare in each watershed.

- Include Candidate (as well as confirmed) Provincially Significant Wetlands and Areas of Natural and Scientific Interest in the weighting, as the program for identifying these features has not been active recently.
- Reduce the weight on Provincially Significant Wetlands, as these already receive a high level of protection from provincial policies.

7.2.10 Other Comments that Informed this Plan

- Consider prioritizing based on the threat level; could the places under the most imminent threat of development be a priority?
- Consider ecosystems that are most likely to withstand climate change as the most important.
- Recognize value of forests and peatlands in carbon management and their potential for cap and trade programs.
- Consider taking a new role in providing signage and other education materials, improving trails.
- This should be a "living plan", being updated regularly and amended based on new data and input from stakeholders.
- Consider incorporating a cultural element into the mapping. The environmentalist view of protecting species and habitat for nature and not including the human element seems limited. Humans are a main user of the land now and people can benefit from enjoyment of the land. This should be reflected in the designations of some of the features mapped in the Plan: for example, an ANSI could be called an ANSCI where C means cultural.

8.0 Information from Additional Studies

Queen's University Master's students (Danielle Beaulne and Rebecca Hudson) conducted two studies that have the potential to inform the Plan in the future. The following provides a brief summary of their findings.

8.1 Exploration of Analyses that Would Contribute to Increased Understanding of the Landscape Within the Plan Area (Beaulne 2017)

A landscape model was created for a portion of the Kingston, Frontenac, Lennox and Addington counties, which comprise the focus area of the LC-KFLA for this Plan. Classification was performed with computer algorithms to analyse LANDSAT-8 multispectral imagery, which has a resolution of 30m x 30m. The analysis was performed on two sets of satellite imagery data from different dates: April and June, 2016. Analysis combining spring and summer imagery has been shown to increase the accuracy of interpreting wetlands. For instance, wetlands may appear as open water in the spring due to snow melt, precipitation, and a lack of vegetative covering. In the summer, wetlands

may appear as vegetation due to the recession of ephemeral wetlands and the growth of vegetation.

Raster Mapping: In its simplest form, a raster consists of a matrix of cells (or pixels) organized into rows and columns (or a grid) where each cell contains a value representing information (for example, the cumulative weighting score). Rasters are well suited for representing data that changes continuously across a landscape.

Seven spectral bands (bands in or near the visible spectrum of light), and two band ratios which help to identify vegetation and water, were used in the analysis, and combined with the two imagery dates, resulting in a raster analysis of 18 bands. Areas obscured by cloud cover were corrected in the analysis.

Four models of land cover were obtained. Pixel-based image analysis (PBIA) and object-based image analysis (OBIA) were used to classify land cover. PBIA analyses each tiny square of image data used to compile the image. OBIA analyses groups of squares based on their similarity. For example, all of the pixels in a lake appear to be similar in the image, so all of those pixels would be analyzed together as a unit. Likewise, agricultural fields, or patches of barren rock, or a grove of coniferous trees would be analysed together. This grouping of pixels tries to mirror the way that humans can look at the image and immediately recognize a whole area as being, for example, 'farmland'. In addition, the data were analysed with “decision tree” and “random forest” classification algorithms: different machine learning algorithms which depend on multiple computer decisions, and “training” of the computer with combinations of multiple decisions, respectively. These algorithms essentially teach the computer how to recognize different land cover classes based on the data that is provided to the algorithm.

Overall, the accuracy of all four models was comparable. However, some landscape configuration metrics differed depending on the model used. The main difference was that pixel-based analysis resulted in a landscape characterized by smaller, more isolated patches of landscape features (such as deciduous forests and wetlands). This in turn generated higher estimates of landscape diversity, which is defined as the number of land cover types as well as the even distribution of different land cover types. Object-based analysis resulted in larger patches of landscape features, with lower estimates of landscape diversity. Both these approaches may be useful, depending on the questions that are being asked.

8.2 Land Cover Change in the Kingston, Frontenac, Lennox and Addington region (Hudson, 2017)

Examination of past aerial photography data concluded that there have been significant changes to both the climate and to the land cover over the past 30 years. Since 1968, there has been an increase in average monthly temperature in this region of 1.5˚Celsius degrees and an increase in average monthly precipitation of 5.7 mm. Between 1984 and 2016, there has been an overall loss of agricultural land of 5.1%, an overall loss of coniferous

trees of 6.2% and an overall gain of wetlands of 9.7%. The loss of agricultural land is most likely due to the flooding of farmland since this land cover type is usually changed to wetland or open water. However, conservation efforts may also play a large part in this change.

When comparing the past data to the future predications for this region, research suggests that the past trends in both temperature and precipitation will continue, most likely at accelerated rates. However, trends in past land cover changes are less well established than that of the climatic data and are based on fewer data points.

It is predicted by Parker et al. (2000) that the forests within the KFLA region will continue to be successful. By examining the past land cover data, we can see that deciduous forests remain fairly constant in area over time despite increased temperatures and precipitation. However, the changes in temperature and precipitation have correlated with a decline in coniferous forests in the land cover maps. If there is a relationship between these climate factors and the presence of coniferous trees, then it is possible that with increased temperature and precipitation that there may be a continuation of this decline. However, this change is quite small and so further study may be needed in order to provide confidence in this trend.

Wetlands are also expected to be impacted by climate change. It has been predicted by Kling et al. (2013) that wetlands will be negatively affected by warmer temperatures and precipitation patterns that are more variable. Comparison between land cover maps show that there have been increases in the area that wetlands have covered despite increased temperatures. It has been predicted that water levels will go down with a warmer climate since with higher temperatures there will be higher rates of evaporation. However, past data shows that there has been a slight gain in area (0.5%) for open water bodies. The relationship between ground water, precipitation, and other factors, like plant species within the wetland class itself, are complex. Therefore, it is possible that there are external factors besides changes in temperature and precipitation (for example, increased Beaver activity) that have resulted in increased wetlands and open water. This could explain the difference between past changes and future predictions.

Habitat diversity, an important environmental parameter, has shown overall decreases over time. However, within the KFLA region, the change in habitat diversity has been quite localized with areas of increased habitat diversity right next to areas of decreased diversity.

8.3 Overlay of data.

The above data analyses and the generated maps will be used as overlays in the future detailed analyses as a qualitative assessment of habitat diversity and climate influences (Hudson 2017) and other landscape analyses (Beaulne 2017).

9.0 Natural Heritage Plan

The Plan (illustrated for the Canadian Shield and Limestone Plain in Figures 26and 27, respectively) shows the map of potential priority areas and the connectivity between these areas, as described above. All features corresponding with criteria shown in Table 3, with their identified buffers and weighting, are included in Figures 26 and 27. The map was created with raster data (see definition box above). Weightings for each variable were applied to the data to create a score for each part of the map. The resulting cumulative scores were divided into three categories based on the standard deviation around the raster score: Low (with scores of 0 to 4), Medium (with scores of >4 to 9) and High (with scores of >9 to 25). This delineation varies somewhat in the Limestone Plain (see below).

Raster maps, which include the headwater lake layer, are shown in Figure 26(Canadian Shield) and 27 (Limestone Plain). The raster maps have different score ranges for Low, Medium and High to emphasize the higher priority areas within each of the regions (if they were on the same scale, then the Limestone Plain would have much smaller areas of yellow and red). The Limestone scores are: Low (0), Medium (1-6) and High (>6-24).

With weighting applied, some patterns emerged. The highest scores on the Canadian Shield (Figure 26) were driven by the headwater lake areas layer, thus those areas that have high elevation points within the quaternary level watershed had higher scores in the northern shield area. Particularly concentrated yellow/red areas were in the northwest (upper reaches of the Salmon River watershed), areas to the north and west of Puzzle Lake and then areas north, adjacent to and south of Frontenac Park.

In the Limestone Plain (Figure 27) the higher scores were determined largely by Provincially Significant Wetlands. The mapping identified an area of high priority in a band approximately 2-3 km south of the Canadian Shield boundary.

Due to the large influence of the headwater lake areas on the raster maps, especially in the Canadian Shield region, raster analyses were re-run without this layer. (Figure 28and 29). Without the addition of the headwater lake layer, the indication was that the main concentrations of high and medium priority were in the east around the Frontenac Park region. (Omission of headwater areas in the south made very little difference, as headwater areas were much smaller in the south.) The headwater lake layer and the 1 km buffer is of high ecological significance and of high priority focus for the LC-KFLA. The raster analysis without the headwater lake layer was explored to examine what other habitat/priority areas would be emphasized without this layer.

All of the raster maps will be used as guidance towards developing prioritization for acquisition, with no one particular map used as part of an ultimate decision tool.

Ultimately, for practical purposes, prioritization for acquisition will be on three levels. First is ecological: areas with the highest contribution to the natural heritage of the Plan area will be the first priority. Future detailed analyses of the headwater lake areas

identified in the initial raster maps (Figs 26 & 27) and the Puzzle Lake, Depot Lake, east to Frontenac Park region (Figs 28 & 29) will help prioritize specific areas of focus for conservation. Second is political or organizational: prioritizing areas which meet the objectives of the LC-KFLA and its partners, and may be in greatest need of protection because they have incomplete protection at the policy and legislative level. Third is vulnerability or high-risk habitats that may be taken into consideration: areas that need a high level of either management or restoration may not be feasible, given the small resources of LC-KFLA. However, even these areas may be within the scope of LC-KFLA's capabilities if a partnership fosters stewardship opportunities for volunteer efforts and fundraising that LC-KFLA could help organize and implement.

9.1.1 Areas of Exclusion from the Plan

Areas of aggregate extraction (with a 500 m buffer), major roads, and built-up areas (with a 500 m buffer) are areas that may weigh against inclusion in the Plan (Figure 30). While their affect would not be subtracted from the raster score, they could be used to inform the final layout of the Plan.

Approach to Mapping and Modifications Through Consultation

This layer will be used to inform priorities for acquisition as a qualitative overlay on the raster maps.

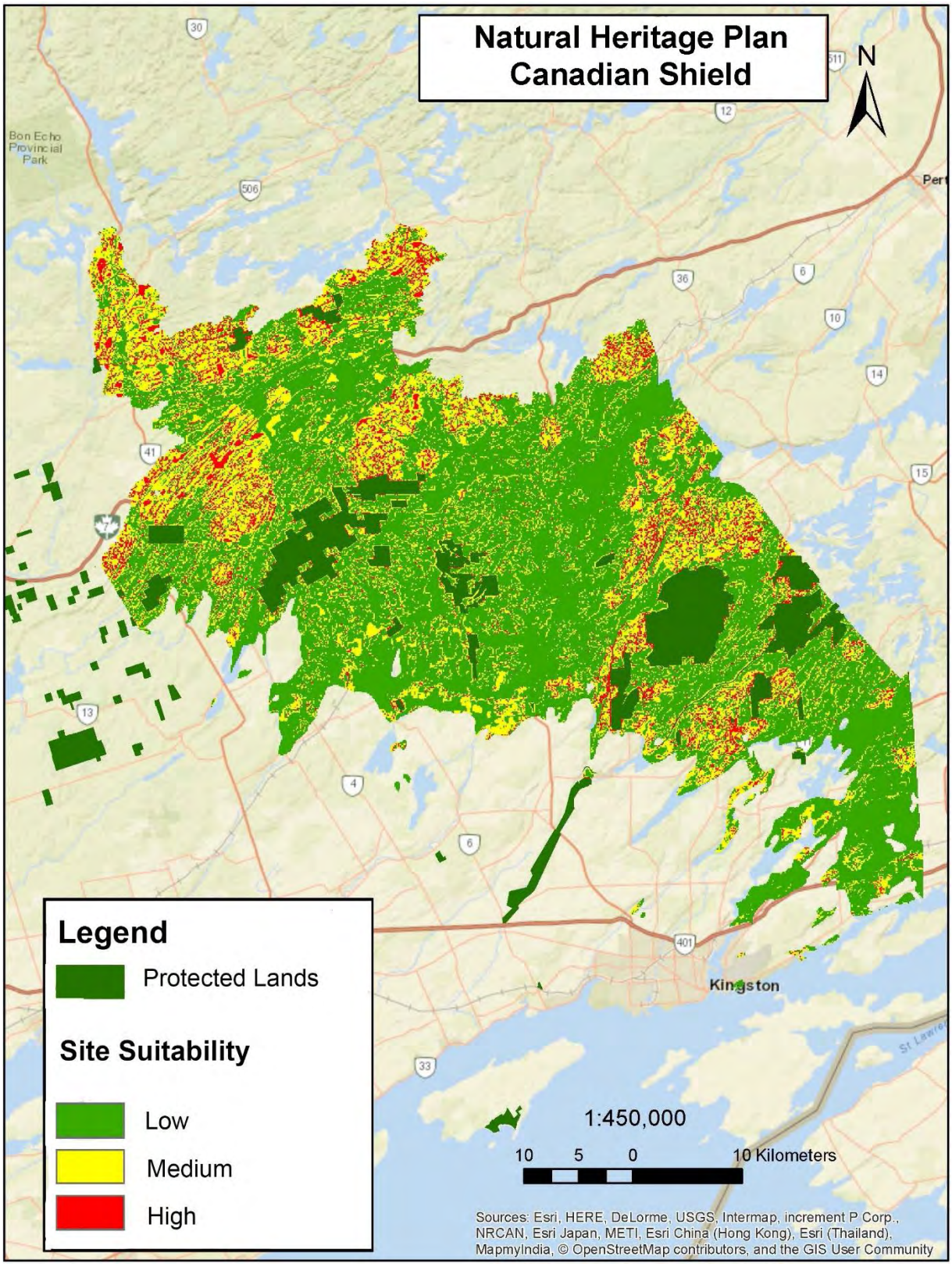


Figure 26: Map of the Natural Heritage Plan within the Canadian Shield, including headwater lake areas.

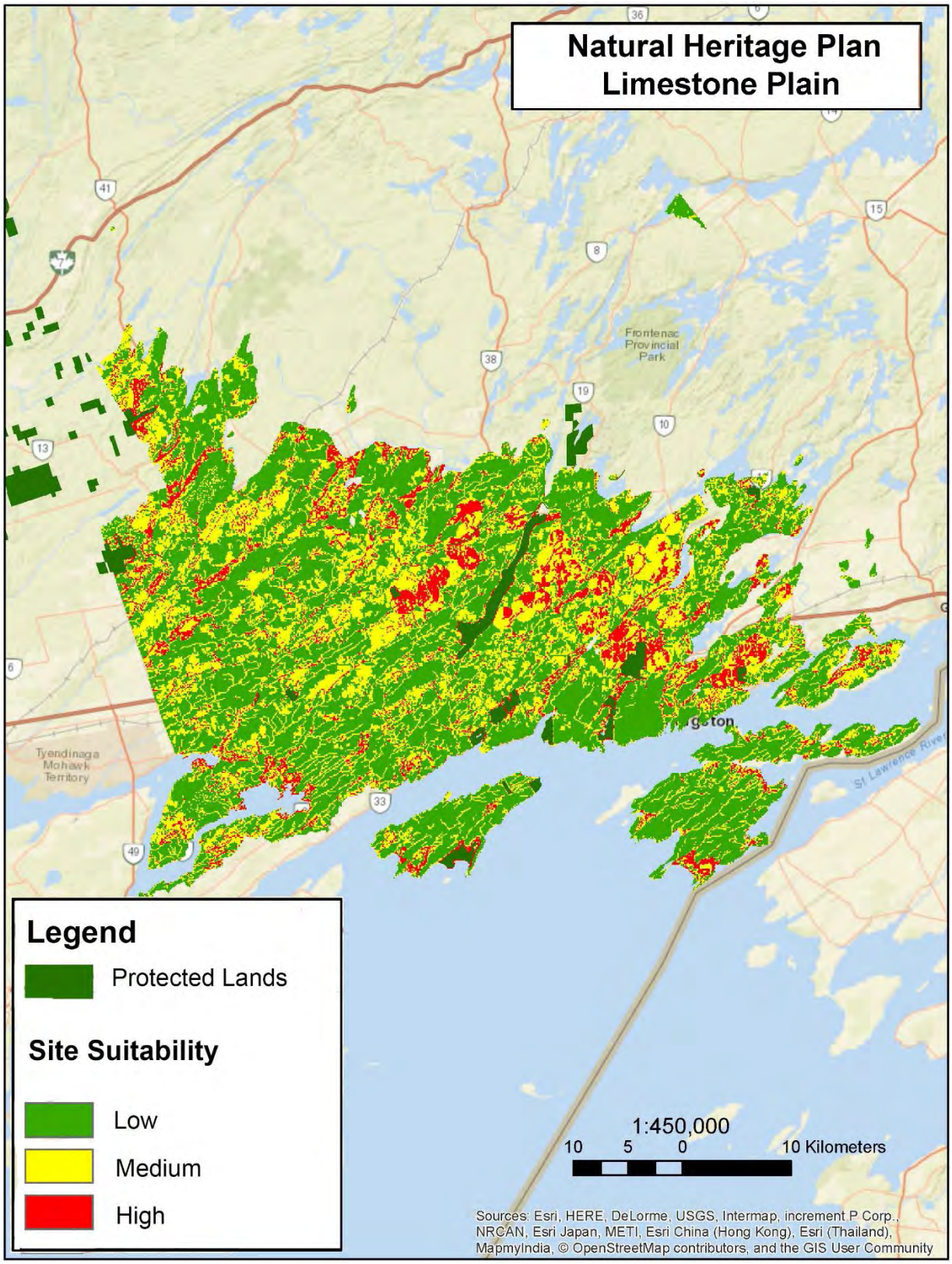


Figure 27. Map of the Natural Heritage Plan within the Limestone Plain, including headwater lake areas.

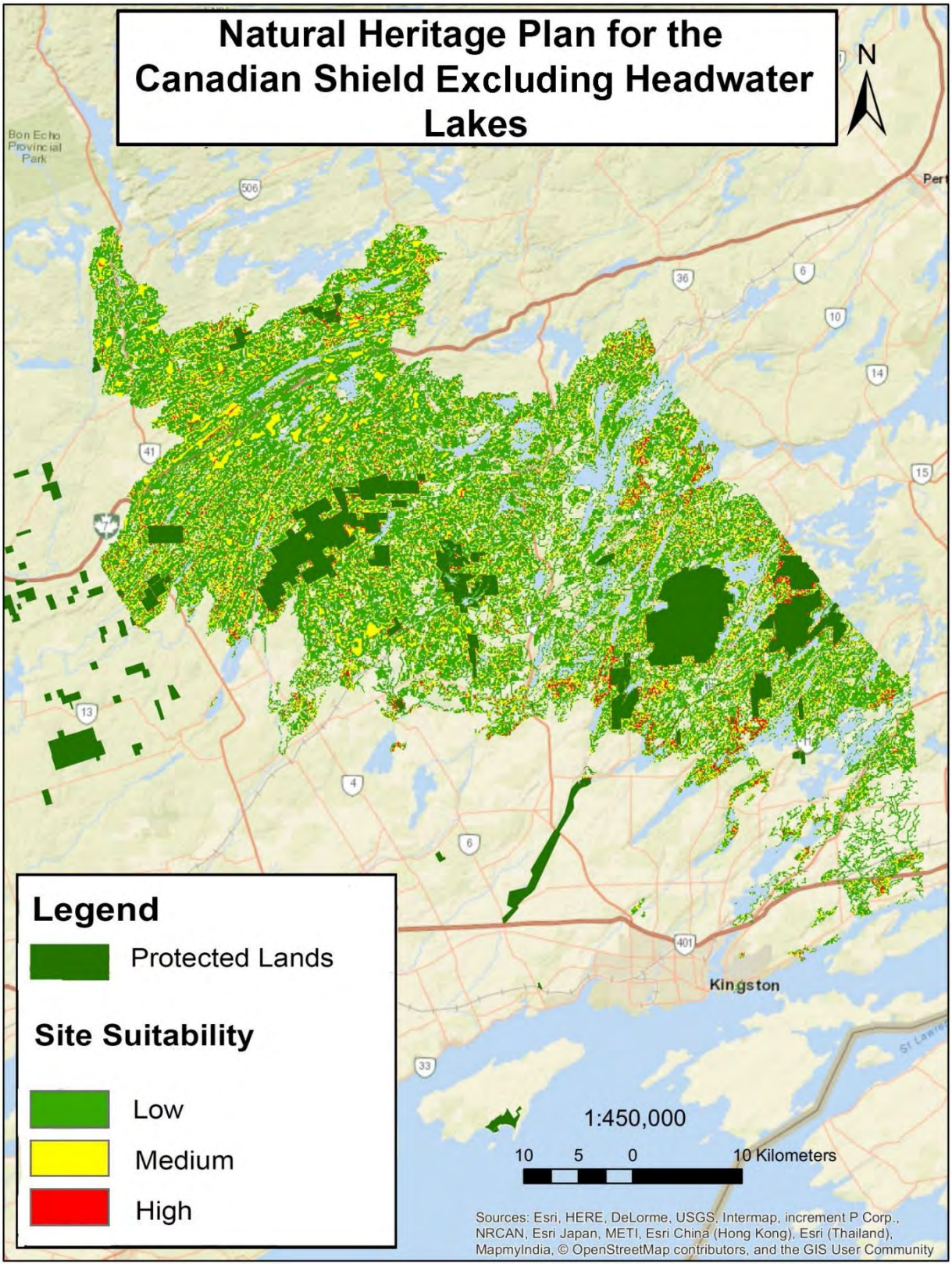


Figure 28. Map of the Natural Heritage Plan on the Canadian Shield, excluding headwater lake areas.

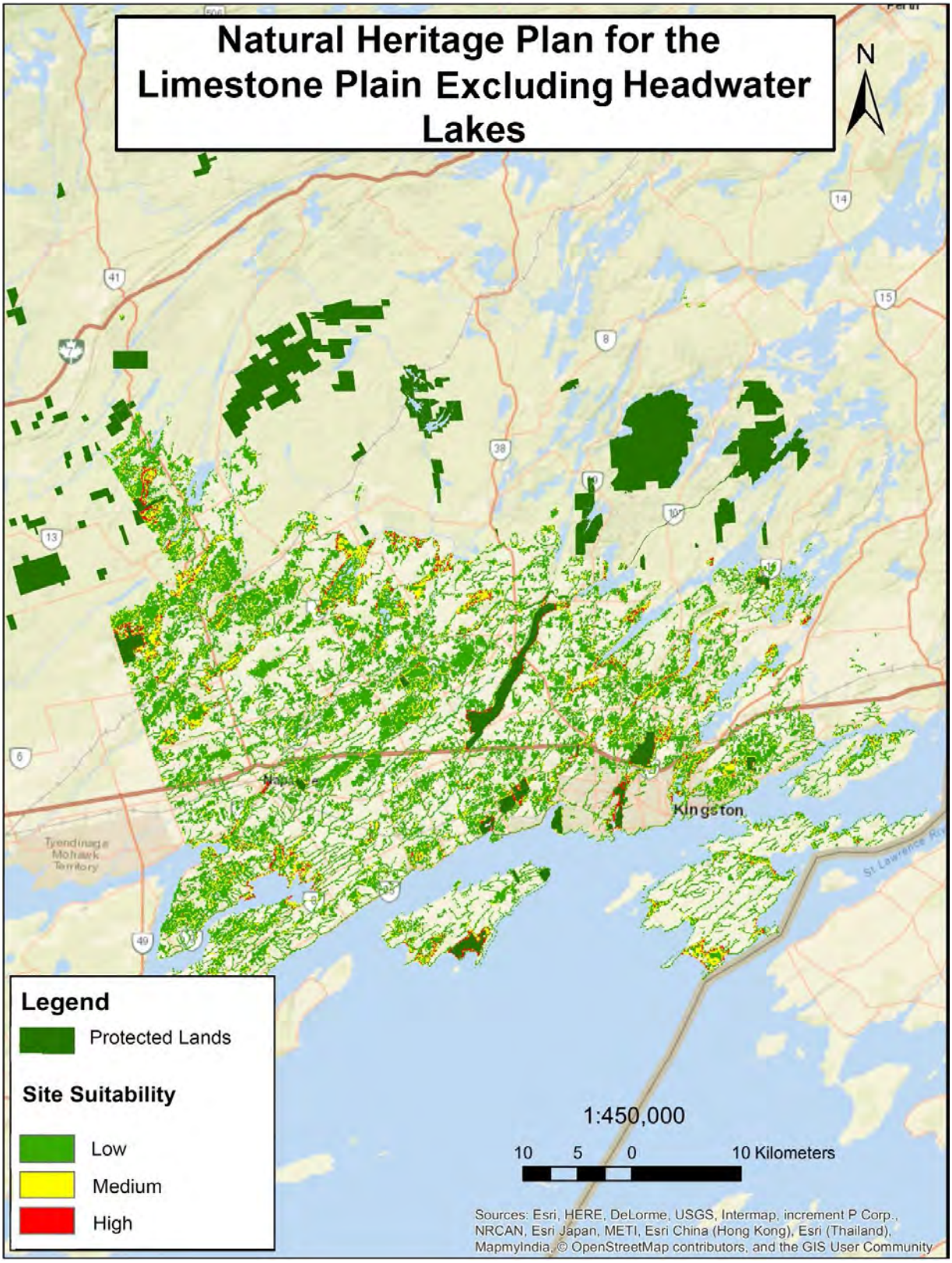


Figure 29. Map of the Natural Heritage Plan on the Limestone Plain, excluding headwater lake areas.

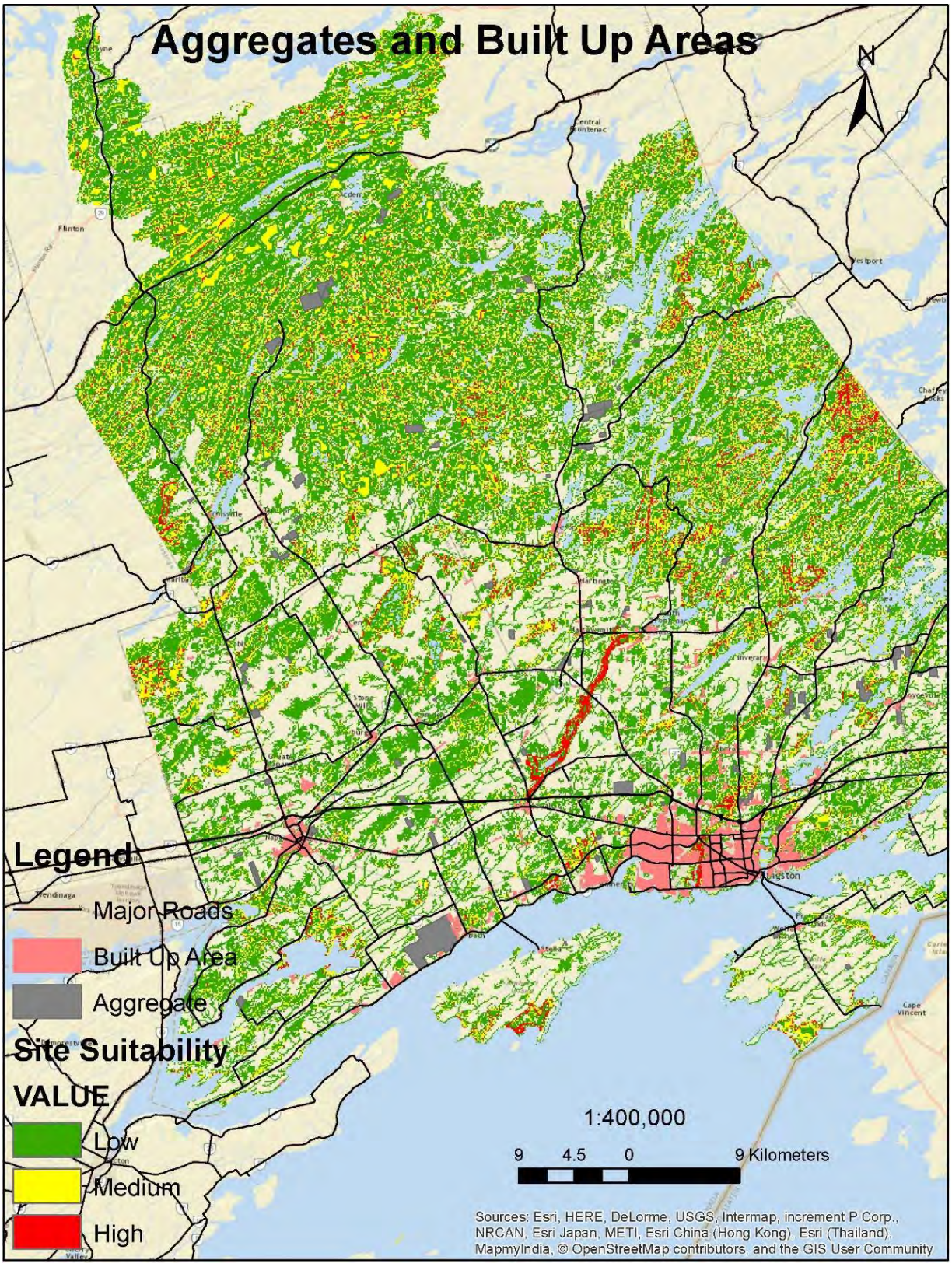


Figure 30. Map of the Natural Heritage Plan showing built-up areas and aggregate areas, which may be areas considered for exclusion.

10.0 Conclusions and Recommendations

The Plan builds on the areas that are protected through ownership (provincial parks, the NCC, land trusts and Queen's University Biological Station lands) and through legislation (PSWs, ANSIs). It takes a landscape approach to look for the consolidation of protected areas and expansion of patches with an aim of increasing habitat diversity and connectivity across the landscape. The Plan takes a feature-based approach to protecting ecosystems, rather than attempting, for example, a species at risk approach and focusing on areas that are used by specific listed species, which may be difficult to map, and for which habitat or provincial distributions may change. Species need different habitats during their life cycles so safeguarding mosaics of diverse patches is important. Increasing connectivity between the protected lands also contributes to ecosystem health.

The Plan presented here provides guidance for the identification of core areas and primary corridors (or connections) throughout the LC-KFLA study area. It uses high-level mapping to identify features, supplemented with more refined mapping where possible. It takes into consideration connectivity provided by watercourses, without specifying the width required for corridors, as this would require more detailed information on prospective land use and species. However, primary linkages (connections) defined by other agencies such as conservation authorities and the Algonquin to Adirondacks Collaborative will be considered when developing priorities for acquisition.

Consultation has indicated that many organizations in the study area have similar interests in defining natural heritage systems and are willing to forge partnerships with LC-KFLA. Municipalities are interested in the techniques used to develop the Plan because of its potential to provide support for protection of lands that have a high value for the broader natural heritage system. While the mapping used is relatively high level, the identification of elements of the Plan cited in the Natural Heritage Reference Manual could provide support for municipal protection, with the caveat that the boundaries of the Plan would need to be refined by additional aerial photo interpretation and ground-truthing.

The weighting of areas, building on existing protected lands and significant features and increasing the connectivity between these lands, has indicated potential priority for acquisition within a broad corridor in the Canadian Shield around Frontenac Provincial Park and west to the Depot Lakes region and Puzzle Lake Park and in the northwest portion adjacent to Hastings County. In the southern Limestone Plain, highlighted areas include a band approximately 2-3 km south of the Canadian Shield boundary driven largely by Provincially Significant Wetlands. Future detailed analyses will help to refine particular areas of conservation interest to the LC-KFLA.

11.0 References

Beaulne, D. 2017. Exploration of Analyses that Would Contribute to Increased Understanding of the Landscape Within the LC-KFLA Plan Area. Report prepared for LC-KFLA.

Bowman, J. and C. Cordes. 2015. Landscape connectivity in the Great Lakes Basin. Accessed on-line January 2018 at figshare http://dx.doi.org/10.6084/m9.figshare.1471658.

Crins, W.J., P. A. Gray, P. W.C. Uhlig, and M. C. Wester. The Ecosystems of Ontario, Part 1: Ecozones and Ecoregions. Report for Science & Information Branch, Inventory, Monitoring and Assessment Section

Environment Canada. 2013. *How Much Habitat is Enough? Third Edition*. Environment Canada, Toronto, Ontario.

Environment Canada. 2014. Terrestrial Biodiversity of Federal Interest in the Mixedwood Plains Ecozone of Ontario. Environment Canada, Toronto, Ontario.
Hudson, R. 2017. Land Cover Change in the Kingston, Frontenac, Lennox and Addington region. Report prepared for LC-KFLA.

Matawa First Nation Open Data. 2017. Accessed on-line January 2018. http://redcp-matawa.opendata.arcgis.com/datasets/089e75bd67854c908a6933d5bf5d0ffd_0

North-South Environmental Inc. 2015. Building a Natural Heritage System for Kingston, Frontenac, Lennox and Addington: Background Report. Report for LC-KFLA

Ontario Headwaters Institute. 2017. What are Headwaters?. http://ontarioheadwaters.ca/what-are-headwaters/ Last Accessed on November 6, 2017.

Ontario Ministry of Environment and Climate Change. 2016. Lakeshore Capacity Assessment Handbook: Protecting Water Quality in Inland Lakes. Accessed on-line January 2018 at https://www.ontario.ca/document/lakeshore-capacity-assessment-handbook-protecting-water-quality-inland-lakes

Ontario Ministry of Municipal Affairs and Housing. 2014. 2014 Provincial Policy Statement, Under the Planning Act. Toronto, Ontario: Ministry of Municipal Affairs and Housing, Provincial Planning Policy Branch.

Ontario Ministry of Natural Resources [MNR]. 2010. Natural Heritage Reference Manual for Natural Heritage Policies of the Provincial Policy Statement, 2005. Second Edition. Toronto: Queen's Printer for Ontario. 248 pp.

Ontario Ministry of Natural Resources and Forestry. 2015a. Significant Wildlife Habitat Criteria Schedules For Ecoregion 7E.

Ontario Ministry of Natural Resources and Forestry. 2015b. Inland Ontario Lakes Designated for Lake Trout Management. Report for Species Conservation Policy Branch, Ontario Ministry of Natural Resources and Forestry, Peterborough, Ontatio. 54 pp.

Appendix 1: Natural Heritage Plans Referenced for this Study

Table provided by Rob McRae, Manager, Watershed Planning and Engineering, Cataraqui Region Conservation Authority referencing other Natural Heritage Plans in the region.

Study Name	Year	Author	Study Area	Eco-district	Municipal	Other	Water-shed
Algonquin to Adirondacks Collaborative – Connectivity Analysis	2014	A2A Collaborative /MNRF NHIC	Eastern Ontario, upper New York State	●		●	
Alvars – A Multispecies Recovery Strategy	2006	Adele Crowder, Hillary Knack, Todd Norris (OMNR)	Napanee – Prince Edward Plains			●	
Bay of Quinte Natural Heritage Study	2015	Lower Trent Conservation	Bay of Quinte watershed (incl. Greater Napanee, Loyalist)				●
Central Cataraqui Region Natural Heritage Study	2006	CRCA	Kingston, Loyalist		●		
Ecodistrict 6E-15 Natural Heritage Study & Appendices	2011	MNRF Peterborough	Ecodistrict 6E-15 (along Lake Ontario)	●			
Frontenac Arch Conservation Plan II (2012-2017)	2012	Nature Conservancy of Canada	Frontenac Arch			●	
County of Frontenac Natural Heritage Study	2012	Dillon Consulting Ltd. for the County of Frontenac	Frontenac		●		

Landscape Connectivity in the Great Lakes Basin	2015	Jeff Bowman and Chad Cordes	Great Lakes Basin				●
Lennox & Addington Official Plan	2015		Lennox & Addington		●		
Napanee Natural Heritage Study	2005	CRCA	Greater Napanee		●		
Pittsburgh Environmentally Significant Areas Study	1996	Environmental Advisory Services Ltd. for the CRCA	Kingston (Pittsburgh)		●		
Sustaining What We Value (Ecodistrict 6E10 & 11) and Appendices	2011	A2A Collaborative (et al)	Ecodistricts 6E-10 and 6-11	●			
The Land Between – Greenway Mapping Project	2015	The Land Between	The Land Between			●	
Woodland Valuation System	2003	Eastern Ontario Model Forest	Leeds and Grenville + associated quaternary watersheds				●

Other documents: CRCA – Conservation Lands Guidelines – June 2010

Appendix 2. Summary of Methods and Input used to Develop Natural Heritage Systems in the LC-KFLA Study Area

Natural Heritage Plan Summary

Appendix 3
Determining areas for inclusion
(see page 14 for Table 2- scoring and weighting)

Plan Name/ author	Area Covered	Year	General Methodology	Input layers	Feature	Classification for inclusion or target
A2A	A2A region, based on Ontario ecodistricts and NY ecoregions with 2km buffer	2014	Based on Marxan/Voros methods used by MNRF, slightly modified	Natural landcover from base map, NHP rare communities, NHP exemplary communities, great lakes coastal wetlands, small lakes (<20ha), small rivers (<60m wide)	Core water areas	lakes larger than 20ha and rivers greater than 6om wide, excluding islands
					Barriers to cores	400 series and interstate highways (excluding locations of land bridges) with buffer, footprints of buildings, road density of higher than 9km/km2, waterbody cores are fragment to land cores
					Land core areas	Greater than 40m wide, include non-natural less than 100m wide surrounded by natural as restoration potential, remove barrier features, still greater than 500m wide
					Least-cost path linkages	Complex. First natural cover over 40m wide and core areas as above, non-natural cover included for distances between cores less than 100m, dissolve into one core layer, repeat for 200m and in 100m increments up to 1000m. Use primary connection zones (less than 500m) and remove high resistance areas such as roads, urban development- there is a tool for this- based on land map (used linkage mapper tool developed by NCC)
					Riparian linkages	Shortest hydrological pathways between cores, outside core areas and can connect 2 or more cores (used linkage mapper tool)
					Species at risk, vegetation communities	Used as corroboration only. NHIC and NY data, excludes records older than 1980, low accuracy data, removed species with anthropogenic habitats (IE; grassland birds)

Plan Name/ author	Area Covered	Year	General Methodology	Input layers	Feature	Classification for inclusion or target
MNRF- Sustaining What we Value	Ecodistricts 6E10&11- contains Leeds & Grenville Townships, much of South Frontenac, southern and eastern parts of Lanark	0	Marxan model. First targets are created and then a series of scenarios are created that meet those targets- IE: 50% of forest should be included	Predictive Vegetation Modelling ELC Vegetation Types for ecodistrict 6E-10 Forest Resource Inventory ELC Vegetation Types for ecodistricts 6E-11, 12 (from EOMF) Southern Ontario Land Resource Information System (SOLRIS) SOLRIS Phase 1 Wooded Areas Updated to 2008 DRAPE Imagery Great Lakes Coastal Wetlands (from Great Lakes Commission) Ontario Ecodistricts Soil Landscapes of Canada (from Agriculture and Agri-Foods Canada) Tertiary and Quaternary Watersheds WRIP Delineated Catchments (Arc Hydro Quaternary Watershed Sessions) Ontario Road Network Canada Land Inventory	Provincially Significant Wetlands • Community Forests (formerly Agreement Forests) • Conservation Authority Conservation Areas and Properties • Ducks Unlimited Owned Properties • Land Trust Properties • Ontario Heritage Trust Properties managed for natural heritage values • Nature Reserves managed by Ontario Nature or its affiliates • Nature Conservancy of Canada Properties • Conservation Easements • St. Lawrence Parks Commission areas • National Parks • National Wildlife Areas • Wildlife Management Areas (also called Provincial Wildlife Areas)	Always included

Plan Name/ author	Area Covered	Year	General Methodology	Input layers	Feature	Classification for inclusion or target
				Agricultural Capability Classes (from Agriculture and Agri-Foods Canada) MPAC Assessment Parcel Socio-political Considerations National Parks Nature Conservancy of Canada Properties **(1)** National Wildlife Areas Ontario Heritage Trust Properties **(1)** Provincial Parks St. Lawrence Parks Commission Properties **(1)** Wildlife Management Areas Frontenac Arch Biosphere Reserve **(1)** Wilderness Areas Important Bird Areas (from Canadian Wildlife Service) Crown Lands (MNR Land Tenure 3 data set) Migratory Bird Sanctuaries (from Canadian Wildlife Service) Evaluated Wetlands (Wetland Unit) Rideau Waterway Heritage River System (derived from	• National Historic Parks and Sites with natural heritage protection objectives • Provincial Parks • MNR-managed crown lands • University Biological Research Properties • Open Water (including Inland Lakes, Rivers)	
					Existing and Approved Urban Areas that are 100% impervious / built-up • Fencerows/ hedgerows	Always excluded
					Wooded Area Types	5% of total woodland cover to be represented by each forest type within the system
					Old Growth Forests	*5% of total woodland cover to be represented by old growth*
					Rare Ecosystems	*100% of S1, S2, S3 communities identified by the NHIC*
					Wetland Types	5% of total wetland cover to be represented by each type within the system

Plan Name/ author	Area Covered	Year	General Methodology	Input layers	Feature	Classification for inclusion or target
				former LIO Water Line Segment) Areas of Natural Science Interest (ANSI) National Historic Canals (from Parks Canada) Conservation Authority Floodplain Mapping **(1)** National Historic Parks and Sites (from Parks Canada) Conservation Authority Properties **(1)** University Biological Research Properties (from COA) Ontario Nature Reserves **(1)** First Nations Reserves Ducks Unlimited Properties **(1)** SOLRIS Hedgerows Community Forests (Agreement Forests) SOLRIS Built-Up Area Impervious Land Trust Properties **(1)** SOLRIS Waterbodies Costs Licensed Aggregate Pits/Quarries (Aggregate Site	Coastal wetlands	100%
					Forest Cover	30% of total land area AND 30% of the land area by quaternary watershed
					Wetland Cover	30% of total land area AND 10% of total land area by tertiary watershed and 6% by quaternary watershed
					Forest Patch Size	100% of patches ≥ 75 ha in size
					Forest Interior	10% of total forest cover at 100 m from forest edge, 5% of total forest cover at 200 m from forest edge
					Wetland Patch Size	a. Ecodistrict 6E-10: 100% of wetlands ≥100 ha . 100% of marshes, fens, bogs 50-100 ha i. 50% of swamps 50-100 ha b. Ecodistrict 6E-11,12, 5E-12: iv. 100% of marshes, fens, bogs ≥100 ha v. 50% of swamps ≥100 ha
					Wetland Adjacent Upland Cover	a. 100% of wetlands with 75-100% cover within 120 m b. 50% of wetlands with 50-75% cover within 120 m
					Riparian Vegetation (within 30 m of streams, rivers, inland lakes)	100% of reaches with 75-100% natural cover
					Remoteness/ distance from roads	100% of natural cover found ≥ 2 km from any

Plan Name/ author	Area Covered	Year	General Methodology	Input layers	Feature	Classification for inclusion or target
				Authorized) Prime Agricultural Lands (SOLRIS Agricultural Areas + CLI Class 1-3) Prime Agricultural Areas (SOLRIS Agricultural Areas + CLI Class 4-7) Major Roads and Concessions (from ON Road Network)		road
					Maple Syrup Production	50% of sugar-maple dominated stands
					Natural Cover in Headwater Catchments	50% of the land area be included, of which: a. 30% consist of wetlands b. 20% consist of upland forest
					Riparian Functional Zones	100% of reaches with 75-100% natural cover within 100 m
CRCA-Queen's, Collin's Creek Greenway Study	Collin's Creek Watershed- in City of Kingston and Loyalist townships	2007	Basic adding to map and scoring, see table 2			
Central Cataraqui Region Natural Heritage Study		2006		Provincially Significant Wetlands (area information-polygons);Evaluated Wetlands (not provincially significant) (area information- polygons); Unevaluated wetlands; Areas of Natural and Scientific Interest (area information-polygons); Environmentally Sensitive Areas (area information- polygons); Wildlife habitat information (point data); and Species of conservation concern data (point data).	Core areas	This is unclear. Significant woodlands, evaluated wetlands and ANSI layers added together. Significant woodland= -40 hectares (area with 15 – 30 % forest cover) > 4 hectares (area with 5 – 15 % forest cover) - habitat at least 100 metres from edge - with an interior core of 4 hectares - any woodland or portion of woodland that is adjacent to a stream is significant (this includes headwater woodlands), 30 m

Plan Name/ author	Area Covered	Year	General Methodology	Input layers	Feature	Classification for inclusion or target
				Woodland data was created by outlining polygons of forest visible on aerial photographs Spawning areas, avian species, valleylands		adjacent forest classified as significant. - forest patches located adjacent to (within 120 m) or overlapping with other significant features, including Provincially Significant Wetlands, ANSIs, Environmentally Significant Areas classified as significant. -woodland patches with old growth forest defined as communities of trees 100 years or older (determined using MNR FRI layer and age progression).
					Linkages	Done visually using a path of least resistance
Frontenac County		2012	Similar to others- collection of available data and mapping. Included a steering committee, policy review and at least two public input sessions and some field checking.	**Aquatic Feeding Area** **Conservation Reserve, Regulated** . **Conservation Area** **Federal Protected Area** **Wildlife Feeding Area** **OHN - Waterbody** **Provincial Park, Regulated** **Wetland Unit & Evaluated Wetland (Consolidated)** **Wilderness Area** **Wintering Area** **Wooded Area** **Agreement Forest Area** **Crown Game Preserves** **Federal Land** **Bird Nesting nesting point** **NGO Nature Reserve** **Natural Heritage Values Area** **Ecoregion Boundary** **Watershed boundaries**	Linkages	-land cover type: 10 general ELC based land cover types were ranked based on suitability as passage -presence of protected areas, in order to try and link them where possible, given 100% -proximity to roads (negative) given -100% at different distances (IE: withing 5m of local road or within 500m of freeway)
					Biodiversity Areas	-Land Cover -Soil Types -Surficial Geology -preserve 10% of all categories for above- except 5% for agricultural land and rock barrens. Weighted to give land cover types higher priority -developed areas more than 125ha excluded, added costs for development and roads

Plan Name/ author	Area Covered	Year	General Methodology	Input layers	Feature	Classification for inclusion or target
				At Capacity Lake Trout Lakes **Quaternary Geology**		
MNRF- Our Land-Healthy-Vibrant-Valued	Ecodistrict 6E-15 and part of 6E-9, Prince Edward County, much of Kingston, lake shore from Brighton to almost Gan	2011	Marxan	**Primary/Base Data** Southern Ontario Land Resource Information System (SOLRIS) SOLRIS Phase 1 Wooded Areas Updated to 2008 DRAPE Imagery in Study Area Great Lakes Coastal Wetlands (from Great Lakes Commission) Ontario Ecodistricts Soil Landscapes of Canada (from Agriculture and Agri-Foods Canada) Tertiary and Quaternary Watersheds WRIP Delineated Catchments (Arc Hydro Quaternary Watershed Sessions) Ontario Road Network Canada Land Inventory Agricultural Capability Classes (from Agriculture and Agri-Foods Canada)	Provincially Significant Wetlands • Community Forests (formerly Agreement Forests) • Conservation Authority Owned Properties managed for natural heritage protection objectives • Ducks Unlimited Owned Properties • Land Trust Properties • Nature Conservancy of Canada Properties • St. Lawrence Parks Commission properties with natural heritage protection objectives • National Parks • National Wildlife Areas • Wilderness Areas • National Historic Canals, Historic Parks and Sites with natural heritage protection objectives • Provincial Parks • MNR-managed	Always included

Plan Name/ author	Area Covered	Year	General Methodology	Input layers	Feature	Classification for inclusion or target
				MPAC Assessment Parcel Socio-political Considerations National Parks Nature Conservancy of Canada Properties **(1)** National Wildlife Areas Ducks Unlimited Properties **(1)** Provincial Parks St. Lawrence Parks Commission Properties **(1)** Fish Sanctuaries Frontenac Arch Biosphere Reserve **(1)** Wilderness Areas Important Bird Areas (from Canadian Wildlife Crown Lands (MNR Land Tenure 3 dataset) Si)Rideau Waterway Heritage River System (derived from former LIO Water Line Segment) Evaluated Wetlands (Wetland Unit) First Nations Reserves Areas of Natural Science Interest (ANSI) National Historic Canals	crown lands • Fish Sanctuaries • Inland Lakes, Rivers and Great Lakes Nearshore Margins	
					All 5 hectare Hexagons which do not contain any natural cover and do not contribute to any of the targets • Existing and Approved Urban Areas that are 100% impervious / built-	Always excluded
					Wooded Area Types: 5% of total woodland cover to be represented by each forest type within the system Wetland Types: 5% of total wetland cover to be represented by each type within the system *Old Growth Forests*: 5% of total woodland cover to be represented by old growth* *Pre-Settlement Forest Soils*: 100%* *Rare Ecosystems*: 100% of S1, S2, S3 communities identified by the NHIC*	

Plan Name/ author	Area Covered	Year	General Methodology	Input layers	Feature	Classification for inclusion or target
				(from Parks Canada) Conservation Authority Floodplain Mapping **(1)** National Historic Parks and Sites (from Parks Canada) Conservation Authority Properties **(1)** SOLRIS Hedgerows Community Forests (Agreement SOLRIS Built-Up Area Impervious Ft)Land Trust Properties **(1)** SOLRIS Waterbodies Costs Licensed Aggregate Pits/Quarries (Aggregate Site Authorized) Prime Agricultural Lands (SOLRIS Agricultural Areas + CLI Class 1-3) Major Roads and Concessions (from ON Road Network) Overlays Species at Risk Element Occurrences (from Natural Heritage Information Centre) Proximity between Forests and Wetlands (derived from base data)	Other Habitat Types/ Unique Features: 100% of features mapped by NHIC and coastal wetlands Forest Cover: 30% of total land area Wetland Cover: 10% of total land area Forest Patch Size: 50% of the patches in each of the top 3 patch size classes (75-100 ha, 100-200 ha, >200 ha) Proximity of Forest Patches: No target – implement through Marxan calibration Forest Interior: a. 10% of total forest cover at 100 m from forest edge b. 5% of total forest cover at 200 m from forest edge Wetland Patch Size: c. 100% of wetlands ≥100ha d. 100% of non-forested swamps ≥ 50 ha e. 100% of marshes, fens, bogs ≥ 0.5 ha f. 50% of forested swamps ≥ 0.5 ha Wetland Adjacent Upland Natural Cover: a. 100% of wetlands with 75-100% cover within 120 m b. 50% of wetlands with 50-75% cover within 120 m Proximity of Wetland Patches: No target – implement through Marxan calibration Riparian Vegetation (within 50 m of all streams, rivers, inland lakes, or the extent of alluvial soils, whichever is greater): a. 100% of reaches with 75-100% natural cover b. 50% of reaches with 50-75% natural cover c. 100% of natural vegetation within 100 m of Great Lakes shoreline d. Riparian Vegetation (within 300 m of all streams, rivers, inland lakes): no target	

Plan Name/ author	Area Covered	Year	General Methodology	Input layers	Feature	Classification for inclusion or target
				Ontario Trail Network Ecosystem Services (from Troy and Bagstad 2009)	Remoteness/Distance from Roads: 100% of natural cover found ≥ 1 km from any road Forest Cover: 30% of the land area by quaternary watershed Wetland Cover: 20% of total land area by tertiary watershed and 12% by quaternary watershed Natural Cover in Headwater Catchments: 50% of the land area be included, of which: a. 30% consist of wetlands b. 20% consist of upland forest Riparian Functional Zones (streams, rivers, inland lakes): 100% of reaches with 75-100% natural cover within 100 m Significant Recharge Areas: 100% of natural cover within significant recharge areas as mapped by Source Water Protection	
The Land Between-Greenway Mapping	From Georgian Bay to Frontenac Arch-between shield and lowlands	2015	Only wanted private property, removed crown and others, sorted end data based on parcel size. Used a few parameters and scored 1, 0 or -1. Scores of 3 were highest priorities (see ranking section)	Federally Protected Areas (LIO-2015-03-03) □ Regulated Provincial Parks (LIO-2014-08-27) □ Conservation Reserves (LIO-2015-03-25) □ Conservation Areas (LIO-2013-03-05) □ Municipal Parks (LIO-2014-10-02) □ Provincially Significant Wetlands (LIO-2014-10)		

Plan Name/ author	Area Covered	Year	General Methodology	Input layers	Feature	Classification for inclusion or target
				Areas of Natural and Scientific Interest Crown Land as defined in the Digital Ownership Parcel Fabric Ontario Land Trust Alliance Lands Marsh Monitoring Program bird and frog data (Bird Studies Canada., 2008); Ontario Breeding Bird Atlas (2001-2005) data (Bird Studies Canada, Environment Canada's Canadian Wildlife Service, Ontario Nature, Ontario Field Ornithologists and Ontario Ministry of Natural Resources, 2008); Ontario Nocturnal Owl Survey data (Bird Studies Canada and Ontario Ministry of Natural Resources. , 2008); and Program for Regional and International Shorebird Monitoring data **NHIC SAR data** **FRI data for:** Algonquin Park Version 2 (2009)		

Plan Name/ author	Area Covered	Year	General Methodology	Input layers	Feature	Classification for inclusion or target
				□ Bancroft Minden Version 2 (2013) (Draft) □ French Severn Version 1 (1999) □ Ottawa Valley Version 1 (1998) □ Mazinaw Lanark Version 1 (2001) Southern Ontario Land Resource Information System (SOLRIS) Version 2 (2015) The Ontario Land Cover Compilation (OLCC) 2000 Ontario Road Network (LIO-2014-10-02) □ Ontario Railway Network (LIO-2014-10-02) □ Airports – Official/Other (LIO-2015-03-31) □ Peat Production Area (LIO-2015-03-31) □ MTO Aggregate Site (LIO-2015-03-03) □ Authorized Active Aggregate Site ((LIO-2015-03-03		
NCC	Frontenac Arch	2012	The conservation analysis was	***Protected Areas***	*Least- cost corridors*	-existing conservation lands (and pending NCC projects) grouped together to make 8

Plan Name/ author	Area Covered	Year	General Methodology	Input layers	Feature	Classification for inclusion or target
			broken down into two components. First, a least cost corridor analysis was completed to determine the optimal conservation corridors across the landscape. Second, priority parcels were then identified.	Provincial Parks National Parks Conservation Authority Land NCC Land Ontario Nature Queen's University Other Land Trusts Pending NCC Projects County Forests Dams Developed Areas Aggregate/Mining Areas Roads - Highways Roads - County/Regional Roads Roads - Local Roads 2 lanes Roads - Local Roads 1 lane Rivers Riparian Habitat Non-riparian Habitat ***Landcover***		blocks of core conservation lands -resistance values based on a variety of data such as landcover and roads were assigned -distance to core ("source") areas also factored in with resistance for a total cost -least cost path between all source areas calculated
Lower Trent Conservation, for BQRAP	Six municipalities and one first nation territory bordering BQ- notes that there is overlap with MNRF's 6E-15 plan and that this was used where possible	2015	Basic mapping of wetlands, significant woodlands, ANSIs	PSWs ANSIs 30m ELC of shoreline (from CWS) SOLRIS land cover DRAPE Fish habitat suitability	*Woodland Size*	Where forest cover (upland and swamp forest combined) is : o about 30–40% of the land cover (Quinte West 30.7%, Belleville 31.6%, Greater Napanee 30%, Loyalist 28.8%, Prince Edward County 31.5%), woodlands 20 ha in size or larger should be considered significant o about 40–60% (Tyendinaga 49.1%) of the land cover, woodlands 30 ha in size or larger should be considered significant

Plan Name/ author	Area Covered	Year	General Methodology	Input layers	Feature	Classification for inclusion or target
					Forest Interior	Woodlands should be considered significant if they have: o 8 ha or more of interior habitat where woodlands cover about 30–60% of the land cover
					Proximity to natural features	Woodlands should be considered significant if: o a portion of the woodland is located within 300 m of a significant natural feature (0.5 ha or larger) and the entire woodland meets the minimum area threshold
					Proximity to watercourses	Woodlands should be considered significant if they: o are located within 50 m of a watercourse and meet minimum area thresholds

TABLE 2
Determining weighting/priority of areas

Plan	Method for scoring	Scoring factors	Score criteria	Weighting?
A2A	Assigned a number value for each factor to each pixel. High=3, Med=2, Low=1, some factors weighted higher as seen in weight column. Negative scores (-3, -2, and -1) assigned to negative layers.	Forest shape complexity (area: perimeter ratio)	High= (Ontario) >117 Med= 67-117 Low= under 67	no
		Species biodiversity (Used SAR density, globally rare species density and density of other tracked species)	Not given (sensitive?)	High=3, Med= 2, Low=1
		Vegetation community diversity (used density of globally rare vegetation communities, density of other tracked vegetation communities (prov/state rare only), density of exemplary tracked vegetation communities)	Not given	No
		Wetland, island and water feature shape complexity (area: perimeter ratio)	High (ont)>306, med=147-306, low <147	No
		Hydrological function (distance of riparian area cover)	High= cover within 100m, med=101-500m, low= >500m	No
		Patch size	Large (>2000ha), Med (200-2000ha), Small (<200)	Large=10, Med=5, Small=2
		Forest interior (size of contiguous patches 100m from edge)	Large (>230ha), Med (90-230), Small (<90)	As above
		Distance to officially protected areas	Coincident, Adjacent (within 1000m), Nearby (1001-2000m)	Co=10, a=7, near=2
		Degree of natural cover	High (90-100%), Med (70-89%) and Low (<70%)	no
		Distance to ag land (negative score)	Coincident, Near (within 200m), Far (greater than 200m)	no
		Distance to developed lands (negative score)	As above	no
		Development density	Ontario high (greater than	no

Plan	Method for scoring	Scoring factors	Score criteria	Weighting?
			54%), med (17-53), low under 17)	
		Distance from roads (negative layer)	Coincident, adjacent (1-200m), far (>200m)	Co=3, a=2, far=1
		Road density (negative layer)	High (6.2-21.5kn/sq.km), Med (1.5-6.2), Low (under 1,5)	no
MNRF- both plans	This method is different- not listed priority areas- just in or out of the plan. The team used their judgement on possible scenarios to choose best one	However, there are maps that show the areas that most contribute to the targets in table one, which can give you priority areas		
Collin's Creek Greenway Study	Based on previous classifications by CRCA and staff knowledge at the time	Woodlands		Base score of 5
		Significant Woodlands	forests over 40 hectares in size, forests over 100 years old, forests with interior habitat, forests within 120 meters of an ANSI or evaluated wetland, and wooded riparian areas.	5 points for each of the criteria (plus base of 5, for at least 10)
		Interior Habitat	patch of forest at least 4 hectares in size, all of which is at least 200 meters from the outer edge of the forest	10 points (plus 10 for previous two categories)
		Riparian corridors	all lands within 30 meters of a watercourse	10
		Wooded riparian corridors	the overlap between woodlands and riparian corridors	5 points, plus points in riparian and woodland categories for a minimum of 25
		Significant valleylands	lands within 15 meters of the floodplain, 120 meters of provincially	15

Plan	Method for scoring	Scoring factors	Score criteria	Weighting?
			significant wetlands, 30 meters of other wetlands, 15 meters of apparent valley banks, or within the meander belt of a stream (defined as 10 times the stream's width).	
		Linkage line buffers	Linkages had been pre-determined by CRCA, scores were assigned to these and adjacent land based on distance from linkage	150 metres 20 points 450 metres 9 points 600 metres 8 points 750 metres 7 points 900 metres 6 points 1050 metres 5 points 1500 metres* 4 points
		Evaluated Wetlands		20+ buffer score 100 meter buffer 10 points 200 meter buffer 9 points 300 meter buffer 8 points 400 meter buffer 7 points 500 meter buffer 6 points 1000 meter buffer 4 points
		Unevaluated wetlands		15+ buffer as above
		ANSIs		20 + buffer as above
		Sensitive Species		20
Frontenac County	Does not appear to be scored- more like MNRF with Marxan			
Land Between	A score of 1 or -1 assigned to features, cumulative score determined priority	Species at risk (from NHIC and BSC monitoring programs)	Presence/ absence only	1
		Proximity to protected area	Within 1km	1
		Natural cover	50% or more	1, -1 for unnatural and 0 for unknown
		roads, railways, airports and areas of resource	Within 30m	-1

Plan	Method for scoring	Scoring factors	Score criteria	Weighting?
		extraction		
NCC-Frontenac Arch	Priority level assigned by staff based on criteria in 4 target areas	Natural cover	> 70 ha natural cover & along least cost corridor -30-70 ha natural cover & along least cost corridor -5 ha parcel with natural cover & along least cost corridor	-priority 1 -priority 2 -priority 3
		Rock barren	> 70 ha rock barren & along least cost corridor 30-70 ha rock barren & along least cost corridor	-priority 1 -priority 2 (no 3)
		Pitch Pine	Either > 70 ha EO Present OR > 70 ha High Probability of Pitch Pine* & along least cost corridor Either 30-70 ha EO Present OR 30-70 ha High Probability of Pitch Pine* & along least cost corridor	Priority 1 priority 2 (no 3)
		Coastal systems	> 5 ha coastal parcel & no buildings present & >90% coastal wetland/forest & along least cost corridor > 5 ha coastal parcel & no buildings present & >90% coastal wetland/forest	Priority 1 Priority 2
Lower Trent-	Layers as described scored and added together. Interestingly,	Patch size and shape- woodlands and wetlands	Size and shape (perimeter ratio) scored, combined and	A bit complicated, but larger size gets higher score as does lower

Plan	Method for scoring	Scoring factors	Score criteria	Weighting?
BQRAP	also include targets for increasing natural cover and map these.		weighted	shape ratio. Size was weighted higher for both wetlands and woodlands, but not the same
		Distance from urban area		10 different categories, scored 1-10, higher score for greater distance
		Distance from road		10 different categories, scored 1-10, higher score for greater distance
		Proximity to natural areas		10 different categories, scored 1-10, higher score for shorter distance
		Proximity of forest to wetland and vice-versa		10 different categories, scored 1-10, higher score for shorter distance
		Proximity to watercourse		10 different categories, scored 1-10, higher score for shorter distance
		Proximity to Bay or Lake Ont		Only 2 categories, </> 5000m-score of 10 for less than
		Proximity to Good fish habitat		Only 2 categories, </> 500m-score of 10 for less than

Appendix 3: Criteria Used to Develop Preliminary LC-KFLA Natural Heritage Plan

Preliminary Habitat criteria, ranking, and mapping considered by the Land Conservancy for Kingston, Frontenac, Lennox and Addington for its Natural Heritage Plan, prior to consultation, March 2017

1. Forest Patch size.

a) Northern shield vs. southern limestone plain. Our initial exploratory mapping was based on 100 acres (40 ha) and then also on 150 acres (60 ha) forest patch sizes for entire area, north and south. This showed dramatically that the northern Shield has high forest cover compared to much less cover in smaller patches on the limestone plain.

Choosing of patch size in Northern Shield: the Natural Heritage Reference Manual (MNR) - outlines forest patch size based on % forest cover: e.g if 15-30% forested use 20 ha patch size; if 30-60% forested -use 50 ha; if > 60% forested - no minimum size. The Northern Canadian Shield in our focus area is > 60% forested. The committee chose to use 60 ha forest patch size.

Excerpt from Natural Heritage Reference Manual (MNR):
Woodlands should be considered significant if they: are located within a sensitive or threatened watershed or a specified distance (e.g., 50 m or top of valley bank if greater) of a sensitive groundwater discharge, sensitive recharge, sensitive headwater area, watercourse or fish habitat and meet minimum area thresholds (e.g., 0.5–10 ha, depending on circumstance)

The Mapping Committee, in consultation with the land acquisitioncommittee and the Board, identified woodlands within the Canadian Shield that are at least 60 ha in size, AND within 60 m of a waterbody as a means of differentiating higher priority woodlands within a highly forested landscape. These criteria together identify and focus on the ecological significance of waterbodies for conservation of habitat and biodiversity of aquatic ecosystems and their associated upland habitats.

Choosing of patch size in Southern Limestone Plain:

Excerpt from Principles of Developing a Natural Heritage System from Mainguy (2015):

In areas where forest patches tend to be smaller, the largest patches (in the top 10%) should be identified (identify all patches over 20 ha).

The Southern Limestone Plain of our focus area has much higher development than the north and few remaining large size forest patches. As such the strategy in the south was to identify the top 20% of remaining forest patch size as priority lands.

While these criteria for both the north and south focus on larger intact tracks of land, it does not negate exploring or focusing on smaller tracks of land, particularly if they are adjacent to protected lands, Provincially Significant Wetlands (PSWs), ANSIs or have a high diversity of habitats or provide a linkage between other high priority lands.

2. Wetland size and buffer

Choosing of size of wetlands and buffer region:
Excerpt below from Principles of Developing a NH System (Mainguy, 2015):
Clusters of wetlands: e.g., networks of isolated wetlands; wetlands in close proximity (within approximately 750 m) including a range of hydrological types (Environment Canada 2013) and wetland types (swamp, marsh, fen and bog);

Forested lands adjacent to wetlands: highest priority is land within 50 m of the wetland boundary; land within 375 m may also be particularly critical for wetland function; for example if certain species of turtles are present - but functions can continue up to 1000 m. (Environment Canada 2013).
Wetlands of a large size (greater than 30 ha, or the top 10% in terms of size within the planning unit) can form part of core area (MNR 2010)

We chose to identify wetlands that were at least 30 ha in size; this size is based on a cluster of smaller wetlands. We wanted to identify large wetland complexes that have not been identified as PSWs. We chose to use a 50 m buffer as this is highest priority and incorporates the riparian vegetation. A minimum of 30 m buffer is recommended for fish habitat in streams. The NH manual does often identify the recommended buffer size of 120 m. In these cases, these are the recommended buffer sizes for minimizing impact on the habitat of interest. In our case, we are identifying the highest priority areas for conservation. In most cases, a property which encompasses an intact 50 m buffer, would likely have a much larger buffer that could be maintained under conservation.

In all of our waterbody habitats we chose to include a 50 m buffer and for the ANSIs we chose to add a 100 m buffer, to highlight those properties adjacent to these habitats as high priority for conservation.

3. Habitat rankings:

The Mapping Committee, with periodic feedback from the Board and land acquisition committee, established the habitat criteria that the Land Conservancy felt were the highest priority layers for our natural heritage strategy. Protected lands and Provincially Significant Wetlands (PSWs) were established as the highest priority layers, as these are the foundation of building the natural heritage strategy. The Mapping Committee asked board members and lands committee members to rank each of the remaining layers outlined in the Excel file (habitat rankings). The Land Conservancy focus area encompasses two extremely different regions: the Southern Limestone Plain and the Northern Canadian Shield, therefore the natural heritage Plan will have slightly different strategies for these two regions. To use the data effectively, each of the layers was ranked for both the north – Canadian Shield – and south – Limestone Plain. A number between 1 and 9, *with 9 being the highest rank*, was used to rank each layer for the north and again for the south to help the

Mapping Committee prioritize the layers. The Mapping Committee was seeking guidance on what each person felt was the most important habitat to consider when identifying areas for conservation. In each grouping, a number could only be used once (in other words, cannot give seven 9s, only one per grouping). The excel file, Habitat Rankings - has the individual rankings, and then summary statistics that were used in the end to provide weights for each of the habitat criteria. The weights for each of the habitat criteria are outlined below.

4. Habitat weights based on the overall habitat rankings:
The summary statistics of the habitat rankings (see Excel habitat rankings file) were used to establish the weights below that are used in the mapping to identify priority areas (raster mapping).

Negative layers: There are several negative layers (roads, aggregates and built up areas) that have been identified. The committee chose to not have these negative layers as additive to the positive habitat criteria layers, but rather to maintain as a separate layer that may be mapped with other layers. This will enable a better distinction of where the negatives are in reference to a particular property.

5. Addition of other NHP mapping layers.
The final priority mapping will be based on our habitat criteria layers with other overlapping NHP mapping from other organizations, e.g., Nature Conservancy of Canada, Adirondack to Algonquin Collaborative, The Land Between, Conservation Authorities. These layers were initially considered as an additive factor on top of our criteria mapping and weighting. So, where there are areas of priority that overlap between the different NHP mapping, consideration was given to additive weights. Thus areas that may have been of mid-priority may become high priority if other NHPs have also identified the same regions as priority for conservation.

Appendix 4: Consultation Participants

Meeting Participation Summary. Individuals shown in red represented more than one organization.

Organization	Individual and Role (if Noted)	Date
Cataraqui Region Conservation Authority	Rob McRae (Manager, Watershed Planning & Engineering) Tom Beaubiah (Manager, Conservation Lands) Travis York (Supervisor, Information Technology)	29 March 2017
Nature Conservancy of Canada	Mark Stabb (Program Manager, Central-East Ontario) Gary Bell (Program Director, Eastern Ontario)	19 April 2017
County of Frontenac	Joe Gallivan (Director of Planning & Economic Development) Megan Rueckwald (Communit Planner)	25 April 2017
Township of South Frontenac	Forbes Symon (Manager, Development Services)	25 April 2017
Township of Stone Mills	Roger Hogan (Deputy Clerk/Planning)	26 April 2017
Town of Greater Napanee	Jean Rixen (Planning Clerk)	26 April 2017
Lennox and Addington County	Mark Douw (Planner) Nick MacDonald (Planner) Stephen Paul (Director, Community & Development Services)	26 April 2017
Lennox and Addington Stewardship Council	Kurt Hennige Susan Moore Marilyn Murray Lawrence O'Keeffe	3 May 2017
Frontenac Stewardship Foundation	Gray Merriam	3 May 2017
Friends of the Salmon River	Susan Moore	3 May 2017
Friends of the Napanee River	Lawrence O'Keeffe Barbara Roch	3 May 2017
Ontario Woodlot Association	David Sexsmith Thom Snowman	3 May 2017
Ontario Ministry of Natural Resources	Justin White (Partnership Specialist)	3 May 2017
Quinte Conservation	Maya Navrot (Stewardship and Education Coordinator) Curtis Vance (GIS specialist)	3 May 2017
Ducks Unlimited	Erling Armson (Head of Land securement/Invasive species/Northern Projects) Chris Delage (Conservation Programs Specialist)	5 May 2017
City of Kingston	Greg Newman (Manager, Policy Planning) Sukriti Agarwal (Senior Planner, Policy) Stewart Waldron (Manager, GIS)	31 May 2017
Tim Yearington	Algonquin Anishinaabe	1 June 2017
Mississippi Madawaska Land Trust	Cathy Keddy (Board Member) Janet Mason (Board Member) Bob Betcher (Board Member) Susan Sentsey (Program Manager)	12 June 2017
Mississippi Valley	Alyson Symon (Watershed Planner)	12 June 2017

Organization	Individual and Role (if Noted)	Date
Conservation Authority	Alex Broadbent (Information Technology Supervisor)	
Loyalist Township	Murray Beckel (Director, Planning and Building) Andrea Furniss (Supervisor, Planning)	23 June 2017

21 organizations; 38 People in total

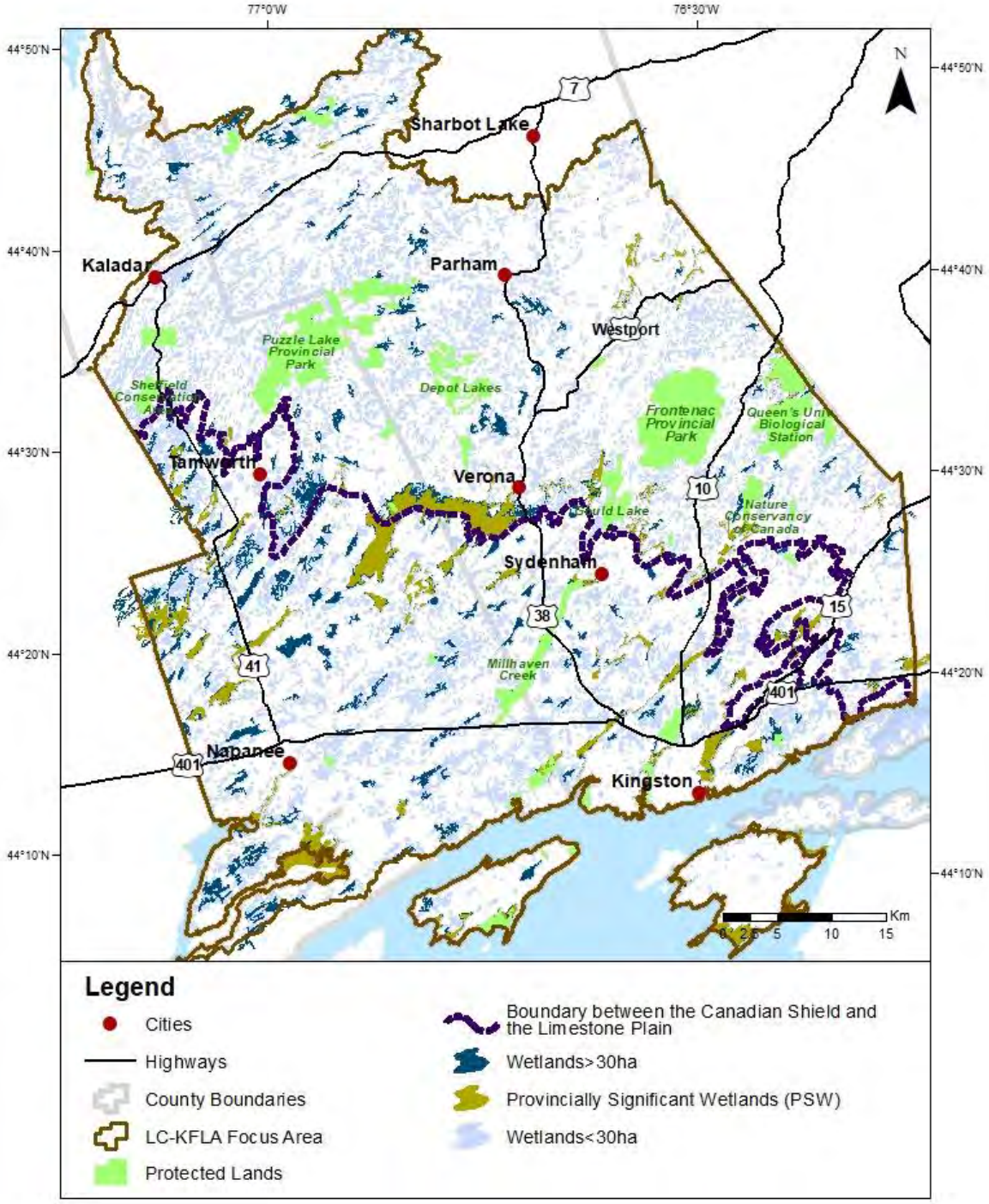
Land Conservancy Board of Directors at the time weighting criteria were discussed

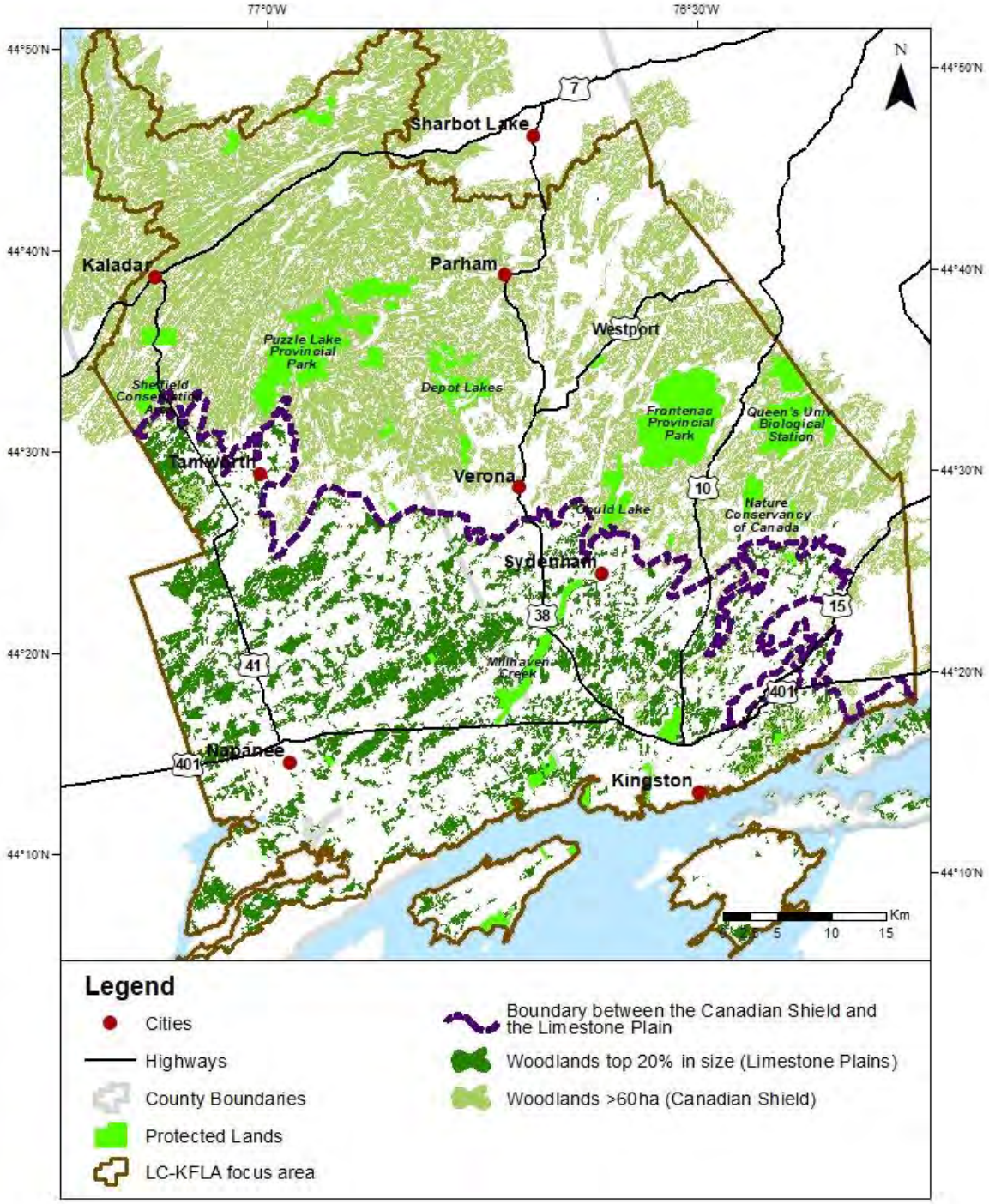
- Tina Bailey
- Christine Cannon
- Dale Dilamarter
- Roger Healey
- Kathleen Laird
- Larry McCurdy
- Paul Mackenzie
- Anne Robertson
- Caroline Rowlands
- Vicki Schmolka
- Mary Alice Snetsinger

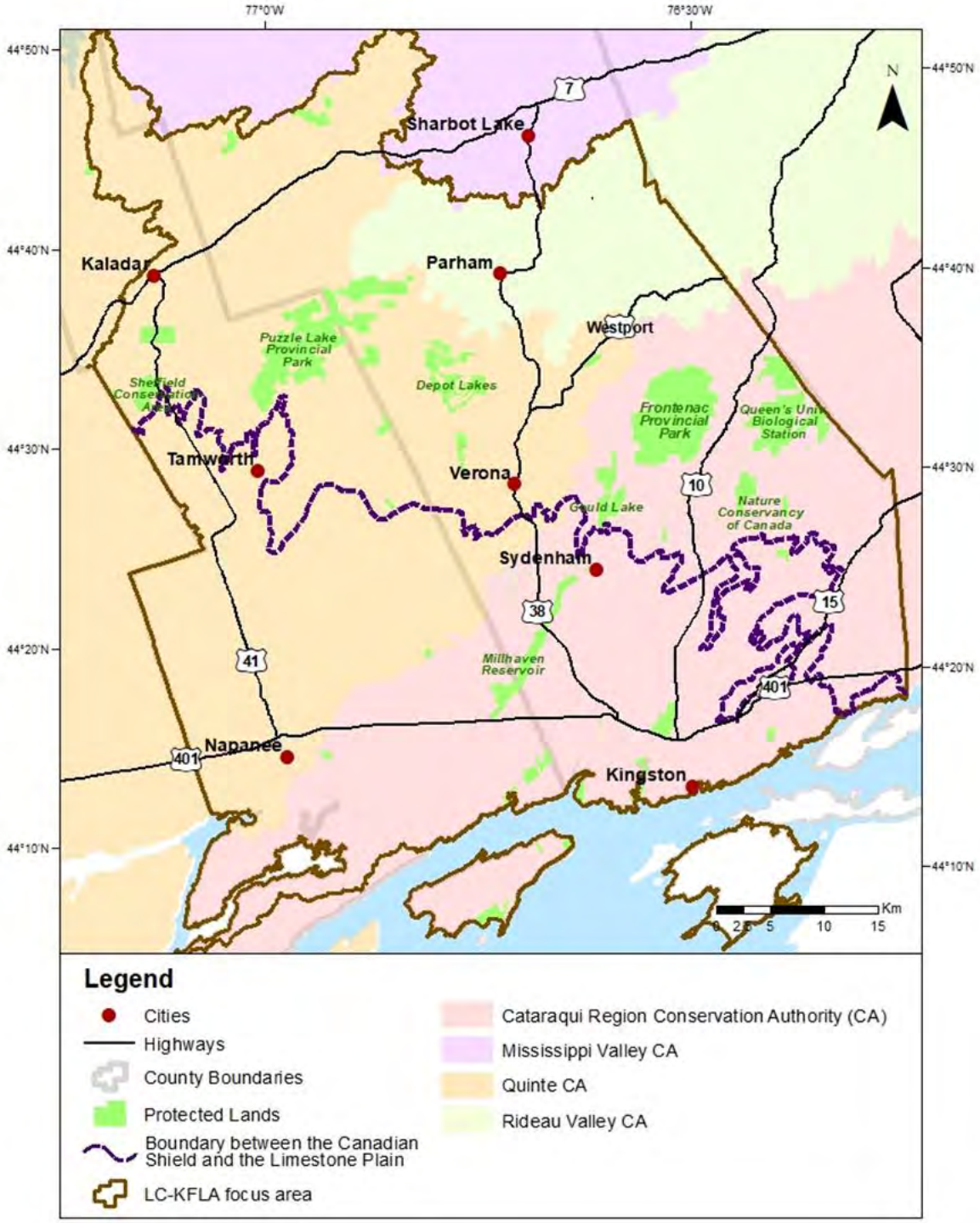
LC-KFLA Land Acquisition Committee members at the time weighting criteria were discussed

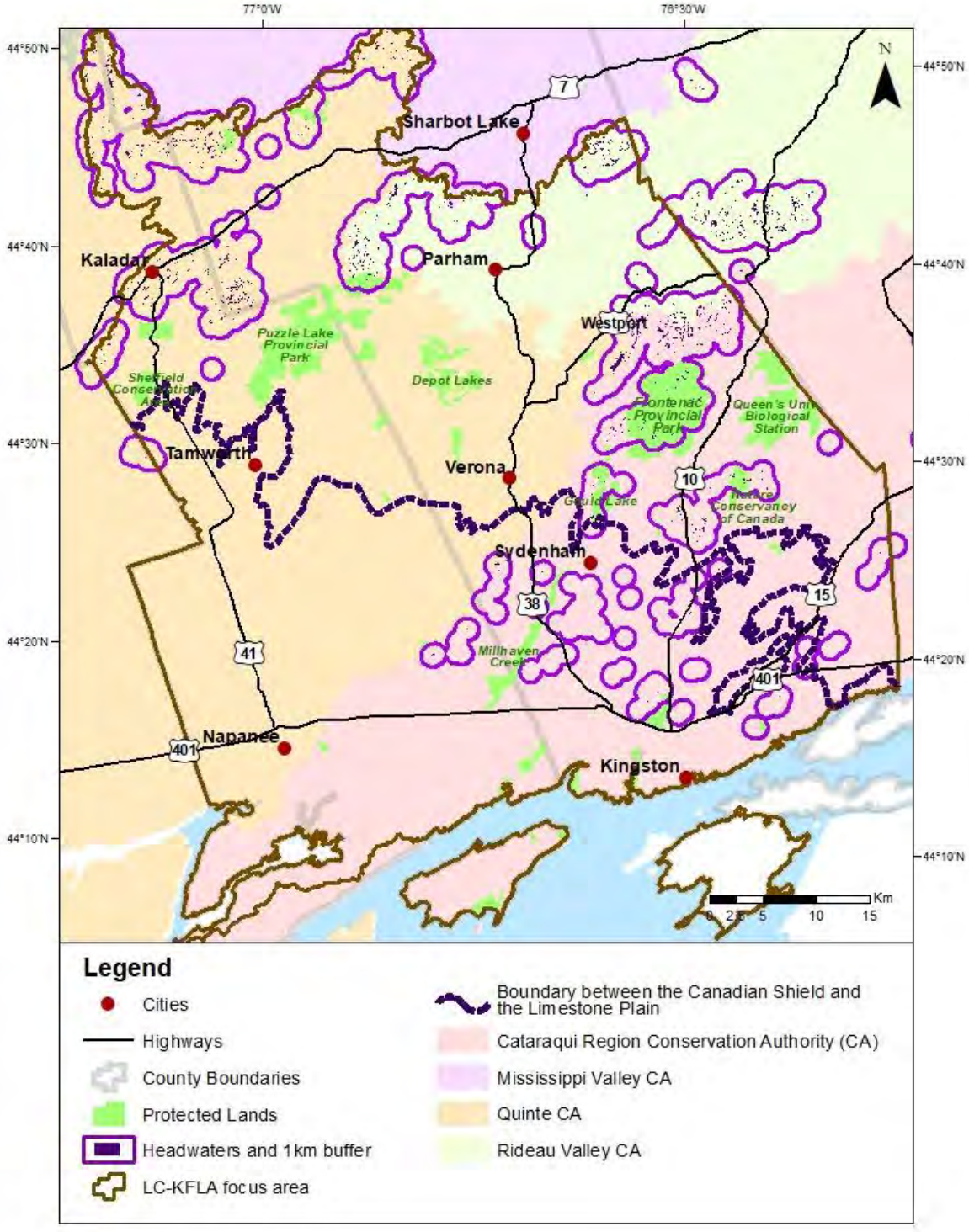
- Chris Cannon
- Dale Dilamarter
- Janet Elliott
- Paul Mackenzie
- Anne Robertson
- Barry Robertson
- Caroline Rowlands
- Mary Alice Snetsinger
- Thom Snowman

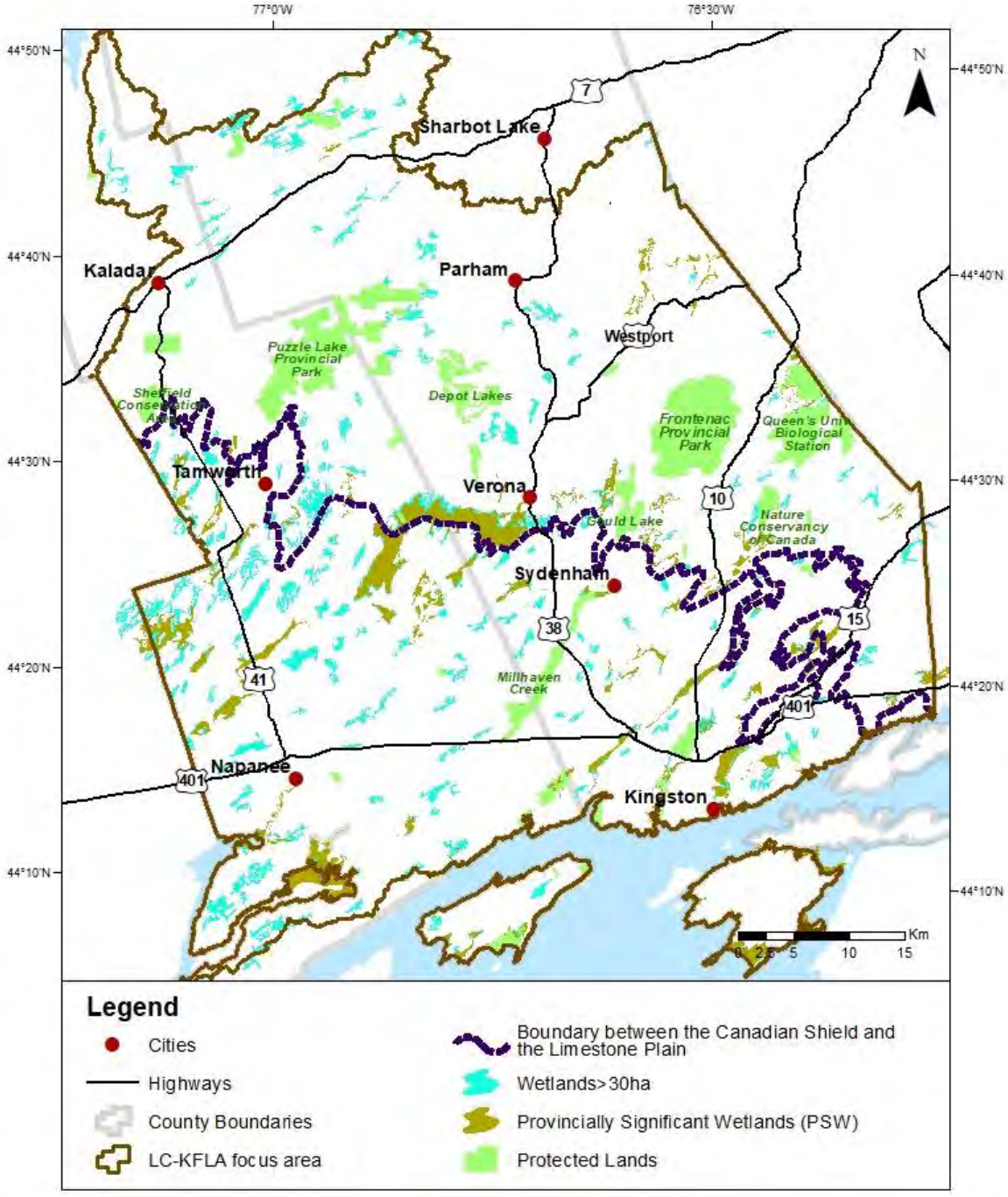
Appendix 5: Maps Prepared for LC-KFLA Natural Heritage Plan Brochure: We Need Nature (www.landconservancykfla.org)

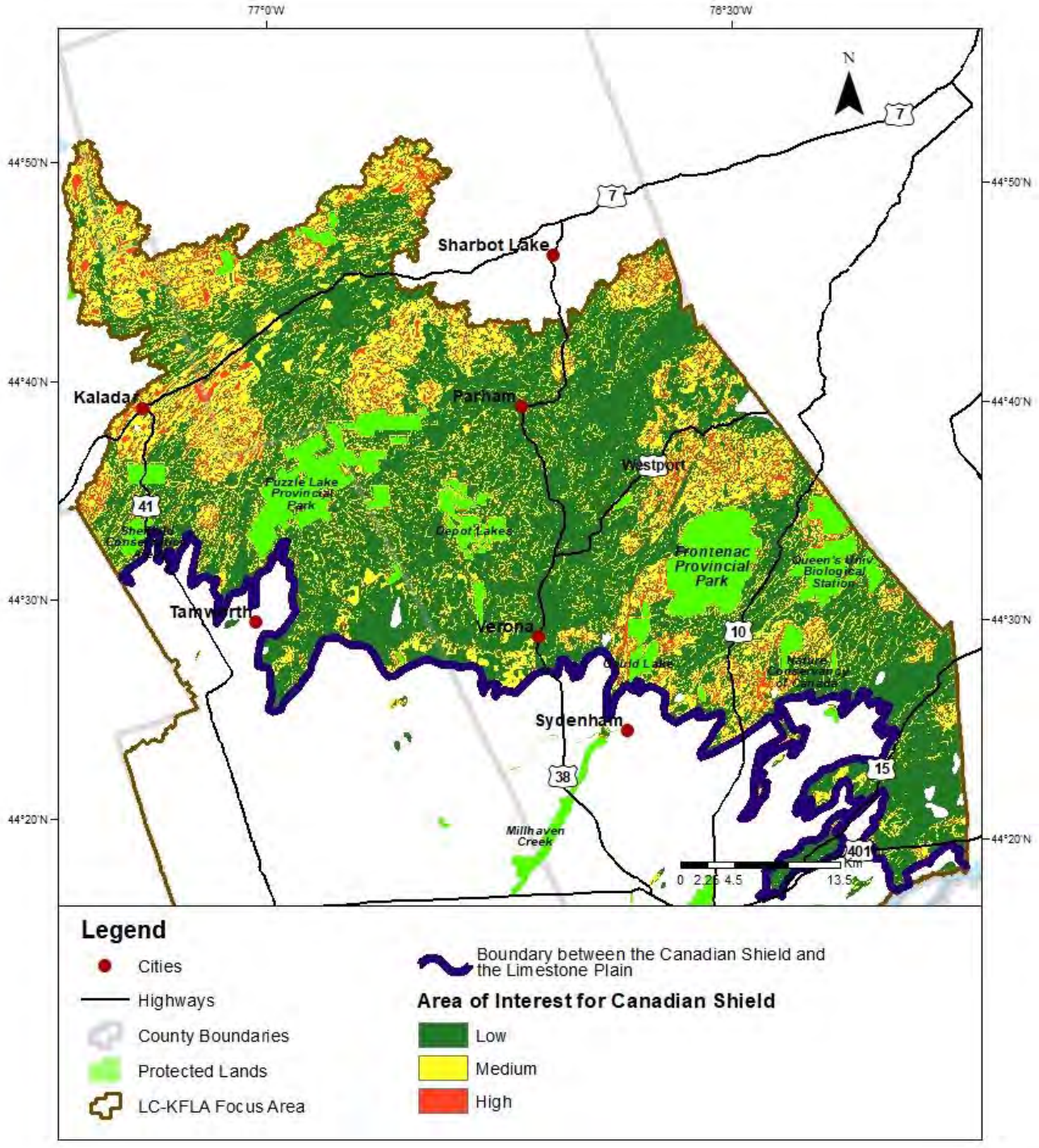

77°0'W
76°30'W
44°50'N
44°40'N
44°30'N
44°20'N
44°10'N
N
Sharbot Lake
Kaladar
Parham
Westport
Puzzle Lake Provincial Park
Depot Lakes
Frontenac Provincial Park
Queen's University Biological Station
Tamworth
Verona
Sydenham
Nature Conservancy of Canada
Millhaven Creek
Napanee
Kingston
7
10
15
38
41
401
Km
0 2.5 5 10 15
Legend
Cities
Highways
County Boundaries
LC-KFLA Focus Area
Protected Lands
Boundary between the Canadian Shield and the Limestone Plain
Wetlands>30ha
Provincially Significant Wetlands (PSW)
Wetlands<30ha

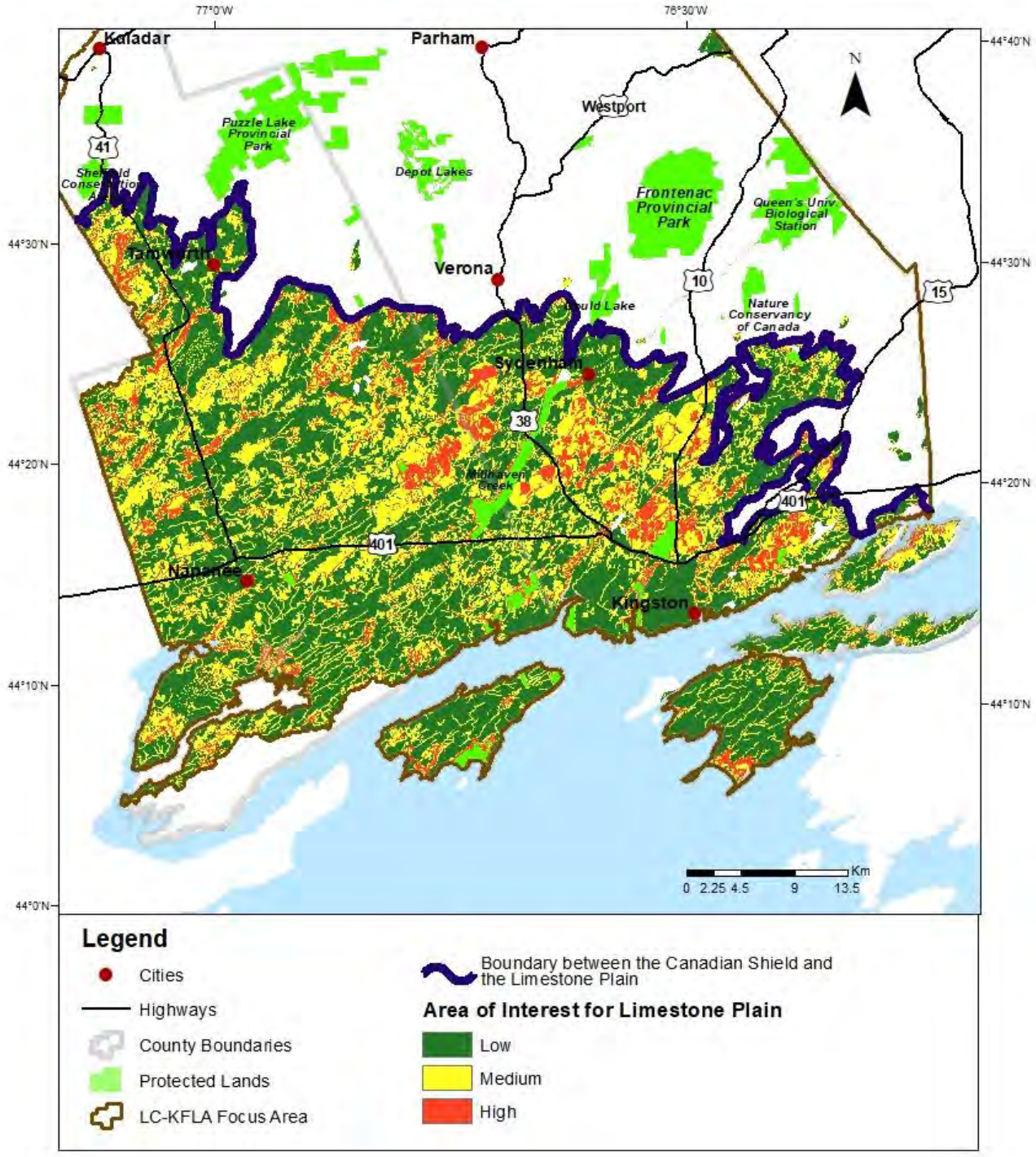

77°0'W
76°30'W
44°50'N
44°40'N
44°30'N
44°20'N
44°10'N
N
Sharbot Lake
Kaladar
Parham
Westport
Puzzle Lake Provincial Park
Depot Lakes
Frontenac Provincial Park
Queen's University Biological Station
Tamworth
Verona
Gould Lake
Nature Conservancy of Canada
Sydenham
Millhaven Creek
Napanee
Kingston
7
10
15
38
41
401
Km
0 5 10 15
Legend
Cities
Highways
County Boundaries
Protected Lands
LC-KFLA focus area
Boundary between the Canadian Shield and the Limestone Plain
Woodlands top 20% in size (Limestone Plains)
Woodlands >60ha (Canadian Shield)


77°0'W
76°30'W
44°50'N
44°40'N
44°30'N
44°20'N
44°10'N
N
Sharbot Lake
Kaladar
Parham
Westport
Puzzle Lake Provincial Park
Depot Lakes
Frontenac Provincial Park
Queen's University Biological Station
Tamworth
Verona
Gould Lake
Nature Conservancy of Canada
Sydenham
Millhaven Reservoir
Napanee
Kingston
7
10
15
38
41
401
Km
0 2.5 5 10 15
Legend
Cities
Highways
County Boundaries
Protected Lands
Boundary between the Canadian Shield and the Limestone Plain
LC-KFLA focus area
Cataraqui Region Conservation Authority (CA)
Mississippi Valley CA
Quinte CA
Rideau Valley CA


77°0'W
76°30'W
44°50'N
44°40'N
44°30'N
44°20'N
44°10'N
N
Sharbot Lake
Kaladar
Parham
Westport
Puzzle Lake Provincial Park
Depot Lakes
Sheffield Conservation Area
Frontenac Provincial Park
Queen's University Biological Station
Tamworth
Verona
Gould Lake
Nature Conservancy of Canada
Sydenham
Millhaven Creek
Napanee
Kingston
7
10
15
38
41
401
Km
0 2.5 5 10 15
Legend
Cities
Highways
County Boundaries
Protected Lands
Headwaters and 1km buffer
LC-KFLA focus area
Boundary between the Canadian Shield and the Limestone Plain
Cataraqui Region Conservation Authority (CA)
Mississippi Valley CA
Quinte CA
Rideau Valley CA


77°0'W
76°30'W
44°50'N
44°40'N
44°30'N
44°20'N
44°10'N
N
Sharbot Lake
Kaladar
Parham
Westport
Puzzle Lake Provincial Park
Depot Lakes
Frontenac Provincial Park
Queen's University Biological Station
Tamworth
Verona
Gould Lake
Nature Conservancy of Canada
Sydenham
Millhaven Creek
Napanee
Kingston
7
10
15
38
41
401
Km
0 2.5 5 10 15
Legend
Cities
Highways
County Boundaries
LC-KFLA focus area
Boundary between the Canadian Shield and the Limestone Plain
Wetlands>30ha
Provincially Significant Wetlands (PSW)
Protected Lands


77°0'W
76°30'W
44°50'N
44°40'N
44°30'N
44°20'N
N
7
Sharbot Lake
Kaladar
Parham
Westport
Tamworth
Verona
Sydenham
41
10
38
15
401
Puzzle Lake Provincial Park
Depot Lakes
Frontenac Provincial Park
Queen's Univ Biological Station
Millhaven Creek
0 2.25 4.5 13.5
Km
Legend
Cities
Highways
County Boundaries
Protected Lands
LC-KFLA Focus Area
Boundary between the Canadian Shield and the Limestone Plain
Area of Interest for Canadian Shield
Low
Medium
High


77°0'W
76°30'W
44°40'N
44°30'N
44°20'N
44°10'N
44°0'N
Kaladar
Parham
Westport
Verona
Sydenham
Tamworth
Napanee
Kingston
Puzzle Lake Provincial Park
Depot Lakes
Frontenac Provincial Park
Queen's Univ. Biological Station
Nature Conservancy of Canada
41
10
15
38
401
N
0 2.25 4.5 9 13.5 Km
Legend
Cities
Highways
County Boundaries
Protected Lands
LC-KFLA Focus Area
Boundary between the Canadian Shield and the Limestone Plain
Area of Interest for Limestone Plain
Low
Medium
High