AN APPLICATION OF SYSTEMATIC NATURAL HERITAGE PLANNING FOR BIODIVERSITY PROTECTION IN THE NATIONAL CAPITAL GREENBELT REGION

by

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Executive Summary

This report applies a systematic conservation planning framework to identity a network of lands that, if protected from development, could contribute to better protecting biodiversity in Ottawa, Ontario, Canada. The analysis adopts a simplified version of the Ontario Ministry of Natural Resources' suggested Process for a Coordinated, Integrated and Comprehensive Approach for Natural Heritage Systems (OMNR, 2010), and uses the MARXAN conservation decision-support tool (Ball, Possingham & Watts, 2009), a GIS-based software program, to facilitate the analysis.

Natural Heritage Systems are networks of features and linked natural corridors that are important for their environmental and social values as a legacy of the natural landscapes of an area (OMMAH, 2005). They are necessary to protect in their unaltered state in order to maintain biological and geological biodiversity, natural functions, and viable populations of indigenous species and ecosystems (OMMAH, 2005). The Provincial Policy Statement, recent City of Ottawa policies, and the National Capital Commission's work all strongly support efforts to protect environmentally significant lands within the region. Generally speaking, biodiversity is important for the provision of food and water, for the regulation of flood and disease, for the provision of services such as recreational and cultural benefits, and for nutrient cycling that maintains habitat conditions (Secretariat of the Convention on Biological Diversity, 2009).

The objective of identifying valuable lands that can help protect biodiversity in Ottawa stems from a current planning exercise, the Greenbelt Master Plan Review, whereby the National Capital Commission is considering expanding the National Capital Greenbelt (SENES, 2010). The Greenbelt is a 21,500 hectare band of land in

the Capital that is publicly owned and protects the significant environment features within its boundaries from urban development. In recent years, the NCC has purchased environmentally sensitive and valuable lands adjacent to the current Greenbelt, in order to better protect the ecological integrity of the entire Greenbelt. Therefore, it follows that during this review process, additional lands may be identified for purchase. In this case, a rational, transparent, and accountable process is needed to justify expanding the Greenbelt boundaries.

As such, the analysis included in this report pulls five steps from the overall process for Natural Heritage System Design recommended by the Ontario Ministry of Natural Resources (OMNR, 2010) and applies it within the context of Greenbelt expansion and connections to other protected natural areas in the City of Ottawa:

- **Step #1 - Study Area Assessment:** The analysis is limited to the boundaries of the City of Ottawa.

- **Step #2 - Establishing Objectives**: The NCC's broader Natural Heritage, environmental, and biodiversity-related policies are adopted to guide the analysis.

- **Step #3 - Establishing Targets:** Targets from the Nature Conservancy of Canada's *Great Lakes Conservation Blueprint for Terrestrial Biodiversity* (Henson, Brodribb & Riley, 2005) and approaches set out in the *Marxan Good Practices Handbook: External Review Version* (Ardron, Possingham & Klein, 2008) are used to create appropriate biodiversity targets for a series of ecological land classifications.

- **Step #4 - Data Collection and Compilation:** Spatial geographic information is used in a GIS program to identify the spatial distribution of ecosystems across the City of Ottawa, using ecological land classifications as an indicator.

- **Step #5 - Modelling and Natural Heritage Systems Scenarios:** MARXAN conservation decision support software (Ball, Possingham & Watts, 2009) is run to determine where there are gaps in the current protected environmental lands in Ottawa and what the options are for filling these gaps, in order to protect biodiversity in the region. In order to find good solutions to the problem, MARXAN assigns an objective value to each analysis parcel, so as to have a basis on which to compare alternatives and to identify the best solutions (Game & Grantham, 2008).

$$\underbrace{\sum_{Planning\ Units} Cost}_{\#1} + \underbrace{BLM \sum_{Planning\ Units} Boundary}_{\#2} + \underbrace{\sum_{Cnsrvt.\ Values} SPF \times Penalty}_{\#3} + \underbrace{Cost\ Threshold\ Penalty\ (t)}_{\#4}$$

1. The total cost of the reserve network, found by adding the user-defined cost of each Planning Unit in the MARXAN reserve solution.

2. The total reserve boundary length, multiplied by the Boundary Length Modifier (a user-defined modifier set between 0 and 1). This variable influences the shape of the reserve, with BLM=0 yielding a dispersed reserve network, and BLM=1 yielding a more compact and continuous reserve system.

3. This variable applies a user-determined penalty for any conservation features that do not meet the user-defined targets set out for the reserve network.

4. This variable applies a penalty for exceeding a preset cost threshold (optional variable).

Box E 1: MARXAN Objective Function (Game & Grantham, 2008)

The MARXAN software runs a series of iterations, testing alternative selections of planning units in order to find a reserve configuration that has the lowest total score. The score is based on the sum of four factors that help to determine the most efficient combination of areas to include in a conservation zone. These factors include land unit costs, land unit boundary (which influences clumping), the cost of not meeting the defined species targets, and/or the cost of not meeting the defined cost constraints. MARXAN works by first calculating the score of a set of planning units chosen at random, then chooses an extra planning unit at random and changes its status to either 'included in the conservation set' or 'not included in the

conservation set'. The score of the temporary selected set of planning units is calculated: if the inclusion of the extra planning unit lowers the total score, it becomes a permanent feature in the conservation zone (referred to as a 'reserve' in most MARXAN-based publications). In this report, the MARXAN program performs 1,000,000 iterations of this test, always accepting only good changes that will improve the solution in terms of the four identified factor areas. By aiming to minimize the total score, the solutions are compact systems that are cohesive and meet the conservation goals and targets set out in Steps #2 and #3.

The outputs of the MARXAN analysis help identify a biodiversity "wish list" that shows hotspot areas that, if protected from disturbances, contribute to meeting the biodiversity targets developed in the report. The MARXAN solution map shown in Figure E-1 points out parcels of land that occurred in over 80% of MARXAN's 1000 estimates of good conservation networks. Therefore, it follows that these lands should be considered when the City and NCC are developing conservation and protection policies. The report does not recommend specific implementation tools to protect these lands, nor does it point towards certain organizations to be responsible for management, as these issues fall outside the scope of this report. Rather, the report describes the unique governance issues in Ottawa and discusses the implementation tools available to build a comprehensive and successful Natural Heritage System.

The value of establishing an ecological "wish list", based on biodiversity goals, is that the information can inform land purchase agreements, land swaps, community growth plans, and development approvals, as the City and NCC can make educated planning decisions based on the potential regional implications that a project might have on biodiversity and nature environmental functions.

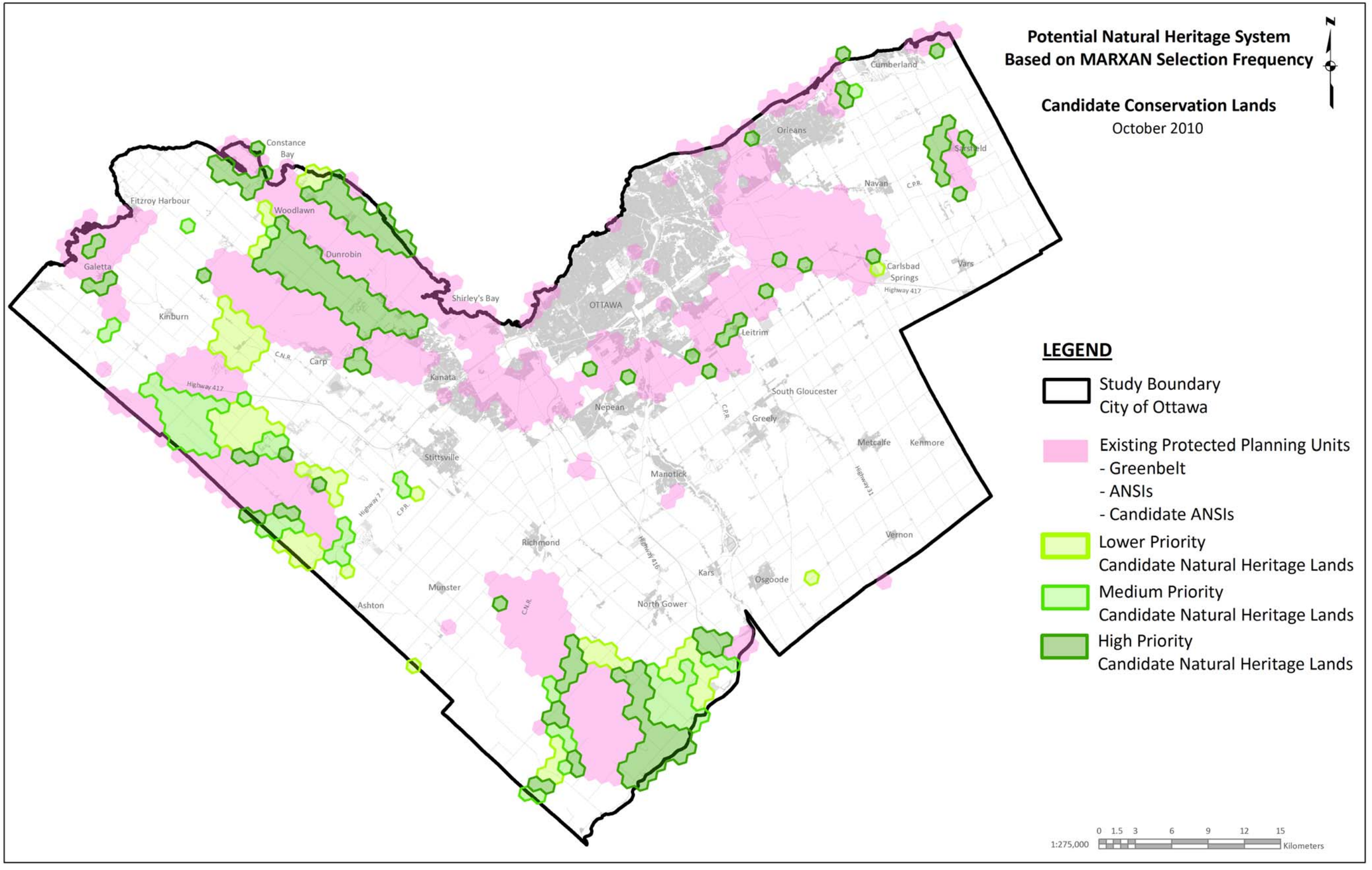

Figure E-1: Summary of MARXAN Results

The MARXAN analysis included in this report is a simplification of OMNR's recommended procedure, because the scope of analysis had to be limited in the context of a Master's Report. As such, next steps have been identified throughout the report, explaining how additional information, like complex socioeconomic factors, and expert opinion could be included in the analysis in order to make more complex and comprehensive conservation scenarios. Limitations aside, the simplified MARXAN analysis highlights that:

- The voluntary conservation program called the "Bay to Bay initiative", which aims to protect the corridor between Shirley's Bay and Constance Bay, is founded on sound ecological principles;

- The City of Ottawa's land purchases in Marlborough Forest make valuable contributions to protecting ecologically significant areas that promote regional biodiversity;

- The City's proposed Natural Heritage System in Official Plan Amendment 76 is a significant policy piece that will strengthen conservation measures for environmentally valuable land in Ottawa;

- The proposed NHS could benefit from adding an additional lens to the analysis: a biodiversity layer that compliments and links to the existing significant woodlands, valleylands, and wetlands. Specifically, the lands connecting to Carp Hills, Constance Creek, Sarsfield, and the Marlborough Forest region should receive consideration for added conservation measures;

- Mer Bleue and Stony Swamp, both protected from development through the NCC's Greenbelt policies, offer significant contributions to protecting biodiversity in the City; and,

- Should the NCC be considering Greenbelt expansion lands, extensions to the northwestern edge of the Greenbelt (near Carp Hills/Barrens and Constance Creek) would be beneficial from a biodiversity standpoint, as it could provide a much needed natural linkage between existing protected areas. This is not to say that other extensions in different directions are not valuable: the limitations of the MARXAN analysis and the limited scope within the City's boundaries mean that the network is biased towards the western portion of the City and does not include likely valuable connections to Alfred Bog in the East.

The methods used in this report draw from a selection of key resources: the *Great Lakes Conservation Blueprint for Terrestrial Biodiversity* (Henson, Brodribb & Riley, 2005); the *Marxan User Manual for Marxan Version 1.8.10* (Ardron, Possingham & Klein, 2008); the *Marxan Good Practices Handbook: External Review Version* (Game & Grantham, 2008); *Evaluating Marxan as a Terrestrial Conservation Planning Tool* (Munro, 2006); and the *Natural Heritage Reference Manual for Natural Heritage Policies of the Provincial Policy Statement, 2005* (OMNR, 2010). All things considered, the analysis provided in this report highlights the potential for conservation planning software to be used in Natural Heritage System planning in Ottawa, ON. The ability to rationally compare different options for Natural Heritage systems, in terms of their costs, their contributions to conservation goals, and their interactions with other land uses, is a powerful evolving tool for land use planning.