Moving Toward a Viable, Representative Protected Area Network in the Great Lakes Basin of Ontario

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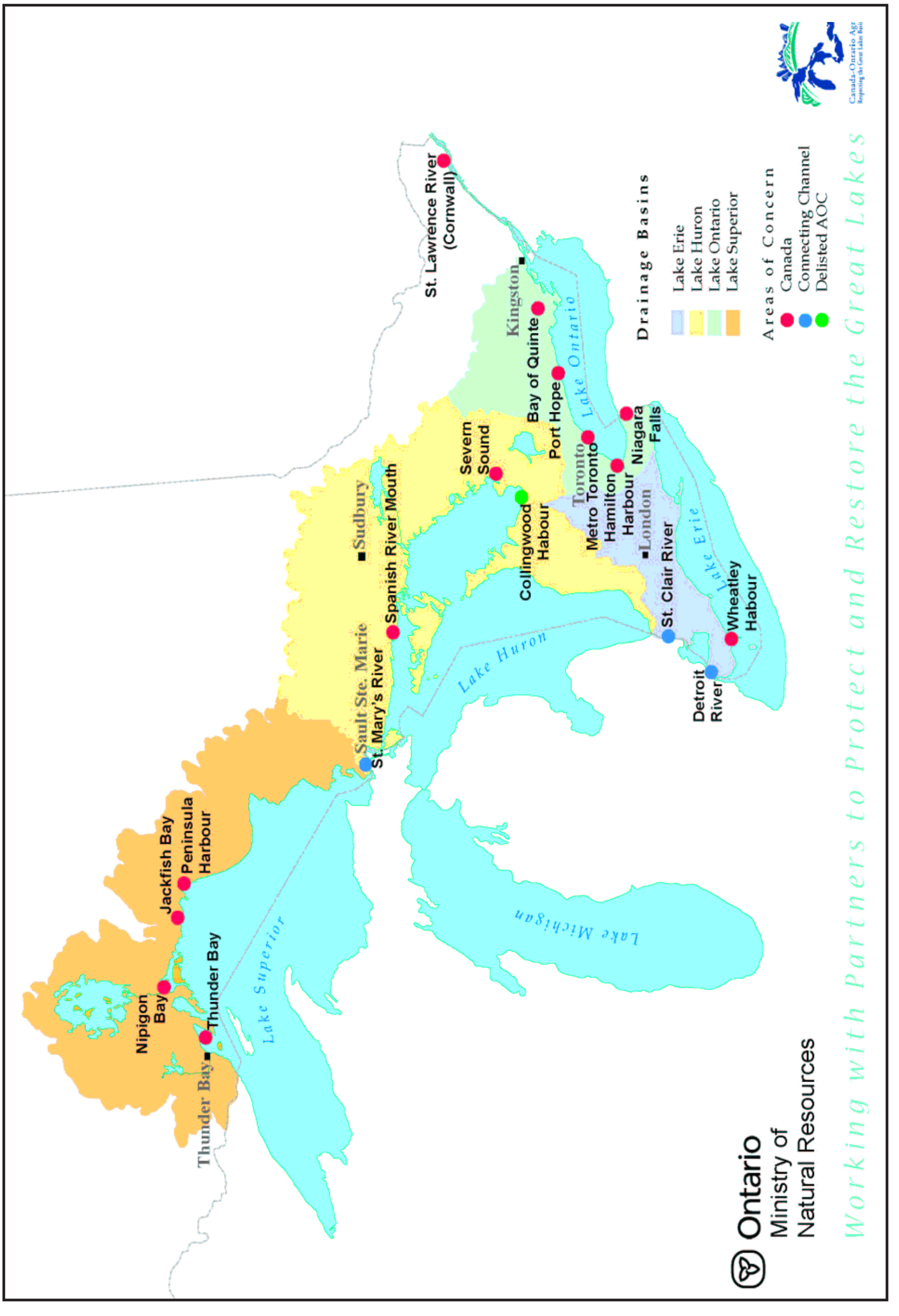
Abstract

Over the past decade, several hypothetical ecological networks (e.g. lands of conservation importance) and systems of protected areas have been proposed within all or part of Ontario's Great Lakes Basin. Many of these systems provide visions of ecologically healthier landscapes within the Basin, as well as focal points for future conservation efforts, including securement and restoration. A key priority of The Canada – Ontario Agreement Respecting the Great Lakes Basin Ecosystem (COA) is improving the health of the ecosystems feeding into this drainage basin. Toward that end, it is necessary to know to what extent the current protected area system in the basin is a network, and to provide additional recommendations for its enhancement and development. Taking a broad view of protection, we have assembled the relevant spatial data on protected areas, and overlaid these data on the hypothetical systems proposed by others (Big Picture 2002, Great Lakes Terrestrial and Aquatic Conservation Blueprints). Areas of coincidence between the actual protected area system and the hypothetical systems were identified. Nearest-neighbour analysis was conducted between core unconnected blocks of conservation lands under two scenarios (blocks ≥ 20 ha and blocks ≥50 ha), and nearest-neighbour vectors were underlain with stream segments, where these existed, to determine whether potential ecological connections exist between the protected, but unconnected cores. All ecodistricts falling wholly or partly within the basin were analyzed. It is recommended that these results, along with those of the hypothetical systems, be used to assist in the prioritization of conservation efforts in the Great Lakes Basin.

Introduction

The Ontario portion of the Great Lakes drainage basin (Figure 1) is a large, diverse area of land and water that includes all or part of 34 ecodistricts, within 7 ecoregions and 2 ecozones (Crins, 2002). Thus, a very large range in climatic, geological, physiographic, and biotic variation exists within this huge area. The southern portion of the Great Lakes Basin (within Ecoregions 7E and 6E) is heavily developed and settled, with most of the former natural cover having been converted for human use and settlement. In sharp contrast, the land on the

Figure 1. Ontario's portion of the Great Lakes Basin



Precambrian Shield (Ecoregions 5E, 4E, 3E, 3W, and 4W) is largely forested, with patches that have been converted for agriculture and settlement, and with industrial activities, particularly forestry, occurring within the forested landscape. The amounts and types of water bodies vary considerably between these two broad landscapes as well. This variation is generated partly by climatic and geological parameters, resulting in different water chemistries and buffering capacities, and different tolerances to eutrophication and acidification processes.

The need to establish a viable, representative network of protected areas in the Great Lakes Basin must be placed into this diverse ecological context. Within the *Lakewide Management Annex* of the *Canada – Ontario Agreement Respecting the Great Lakes Basin Ecosystem* (COA) (Environment Canada and Ontario Ministry of the Environment, 2002), Result 2 focuses on "*Rehabilitated, conserved and protected fish and wildlife habitats and protected areas*". One of the commitments under this desired outcome (result) is that "*Canada and Ontario will begin to establish a viable and representative Great Lakes protected areas network*".

This paper describes an analytical approach that should provide a useful tool in moving toward a viable, representative network of protected areas in the Great Lakes Basin. It takes advantage of the existing protected area system and provides suggestions on areas that would provide efficient, but ecologically meaningful, connections between existing protected areas through the use of nearest-neighbour analysis and overlays with previously created visions for natural heritage systems and water courses.

Current Protected Area System

There are many mechanisms in place in the Great Lakes Basin that afford varying degrees of protection for natural cover and natural heritage values (Crins and Janetos, 2006). In the southern portion of the Basin (much of the Lakes Huron, Erie, and Ontario watersheds), substantial portions of the landscape are in private ownership. Thus, reliance on the traditional, regulated forms of protection (national parks, provincial parks, conservation reserves) is inadequate. Other mechanisms of full and partial protection are required to ensure that natural heritage features are represented and that ecological functions can continue to operate, or be restored. In order to meet the commitment to begin to establish a viable, representative protected area network in the Basin, it is necessary to take account of, and utilize to the fullest extent possible, all of the protection mechanisms that are available. On the Precambrian Shield, the traditional regulatory protection mechanisms contribute a larger proportion to the network than do private ownership, conservation easements, policy mechanisms, and planning mechanisms. However, even there, policy-based protection mechanisms are important (for example, forest management planning designations such as Areas of Concern* contribute substantially to connectivity among more formally regulated protected areas).

For the purposes of the approach being described here, all forms of full and partial protection are considered to be integral parts of the existing protected area system, and are treated equally in the analytical procedure. However, a potential enhancement, once the current state of the protected area system is known, would be to factor in the level of protection, in terms of determining priorities for securement and restoration. A classification system for protected areas, based on their management direction and conservation goals, has been developed by the IUCN (International Union for the Conservation of Nature and Natural Resources, now called the World Conservation Union; Phillips and Harrison, 1997). In Ontario, protection mechanisms have been classified using this system, and an approach to classifying partial protection mechanisms has been added (Gray *et al.*, 2007).

COA has provided the context in which the analytical approach described here was developed. To expand on the commitment made in COA, a vision for the protected area network is necessary, to provide a broader philosophical context. We propose the following vision:

The protected area network within the Great Lakes Basin is to be fully connected and ecologically viable, providing a full range of ecological services, including the protection of high-quality, representative terrestrial and aquatic ecosystems, hydrological functions, and suitable habitat for the native biota of the Basin.

Analytical Approach

The approach taken in this study involved:

- compiling all available digital information on protected areas (in the broad sense discussed above) within the Great Lakes Basin;
- overlaying these protected areas on proposed natural heritage visions and systems found in the Big Picture, 2002 (Nature Conservancy of Canada and Natural Heritage Information Centre, 2003) and the Great Lakes Conservation Blueprint (both terrestrial and aquatic components) (Henson and Brodribb, 2005; Wichert *et al.*, 2005);
- examining the degree of coincidence between existing and proposed or hypothetical protected areas and connections; and,
- assessing the distances between existing protected areas that are nearest neighbours to obtain a measure of the potential ease or difficulty of establishing connections between them.

*Areas of Concern in forest management should not be confused with Areas of Concern designated under the Great Lakes Water Quality Agreement. In forest management planning, Areas of Concern include numerous natural heritage and cultural values, some of which are related to water body protection.

Water courses were intersected with the nearest neighbour vectors to determine if there are natural landscape connections with which these vectors might coincide, to assist in increasing connectivity (functionality, viability) through focused securement and restoration efforts. This approach was tested with several pilot ecodistricts in southern Ontario to ensure its feasibility. When the pilot study was completed, and the methods for overlay and analysis refined, all ecodistricts coinciding, in whole or in part, with the Great Lakes basin were analyzed. Cartographic, digital, and tabular results were generated for each ecodistrict in the study area.

Data assembly and analysis were conducted using the Lambert Conformal Conic projection (NAD 83). The resolution of the raster data was 30 m. Forty-three input data layers were used in the compilation and analysis. Nearest neighbour analysis was conducted using the 'Nearest Features V.3.8' extension in vLATE 1.0 (Jenness Enterprises). During the application of the nearest neighbour analysis, a size constraint of 20 ha was placed on protected areas to be connected, to minimize the influence of small fragments on the analysis. The nearest neighbour analysis was conducted on an ecodistrict by ecodistrict basis. However, to ensure that nearest neighbours were found, the boundary of each ecodistrict was buffered by 10 km and any protected area that intersected the boundary was used as part of the nearest neighbour analysis for that ecodistrict. When nearest neighbour vectors were intersected with water features (lakes and rivers), the water features were buffered by 100 m on each side, and then intersected with the vectors.

Basic Technical Methodology for Creation and Analysis of Protected Areas Network Layer

1. Project all input data to Lambert Conformal Conic projection (NAD 83)
2. Convert first two sets of input data to grids (scores of 1 and 2 and background value of 0)
3. Add them together
4. Draw newly created grid
5. Based on score of output, determine the next number in sequence (Score of 1 + Score of 2 = Overlap score of 3; therefore the next input grid receives a score of 4)
6. Keep track of land types and overlapping areas in spread sheet
7. Repeat this process until all input grids are added to the Protected Areas Network grid
8. Transfer attributes from spreadsheet to grid (export to DBF and join in ArcView)
9. Reclassify all non-zero grid cells to 1

10. Overlay Protected Areas Network with Big Picture (delete islands and non-natural features, retain only cores and corridors)
11. Overlay Protected Areas Network with Aquatic and Terrestrial components of Great Lakes Conservation Blueprint, separately
12. Overlay Protected Areas Network with all 3 (Big Picture, Aquatic and Terrestrial components of Great Lakes Conservation Blueprint) together
13. On the Protected Areas Network, reclassify all non-zero grid cells to 1 and reclassify 0 to No Data
14. Run 'gridpoly' on reclassified Protected Areas Network on ArcInfo workstation to create polygon coverage
15. In ArcView, reselect all Grid Values = 1 from polygon coverage and convert to shape file
16. To dissolve adjacent polygons, add shapefile to an ArcMap project, make the shape file editable, and run vLate 1.0
17. Select polygons >20 ha and create shapefile
18. Add the Nearest Features V3.8 extension to the ArcView project and run on the >20 ha shapefile
19. Save resulting shapefiles and tables and run summary statistics
20. Buffer all streams and lakes/double line rivers by 100m for the entire study area
21. Intersect buffered water polygons with Protected Areas Network and convert to shape file
22. Intersect buffered streams with the nearest neighbour vectors for areas >20 ha
23. Create spread sheet of all summary statistics

Results and Discussion

Each ecodistrict within Ontario's portion of the Great Lakes Basin contains a partial (not fully connected) network of protected areas at the present time. On the Precambrian Shield, the present system is comprised largely of regulated protected areas on Crown land, although other protection mechanisms contribute to a small degree. In the south, the existing system is comprised of numerous protection mechanisms, providing variable degrees of partial to full protection. Maps illustrating the application of the approach described here, including the existing protected area system, overlays with two different hypothetical protected area systems based on different approaches and visions (Big Picture, Great Lakes Conservation Blueprint), and nearest neighbour vectors between protected areas over 20 ha in size, are presented in Figures 2-9, using Ecodistricts 5E-13, 7E-4, and 7E-5 as examples.

The landscape context (matrix) for each of these two broad regions (Precambrian Shield, south of the Shield) is entirely different. This is an important consideration in terms of the assessment of the viability of the network. In the

Figure 2. Ecodistrict 5E-13, with existing protected areas (mid-gray), important aquatic areas from Great Lakes Conservation Blueprint (Wichert *et al*., 2005) (pale gray), areas of overlap between them (dark gray), and nearest neighbour vectors (line segments of varying width and darkness).

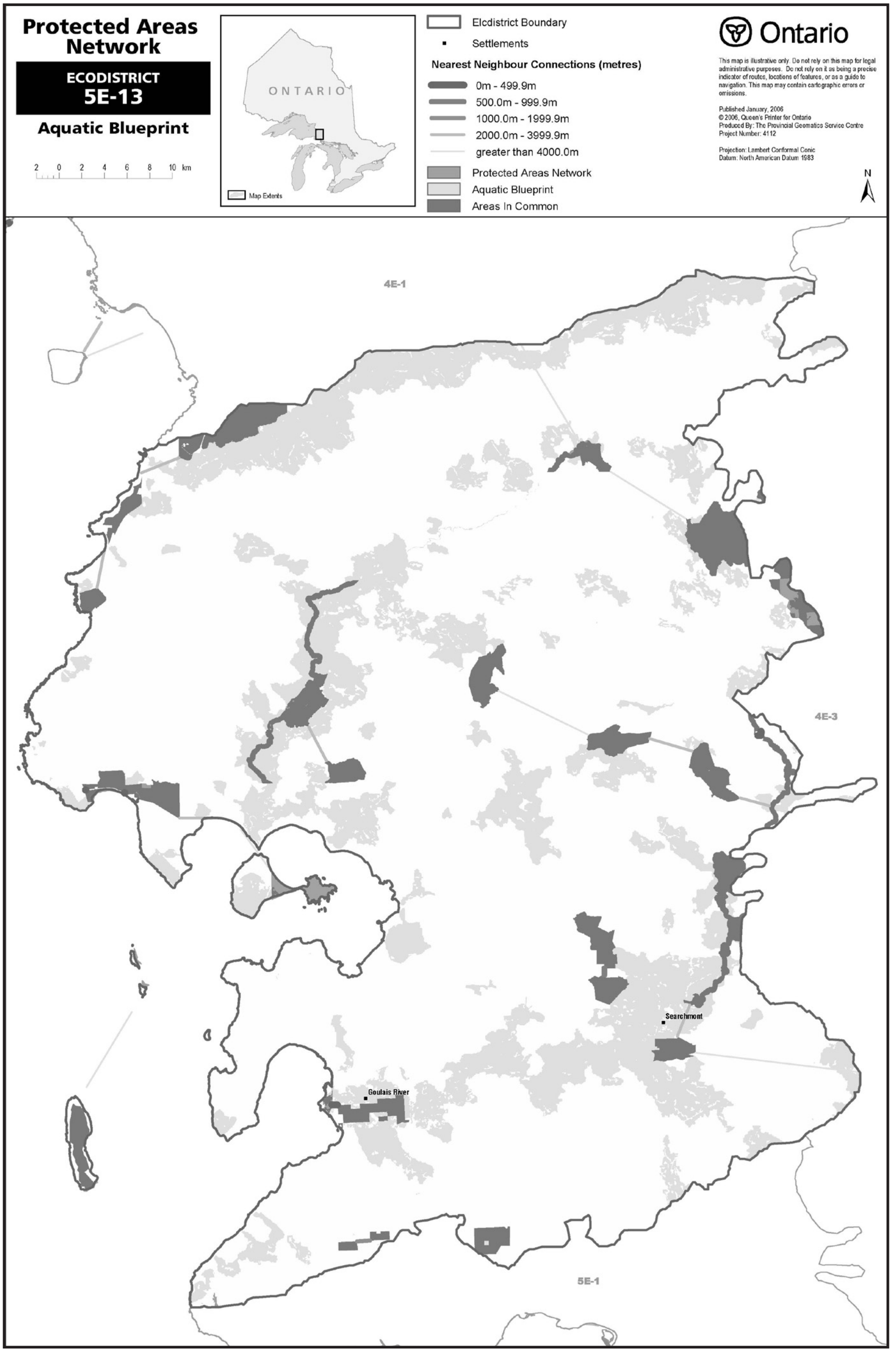


Figure 3. Ecodistrict 5E-13, showing existing protected areas (dark gray), nearest neighbour vectors (line segments of varying width and darkness), and water courses (dendritic mid-gray lines) that intersect nearest neighbour vectors.

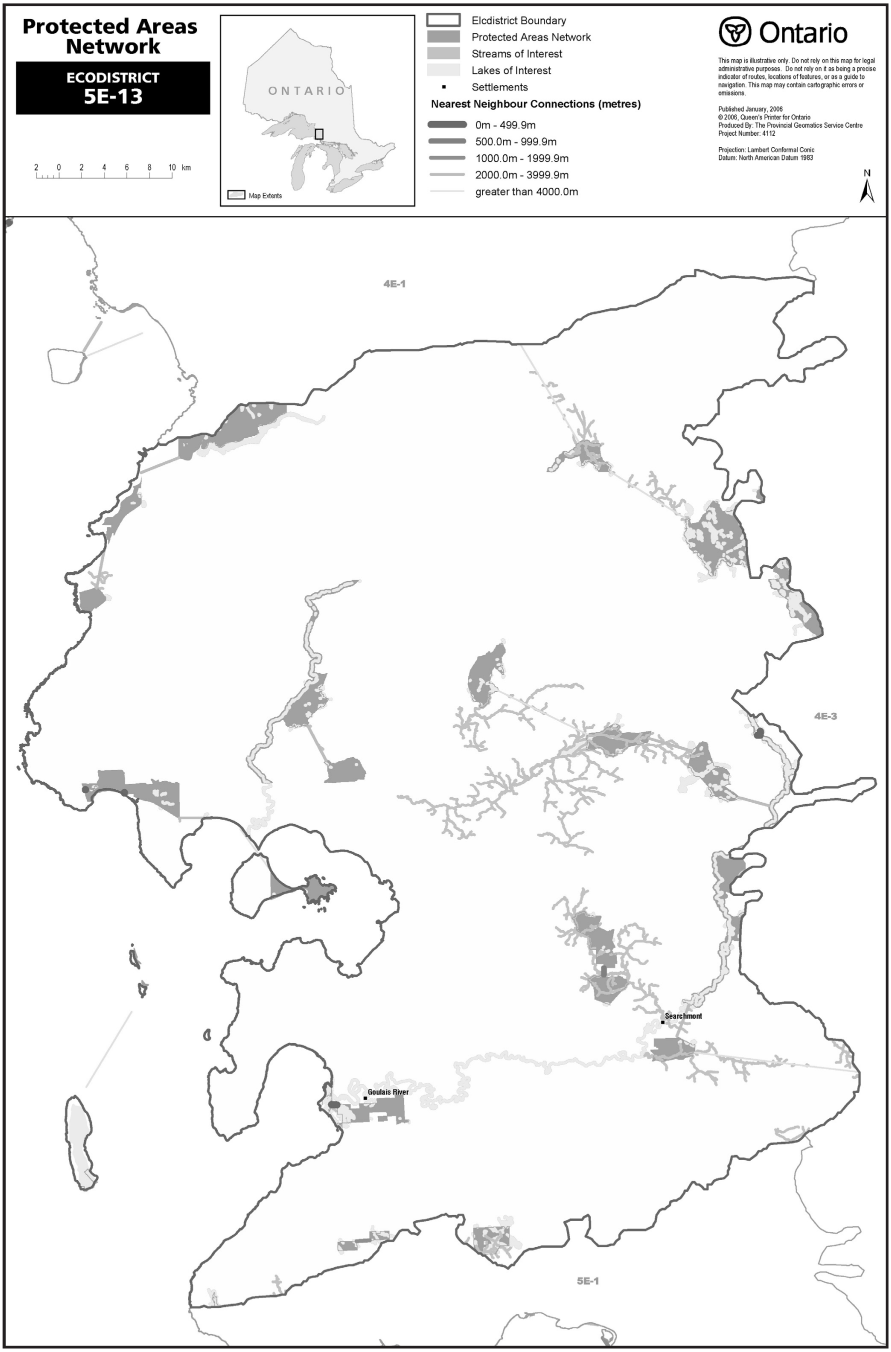


Figure 4. Ecodistrict 7E-4, with existing protected areas (mid-gray), important terrestrial areas from Great Lakes Conservation Blueprint (Henson and Brodribb, 2005) (pale gray), areas of overlap between them (dark gray), and nearest neighbour vectors (line segments of varying width and darkness).

Figure 5. Ecodistrict 7E-4, with existing protected areas (mid-gray), important aquatic areas from Great lakes Conservation Blueprint (Wichert *et al*., 2005) (pale gray), areas of overlap between them (dark gray), and nearest neighbour vectors (line segments of variable width and darkness).

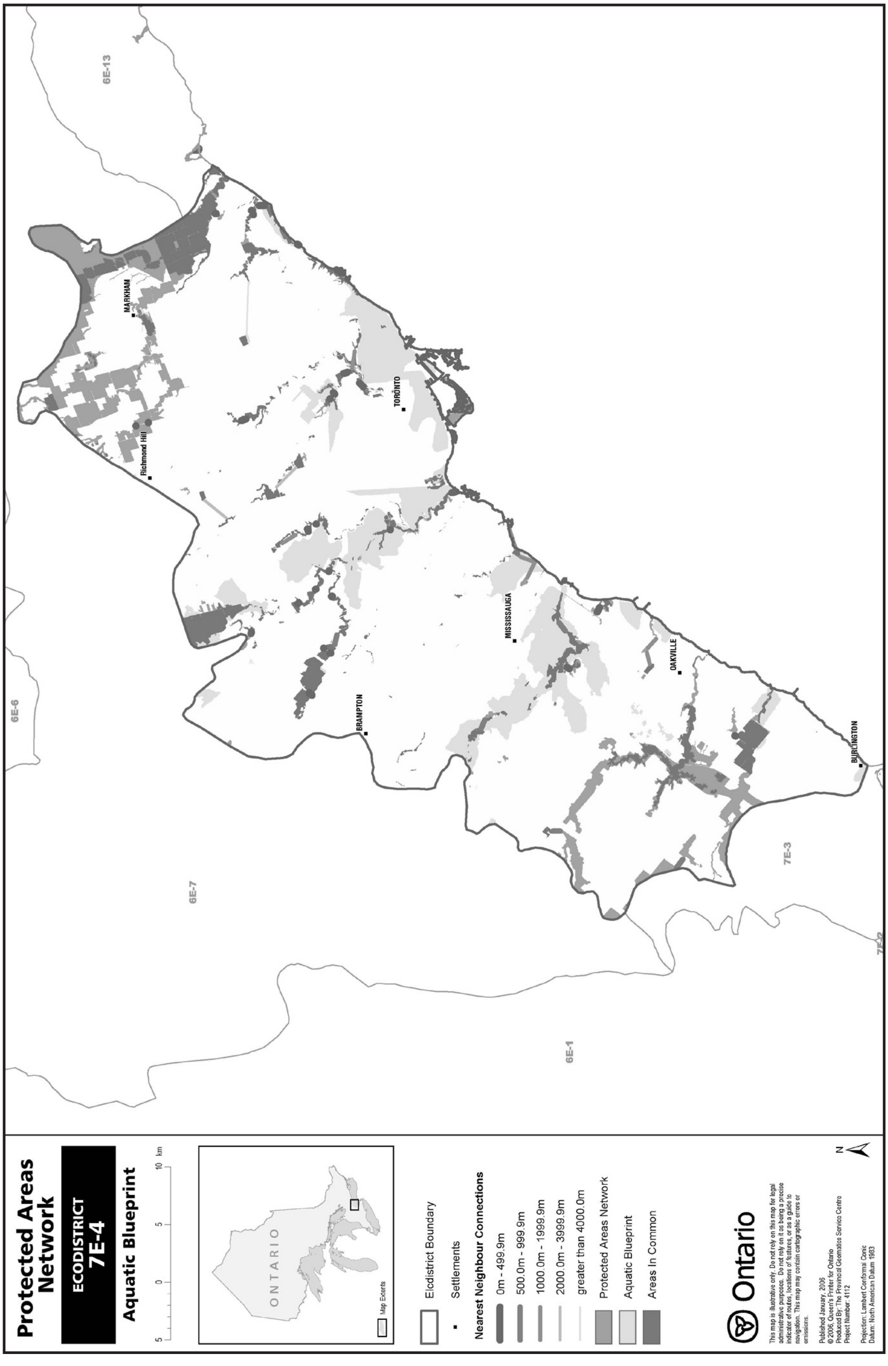


Figure 6. Ecodistrict 7E-4, with existing protected areas (mid-gray), Big Picture network (pale gray) (NCC and NHIC, 2003), overlap between them (dark gray), and nearest neighbour vectors (line segments of variable width and darkness).

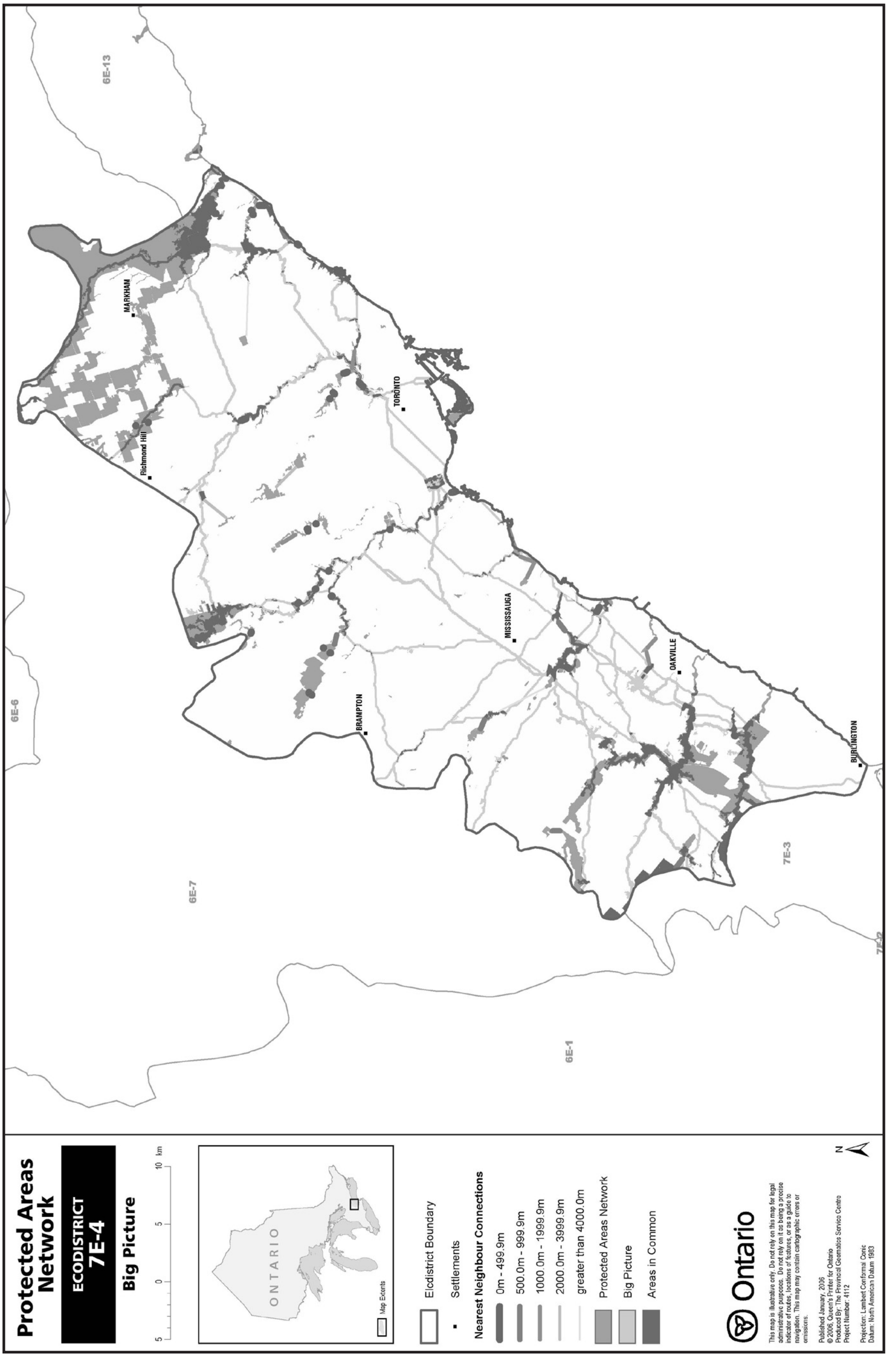


Figure 7. Ecodistrict 7E-4, with existing protected areas (mid-gray), nearest neighbour vectors (line segments of variable width and darkness), and intersecting water courses (dendritic pale gray lines).

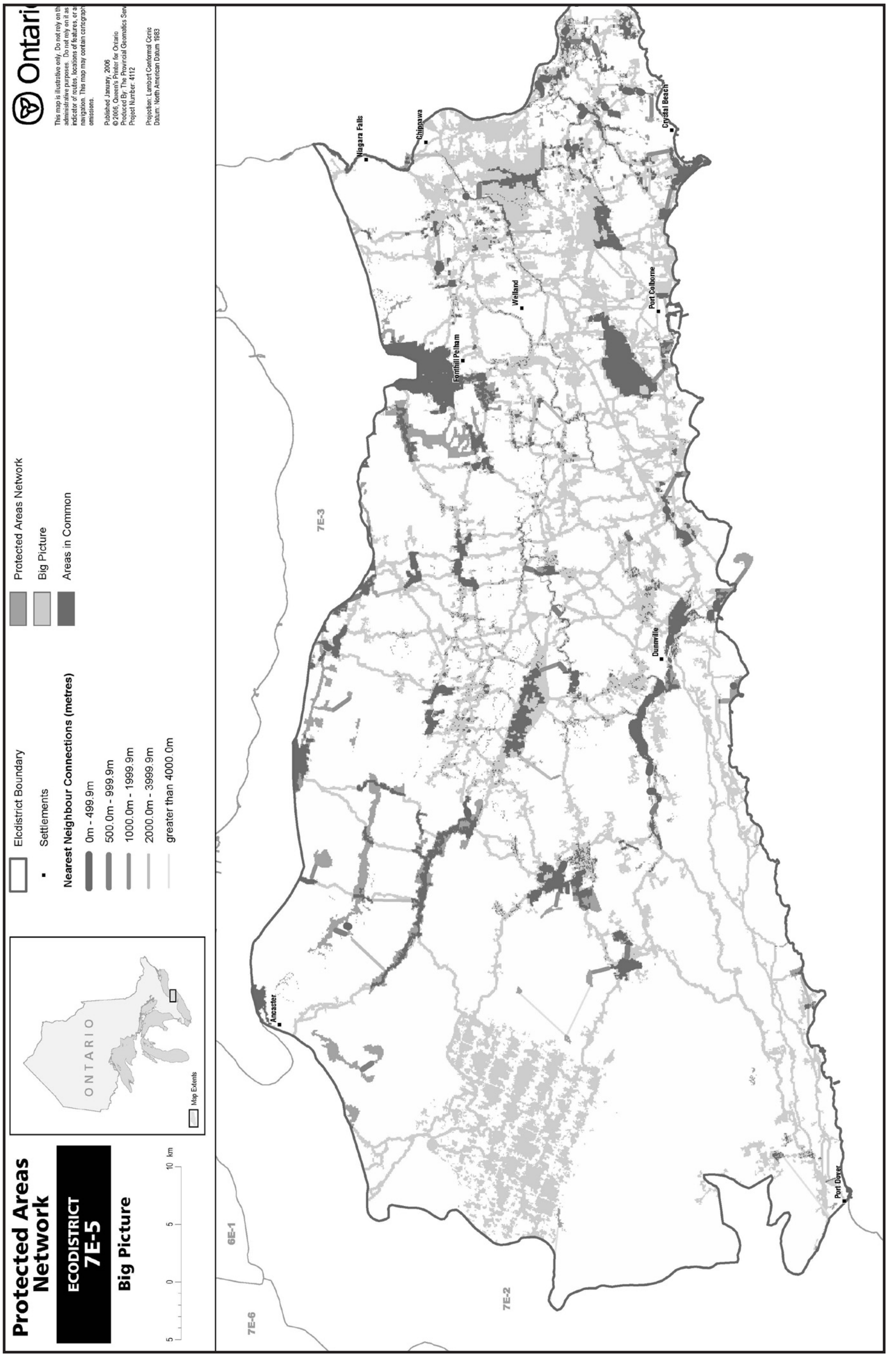
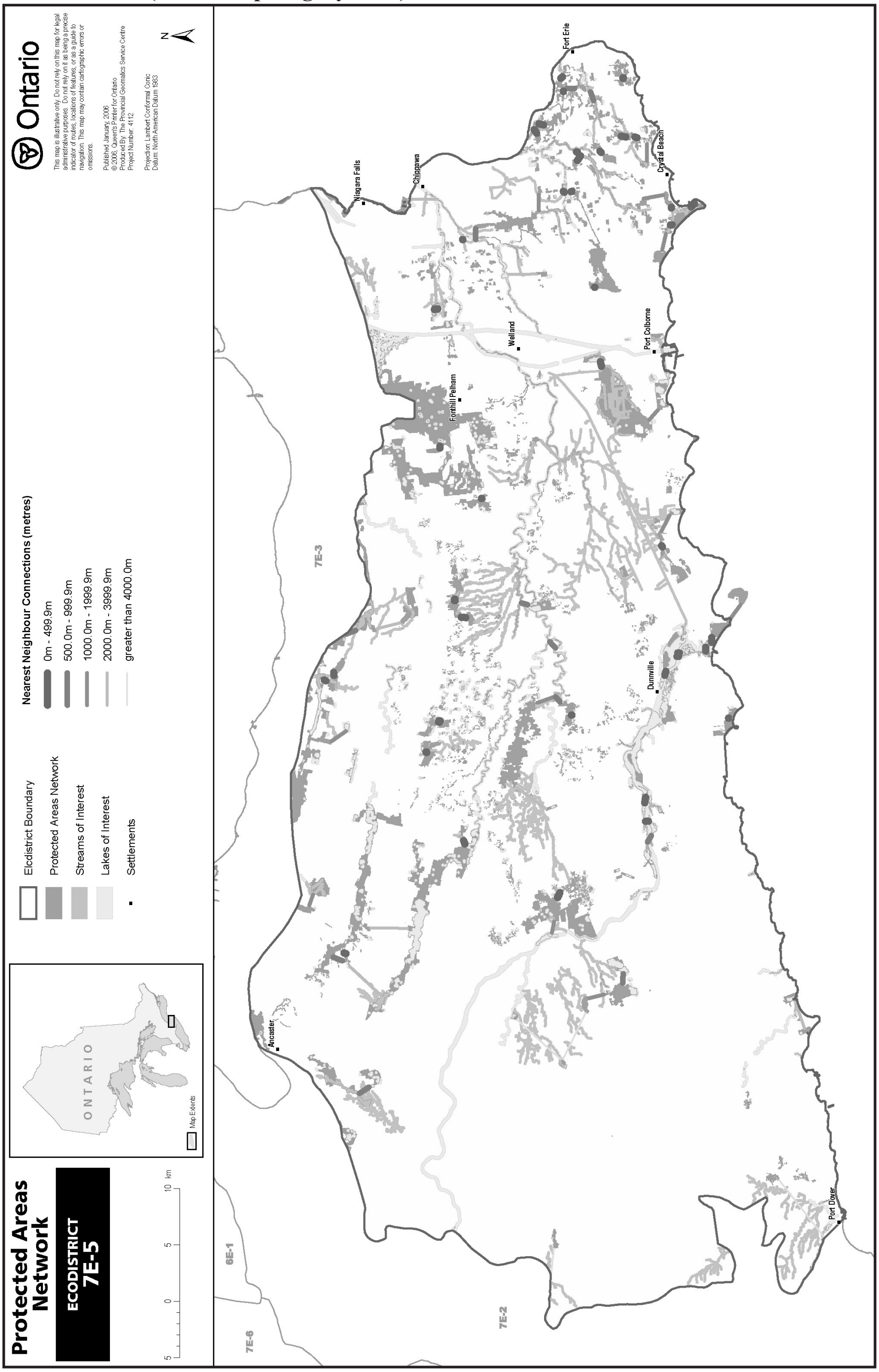


Figure 8. Ecodistrict 7E-5, showing existing protected areas (mid-gray), Big Picture network (pale gray) (NCC and NHIC, 2003), overlap between them (dark gray), and nearest neighbour vectors (line segments of variable width and darkness).

Figure 9. Ecodistrict 7E-5, showing existing protected areas (mid-gray), nearest neighbour vectors (line segments of variable width and darkness), and intersecting water courses (dendritic pale gray lines).



south, where the landscape largely has been converted away from natural cover to land uses supporting settlement and agriculture, the matrix provides limited support for biodiversity conservation. Therefore, the sum of all protected areas does not provide a well connected network. In order to increase the level of functionality or viability of the system, efforts will be required to secure and/or restore lands and waters to build the level of connectivity in the system, and to build the existing blocks of core natural heritage values so that their long-term viability is increased.

In the north, the matrix provides a supportive landscape for connectivity between protected areas. Since much of the land base still supports natural cover, the land base does not provide significant barriers to movement of terrestrial organisms, either through the matrix or between protected areas, but there are exceptions. In the vicinity of settled areas, and perhaps also in heavily cottaged areas, more barriers will exist to the movement of organisms. Also, aquatic ecosystems may be more compromised than terrestrial ecosystems, in terms of natural flows and movement of organisms. This would be true on heavily developed lakes, as well as on all dammed systems, of which there are many.

When interpreting the maps, each of the overlays and analyses should be examined, along with supplementary information regarding land use, built infrastructure, zoning, etc., in order to assess opportunities for enhancing the system and moving toward a connected network. The maps may assist in setting priorities for securement or ecosystem restoration. Each map provides a different perspective on the protected area system and its connectivity in a given ecodistrict. The nearest neighbour vectors may be short, giving the impression that enhancing connectivity may be relatively simple, but supplementary information may determine the actual feasibility of creating such connections. Likewise, long vectors do not necessarily imply difficulty in building the network. Once again, the landscape context, including existing uses and land tenure will be important considerations. Coincidence of the nearest neighbour vectors with natural features on the landscape, such as riparian systems, will enhance the ecological value of any securement or ecological restoration projects undertaken to build the network. All of the maps generated by the approach will serve as guides in building the protected area network, when supplemented by other information.

The analyses conducted using the approach described here should be used for prioritization for network-building projects (securement, restoration) at the ecodistrict scale. Once this has been done, we recommend that finer scale analyses be conducted at the local level (municipality, CA watershed, etc.), to focus in on particular tracts of land and water courses that will provide the highest value in building the network.

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