

**THE BIG PICTURE PROJECT:  
DEVELOPING A NATURAL HERITAGE VISION FOR  
CANADA'S SOUTHERNMOST ECOLOGICAL REGION**

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**ABSTRACT**

“The Big Picture: Cores and Connections in Canada’s Carolinian Zone” project aims to design a long-term natural heritage vision for Canada’s southernmost ecological region. Challenges to the re-establishment of a functioning landscape in the most populous part of the nation are multifarious and daunting. Fragmentation is extreme, and existing natural areas are generally highly disturbed. Many taxa, including the full suite of mammalian high carnivores, have been extirpated, and the region has the highest concentration of endangered species in the country. The Big Picture project aims to reverse these trends by increasing public awareness and promoting a spatial image of a sustainable natural heritage system for the public and planners to work toward in the coming centuries. Using multiple data sets in a geographic information system (GIS) environment, the project identifies existing natural cores, corridors and outlying natural areas, as well as potential connecting links and meta-sites. Core selection is weighted heavily in favour of existing “natural” features and natural areas with legislated protection. Concentrations of high-quality element occurrences also receive high weighting, as do waterways and areas with extensive forest cover. Human-modified lands

receive negative or zero values. Corridors and other areas with potential for restoration or rehabilitation are selected by creating a “cost” layer that allows the GIS to select an optimal path between natural areas, based on lower “resistance” by different weightings of incompatible land uses. The digital data set will be updated and made available to conservation practitioners and municipal planners as new information becomes available.

## **1. INTRODUCTION: THE HUMAN AND BIOPHYSICAL CONTEXT**

The significance of Canada’s Carolinian Life Zone has long been recognized. It is at the northern limit of the (Eastern) deciduous forest region<sup>1</sup>, and is the southernmost ecological region in Canada. It sustains vegetation and species more typical of the eastern United States south to the Carolinas. It has been described as Canada’s most endangered major ecosystem, and many of its flora and fauna are found nowhere else in the nation. This is largely because many southern species are at their northern limits here, and because most of their natural habitat has been lost to human uses over the past three centuries. Almost 7 million people, or 25% of Canada’s population, live in the Carolinian Zone or its immediate vicinity, yet it covers only 0.25% of Canada’s area. Seventy-three per cent of the region is highly productive agricultural land, and major urban centres continue to rapidly expand. Nevertheless, the Carolinian Zone contains two UNESCO World Biosphere Reserves (Long Point and the Niagara Escarpment), the world’s largest freshwater delta at the St. Clair River, one of the natural wonders of the world at Niagara Falls, and one of North America’s most famous birdwatching sites at Point Pelee.

The Carolinian Zone is also known as ecological site region (ecoregion) 7E<sup>2,3</sup>. It covers approximately 22,000 km<sup>2</sup> in extreme southern Ontario, extending northeast from the United States border to Toronto, and northwest to Grand Bend on Lake Huron. It is bounded by four major lakes (Huron, St. Clair, Erie and Ontario), and the St. Clair, Detroit and Niagara rivers. Climatically and biophysically it shares more with the “hot continental (broadleaved forests)”<sup>4</sup> of the north-central United States than with the “warm continental (mixed deciduous-coniferous forests)” division farther north<sup>3</sup>. Ecoregion 7E is divided into six ecological site districts (ecodistricts), delineated primarily on the basis of surficial geology. Major physiographic features include: clay plains, sand plains, till plains, limestone plains, and the limestone/dolostone outcrop of the Niagara Escarpment.<sup>5</sup> Major river systems include the Thames, which drains into Lake St. Clair, and the Grand, which empties into Lake Erie. Many smaller rivers and creeks feed watersheds that flow into the surrounding Great Lakes. The ecoregion has the longest growing season in Ontario because of its southern location and the moderating effect of the Great Lakes.

Historically, the Carolinian Zone was covered with vast tracts of Maple – Ash – Elm upland forests on fine-textured mesic soils, Oak and Oak – Pine forests on sandy soils and Elm - Ash swamps on clay plains.<sup>6</sup> The majority of these woodlands were in old-growth condition.<sup>7</sup> Nested within these matrix communities were large patches of marsh, savannah and prairie.<sup>6</sup> Dune, alvar and cliff ecosystems occurred as small patches on more exposed substrates. Rarer communities such as bogs, prairie fens and various

woodland types (dominated by southern species such as Blue Ash, Tulip Tree and Pin Oak) occurred where suitable conditions prevailed. Today, most of the natural cover is found around Long Point, in the southern portion of the Niagara Peninsula, along the Niagara Escarpment, on the Dundas Valley kame, around Skunks Misery southwest of London, and on the First Nations at Walpole Island and Six Nations.

According to LANDSAT <sup>TM</sup> satellite imagery (vintage 1987-1993), less than 15% of Ontario's Carolinian landscape is classified as having "natural" cover. The Canadian portion of the Carolinian Life Zone has been described as the most ecologically-degraded part of the Great Lakes basin.<sup>8</sup> Forest cover has been reduced from 80% to 11% (Table 1), and wetlands from 28% to 5% of the area. Only 0.07% of southern Ontario is now in old growth condition (over 120 years in age).<sup>7</sup> Nearly all of the remaining "natural" cover in the Carolinian Zone has been logged, irrigated, cleared, polluted or otherwise disturbed by human activities at one time or another over the past few centuries. Because the most intact natural areas have persisted where feasibility of agricultural and urban development is poor, the remnant vegetation proportions differ significantly from pre-European settlement conditions.<sup>6,7,9</sup>

Table 1. Current woodland extent and loss since pre-European settlement in the Carolinian Life Zone based on Ontario Ministry of Natural Resources (OMNR) and Ontario Hydro data<sup>7</sup>

<u>County</u>	<u>Extent-OMNR</u>	<u>Extent-Hydro</u>	<u>LOSS</u>
Essex	2.6	3.5	>90
Kent	3.8	4.4	>90
Lambton	10.1	11.6	>85
Middlesex	10.5	12.5	>85
Elgin	14.4	16.0	>80
Oxford	11.3	12.3	>85
Brant	20.2	22.6	>70
Haldimand-Norfolk	17.3	22.7	>70
Niagara	13.8	23.7	>70
Hamilton Wentworth	13.9	16.6	>70
Halton	16.9	24.2	>70
Toronto	n/a	n/a	n/a

Note: Above extent figures include plantations

The Carolinian Zone sustains at least 18 globally rare and 42 provincially rare vegetation communities. Thirty-six of the ecoregion's species are globally rare, 64 are considered nationally endangered or threatened, and 44 are nationally vulnerable (Tables 2,3). Over 400 plant and animal species are provincially rare (Table 3). At least 39 of the province's extirpated taxa (14 animals and 25 plants) occurred in the Carolinian Zone.<sup>10</sup> Twenty-five per cent of the ecoregion's 57 native mammal species no longer occur. Nine of the 18 native mammalian carnivores have not been recorded in the region for over 30 years.

Gray Wolf, Eastern Cougar and Black Bear have disappeared. Such a high extirpation rate is no doubt linked to the decimation of the region's wilderness and the fragmentation of remaining natural areas. The top carnivore today is the Coyote, a species that became naturalized after the forests were cleared.

Table 2. Officially designated endangered, threatened and vulnerable species occurring in the Carolinian Life Zone<sup>10</sup>

	<b>Endangered</b>	<b>Threatened</b>	<b>Vulnerable</b>
National Status (COSEWIC)	39	25	44
Provincial Status (OMNR)	20	16	16

Table 3. Globally and provincially imperiled species and vegetation communities in the Carolinian Life Zone<sup>10</sup>

	<b>5 or fewer occurrences</b>	<b>6 to 20 occurrences</b>	<b>21 to 100 occurrences</b>
Global Status	3 species 4 communities	8 species 6 communities	25 species 8 communities
Provincial Status	146 species 14 communities	160 species 12 communities	102 species 16 communities

## **2. CONSERVATION PLANNING IN CAROLINIAN CANADA**

### **2.1. PAST CONSERVATION ACTIVITIES**

Many great challenges to conservation are faced in the Carolinian Zone. Foremost from the perspective of terrestrial biodiversity protection is the extreme fragmentation of natural areas by agriculture, roads and urbanization. Almost all the land is in private ownership, and property values are high, resulting in major fiscal and public relations challenges for public agencies and non-government organizations interested in land acquisition. Urban sprawl continues, with associated habitat loss, exotic species invasion, and industrial and recreational pressures (e.g., forestry, off-road vehicles, golf course development) within and adjacent to nearby "natural" areas. Hydrological impacts are widespread, resulting from extensive tiling of agricultural lands, irrigation, dams, channelization and re-routing of watercourses. Waterbodies also face non-point-source pollution, eutrophication and high sediment loads due to surrounding land uses, resulting in a high number of imperiled freshwater fauna.

Over the past century, one national park (Point Pelee), 4 national wildlife areas, 18 provincial parks and nature reserves, and the municipal/provincial Rouge Park, have been created in the Carolinian Zone. These sites perform various functions, from strict conservation in nature reserves and natural environment parks (covering about 0.68% of the ecoregion) to multiple uses in recreational parks (covering about 0.15%) (Table 4).

The Ontario Heritage Foundation and non-government nature reserves protect about 0.11% of the area (Table 4). Unfortunately, detailed figures on conservation authority holdings were not available to the authors, but these quasi-public lands are managed for watershed management as well as environmental protection and recreation, and are important to conservation. Of these properties, multiple-use “conservation areas” cover about 0.38% of the region. Agreement forests, managed primarily for timber harvest, provide some protection to an additional 0.18% of the region (Table 4). Combined, these public and private managed areas cover only about 1.5% of the Carolinian Zone. Additionally, land trusts and other non-government organizations have negotiated conservation easements on some key private lands.

Table 4. Area (in ha) and percentage of protected and publicly managed areas in the Carolinian Life Zone, broken down by ecodistrict<sup>10</sup>

	7E1	7E2	7E3	7E4	7E5	7E6	Total (Ha)	% of 7E
<b>National Parks</b>	1564	0	0	0	0	0	<b>1564</b>	<b>0.072</b>
<b>National Wildlife Areas</b>	244	4026.11	0	0	4.05	0	<b>4274.16</b>	<b>0.196</b>
<b>Provincial Parks</b>								
- Nature Reserve	323.42	67.84	0	0	0	0	<b>391.26</b>	<b>0.018</b>
- Natural Environment	2034.88	975.21	698.61	0	0	0	<b>3708.7</b>	<b>0.170</b>
- Recreation	234.22	2075.18	0	544.99	359.92	0	<b>3214.31</b>	<b>0.147</b>
<b>Ontario Heritage Foundation Properties</b>	0	38	185.85	199	0	99	<b>521.85</b>	<b>0.024</b>
<b>Rouge Park</b>	0	0	0	4800	0	0	<b>4800</b>	<b>0.220</b>
<b>NCC Properties</b>	0.8	132	541	0	1108.4	83	<b>1865.2</b>	<b>0.086</b>
<b>FON Nature Reserves</b>	64	76	0	52	13	0	<b>205</b>	<b>0.009</b>
<b>Agreement Forests</b>	0	3004.11	8.82	38.51	242.37	633.56	<b>3927.37</b>	<b>0.180</b>
<b>Conservation Areas</b>							<b>ca. 8000</b>	<b>0.38</b>

Additional sites of ecological importance have been recognized and receive limited protection through provincial policy and the land use planning process (Table 5). Life science Areas of Natural and Scientific Interest (ANSIs) are identified by OMNR as sites that best represent the characteristic landform-vegetation patterns of each ecodistrict, regardless of land tenure. Although often exemplary in terms of ecological quality and biological diversity, these sites are generally small in the Carolinian Life Zone, averaging less than 300 ha, and occupy only 2.5% of the ecoregion.<sup>11</sup> Also in the early 1980s, thirty-eight of the most significant Carolinian sites on private lands were identified to complement the suite of public protected areas and to provide a focus for conservation action and stewardship. The “Carolinian Canada Sites” generally overlap with ANSIs and cover about 2.7% of the ecoregion. Stewardship awards and property tax incentives have been offered to landowners of Carolinian Canada sites and ANSIs to recognize and encourage low-impact uses of their lands. Additionally, most of the ecoregion’s wetlands have been evaluated, and provincially significant ones receive similar policy protection and tax incentives as ANSIs. They cover about 2.1% of the ecoregion (Table 5), with a considerable proportion overlapping with ANSIs and Carolinian Canada sites.

Endangered species habitat covers another small percentage of the land base; landowners receive a property tax incentive to leave the habitat undisturbed.

Table 5. Provincially designated areas receiving policy protection and property tax incentives in the Carolinian Life Zone<sup>10</sup>

<b>Provincial Life Science ANSI</b>	13925.09	20412.23	6975.22	3982.24	6612.38	3389.19	<b>55296.35</b>	<b>2.535</b>
<b>Provincially Significant Wetlands</b>	8688.91	23339.68	1084.26	218.66	7740.56	5578.37	<b>46650.44</b>	<b>2.139</b>
<b>Carolinian Canada Sites</b>	25222.75	4988.6	3186.31	272.11	23468.22	1298.26	<b>58436.25</b>	<b>2.679</b>

## 2.2. BEYOND FRAGMENTS AND IRREPLACEABILITY

The need for conservation efforts to expand beyond protecting landscape fragments has been expressed for many years.<sup>12,13,14</sup> Studies in Ontario and throughout the world have shown that species requiring interior habitats or large tracts of intact habitat are unable to maintain viable populations in landscapes greatly fragmented by agriculture, roads and urbanization,<sup>15,16,17,18</sup> and that natural corridors are valuable conservation tools.<sup>19</sup> Endangered species recovery plans have been undertaken in the Carolinian Life Zone for some such species. However, the single-species approach to conservation is generally considered too costly, reactive and impractical to be used as the primary method for protecting biodiversity.<sup>20</sup> Proactive conservation that focuses on landscapes and ecosystems is believed to provide the best long-term results at the lowest cost. Thus, a fundamental objective of The Big Picture project is to expand conservation planning beyond the existing “islands of green”.

“Irreplaceability analysis” is one widely used approach to conservation planning.<sup>21</sup> This method uses algorithms in a GIS environment to identify a minimum set of sites to be protected in order to preserve the complete range of biodiversity in a region. Ontario’s representation-oriented ANSI program was an early “manual” version of such an approach. The Nature Conservancy’s ecoregional planning exercises in North America apply similar techniques to identify critical areas for conservation, with algorithms that “allow users to examine portfolios of sites...that attempt to achieve the conservation goals for all targets in the least amount of land”.<sup>22</sup> The Nature Conservancy of Canada plans to apply similar methods to prioritize sites for conservation action in Canada. The results of irreplaceability analysis are normally unequivocal and easily understood, as long as there is agreement that there should be no permanent loss of any native species or natural community in a given region.<sup>21</sup>

However, if an ecologically functioning landscape is the goal, Canada’s Carolinian Life Zone is long past the point where “irreplaceable” sites could be identified at the expense of losing “replaceable” sites to further development or degradation. With so little natural area remaining, and with so much of it severely degraded, much that was “irreplaceable”, such as an adequate amount of habitat for the native high carnivores, has already been lost. Many of the irreplaceable elements of the ecosystem have been extirpated or occur in such

small, isolated populations that their long-term viability requirements cannot be met with the existing extent and configuration of habitats. At the same time, large-scale ecosystems (such as the waters of Lake Erie and the swamps of the clay plain in the Essex County area) have been altered to such an extent that they can almost certainly never be rehabilitated to resemble historic conditions.

Conservation practitioners have a responsibility to respond to this perilous situation with a tangible model and bold action that restores hope for a healthier, greener future in the region. A system of core natural areas functionally united by a network of natural corridors results in a whole that is greater than the sum of its parts.<sup>23</sup> Species unable to maintain viable populations in isolated habitats may be able to do so in a connected landscape. Although re-colonization by some of the historic taxa may seem highly unlikely, the recent southward reclamation of range in Ontario by species such as Black Bear and River Otter appears to coincide with increases in forest cover and improved water quality in the adjacent ecoregion 6E. A functioning natural landscape in Carolinian Canada would provide multiple benefits to humans as well.

### **3. THE “BIG PICTURE” METHODOLOGY**

#### **3.1 PRINCIPLES AND GOALS**

The Big Picture project was designed to effectively work within the context of the remaining natural and quasi-natural cover and with the best available data. The methodology accords with generally accepted primary steps used in systematic conservation planning<sup>14</sup>, namely: 1. clear choices for features to be used as surrogates for overall biodiversity; 2. explicit, quantitative, operational goals and targets; 3. recognition of the extent to which such goals are met in existing protected areas; and 4. simple, explicit methods for designing new reserves to complement the existing system. A multi-agency Technical Committee (see Acknowledgements, below) was assembled to provide expert review throughout the analysis. The following principles guided the development of the project:

1. Ensure replicable, transparent methodology applicable in a Geographic Information Systems (GIS) environment.
2. Ensure that existing natural cover is included in the natural heritage system.
3. Ensure that existing parks and protected areas are included.
4. Ensure that all recognized areas of ecological importance are included.
5. Favour larger intact natural areas, areas with more extensive interior habitat and regions with high percentage natural cover in selection of core natural areas.
6. Reduce fragmentation of natural areas by increasing connectivity.
7. Increase extent of natural and rehabilitation areas to a minimum of 30% natural cover per ecodistrict.

8. Identify for protection all viable occurrences of globally rare elements and all significant concentrations of provincially rare elements.
9. Where possible, ensure a minimum core size of 200 ha and a minimum corridor width of at least 200 m.
10. Wherever practical, identify areas that contain soil types not represented or poorly represented in existing natural areas in order to prioritize sites for rehabilitation (to approximate historic vegetation patterns).
11. Identify areas where restoration and rehabilitation can be accomplished most efficiently and practically by applying an algorithm that includes ecological, social and economic considerations.
12. Modify methodology through consultation with the technical committee as issues and problems arise.
13. Allow for future updates to data and methods as new information becomes available and knowledge improves.

There was considerable discussion among the technical committee members regarding the minimum size for core areas. Scientific opinion differs widely on this question and a complex array of variables must be considered. It was deemed most practical and ecologically sensible to opt for a relatively small minimum size, given the extreme fragmentation of the Carolinian landscape in Ontario and the generally small size of its natural areas. The extent of an average disturbance event in the pre-European settlement forest of Southern Ontario was probably 2 ha or less.<sup>7,25,26,27</sup> It has been estimated that protected landscapes must be 50 to 100 times larger than average disturbance patches in order to maintain a relative equilibrium of habitats.<sup>28</sup> In a such a landscape, the proportions of different seral stages would be relatively constant over time, even though the sites occupied by various seral stages would change.<sup>29</sup> On this basis, minimum recommended area for cores in the Carolinian Zone would be between 100 and 200 ha. Given recent larger storm disturbances (such as the blowdown at Rondeau in 1998 and the massive Eastern Ontario ice storm in 1998), a conservative strategy would recommend cores of at least 200 ha. However, even 200 ha natural areas are extremely scarce in some parts of the region, so standards for minimum size for “significant woodlands” developed by the OMNR<sup>30</sup> were used for townships with extremely low percentage forest cover.

## 3.2 IDENTIFICATION OF CORES

### 3.2.1. GIS Processing

Digital data sets were assembled to show the locations of natural features. These included: slope and aspect heterogeneity, drainage, life science ANSIs, evaluated wetlands, Carolinian Canada sites, older growth woodlands, forest cover, and element (rare species and significant vegetation) occurrences. These data layers were registered to UTM Zone 17, NAD27 and error tolerances were explicitly stated. Vector layers were converted to 25m rasters.

Each feature type was assigned a point value, based on its perceived relative ecological (or conservation) “value”. For example, each pixel within a documented older growth forest received 15 points, whereas all pixels in the path of rivers and streams received 3 points. The point-values were reviewed by the technical committee until consensus was reached. Data layers were then combined (through addition) to create the core “values” coverage.

### 3.2.2. Analysis and Results

To create core areas, this continuous values coverage needed a minimum point-sum that would result in a suite of cores of reasonable extent and configuration. Two values were considered most closely, 11 and 12. Use of a cut-off of 11 would have resulted in larger core areas, but would include features with low ecological integrity (e.g., drainage ditches). A cut-off value of 12 points resulted in representation of over 30% of the ecoregion in cores, with fewer patches of low integrity.

Clusters of adjacent 25 metre by 25 metre raster values 12 or greater were grouped. Any group larger than 200 ha was automatically considered a “core”. Cores over 200 ha were concentrated mainly in areas with higher percentage natural cover. Sizable regions of the study area had no cores larger than the 200 ha minimum. In such areas, the OMNR-recommended minimum “significant woodland” was used, based on percentage forest cover by township.<sup>30</sup> As a result, in some townships cores were as small as 4 ha. The combination of these smaller cores with the 200 ha or greater cores produced the final “cores” coverage. The 200 ha or greater cores were then buffered out to select any adjacent, 12-value or higher, natural areas. These were added to the original cores to create “metacores”.

## 3.3. IDENTIFICATION OF CONNECTIONS

### 3.3.1. GIS Processing

To determine the connections between the cores, the values layer was first augmented to include new layers, some of which encourage and some which discourage connection paths between the cores. Recreational Class Provincial Parks, for example, would make good potential additions to the connections network, but connections across divided highways would be discouraged.

A new “values” layer was formed by addition of the additional features. The sums were then inverted to form a “resistance” layer to determine the “least-cost” (i.e. greatest ecological value with fewest practical obstacles) connection between cores. The minimum value of the least-cost connection between the two cores furthest apart was calculated, and this figure was used as the maximum cost to form a path between any two cores. This ensured that all cores were linked to at least one other core, and often many more where there was a high density of cores and natural values. These connections were widened to incorporate adjacent natural areas having greater than 12 value in the original core values layer.

### 3.3.2. Results

Not all connections achieved the targeted minimum width of 200 m. Connections that narrowed to less than 200 m were highlighted as potential restoration/rehabilitation areas. Metacorridors were created by combining the least-cost path, the high-valued natural areas adjacent to the connections, and the lands requiring rehabilitation to achieve 200m-wide connections between the metacores.

### 3.4. LINKAGE TO ADJACENT ECOREGIONS

Combined, the metacores and metacorridors form a potential heritage network for the Carolinian Zone. However, the Big Picture would not be complete without considering potential corridors to natural areas in ecoregion 6E to the north. These were visually evaluated, selected manually, and indicated as nodal points on the Big Picture map. Future updates to the Big Picture project should include a buffer of perhaps 20km along the ecoregion boundary so that GIS could be used to identify existing natural corridors and potential linkages to the adjacent ecoregion(s). Identifying links to ecoregions in the adjacent United States are not as straightforward because of the intervening waterbodies, but these should be considered as well.

## 4. PRODUCTS OF THE BIG PICTURE PROJECT

The Big Picture project provides a coarse scale spatial image that highlights existing natural cores and connections, and preferred areas for restoration and rehabilitation. The final map will be posted on the Carolinian Canada web site (<http://www.carolinian.org/>), and will be distributed to appropriate venues, as determined by the Big Picture communications committee. Core and connection boundaries are mapped as soft, fuzzy lines, according to criteria agreed upon by technical committee to ensure that private land issues are addressed. The finer-scale digital data set will be made available to conservation practitioners and municipal planners for use within their jurisdictions. The Big Picture vision will undoubtedly be refined as new and better information becomes available and ecological knowledge improves. The project cannot guarantee a fully functioning “ecologically healthy” landscape. However, if its vision is adopted there can be little doubt that the imperiled Carolinian ecosystem and many of its elements will stand a much greater chance of long term viability. Most of the species that are currently in decline or on the threshold of extirpation will have more habitat. There will be increased opportunity for genetic exchange and re-colonization into degraded habitats, particularly for sedentary species that now occur only in isolated habitat fragments. It is also conceivable that extirpated taxa, such as some of the carnivores, may recolonize or can be reintroduced. The human population will benefit in many ways, from improved water quality, air quality, aesthetic values, recreational opportunities, psycho-spiritual health, natural heritage education, ecotourism, forest resources and wildlife resources, and many other social and economic benefits associated with a clean environment.

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