Algonquin to Adirondack Conservation Association

Analyzing the Resistance Values of the 401 Highway to Wildlife Movements in the Thousand Islands Section of the Algonquin to Adirondack Corridor and Thousand Islands Frontenac Arch Biosphere Reserve

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with funding from
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Introduction

The Algonquin to Adirondack Conservation Association is a non-government organization which has taken the initiative to explore, enhance and restore biodiversity and landscape corridor connections for the free movements of wildlife between the Canadian Shield region, as represented by Algonquin Park, and the wilderness and forests of the Adirondack Mountains and areas to the south. The Thousand Islands Frontenac Arch Biosphere Reserve is one landscape component between these two landscape units.
The Association works with the community, agencies and organizations in projects revolving around connectivity, and recognizes the complexity of the cultural landscape. As a partner member of the Biosphere Network, the Network and the Association share common goals and values of conservation, social and cultural fabric, and economic well-being of the region and broader landscape.

Purpose of this Study

The Algonquin to Adirondack Conservation Association, with a view to restoring and enhancing connectivity of this landscape, needs to document and understand the threats and opportunities related to connectivity. Perhaps the most significant and problematic barriers to the corridor are the roadway barriers of the 401 Highway and the urban barrier of the Town of Gananoque, especially related to the Gananoque River at the 401 Highway. It is apparent from various landscape mapping work that an important section of the A2A corridor in this region is the Gananoque River watershed and other forest and wetland connectors. The effectiveness of corridors , however, is seriously impaired by the physical barriers of development and roadways within just a few kilometres of the north shore of the St. Lawrence River. Therefore, a vital step in the process of enhancing and restoring the connectivity from the Algonquin to Adirondack parks regions is to develop an understanding of the nature and complexity of the barriers, and to determine scenarios and models of cooperation which may help to overcome them.

As stated above, the work here has been to quantify threats and opportunities, by valuating resistance to connectivity on segments of the highway, and for highway underpass structures. It is not the purpose of this study to enable more animals to cross onto the highway. Rather, the information learned here may enable stakeholders to improve crossing success and lower the resistance values of the highway by diverting, guiding and channeling wildlife large and small to new and/or improved structures. In the process, wildlife — vehicle collisions may be reduced, and wildlife migrations, population diversities and habitat restoration may benefit.

Collaboration and Study Support

This study was undertaken by the Biosphere Network of the Thousand Islands Frontenac Arch Biosphere Reserve. The Biosphere Network as consultant worked with the supporting steering committee of the Algonquin to Adirondack Conservation Association during the different aspects of the work. The work was done in collaboration with the Eastern Ontario Model Forest, the Leeds County Stewardship Council, and St. Lawrence Islands National Park - Parks Canada. All map work was completed by the Eastern Ontario Model Forest, and was adapted from work completed by the Eastern Ontario Heritage Working Group.

The project was funded by grants from the Trillium Foundation to the Algonquin to Adirondack Conservation Association, and in funding to the Biosphere Network by the Environment Canada Habitat Stewardship Program.

Executive Summary

The following study is divided into three sections.

Part I discusses the valuation of the Highway 401 in terms of i) the value of existing highway underpass structures as passages for mammals and herptiles, and ii) the value of visibly different segments of the Highway 401 related to their porosity for wildlife crossings. A 46.9 km stretch from the west edge of Leeds County to the sound barrier wall at Long Beach was walked to score underpass structures and highway segments, locating each aspect with GPS recordings. Notes captured observations and findings, which were elaborated on in the discussions below. Improvement potentials and recommendations for underpass structures are presented. Highway segment potential and recommendations related to wildlife corridor improvements are presented.

Part II is subdivided into two sections. Part II a deals with the complex area of the Gananoque River — 401 Highway intersection, and the immediately surrounding area. The discussion reveals the existence of a corridor effect, and discusses methods and scenarios for improvements. Part II b discusses a related wildlife crossing situation at 401, east of Highway 32.

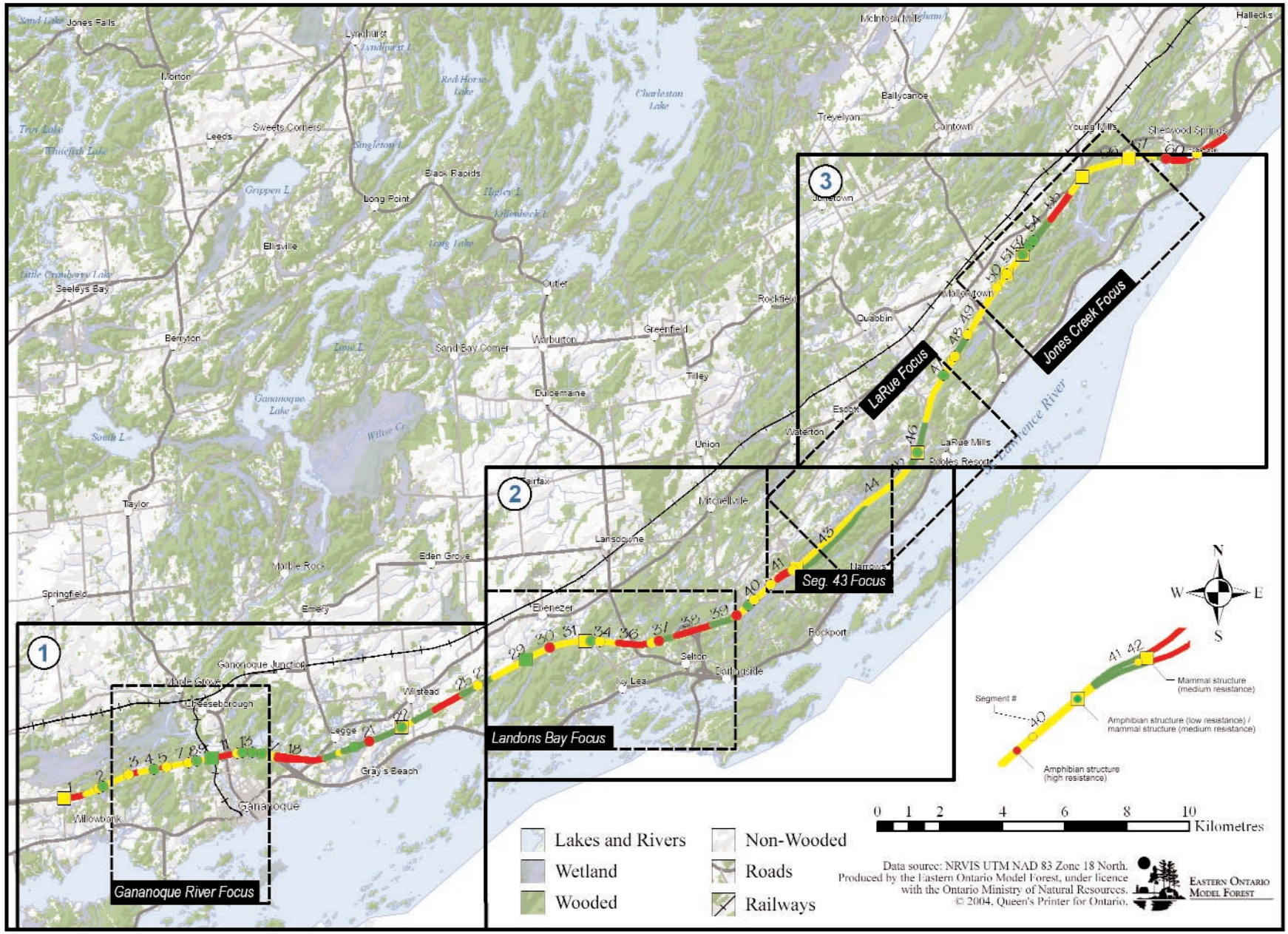
Part III discusses conditions along the section of the Gananoque River waterway from north of 401 to the general area of Charleston Lake. Various aspects of the wildlife corridor are reviewed, and problematic areas are highlighted, with improvement scenarios discussed. An overall strategy for conservation related to the corridor effect is discussed.

Study Areas

In the original concept, the study area was to have been the intersection of the 401 Highway and the Gananoque River, and the urban area of the Town of Gananoque. However, application was made to the Environment Canada Habitat Stewardship Program and that additional funding allowed for the study of a broader area. This was very fortunate, as it allowed the Gananoque focus to be discussed in context and comparison with the 401 Highway across most of the Thousand Islands. The width of the study area was expanded to include a 46.9 km stretch of 401, from the west edge of Leeds County where the Bay Road underpasses the 401, to the Long Beach area west of Brockville, where the sound barrier wall begins at the interchange of 401 Highway and County Road 2.

However, it is recognized that the original focus area of Gananoque and the Gananoque River still has special merit for discussion. It is apparent from map exercises of the Eastern Ontario Heritage Working Group that there is a high potential for connectivity north-south along the river. Therefore, this focus area will be discussed both in relation to the width of the study area, and in its special circumstances in the town and suburban area. Then, to further explore the role and potential of the Gananoque waterway, there will be some analysis of the waterway from the St. Lawrence River to Charleston Lake.

The map on the following page is an overview of the study area. It illustrates to length of the study area, and shows locations of the focus areas.


Gananoque River Focus
Landons Bay Focus
Seg. 43 Focus
LaRue Focus
Jones Creek Focus
Lakes and Rivers
Wetland
Wooded
Non-Wooded
Roads
Railways
Segment #
Mammal structure (medium resistance)
Amphibian structure (low resistance) / mammal structure (medium resistance)
Amphibian structure (high resistance)
0 1 2 4 6 8 10 Kilometres
Data source: NRVIS UTM NAD 83 Zone 18 North.
Produced by the Eastern Ontario Model Forest, under licence with the Ontario Ministry of Natural Resources.
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Eastern Ontario Model Forest

Methodologies

The work for the study fell into several task areas. These were:
Literature search.
There was need to determine what other sort of work had been done that would be relevant to understanding the effects of major highways on wildlife crossings and wildlife populations. There was also need to adapt or develop methods to score and value highway crossing structures in terms of connecting highway-separated habitats, and to determine or value the porosity of highway itself. To that end, searches were conducted online, at libraries of Queen s University, at St. Lawrence Islands National Park and through volunteered sources. For the latter, the accumulated files made available by Doug Wolfhausen were especially valuable, and lead to many other papers which may have otherwise gone undiscovered.

As general comment, there is not a tremendous amount of work done in evaluating porosity of highways. There has been extensive work on the many topics surrounding wildlife collisions, and their remediation, but little on how the values of existing structures were determined. Wildlife crossing issues have been documented especially in the last decade, all over the world and it would appear from the literature that this is a matter of global study interest.

Structure and Highway Segment Assessment. With no ready-made template for analysis of highway crossing structures or for evaluating the porosity/resistance of the highway as a structure on the landscape, methods were home grown. To do this, the findings from the literature search were assembled and developed. This is elaborated upon further below. The resulting tables were field tested and refined.

Field Work. Much of the field work was done on foot. The entirety of the 401 study section was walked in a three week period from mid-April to mid-May to complete the information tables. Many parts of that study section were walked and cross-country skied on other occasions, to gather observations. The lower section of the Gananoque River basin, through the Wildlife Reserve and urban and rural areas around the Town of Gananoque were walked and, on winter snow, skied extensively.

Location information as captured on a Garmin GPS unit, property of the Biosphere Reserve.

Land Ownership. In order to discuss scenarios for improving/recovering wildlife crossings, it was felt that it was important to know general details of land ownership, both abutting the 401 Highway through the study area, and through the Gananoque River corridor. To that end, Mr. Neil Ainsworth, working through an HRDC placement with the Biosphere Reserve, gathered extensive detail at the municipal and county land registry offices. A Land Ownership Table, available but not included for privacy protection, lists ownership of properties that are approximately four acres (about 2 hectares) in size or larger. The assessment numbers of properties were mapped for the overall study area, and ownership may be cross-referenced in the tables.

Mapping. Very fortunately, there is an excellent resource of maps which define and illustrate landscape values for woodlands and wetlands, and potential corridor linkages, for this region of eastern Ontario. As above, these were developed by the Eastern Ontario Heritage Working Group, spearheaded by the expertise of the Eastern Ontario Model Forest. The 401 Highway and Gananoque urban area may be viewed as features or developments on that mapped landscape. It was felt that those features could be valuated and reviewed in context of the existing mapped information. The values for relative porosity of highway structures and highway segments were overlaid on mapping for significantf woodlands and wetlands. The final maps showing the relationship of the 401 Highway and its crossing structures to potential corridor linkages appears further below, in three parts.

Part I. Value system for existing Thousand Islands 401 underpass structures

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Towards a Resistance Model

In part, the discussion of the situation of the 401 highway in the Thousand Islands as a barrier to wildlife movements north and south needs to review the existing degree of porosity or relative impermeability. The term proposed for this valuation is resistance . To that end, the following steps were taken:

To develop a scoring or valuation system for structures which pass under the highway in the study area in order to quantify their potential contribution to wildlife movements;
To determine a scoring or valuation system for segments of the highway through the area that will quantify and qualify those segments in terms of resistance to crossing for wildlife movements;
To map the GIS-referenced highway underpass structures and differentiated highway segments in order to relate their value in terms of degree of resistance to wildlife movements to quantified values of significance of woodlands, wetlands and potential corridors of the landscape adjacent to and radiating away from the highway;
Based on the completed tasks above, and with consideration of land ownership across the study area, to develop scenarios which may lower the degree of resistance of the Thousand Islands section of the 401 highway as it relates to movements of wildlife across the highway in the region.

Location of structures. Through the fine cooperation of Mr. Gordon Bell, Superintendent, Environmental Planning Unit, Ontario Ministry of Transportation, mapping was obtained for the Leeds County section of the 401 highway. The maps are in 700 foot sections, and show all of the structures and work along that section. However, while the maps are an excellent resource to show layout and type of structures related to the project, they are not GIS referenced. As a result, the highway was walked from west to east, from the west Leeds County line to the eastern intersection of the 401 and Thousand Islands Parkway, and back. In that exercise, the relevant structural features and qualities of the highway were noted and GIS referenced. That information was applied to the valuation system as discussed below. The exercise allowed ground-truthing of the qualities of the highway structures.

Ranking/valuation system for structures.

Nowhere in the literature search was there found a ranking or measurement system that would help quantify highway passage systems or structures to aid in wildlife movements. This paper proposes such a system that may help in developing such a model. There were, however, many instances where the preferred qualities of passages and structures were discussed. Perhaps the most comprehensive of these is Scott Jackson and Curtice Griffin, Department of Forestry and Wildlife Management, Massachusetts. From a paper *Practical Strategy for Mitigating Highway Impacts on Wildlife* , International Conference on Wildlife Ecology and Transportation, 1998, the following summary for the placement of passage structures is derived. Note that while the discussion relates to characteristics of proposed structures, those qualities would help understand existing structures as well:

Placement: Travel distance between normal wildlife routes and habitats, if the structure was not directly in line with the normal route, should be as short a detour as possible.

Size: Generally, bigger is better, although some Australian and European work suggests that in the case

of small mammals, there is a preference for passages that are smaller, for better concealment.

Shape: There is little discussion of shape, but more on size. However, related to the bigger-is-better theme is that box-shaped structures have more volume and more vertical clearance from side to side. The box shape lends to better air flow for more consistent temperatures, and better light penetration.

Light: Some species are reluctant to enter passages where there is a substantial difference in light levels from outside to inside.

Moisture: Generally, the type of species moving through passages are most likely to use the structures if the substrate moisture levels inside are closely comparable to those of the environments outside.

Temperature: Variations of internal to external temperatures deter movements.

Noise: Traffic noise is a deterrent for mammals in particular, especially where the passage is interrupted at the median, in the case of four lane highways.

Substrate: A ground surface that replicates the habitats outside of the passages is less likely to deter animals than if the substrate surface were discontinuous with the outside.

Approaches: passages that are not clearly visible from a distance, and through the passages, deter use.

Fencing: Fencing that is inadequate to control and guide animals to the structures take away from the effectiveness of the structures.

The information above is useful as a guide in developing a set of values for the structures that already exist along the section of 401. The literature also underscores that there are differing, and sometimes conflicting, best qualities of passageways for mammals and herptiles. To that end, two sets of valuating systems were proposed; one for mammals and the other for herptiles. There is overlap in the criteria, and of course there are existing structures that may present opportunities for both animal groups. Naturally, the more broadly useable the structure is for both groups, the better it is positioned, potentially, for both groups as migration corridors.

Scoring Tables

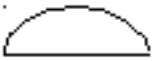
Using the information about qualities of structures, the following tables were constructed to score values for the existing 401 underpass structures. The Mammals Table and Herptile Table were constructed separately.

An intent was to create a scoring/valuing system that would be simple to use in the field, but that would still capture enough information as to be useful in future work regarding aspects of the porosity of the highway. Another intent was to develop the ranking in a format that would be compatible with the valuating systems already in place, as the basis of mapping for the region. A three-tiered system, as for Significant Woodlands and Valuated Wetlands, developed by a partnership The Eastern Ontario Natural Heritage Working Group, derives a valuation of High, Medium and Low. Consequently, characteristics of the 401 structures in this region were assessed and valued in a three-tiered system. In order to retrieve the field-assessed data for future analysis, the structures were catalogued in a database, using the GPS location as the primary key.

A second type of table was developed to value the segments of highway in which the underpass structures are located. This is called the Highway Corridor Features table. Development of this table is discussed further, below.

Mammals Table

GPS location
Type: bridge____ culvert____ other_____

Score	3		2		1	
cross-section size	> 100 sq. m		10 – 100 sq. m		1 – 10 sq. m	
shape	box 		arch 		circle 	
function	drainage		watercourse		transportation	
continuity	crosses all lanes		broken at median		disjunct at median	
substrate	dry		seasonally dry		aquatic	
visibility/ accessibility	good		fair		poor	
micro-connectivity	same habitat		similar habitat		dissimilar habitat	
improvement potential	good		fair		poor	
Total score						

Underpass Structure Table Glossary — Mammals

Cross-section Size: The literature generally agrees that bigger is better. At the top end of the desired size is a width of 30 to 50 metres, and heights upwards of four metres (S. Jackson, 1998; Keller and Pfister, 1997). For mammals, there is obviously a lower practical limit to the size, where the animals wouldn t have sufficient headroom to traverse. In addition, there are various shapes and configurations for sub-highway features. In order to develop a simple value for the cross-section size of the structures, three size ranges of the area in square metres was used. The range of sizes of structures used by the Ministry of Highways in the region varies considerably. The structures have a range of functions, presenting size options. As a 400-series highway, the drainage use structures were based on perceived needs in a hundred year weather event scale (personal communication; G. Bell, MOT).
After considering the parameters of optimum size and range of structural types, the three ranges of cross-section area of >100 square metres; 10 — 100 square metres; and 1 — 10 square metres were chosen. While there are structure dimensions that exceed the largest range, and fall below the smallest range, the categories roughly fit the function of the structures at various locations. As well, while there are many culvert structures that are smaller in cross-section than the 1 — 10 square metre category, these were not noted in the Mammal Table, because their size in any event would be restrictive to the movements of any but small mammals. The reader will note in the segment which discusses Herptiles that the largest opening size was omitted from the table, and that a <1 square metre category was used instead. This reflects the smaller body size of these animals and that smaller structures may be of value in their case.

Shape: The Ministry of Transportation has used three basic shapes in construction of the various underpass structures box, arch and circular tube. The literature discusses wildlife crossing features in the same terms. Box structures were given the highest value, for the reasons discussed above: they present the most clearance throughout, have a better ability to contain preferable substrate characteristics than round-bottom structures, and have better potential for higher ambient light levels and lower temperature extremes. Arches were ranked second, for their next best potential for clearance, and ability to contain preferable substrate characteristics than round-bottom structures. Circular-section structures were accordingly ranked third.

Function: MOT structures in this area have three basic functions: drainage, watercourse flow, and transportation. In the table, drainage was ranked highest because those structures would generally have the best range of conditions for the movements of animals. Drainage structures may be at all times wet, or aquatic, but may be seasonally dry or moist, but would likely have the highest potential at least seasonally for the movements of mammals. Structures built to allow the flow of watercourses, such as rivers or streams, would always be aquatic, but not necessarily aquatic across all of their width. Many mammals will take to water, wading or swimming, although most all would prefer to walk. Therefore, watercourse structures were second-ranked. Transportation structures used in the region are for road and rail underpasses, and highway overpasses. While there is certainly plenty of observations and evidence that transportation structures are used by mammals, and indeed be more important in some instances and seasons that the other two structure types, they were lowest ranked because of the deterrence value of the substrate, noise, and potential threat of collisions with vehicles.
Function is a most difficult aspect to definitively rank because of the variability of the structure s characteristics. A watercourse may have dry banks but also vehicle routes, as at the Gananoque River site. A watercourse such as La Rue Creek flows rapidly in spring, is nearly idle in summer, and is hard frozen for part of the winter, and so presents better crossing opportunities seasonally. However, the variability is somewhat surmounted in consideration of the ranking of other characteristics, such as substrate and accessibility. Where the structure has a constant of two substrates, such as land and water, it was placed in the higher-ranking category, drainage, even though the primary function may have been for a watercourse.

Continuity here refers to the completeness of the structure from one side of the highway to the other. In the literature, the structure has most value, and so three points here, if it is complete from one side of the highway to the other. It has lesser value, or two points, if it is broken at the medium. Noise increase at the median in two-sectioned structures is given as the reason for the lesser value (S. Jackson, 1998), even though there may be some

habitat in a naturalized median. Structures that are under both lanes, but not continuous through the median and separated by some distance so that they are not more or less in line still have some potential for permeability, but have lesser value because of the noise at the median and because travel distance is increased. No score is given for structures that traverse only one lane, and so end at the median, not completing the highway crossing.

Substrate refers to whether the condition of the bottom of the structure is dry, wet or intermediary. In this mammal table, dry is given highest value, with seasonally dry next in value and aquatic ranked third. Aquatic-substrate structures may be frozen and thus easily traversable in winter. If a structure s substrate is both dry and seasonally dry, or dry and aquatic at the same time, because of both conditions present, it was placed in the dry, or top-ranked, column.

Visibility/accessibility refers to how apparent the opening is from a reasonable distance, given that area s terrain, and whether there is visibility through the structure from one end to the other. Ideally, the structure s presence would be apparent to wildlife approaching the highway, and that the opposite end of the structure would be visible through the structure would be less of a deterrent (Predavillano and Wright, 1987; ICOWET 1998, various authors). There is also considerable discussion in a number of papers about learning and establishing of routes, particularly with larger mammals, where established pathways to structures improves the use by wildlife. Since there were no firm recommendations found regarding what definitively becomes criteria for visibility or accessibility, but because these qualities are seen as important, the values were not pegged to criteria but were simply given a good, fair, poor valuation. These three values might be thought of as the structure being easily visible from both ends and through, or degrees of lesser visibility from both ends and through..

Micro-connectivity refers to the structure linking habitats at opposite sides of the highway. The highest value would be structures that would connect same habitats, with similar habitats next valued, and dissimilar — while possibly seasonally compatible — were third ranked. References alluding to values of separating habitats by highways, from studies in eastern Ontario by C.S. Findlay et al. In 1996, 1999, were useful in this regard.

Improvement Potential: Three value levels of good, fair, poor were applied to the structures. These were subjective values, related to the apparent potential to improve the porosity of the highway at those points. Taken into consideration were all of the other criteria above. No specific recommendations are made for each structure in this study, but if there is work done in the future to improve the permeability of this section of 401, the improvement potential may be reviewed in the search of the database.

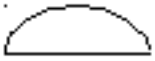
Total Score: The maximum score that can be achieved in the Mammal Table is 24.
Structure Value: The structure was given a value for its porosity as high, medium or low, based on ranges of the value scores. They were defined as follows:

High	> 20
Medium	14 — 19
Low	< 13

The ranges of score values are broad and somewhat flexible. They were derived from observations of a number of the structures, and recognize that there is seasonal variability in the qualities of the structures.

Herptiles | Table

GPS location
Type : bridge ___ culvert____ other _____

Score	3		2		1	
cross-section size	10 - 100 sq. m		1 – 10 sq. m		< 1 sq. m	
shape	box 		arch 		circle 	
function	drainage		watercourse		transportation	
continuity	crosses all lanes		broken at median		disjunct at median	
substrate	aquatic		seasonally wet		dry	
water flow	still		slow		rapid	
micro-connectivity	same habitat		similar habitat		dissimilar habitat	
improvement potential	good		fair		poor	
Total score						

Glossary — Herptile Table

Cross-section Size: The three size ranges of cross-section size of the structures is slightly different than from the Mammals Table. These animals are much smaller than many of the mammals, and overhead clearance requirements are less. The largest size registered here is greater than 10 square metres in area of the section, as references in literature about amphibian crossings relate to values of smaller structures. Large openings are in any case beneficial as there is more potential for large structures to contain more conditions conducive to use by herptiles. Various authors (eg. R.T.T. Forman and A.M. Hersperger, 1996) relate that structures are apparently most successful as herptile crossings if inside and outside light regimes, temperature and humidity are as close to equivalent as possible. To that end, specially built structures for herptiles, in parts of Europe and the United States, have a grid or grill top to allow for light and temperature to equalize in and out of the structure. As there are no specially built tunnels in the 401, larger cross sections would be assumed to be more valuable as they would permit more ambient light and moderating temperature. At the other extreme of structure size, use of relatively small 30 cm x 30 cm commercially-built amphibian tunnels have met with some success in England and the U.S. (Langton, 1989). With those dimensions in mind, and given that MTO uses a variety of sizes of structures for under-highway functions, the small-size category was set at less than 1 square metre in cross-section area, and the mid-size was then 1 to 10 square metres of cross-section area.

Shape: As in the case of the Mammals Table, the values were ranked highest to lowest for box, arch and circular-section structures. As was the case for mammals, the various structure s shapes lend best to porosity for box shapes, next best for arches, and third for circular sections.

Function: Values and discussions here are as per Mammals.

Continuity: Values and discussions here are as per Mammals.

Substrate: The order of values is essentially reversed here from the Mammals Table. For amphibians, for part of or all of their life stages, an aquatic environment structure would best lend to movements. Perhaps the most ideal condition would be partially aquatic and partially terrestrial. If such a condition was found, it was placed in the top-value column; aquatic. An structure could be seasonally wet or seasonally aquatic, due to spring run-off or following periods of heavy rain. If the structure was determined through observation to be in an aquatic or wet state through spring to summer months, it was placed in the higher ranking aquatic category. If it was determined to be aquatic or wet only in early spring runoff, it was left in the seasonally wet column. Structures that are dry continually or for nearly all of the year were categorized as dry. Even so, they may have some value for porosity for parts of some amphibian life cycles.

Water Flow: A structure may have apparent value because it is an aquatic environment, but that value may be diminished if the speed of the water flow is too great to allow species to transfer through the structure in both directions. Still water would allow movement most easily, and would allow plant debris and sediment, with better habitat qualities, to accumulate. Slow flows would be less ideal for movements and enhancement of the structure s environment, but would have better values than structures with rapid water flow. Hence, values were assigned with still water highest-ranked, and rapid flows valued lowest.

Micro-connectivity: As was the case with the Mammals Table, micro-connectivity refers to the structure linking habitats at opposite sides of the highway. The highest value would be structures that would connect same habitats, with similar habitats next valued, and dissimilar — while possibly seasonally compatible — were third ranked. References alluding to values of separating habitats by highways, from studies in eastern Ontario by C.S. Findlay et al. In 1996, 1999, were useful in this regard.

Improvement Potential: Three value levels of good, fair, poor were applied to the structures. These were subjective values, related to the apparent potential to improve the porosity of the highway at those points. Taken

into consideration were all of the other criteria above. No specific recommendations are made for each structure in this study, but if there is work done in the future to improve the permeability of this section of 401, the improvement potential may be reviewed in the search of the database.

Total Score: The maximum score that can be achieved in the Herptile Table is 24.

Structure Value: The structure was given a value for its porosity as high, medium or low, based on ranges of the value scores. They were defined as follows:

High	> 20
Medium	17—19
Low	< 16

Note that the scores for Medium are a narrower range for herptiles than for mammals. As well, many Medium-ranked underpass structures actually have poor potential for improvement. Combinations of poor improvement potential, dissimilar habitat linkage and seasonal wet state were judged to diminish the value of structures crossing all lanes, with still water and best structure shape. Therefore, the bar was set higher for herptile passages than for those for mammals. The ranges of score values are broad and somewhat flexible. They were derived from observations of a number of the structures, and recognize that there is seasonal variability in the qualities of the structures.

Highway Corridor Features

The potential of linkages and corridors that may exist to the south and north of the highway are made far moreclear than previously known through recent mapping work by the Eastern Ontario Model Forest, Parks Canada, Ministry of Natural Resources and the Canadian Parks and Wilderness Society. The task here is to attempt to evaluate and valuate the degree of the porosity, or resistance to connectivity, of this study area, and relate those segments of the highway to the existing maps of corridors and core areas.

The presence of highways is broadly documented as diminishing habitat and affecting populations over an area considerably wider than the highway itself. The area affected may be up to and possibly exceeding two kilometres in southeastern Ontario (Findlay and Houlahan, 1997). The discussion of those effects though is beyond the scope of this study. Again, the purpose of this study is to find a means of measurement of the amount of porosity through existing cross-highway structures, and the degree of resistance to highway crossing, or value to corridor linkage, of discernibly different segments of the highway across the study area. This portion of the study will examine segments of the highway from west to east to apply value in terms of connectivity. High value segments will have lower resistance to connectivity. Low value segments will have higher resistance to connectivity.

The length of the highway studied was 46.9 km, from the west edge of the Leeds County at the Bay Road to the west end of the sound barrier wall at Long Beach. The characteristics of the highway will have a direct bearing on the degree of porosity or resistance to wildlife crossings. Below is the discussion which lead to the tables for the valuation of the highway. Because of the nature of the terrain in the Thousand Islands section of the 401, with its complexity and variability of hills, valleys and drainage features, the segment lengths were not of fixed intervals in length. Instead, the segments were lengths of highway where the features were relatively consistent for some interval. The start and end points of those segments were plotted with a GPS instrument, for reference in mapping. The features indicate potential value for connectivity in the highway segments.

To be consistent with values for the Mammals and Herptile Tables, a three-tiered value system was devised. Three aspects of the highway characteristics were used in the valuation. These examined the median, the grade level of the road in relation to the surrounding landscape, and whether there was development or no development in the adjacent landscape.

The median can be more or less conducive to allowing animals to cross the highway. An open, vegetated median offers the least resistance to crossing, and if this was the situation, the value of three points was given. In this region, there are segments of the highway where it is divided by a height of land that has been through-cut, called landform divided for this study. Even though parts of this landform divided segment may have near vertical rock walls, examination shows there to be numerous passages available through and over such segments. Consequently, landform divided segments were given a medium, or two point value. Third ranked were segments of the highway where concrete median barriers have been installed. To all but the largest of mammals, these barriers are insurmountable.

Grade level is a factor in wildlife crossings. If the highway segment is at grade, or relatively at the same topographic level as the surrounding landscape, it has greater potential for crossing, because animals may see the terrain of the opposite side, and because there is no bordering slope to be scaled. At grade segments were given the highest three point value. Where the grade of the highway segment was raised above the surrounding landscape, visibility to the opposite side is reduced and there is a slope that must be scaled, but there is still potential that animals may be able to cross from one side of the highway to the other. Two points were assigned. Segments of highway below the level of the surrounding landscape are generally those which run through continuous rock cuts, on either one side or both sides. They were considered to have the least potential for crossing because of the barrier they present, and were ranked third, with one point. Small (short) rock outcrops were differentiated from continuous rock cuts. These are isolated features and can be relatively easily circumvented, and were not an

influence in the scoring.

Adjacent corridor features are very general characterizations of the landscape on either side of the highway segment. They were placed into three broad categories of open land, interchange, and adjacent development. Open land here is considered as structurally undeveloped land, and could be forested, wetland, or farmland. While particular species would gravitate to one type of habitat over others, in general terms land without development structures would be conducive to wildlife movements, and given three points. Interchanges add to the complexity and quantity of road development, but in this region there are some habitat qualities at interchanges and their presence does not entirely eliminate wildlife crossings. Two points were given. There are some segments of highway that have extensive structural developments which may be in themselves barriers to wildlife crossings. Weigh scale stations, service centres industrial site development, subdivisions and the casino present limitations to wildlife movements. Segments with structural developments were third-ranked. Features such as individual houses, dead-end roads and lanes or isolated farm buildings were considered as avoidable, and as such did not enter into the valuing.

Highway Corridor Featues

Highway Table

GPS location: From_____ To_____

Score	3		2		1	
median	vegetated		landform divided		barrier wall	
grade level	at grade		above grade		below grade	
adjacent corridor Feature	open		interchange		structural development	
Total score						

The maximum score value here is nine. Ranges of values are:

High	9 points
Medium	7,8 points
Low	<7 points

The criteria for the ranking are quite high as the lesser values are potentially quite limiting in terms of wildlife crossings.

Tables Summaries

Mammals Tables

#	GPS location	score	notes
1	44 19 870 76 14 127	19 medium	Underpass; Bay Road; fox and deer tracks; limited potential for improvement
2	44 20 600 76 10 575	22 high	Gananoque River bridge; has both watercourse and dry land components; excellent improvement potential
3	44 21 170 76 06 003	18 medium	Gray's Creek; ditched watercourse; deer, coyote, raccoon, mink, muskrat, beaver tracks; could be improved with one side filled for mammal crossing but limited adjacent habitat potential
4	44 22 350 76 03 005	21 high	Landons Bay Creek bed; reputed to be built as livestock underpass; deer tracks, coyote, raccoon; tall structure
5	44 22 703 76 01 615	16 medium	Round culvert in Fitzsimmons Mtn area; deer, fox, raccoon tracks lead to it; crossing area
6	44 23 990 75 56 520	18 medium	Underpass, Rockport-Escott Rd.; good circumstances of habitat, size etc, but poor improvement potential due to construction format
7	44 26 035 75 53 630	18 medium	La Rue Creek bridge; aquatic side to side, open at median; some raccoon, deer muskrat tracks in spring mud, deer tracks on ice in winter under bridge; generally less use than expected; could be improved with planting screen, land section to west side
8	44 29 140 75 51 520	18 medium	West side of west-bound service centre; deer crossing area, but not in culvert; poor location for improvements
9	44 29 476 75 51 150	16 medium	East side of west-bound service centre; carries watermain to east-bound service centre; some potential for small mammal crossing with fill added
10	44 30 848 75 49 775	19 medium	Jonas Creek tunnel; rapid and noisy waterflow, depth varies from 10 cm to 1 metre; otter, raccoon, bats in tunnel, deer, fox tracks outside; improve with rock fill on one side
11	44 31 150 75 48 610	17 medium	MacIlhennys Creek box culvert; stream flow, part of Jonas Creek complex; muskrat, raccoon use; aquatic but good area for crossing construction

Summary:

In the length of 401 highway from the west edge of Leeds County to the east end of the Butternut Bay service Road, there were only 11 structures which had size and circumstance that were felt capable of allowing the passage of mammals. There are no structures that were placed with the intention of allowing wildlife passages, although one was reportedly built for livestock passage, and none of the structures are entirely ideal or ideally located to allow such passages. Nonetheless, there is some use of all of the structures by wildlife. The highest ranking structure is the bridge over the Gananoque River. Second is the tall box culvert at the back of Landons Bay, originally built for livestock. All of the remainder ranked at medium value.

Herptile Table |

#	GPS location	score	potential for improvement and notes
1	44 20 049 76 13 292	19 medium	Poor potential
2	44 20 082 76 13 195	21 high	Fair potential; links wetland
3	44 20 287 76 12 582	18 medium	Poor; dissimilar habitats; dead beaver, muskrat and mink; beaver activity on south side; minnows in water shows permanent wet area
4	44 20 386 76 11 970	21 high	Fair; larger box culvert links same habitats; beaver lodge south end, minnows; probable turtle use
5	44 20 438 76 11 666	17 medium	Poor;
6	44 20 510 76 11 139	19 medium	Poor; shrub wetland connection, ditched to culvert
7	44 20 543 76 10 943	21 high	Fair; seasonal habitats north (marsh) and south (swamp); could be opened at south end for better access
8	44 20 688 76 09 962	19 medium	Poor; small drain culvert
9	44 20 704 76 09 839	20 high	Fair; wetland link; chorus frogs and spring peepers at both north and south ends
10	44 20 710 76 09 607	22 high	Good; watercourse southward from Gan sewage ponds; at bottom of steep grades, but many amphibians present, also deer, beaver, racoon, muskrat;
11	44 20 680 76 09 383	22 high	Fair; relates to Gan sewage ponds, turtle and frog route
12	44 20 815 76 07 147	21 high	Fair; large box culvert at Legge's Creek; broad wetland south side with populations of amphibians, but farm practice on north side needs improvement for stream quality and habitat improvement
13	44 20 919 76 06 778	16 low	Poor; small culvert ditched for drainage; fresh dead deer south side
14	44 21 170 76 06 003	20 high	Fair; larger box culvert to ditched creek; tracks of beaver, deer, coyote, raccoons; minnows, painted turtles; one side could be filled for mammal path
15	44 21 908 76 04 180	19 medium	Poor; minimal suitable habitat across highway
16	44 22 578 76 02 458	10 low	Poor; undersize, separated at medium
17	44 22 704 76 01 480	20 high	Fair; could be filled one side for mammals, reptile crossing
18	44 22 700 76 01 265	18 medium	Poor; drainage only function, lacks habitat
19	44 22 683 76 00 000	17 medium	Poor; good habitat connection but small size and poor approaches; possibly some frog, turtle, snake use
20	44 22 719 75 59 834	16 low	Poor; as above
21	44 23 174 75 57 956	16 low	Poor; undersize, drainage function
22	44 23 358 75 57 677	20 high	Fair; connects wetland habitats north and south; green, chorus, spring peeper frogs present both sides; needs some habitat restoration and amphibian fence

23	44 23 453 75 57 542	19 medium	Fair; could rank higher; small but with defined approach, and good north-south connection, 4 frog species, painted turtles, garter snakes; good funnel location
24	44 23 717 75 57 145	17 medium	Poor; small with no habitat connection
25	44 23 964 75 56 604	19 medium	Fair; back of marsh at 401-Escott Rd.; large but separation at median as road widens; some potential to link similar habitats
26	44 26 035 75 53 636	20 high	Good; LaRue Creek bridge; permanent creek; very few culverts for distance to east and west
27	44 27 375 75 53 030	20 high	Poor; good linkage conditions, but small areas of habitat connected; permanent water flow, minnows in creek
28	44 27 630 75 52 825	18 medium	Fair; feeder creek to Mud Creek, west side of Leeds Rd 5; green and leopard frogs north - south
29	44 27 710 75 52 760	18 medium	Poor; drain from field on north to small marsh on south
30	44 28 085 75 52 455	19 medium	Poor; small areas of similar habitat connected
31	44 28 900 75 51 752	17 medium	Poor; small, seasonal drain
32	44 29 140 75 51 521	19 medium	Poor; would rank higher but north entrance at west edge of service centre
33	44 29 476 75 51 151	20 high	Fair; needs entrance habitat restoration at both ends; painted turtles, green, leopard frogs; also carries water main from west to east service centre
34	44 29 630 75 50 980	22 high	Fair; leopard, bull, green frogs; narrow channel at present, enlarging and restoration needed
35	44 29 716 75 50 890	21 high	Fair; very good habitat connection on watercourse; species rich; major limitation is size of the culvert – needs major expansion in size
36	44 31 148 75 47 721	15 low	Poor; drain function
37	44 31 245 75 46 951	17 medium	Poor; large old drain at Butternut Bay; sandstone bottom, flow varies with runoff

In summary, 37 underpass structures were quantified. Again, all of these crossed the whole of the highway, either continuously or in segments. Ranking summaries are:

High value — 15
Medium value — 17
Low value - 5

In terms of potential for improvement, a summary is:
Good — 2
Fair - 15
Poor - 20

Highway Corridor Features – Table Summary

Seg#	GPS – from..	GPS – to..	Value	notes
1	44 19 869 76 14 127	44 19 940 76 13 626	6 low	West study limit, Leeds County line
2	44 19 940 76 13 626	44 20 310 76 12 495	7 medium	Road kill: 1 mink, 1 beaver, 3 muskrat, 1 coyote
3	44 20 310 76 12 495	44 20 337 76 12 323	5 low	
4	44 20 337 76 12 323	44 20 417 76 11 794	7 medium	Marsh area north and south; road kill: 23 muskrat (13 of them at barrier wall 12 north side, 11 south side), 1 raccoon at wall, 1 coyote – remedy remove barrier wall, replace with guard rail
5	44 20 417 76 11 794	44 20 438 76 11 666	5 low	
6	44 20 438 76 11 666	44 20 452 76 11 560	5 low	Road kill: 1 deer, 1 coyote, 1 raccoon (at median wall)
7	44 20 452 76 11 560	44 20 526 76 11 065	7 medium	
8	44 20 526 76 11 065	44 20 548 76 10 918	6 low	
9	44 20 548 76 10 918	44 20 590 76 10 600	7 medium	
10	44 20 590 76 10 600	44 20 612 76 10 484	4 low	Gananoque River overpass; low value from road surface viewpoint, while underpass value very high – see mammals table
11	44 20 612 76 10 484	44 20 682 76 09 997	6 low	Interchange # 645, highway 32
12	44 20 682 76 09 997	44 20 703 76 09 875	7 medium	
13	44 20 703 76 09 875	44 20 712 76 09 632	5 low	Rock cut area, animal path south side at bottom of rock cut; 1 road kill deer
14	44 20 712 76 09 632	44 20 705 76 09 547	6 low	Highway here over creek connecting Gan sewage ponds to river; well used animal path east side of creek; road kill: 6 deer, 2 raccoons – suggests high animal traffic in low value crossing area=improvement area
15	44 20 705 76 09 547	44 20 694 76 09 444	5 low	Low rock cut; 2 deer road kill
16	44 20 694 76 09 444	44 20 687 76 09 383	6 low	
17	44 20 687 76 09 383	44 20 605 76 09 050	8 medium	Parkway exit starts, barrier wall ends
18	44 20 605 76 09 050	44 20 620 76 07 860	3 low	County Rd 2 overpass, casino south side, RV sales centre north side
19	44 20 620 76 07 860	44 20 714 76 07 536	9 high	Old field farmland north and south
20	44 20 714 76 07 536	44 20 741 76 07 424	8 medium	Low scattered rock cuts
21	44 20 741 76 07 424	44 21 137 76 06 100	9 high	1 road kill deer, 3 muskrat, 2 raccoon
22	44 21 137 76 06 100	44 21 290 76 05 715	8 medium	Some slightly above and below grade, west side of Cliffe Road
23	44 21 290 76 05 715	44 21 480 76 05 249	9 high	
24	44 21 480 76 05 249	44 21 747 76 04 575	5 low	Truck inspection areas, north and south sides, with barrier walls

25	44 21 747 76 04 575	44 21 883 76 04 249	9 high	
26	44 21 883 76 04 249	44 21 914 76 04 168	8 medium	
27	44 21 914 76 04 168	44 22 053 76 03 810	9 high	
28	44 22 053 76 03 810	44 22 103 76 03 700	8 medium	
29	44 22 103 76 03 700	44 22 550 76 02 550	8 medium	
30	44 22 550 76 02 550	44 22 590 76 02 405	8 medium	At back of Fitzsimmons Mt; extensive animal paths at west side of these coordinates; enough depth of rubble fill to place tunnel
31	44 22 590 76 02 405	44 22 704 76 01 507	8 medium	1 road kill deer
32	44 22 704 76 01 507	44 22 703 76 01 402	8 medium	Above grade
33	44 22 703 76 01 402	44 22 700 76 01 300	7 medium	Below grade; 1 raccoon road kill
34	44 22 700 76 01 300	44 22 690 76 01 144	8 medium	
35	44 22 690 76 01 144	44 22 672 76 00 850	7 medium	Road kill: 1 fisher, 1 ground hog, 2 raccoon
36	44 22 672 76 00 850	44 22 683 76 00 000	6 low	#659 interchange
37	44 22 683 76 00 000	44 22 809 75 59 447	9 high	Between interchanges 659 and 661
38	44 22 809 75 59 447	44 23 005 75 58 576	6 low	#661 interchange
39	44 23 005 75 58 576	44 23 141 75 58 041	9 high	
40	44 23 141 75 58 041	44 23 810 75 57 000	8 medium	Marsh on south side; some marsh north; well-worn animal trails lead to crossing at 44 23 340 / 75 57 700
41	44 23 810 75 57 000	44 23 990 75 56 700	6 low	Landform divided section starts; well-worn animal paths lead to "downstream" ends of rock cuts; 1 deer road kill east-bound lane
42	44 23 990 75 56 700	44 24 000 75 56 490	6 low	East-bound lane; marsh area crosses through landform divided section at culvert just west of Rockport-Escott Rd
43	44 24 000 75 56 490	44 25 200 75 54 940	9 high ebl 8 med wbl	Landform divided section; ends at east co-ords; note west-bound lane has rock face on south side
44	44 25 200 75 54 940	44 25 429 75 54 326	8 medium	Only slightly above grade, minor rock cuts
45	44 25 429 75 54 326	44 25 830 75 53 800	8 medium	Slight above and below grade slope; LaRue wetland north, woodlands south
46	44 25 830 75 53 800	44 26 595 75 53 450	9 high	LaRue marsh near highway starts at west coordinates, ends at LaRue Rd
47	44 26 595 75 53 450	44 27 800 75 52 750	7 medium	LaRue Rd through low rock cuts and hillside
48	44 27 800 75 52 750	44 28 185 75 52 450	9 high	Fields and woods north, woods south
49	44 28 185 75 52 450	44 28 670 75 52 045	8 medium	Interchange #675 to Mallorytown
50	44 28 670 75 52 045	44 29 178 75 51 480	9 high	
51	44 29 178 75 51 480	44 29 476 75 51 155	7 medium	Service centre north side

52	44 29 476 75 51 155	44 29 642 75 50 972	9 high	
53	44 29 476 75 51 155	44 29 722 75 50 880	7 medium	Rock cut north side only; 1 raccoon road kill
54	44 29 722 75 50 880	44 30 078 75 50 500	9 high	
55	44 30 078 75 50 500	44 30 563 75 49 998	5 low	Service centre south side, in rock cut area
56	44 30 563 75 49 998	44 31 175 75 48 455	7 medium	From east end service centre, high and steep fill over Jones Creek; deep rock cuts alternate with above-grade sections
57	44 31 175 75 48 455	44 31 215 75 48 200	8 medium	Farmland south, woodlot north
58	44 31 215 75 48 200	44 31 180 75 47 900	7 medium	Deep rock cuts to east side of Clow farm, south side; some deer crossing at east side of Sherwood Springs Rd overpass at 44 31 215 /75 48 200 and also east coordinates
59	44 31 180 75 47 900	44 31 148 75 47 772	9 high	Quarry on south side of highway
60	44 31 148 75 47 772	44 31 270 75 46 890	6 low	Divided highway section with Parkway interchange
61	44 31 270 75 46 890	44 31 544 75 46 300	5 low	From Parkway exit to Long Beach sound barrier wall – wall is total barrier East boundary of study area

Highway Corridor Features Table — Notes

Again, the purpose of assigning values to sections of the highway was to be able to quantify the value of the highway sections in terms of connectivity. Sections that rank High are highest in value for connectivity, or have lowest resistance to animal movements from the landscapes north and south of the highway. Conversely, Low valued sections have the highest degree of potential resistance for movements.

Only a full points (9 points) valuation would rank the highway segment a high value. Because of that, the first 6.7 kilometres of 401 from the west side of Leeds County, with a continuous barrier wall in the median, ranked medium at best. Without that wall, since much of the topography means that the highway is at grade level, that section of highway would have valuated at high.

Another long segment of road that values no higher than medium is generally between the Escott Road and west of LaRue Creek, where the highway is landform divided.

Through much of the remainder of the study section, there is a randomness of the ranking because the grade level in relation to road level varies so considerably. The Frontenac Arch, with its ridges, cliffs, valleys, streams, creeks, marshes and meadowlands caused the highway builders to blast and fill their way across the region. A level roadway resulted in there being few long stretches where the road bed is at the same grade level as the surrounding landscape.

As a result, there are few sections of the highway across the region where the resistance value a top score value of 9 can be found. Further, because there is a median barrier on the first several kilometres of the highway in the west end of the study area, the number of sections of highway with low crossing resistance are further reduced.

Summary from Highways Table Data:

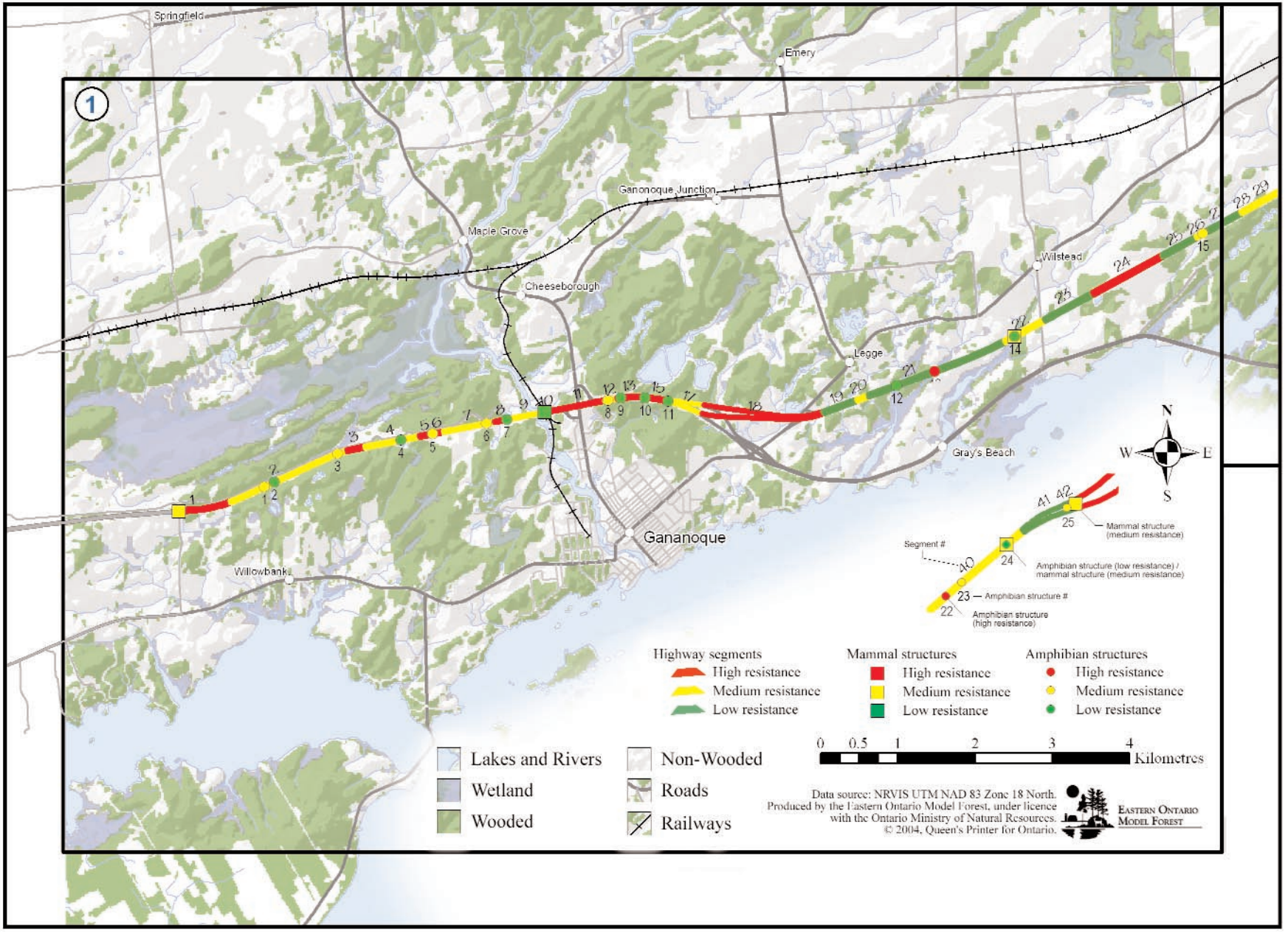
There were 61 differentiated segments of the 401 highway in the study area. Of these, the scoring shows the following numbers assigned to values:

High (low connectivity resistance) -	14
Medium (medium connectivity resistance)—	27
Low (high connectivity resistance) -	20

Less than 25% of the study sections have high values, or lowest resistance, for connectivity areas. 33% of the sections have low value, or high resistance, for connectivity. The remainder of approximately 40% of the sections have intermediate values in terms of connectivity.

It s important to remember that to this point in the study discussion, the highway segments are valuated in isolation from the context of the values of the landscape itself. In other words, and by example, a section of highway may have High value, but the relationships to the adjacent landscape or analysis of corridors hasn t been part of that highway section valuing process. The values relate only to the segment of the road itself. The landscape relationships are discussed in the next section.

The following three pages are of the overview map of the study area, enlarged in three segments for better viewing and reference. These will also show the location of the closer focus areas which are discussed in the portion of the study which follows.


1
Springfield
Emery
Gananoque Junction
Maple Grove
Cheeseborough
Wilstead
Legge
Gray's Beach
Gananoque
Willowbank
N
W
E
S
Segment #
Mammal structure (medium resistance)
Amphibian structure (low resistance) / mammal structure (medium resistance)
Amphibian structure #
Amphibian structure (high resistance)
Highway segments
High resistance
Medium resistance
Low resistance
Mammal structures
High resistance
Medium resistance
Low resistance
Amphibian structures
High resistance
Medium resistance
Low resistance
Lakes and Rivers
Wetland
Wooded
Non-Wooded
Roads
Railways
0 0.5 1 2 3 4 Kilometres
Data source: NRVIS UTM NAD 83 Zone 18 North.
Produced by the Eastern Ontario Model Forest, under licence with the Ontario Ministry of Natural Resources.
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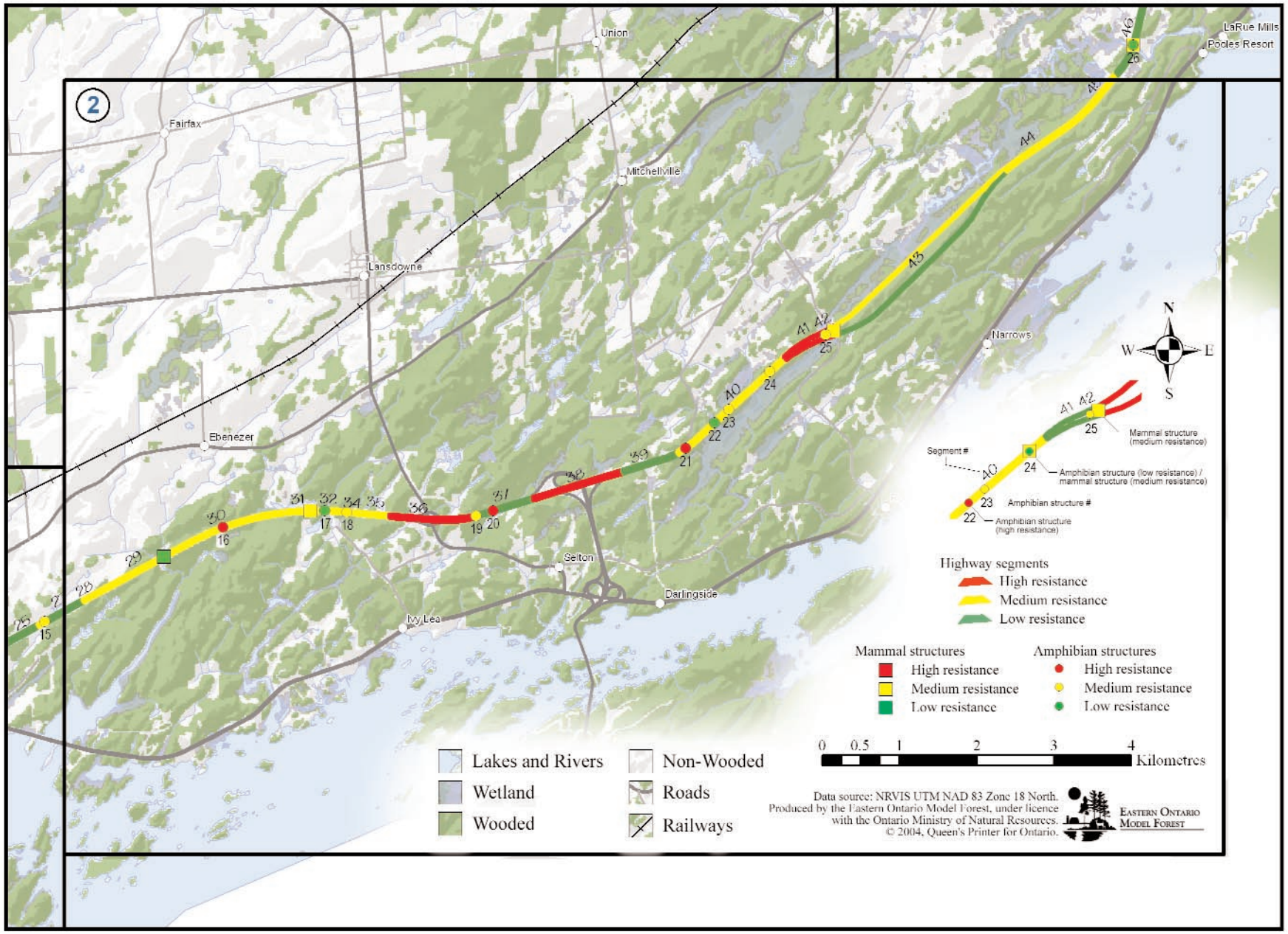
2
Union
LaRue Mills
Poodles Resort
Fairfax
Mitchellville
Lansdowne
Narrows
Ebenezer
Selton
Darlingside
Ivy Lea
N
W
E
S
Segment #
Amphibian structure #
Amphibian structure (high resistance)
Amphibian structure (low resistance) / mammal structure (medium resistance)
Mammal structure (medium resistance)
Highway segments
High resistance
Medium resistance
Low resistance
Mammal structures
High resistance
Medium resistance
Low resistance
Amphibian structures
High resistance
Medium resistance
Low resistance
Lakes and Rivers
Wetland
Wooded
Non-Wooded
Roads
Railways
0 0.5 1 2 3 4 Kilometres
Data source: NRVIS UTM NAD 83 Zone 18 North.
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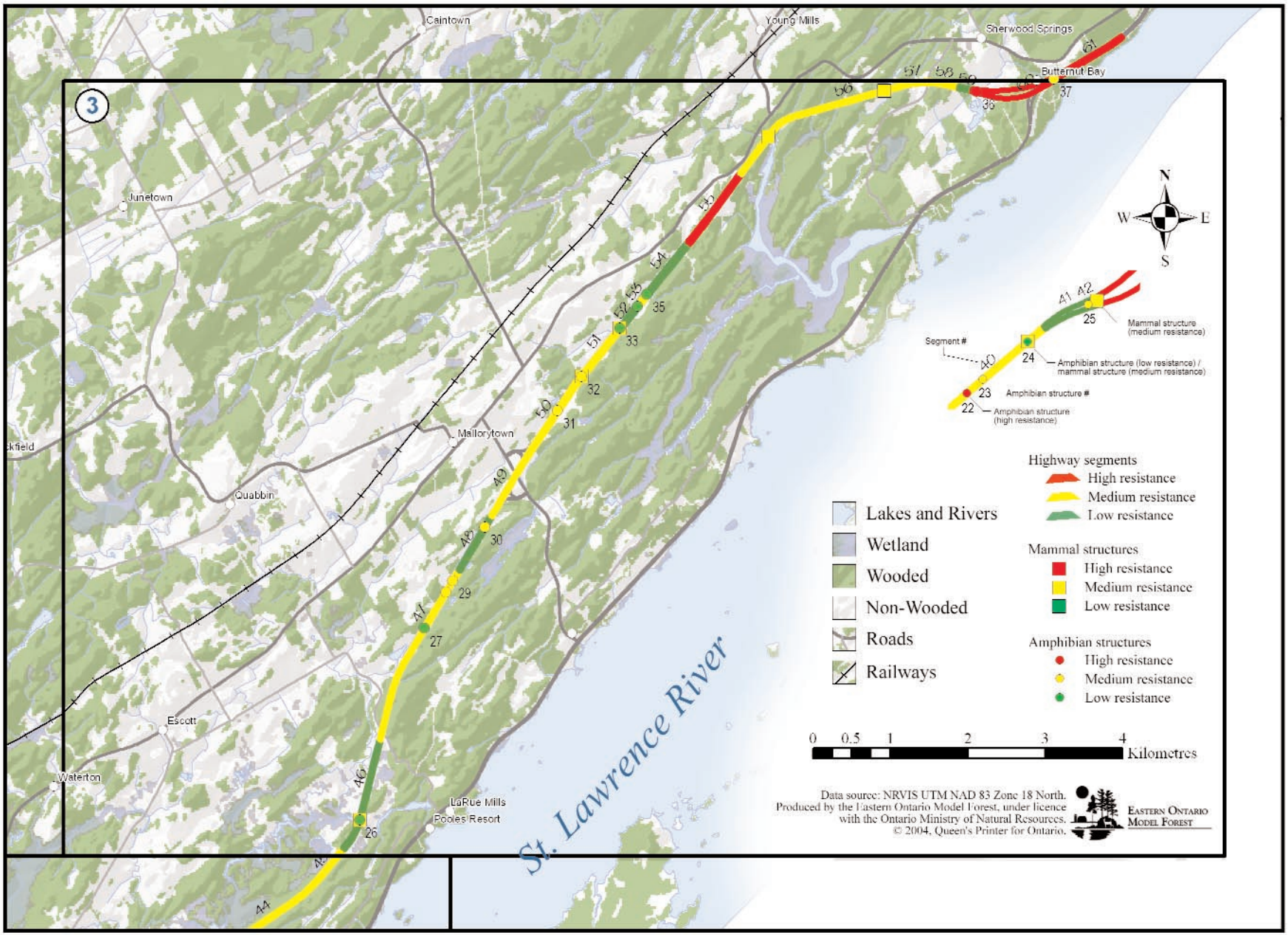
3
Caintown
Young Mills
Sherwood Springs
Butternut Bay
Junetown
Mallorytown
Quabbin
Escott
Waterton
LaRue Mills
Pooles Resort
St. Lawrence River
N
W
E
S
Segment #
Mammal structure (medium resistance)
Amphibian structure (low resistance) / mammal structure (medium resistance)
Amphibian structure #
Amphibian structure (high resistance)
Lakes and Rivers
Wetland
Wooded
Non-Wooded
Roads
Railways
Highway segments
High resistance
Medium resistance
Low resistance
Mammal structures
High resistance
Medium resistance
Low resistance
Amphibian structures
High resistance
Medium resistance
Low resistance
0 0.5 1 2 3 4
Kilometres
Data source: NRVIS UTM NAD 83 Zone 18 North.
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Relationships of highway segments and underpass structures to landscape features.

The thought process that went into selecting which features and levels of information which would be used in mapping was as follows:

~ Highway segments, and mammal and herptile underpass structures were placed together in the maps. There is a strong relationship between underpass structures and segments of the highway in that the structures are opportunities within segments, and it is helpful to view them in the same image. As well, some structures serve both mammals and herptiles.

~ Woodland and wetland information is shown in the same maps. These layers were made semi-transparent so that the relationships and overlaps could be easily seen.

~ Woodland mapping information was drawn from the work done by the Eastern Ontario Natural Heritage Working Group, specifically at the Eastern Ontario Model Forest, for Significant Woodlands. However, the final summary layer showing levels of significance was not used. Instead, one of the lay ers from that summary, the Proximity layer, was used, with the significance levels within that layer flattened out. The Proximity layer was designed to show location of all woodlands, and individual wooded sections were valued based on their proximity to each other (see Significant Woodlands Methodology; Technical Report: Woodland Valuation System 2.0 - Methods and Rationale for Assigning Woodland Value at the Patch Scale for Consideration in Planning and Conservation in Eastern Ontario - June 2003). Here, the values of woodlands were not portrayed as there was no work done to ground truth the quality or ecology of the woodlands, but rather to illustrate the values of structures and segments in terms of continuity of forest cover on the landscape.

~ Wetland mapping came from the same sources as woodlands, and the approach was similar as well. Continuity was the primary concern.

~ Stream courses were shown to display their relationships to wetlands, and to also show the lay of the land. Streams follow valleys and show landscape trends.

~ All roads were shown, to indicate both the flow of other traffic and for relationships to crossing points of the 401 Highway. Road patterns also lend a human scale and interpretation to the mapping.

~ Highway segments and underpass structures were coloured green, yellow and red to display high, medium and low score values.

This mapped information is a means to visually interpret and infer the existence of corridors connecting woodlands and wetlands on this landscape, and to relate the value of underpass structures and highway segments to them. This is a fairly coarse view. Work on improvements or detailed evaluation would in any event require ground truthing. The value this mapping is to display the potential of structures and segments which may allow connection to woodlands and wetlands north and south of the 401 Highway.

The Ministry of Natural Resources has done work in the Big Picture project to portray potential wildlife corridors in Ontario. While these perhaps have merit on a very broad scale, they do not relate to connectivity of woodlands and wetlands at this study s scale.

Study Area Apparent Corridors

The highway segments and underpass structures are numbered, from west to east, for reference to the table which further describes them. Tables also include notes on aspects of segment or underpass values.

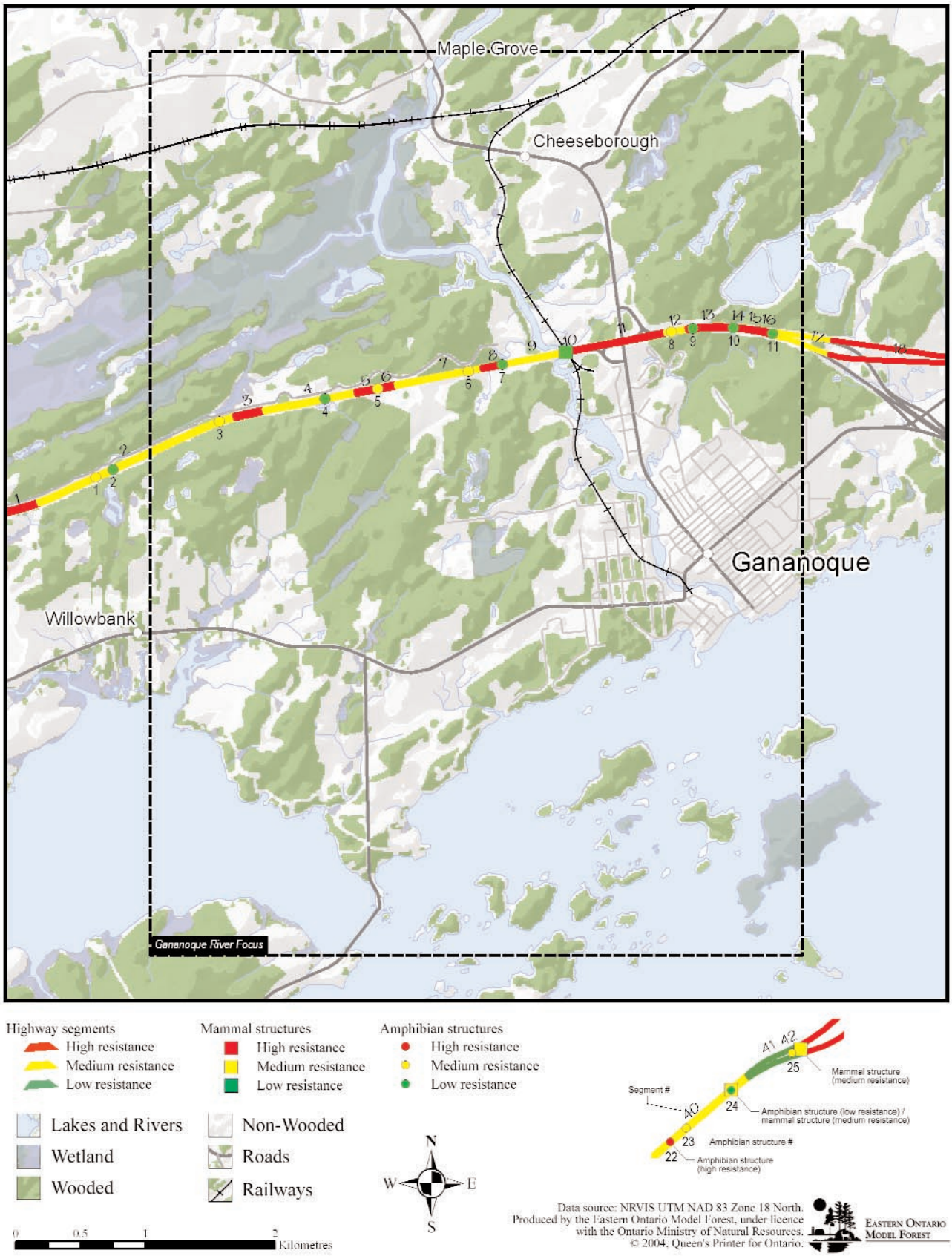
It becomes apparent when looking at the overview study area map that there is considerable woodland area in this region. At the same time there is a large mass of cleared/agricultural land north of the 401 Highway, and east of the Gananoque River area. The mapping also shows extensive unforested areas (by forest layer criteria) west of the Gananoque waterway, and north and to the east of Mallorytown and Jones Creek. A review of the overview map at the beginning of the study shows that these unforested or white-space areas that are the more level lands that were and remain the most suitable places for agriculture and settlement. This use/development pattern of the landscape has in effect leaves two apparent, but still hypothetical, corridor areas for the study area swaths of woodland and wetland that show green and blue on the maps.

Along the 401 Highway corridor, the map shows these green and blue strips also tend to parallel the highway, but are separated by agriculturally developed land, like the north-south green space, east of the Gananoque River drainage, and west of Landons Bay. In effect, there are two apparent corridor effect areas of the study area. One follows the Gananoque River drainage basin. The other is broad at its base, essentially continuous from just west of Landons Bay to just east of Jones Creek, with a north-south effect arcing from the St. Lawrence to Charleston Lake as it swings east of the village of Lansdowne. Both of these potential area corridors connect near the north end of the Gananoque River watershed.

The Gananoque waterway corridor is further discussed in Part II a) and b) below. In terms of highway segments and underpass structures, this section shows that there are important threat and opportunity considerations. The opportunity is that wildlife, as shown in mortality tables, attempts crossings here in considerable numbers. The highway segments here are largely of medium value, with at-grade conditions and open land north and south. The concrete median barrier disrupts the highway crossing, and if it were not present, the greatest part of the 401 Highway here would score a High value, for low crossing resistance. As shown on the map of the Gananoque study section, the highway here runs through woodlands and substantial areas of wetlands that would otherwise be continuous. Also discussed in Part II a) and b) are other influences to the corridor effect of this area.

The largest part of the Gananoque waterway section of the study area, from the county line on the west to the County Road 2 overpass on the east, has no High value highway segments. These first 18 segments score Medium or Low. In this same section of highway, there are six herptile underpass structures scoring High, and one mammal structure scoring High.

The next section of highway, from the west on-ramp to County Road 2 to the truck inspection plazas east of the Cliffe Road passes through cleared/developed agricultural and residential lands. There are five highway segments here, with three scoring High and two as Medium. At Gray s and Legge s Creeks, the Herptile structures rank High. The other two of the four herptile structures score Medium and Low. There is one mammal-potential structure, scoring Medium. In this five-segment strip, though, the map illustrates that there is low resistance but poor connectivity potential. The herptile habitat is limited to stream courses, especially north of the 401 Highway, and there is little forest cover present. Corridor potential, subject to finite scrutiny, would appear to be poor in this area. Another observation here is that this segment of the landscape, which is actually unrelated to the 401 Highway corridor itself, is that development patterns here have possibly severed the west-east wildlife movements, isolating the Gananoque waterway corridor from the other wide corridor to the east. This would suggest that possible future efforts to reconnect sections of the landscape on a north-south axis at the Gananoque waterway corridor would necessarily focus on the west side of the town of Gananoque for best results.



above: Gananoque River focus of study area

Another focal area is from just west of Landons Bay to just east of Jones Creek, parallel and especially south of the 401 Highway, as seen from the mapping. This area begins on the west essentially at the east end of the MOT vehicle inspection plazas. The east limit is where a divided section of 401 starts at about the township boundaries of Elizabethtown and Front of Yonge Townships. As mentioned above, it connects northward through an extensive patchwork of woodlands and wetlands between Lansdowne and Mallorytown, to the Charleston Lake area and beyond.

In examining the creek patterns in the Landons Bay — Jones Creek focus, the trend of northeast-southwest ridges and valleys is very apparent. It shows as well that the headwater or source areas of most of these creeks are very close to each other, that the creeks then are nearly connected, and so there is a strong degree of connectivity of habitats here. This long strip of landscape is largely one unit of landscape.

This landscape strip from Landons Bay to Jones Creek has extensive woodland cover and long strips of wetlands. There is considerable potential for wildlife movements here, especially south of the 401 Highway. A benefit of this potential is to allow it for latitude, leeway or choice of 401 Highway crossing points. This may allow the existing (and possible future) crossing points/underpass structures to collectively contribute to north-south wildlife movements at barrier points including the 401 Highway. An important consideration for maintaining and improving wildlife movements in the region is to maintain and improve the landscape and habitat connectivity in the Landons Bay to Jones Creek section.

This landscape strip has broad links to the chains and clusters of islands in the river, and to the American shores where habitats and ecological communities are continuous with the Canadian mainland. It also connects northwards through the afore-mentioned patchwork of woodlands and wetlands. In maintaining ecological integrity of this landscape strip biodiversity may be retained, but the connectivity value depends on the links to landscape connectors to the north and south.

Within this landscape strip the majority of the highway segments are medium value that is, the median is grassed or treed, and the lands to the north and south are open as field, wetland or woodlands, and with no structural developments. The medium score was generally because segments were above or below grade for their length. High value segments were at grade, with open lands north and south, and with grassed or treed medians. The five Low scored segments in this section were at interchanges #659 and #661, where the landform divided highway section began west of and at the Escott Road with its rock cut and fill areas, and at the east-bound service centre just west of Jones Creek. Those Low scored segments are short in length compared to the Medium and High scored segments.

Mammals:	number	percent of total
Number of mammal underpass structures this section	8	73%
Total number mammal Underpass structures	11	
High value structure In High score segment	0	0%
High value structure In Medium score segment	1	9%
Medium value structure In High score segment	3	27%
Medium value structure In Medium score segment	4	36%

There are 8 mammal-suitable underpass structures in the Landons Bay — Jones Creek section, out of a total of 11 mammal-suitable underpass structures:

There are no High score structures at High value segments. There is one High score structure at a Medium value segment, and this is located as a former livestock underpass at the top of Landons Bay. There is somewhat limited utility here at present because the woodlands north of the 401 Highway end just to the north, and are patchy in their connections to the northeast trending corridor. to be good potential for woodland restoration here. There are 7 other Medium scored structures which fall into High and Medium value highway segments. As discussed above, these structures would collectively contribute to connectivity in this section if the ecological integrity of the section were to be retained, and improved.

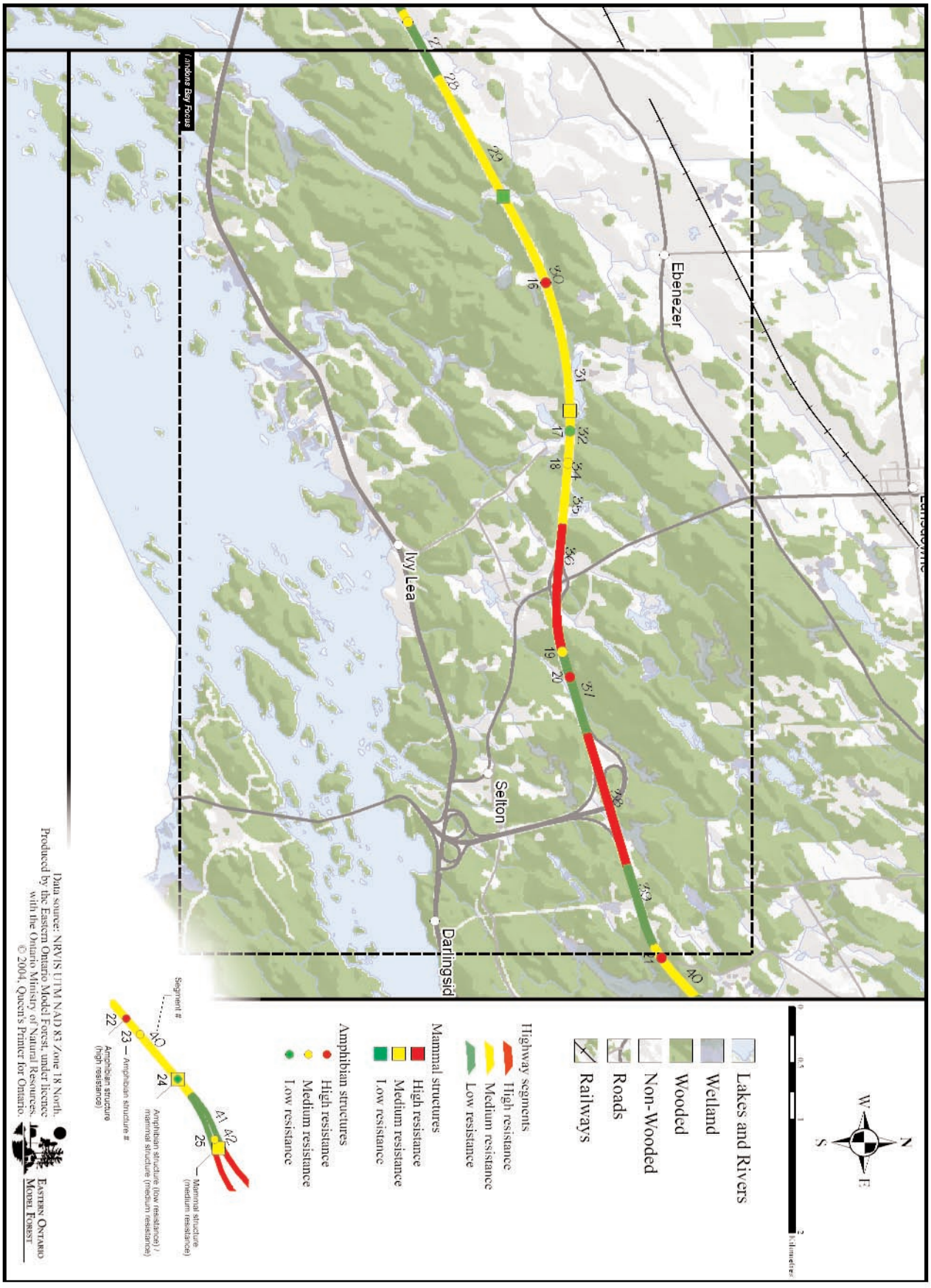
Another view of the relationship of underpass scores and highway segment values might be that since no ideal situation exists, there may be opportunity to create better crossing points. Study into that could be done using the funnel effect of the landscape and the relationship of those locations from the mapping to indicate which precise locations might have wildlife crossings installed.

Herptile Structures

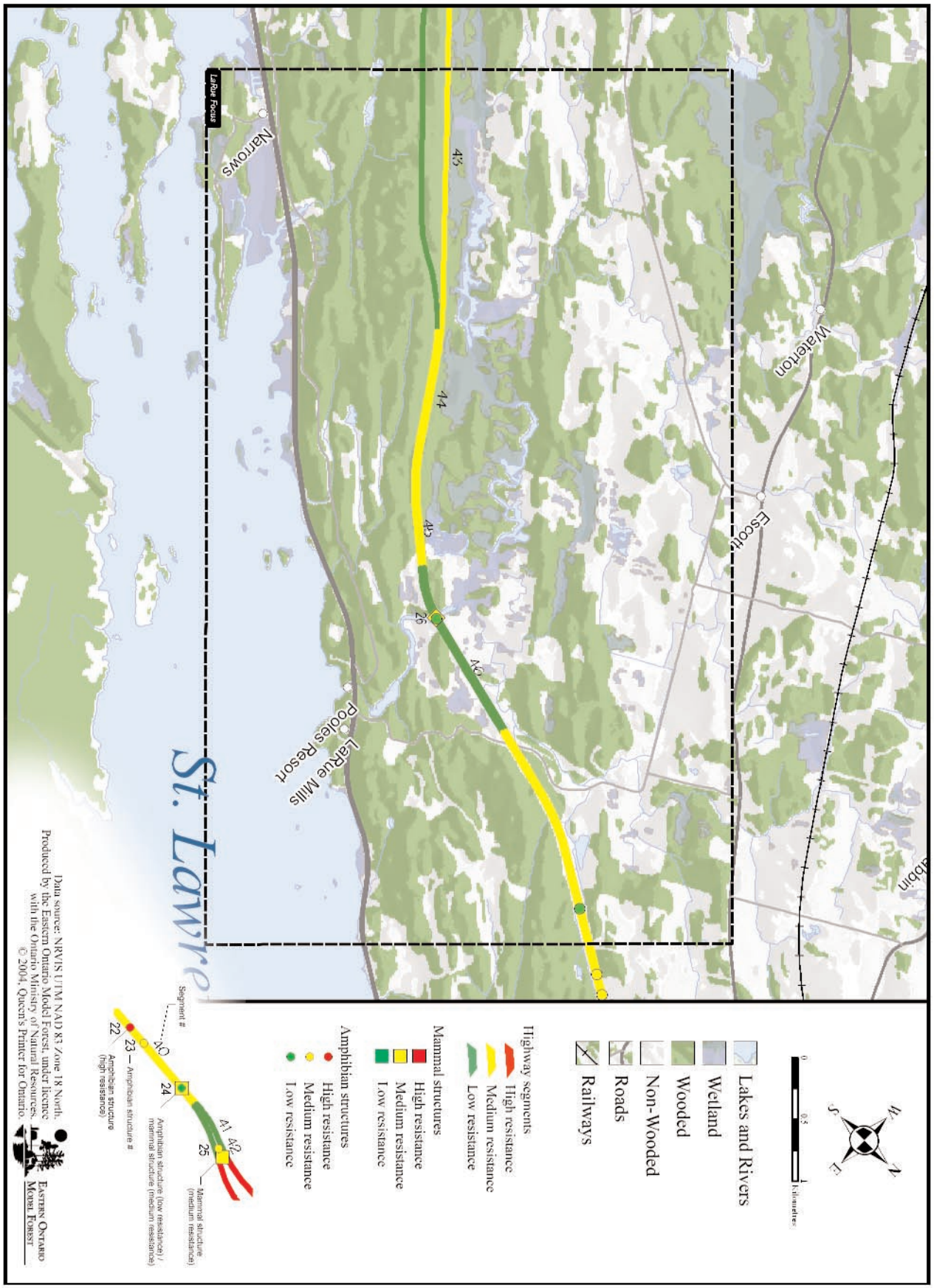
herptile:	number	percent of total
Number of herptile underpass structures this section	21	57%
Total number herptile underpass structures	37	
High value structure in High score segment	4	11%
High value structure in Medium score segment	3	8%
Medium value structure in High score segment	2	5%
Medium value structure in Medium score segment	7	19%
Low value structures; 1 in High score seg.; 2 in Med. score seg.	3	8%

There are 21 herptile-suitable underpass structures in the Landons Bay — Jones Creek section, out of a total of 37 herptile-suitable underpass structures:

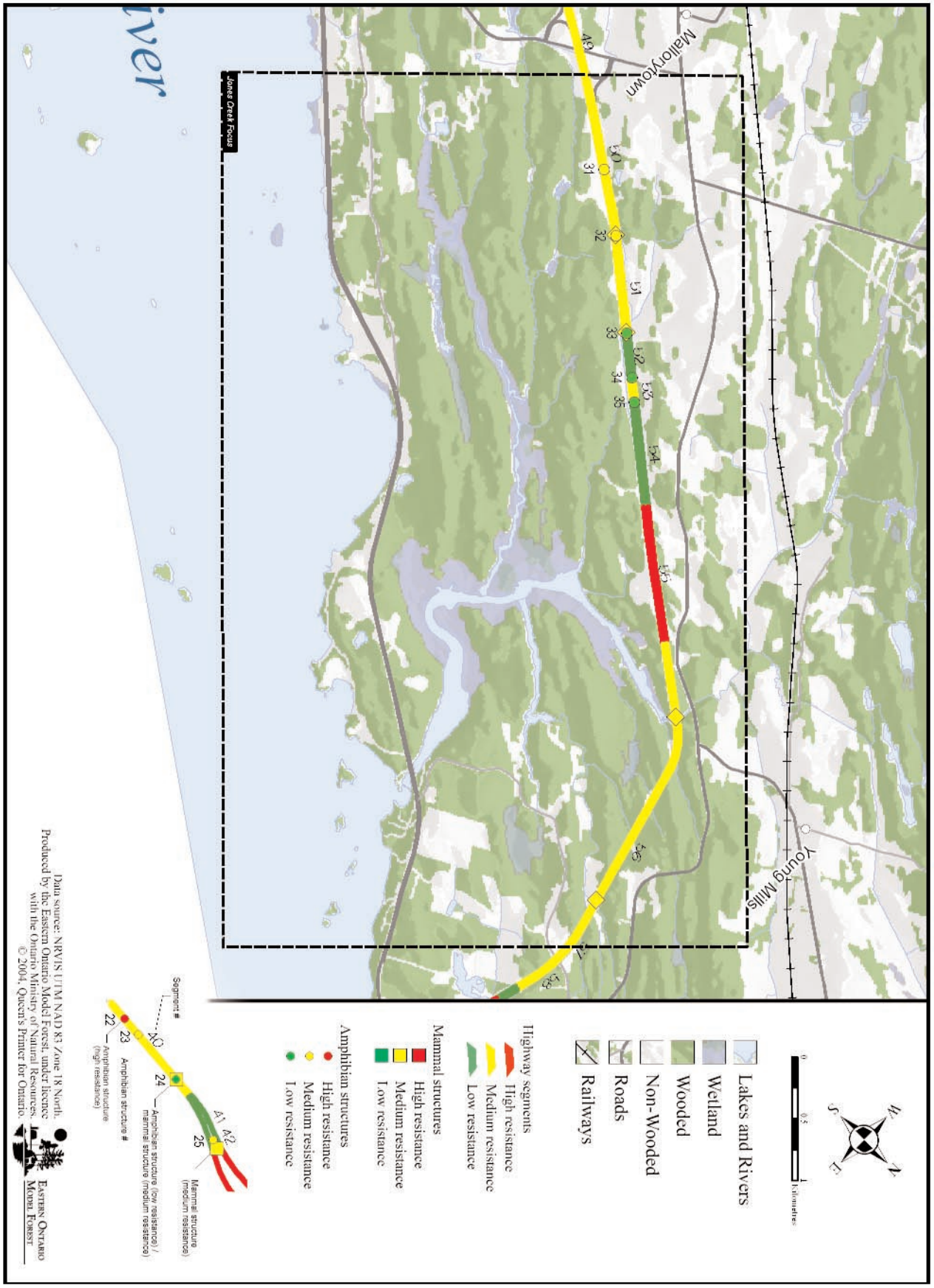
From the table and map, 3 of the best herptile crossing opportunities (High score structure at High value segment) are within a short distance of each other, at the top of one of the small feeder creeks to Jones Creek. Unfortunately, the utility is limited because the small creek does not reach further inland than this area, and does not interconnect with other streams or wetlands. The other High score structure at High value segment is at LaRue Creek, where there is good value of the connection, especially because the associated wetlands and creeks cover much of that area on both sides of the 401 Highway. There is improvement potential for the mammal and herptile crossing here, especially if the habitats were restored to a better degree on the north side of the 401 Highway, along the creek course.



above: Landons Bay focus of study area



above: LaRue Creek Complex focus of study area



above: Jones Creek focus of study area

Discussions

There were a number of observations and notes made during the scoring of the highway sections. A review of these will help in understanding the values of the highway segments better, and will help establish the potential to improve connectivity across the highway.

Highway median barrier and road kill. At present, concrete median barrier has been built only in the western end of the study area, running continuously for 6.7 kilometres. The remainder of the highway in the study area is either wide enough so that the accident preventing structure is not necessary, or the highway is divided a landform.

Road kill was recorded one-time only, on the occasion where the segment of highway was walked in the valuation of underpass structures. Only relatively recent carcasses were recorded those that were intact, and at a guess less than two months killed. As the walks were done in the period from mid-April to mid-May, there was an absence of reptiles such as turtles and snakes, although there is mention of instances of turtle crossings further below. There were many other fragments of animals, with well-flattened and weathered skins. Road kill finds were as follows:

Road Kill Observations in Grouped Median Sections

Species	Median barrier section	Landform divided section	Open median section
Beaver	1		
Coyote	3		
Deer	10		3
Fisher			1
Groundhog			1
Mink	1		
Muskrat	26		3
Raccoon	4		6
Total animals	45	0	14

note: The reader should recognize that these mortality observations are a snapshot of the study area, at just one brief point in time. The results may show a trend, but observations would no doubt vary from season to season.

A discussion paper *Study Design to Assess the Effects of Highway Median Barriers on Wildlife*, Hubbs, A.H.; Boonstra, Dr. Rudy; June 1995 Research and Development Branch MTO, suggests that the solid concrete barriers have limited negative effects on highway crossings by animals. In summary, the paper states seven conclusions:

1.Although this is essentially a study design, median barriers have a small role in road kill because roads are barriers anyway;
2. Forest herbivores may be attracted to vegetation in medians, and with the median barriers and eliminated vegetation, such animals would not be attracted to cross to the median;
3. The 401 through woodlands creates an abrupt (no transition) edge effect that animals do not like;
4. Animals that cross onto highways are likely to die anyway so median barriers have little change in effect;
5. Road mortality has no effect on overall populations;
6. Barriers obscure views across the highway, therefore discourage crossings; and
7. Because there is poor records of road kill beforehand, there is no statistical analysis of effect of barriers damaging populations.

Observations in this study area, however, suggest that animals in this region may not concur with the MOT study. The following table summarizes road kill observations in relation to characteristics of the median:

Summary of Road Kill Related to Median Characteristics

Feature	Barrier wall	Landform divided	Open/ grassed median
Length in kilometres	6.7 km	4.1 km	36.1 km
Percentage of study area	14%	9%	77%
Total road kill	45	0	14
Percent total road kill	76%	0	24%
Road kill / km – each segment	6.7	0	0.4

Note as above, this was a one-occasion walking review of the highway segments. Road kill noted was likely within two months of age. The absence of road kill in the landform divided section may have been unusual to that occasion. The quantities at other segments could likewise be unusual. However, as all of the walks were done at about the same time of year, the overall count is probably reliable as a sample for the purposes here. Unfortunately, neither the MTO or the OPP keeps records of road kill, nor have there been any systematic studies of road mortality in the area as far as could be discovered. As a result, no cross-referencing could be done.

The conclusion one may draw from this exercise, assuming all other factors are equal, is that the presence of the wall tends to increase the amount of road kill. The landform divided section, essentially from 3.3 km east of interchange #661 to just west of LaRue Creek, and a .3 km segment on the west side of the west Thousand Islands Parkway interchange, is actually quite dissimilar from the barrier wall and open median areas: it is largely in rock cuts, mostly below grade except for apportion of the north-side westbound lane which is above grade. However, the open median section is overall similar to the barrier wall section, but wider at the median. It then seems very likely that the barrier wall does in fact increase road kill numbers.

When the details of the road kill are examined a little closer, the barrier wall appears more culpable. As example, of the 23 muskrats in one segment of the road along the Gananoque Game Preserve, Crown Land, almost half were killed next to the barrier wall. Two of the four raccoons were at the wall, as was one of the three coyotes.

The quantities and locations of road kill, taken together or separately, would tend to cast some doubt on the assertions of the Hubbs/Boonstra MOT study.

While the purpose of this study is to examine the porisity of the highway, where the median barrier obviously has an impact, an observation could be made. The purpose of the median barrier is to reduce head-on collisions, especially in sections of the highway where the median is narrow and therefore the probability of vehicles crossing to the opposite lane is increased. The value of the barrier in that sense is not disputed. However, if animals are more likley to be hit by vehicles where there is a median barrier, then there may also be a greater risk to motorists if vehicles swerve to avoid hitting animals that are trapped by the median barrier. Perhaps this risk could be lowered if the animal crossing locations were improved, as discussed further elow in recommendation sections.

Crossing Points. If one were to look for best locations to improve the success of animal crossings in the study area, a number of the incidental findings in this study would be of help. Observations for mammals were sometimes different than for herptiles.

Mammals.

Except at a very few existing structures, mammals cross over the highway itself. Of the 9 underpass structures valuated, only one, the Gananoque River bridge, value High. Even there, the amount of actual use was limited. Of the remainder, mammal use appeared limited and sometimes seasonal at three locations — Bay Road, LaRue Creek and Jones Creek. While the values of the structures were done in the mid-April to mid-May period, those structures as well as all of the remainder of the study area were also visited on a number of locations in winter, with snow cover. At those times, it was hoped that track evidence would lead to some useful observations, and those are related a little further below.

Gananoque River bridge. While the highway segment here has low value, because the surface is virtually inaccessible from north or south, the underpass value is High. The bridge was visited on a number of occasions from December to late May. From track evidence under the bridge, in sand and snow, there is light but regular traffic by deer, coyotes, raccoon, fox, weasel and meadow voles; and muskrats and beaver were seen in the water. (note: more detail presented in Gananoque River Corridor Section)

Gananoque River Bridge; west side as seen from north side

Animal paths follow water s edge

Bay Road. The Bay Road crosses under the 401 at the Leeds County line at the west end of the sturdy area. On two occasions, tracks from two deer and a fox were seen in the snow, against the east side of the underpass, originating in the wildlife area and heading into the small woodlot south and east of the underpass. There was nothing to indicate that this was a regularly used passage, and in fact, there were many other places along the section of highway from the Bay Road to the Gananoque River where tracks of deer, fox and several other animals crossed the highway.

Fitzsimmons Mountain area. The private and public lands on the south side of the Highway 401 in this area are known for their ecological diversity, and are a designated Area of Natural and Scientific Interest (ANSI). The lands directly across the north side of the 401 at this area have lesser ecological value, and the corridor linkages would seem, from map exercises, to tend east-west here. Even so, this particular area has notable wildlife mortality. However, because of the character of the terrain, the road bed is substantially elevated above grade where valleys have been rock-filled, or in other places blasted through ridges leaving deep rock cuts. In several places, there may be above grade, rock-fill portions south and rock cuts north, or vice-versa. The rock cut funnel effect discussed above comes into play here, focusing locations of road kill.

Two views of highway typical at 401 north of Landons Bay - Fitzsimmons Mountain

There was apparently at one time a livestock underpass near a location where the creek flows to Landons Bay under the 401 (personal communication, Wilfred Leakey and John McLeod), placed during the original highway construction at the Leakey farm as livestock access to the water at Landons Bay. That location is well above grade because of extensive rock fill, and has potential still for a substantial wildlife underpass. There is a tall, concrete box culvert there which leads to wetland meadows and woodlands to the south side, and a damp to dry pasture at the edge of woodlots on the north side. There are deer and coyote tracks in the soft ground leading into the culvert, but at the same time, there is a more thoroughly worn animal path just to the west of the culvert where rock cuts on both sides of the highway come down to grade level before the terrain dips below grade level. For the culvert to be better used, fencing would have to direct animals into the wet meadows to the culvert entrance. The floor of the culvert should be landscaped for better footing.

LaRue Creek bridge. On the spring day when the LaRue Creek bridge was valued, there were surprisingly few tracks of animals of all kinds in the mud to the north and south of the bridge. Perhaps the fact that there is no terrestrial component, no land to walk on, under the bridge might mean that animals were not inclined to use this wide underpass. In winter, however, when ice was in, there many tracks of deer, coyote and fox on a number of occasions. It would appear that the bridge is a better conduit in winter than the remainder of the year, but perhaps this could be changed by adding a terrestrial area under one or both sides of the bridge,
leaving ample volume for water flow in spring runoff.

LaRue Bridge, looking north: lacks terrestrial passage

LaRue Creek, looking south

Jones Creek. Jones Creek passes under the 401 at Yonges Mills, where there was at one time a waterfalls, and grist mill. The underpass structure for the creek is an arch-shaped tunnel. The flow of the creek is still brisk through the tunnel, and there rapids in the tunnel. Well-used animal tracks of deer and coyote, and likely others, approach the tunnel from the north, but it is unclear whether they use the passage or are merely guided to it after following the creek valley. The noise of the rushing water, the darkness inside, and the rock and boulder-strewn creek bottom with deeper pools seem intimidating, at least from a human standpoint. However, inside the tunnel, running along both sides, there is a narrow (20 — 25 cm wide) ledge in the cement which forms a walkway end to end in the tunnel. As the concrete roof of the tunnel arches over the ledge, there is not much vertical clearance for passage by tall animals. Along the ledge, though, there is occasional scat of otter and raccoon, and droppings of bats. A wider ledge, soft-surfaced, may be incentive for more use by a broader range of species, as the creek valley seems to funnel traffic to the tunnel area.

Jones Creek tunnel, from north side

Jones Creek, looking north

There is a feeder branch of Jones Creek called Maclhennys Creek, 1/2 km west of the Sherwood Springs Road overpass. This box culvert also carries a stream, but with less flow and no fall within the culvert. Some mammals such as muskrat and raccoon appear to use the culvert, but it is too aquatic for general use. It is mentioned here because of the relationship of this creek to Jones Creek. The area has more potential than the culvert would suggest. There is extensive woodlands and wetlands leading north to Lyn Creek and beyond from this location. That potential dwindles somewhat towards Brockville, where development increases, but there are several square kilometres of diverse wildlife habitat in the area.

Other crossings. All of the other underpass structures valued in the Mammals Table may have occasional and perhaps seasonal use by mammals. For example, the third structure from the west, at Gray s Creek, has plenty of tracks of deer, coyote, raccoon and others leading to it from north and south, and there were tracks of deer in winter leading through it. Also, there were road kill animals on the highway in that general area.

Box culverts such as this at a branch of Mud Creek, of Jones Creek, and at Grays and Legge s Creeks have good potential to improve both herptile and mammal crossings with efforts in both structures and linked habitats

Hesitation Marks. Some of the extensive ski and hiking travel was through the Gananoque Wildlife Preserve, from the Leeds County line to the Gananoque River, and inland in places up marsh bays and beaver ponds. The snow cover was very helpful in understanding animal movements. Of note is that wherever there are low-lying areas near the 401 with good dense cover of dogwoods etc there are numbers of hesitation marks where deer, fox, coyote, weasel, rabbits, mice approach the highway area, up to the fences, several times, and even up to the road itself, and turn back in almost all cases (track stories). There are several places where the fence is bent down or pushed open from animals crossing. One deer carcass was found; 1.5 km west of the Gananoque River, near the highway: it was hit but ran from the roadway, where it died and was later eaten by coyotes. The observation of interest is the hesitation marks, showing desire but trepidation over crossing the highway. Such observations were made many times in the winter exploration part of he study, at many locations. The scenario is likely oft-repeated in all seasons of the year.

Hesitation marks - many species of animals approach the highway several times before attempting or abandonning the crossing

Funnel Effect. Perhaps one of the most valuable findings from the study is a funnel effect of the landscape. This is an effect where the topography funnels meandering mammals to segments of the highway.

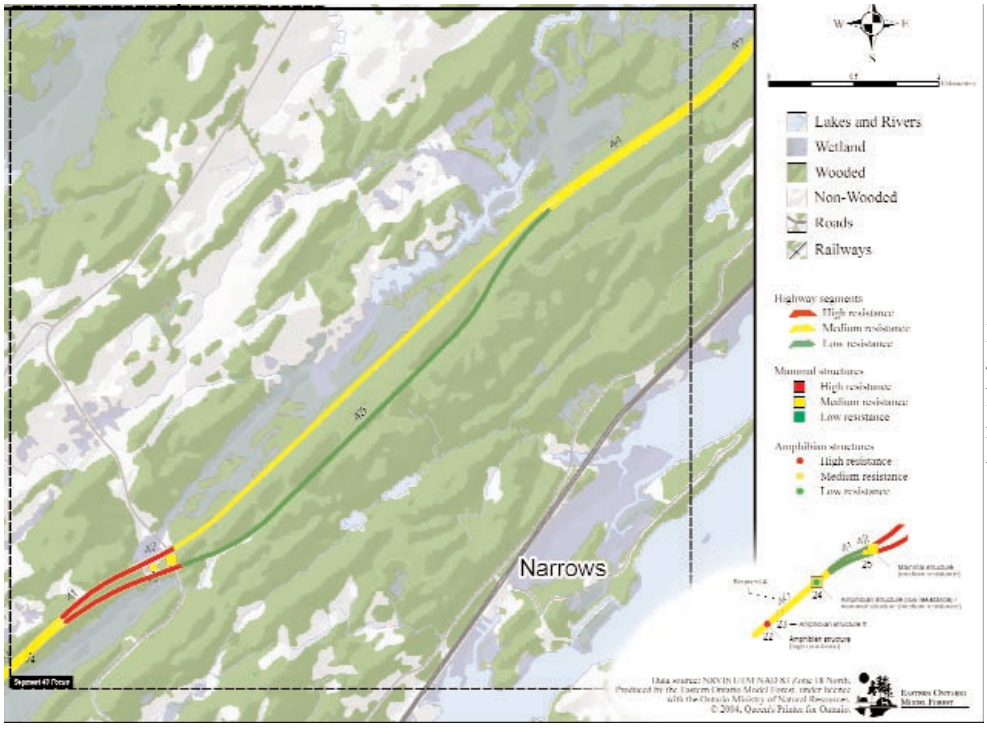
As suspected, when the highway runs through rock cuts, there are not often road kills found. The drop-off seems to discourage crossings. However, those rock cuts are from rock ridges that were cut through when the roadbed was being laid. The rock ridges have poor or shallow soil, and most often in this area remain or have again become forested. Animals may be channeled to segments of the highway along these forested ridges. Many of these were explored, to look for established animal trackways, and many such trackways were found leading to the top of rock cuts. At the rock cuts, the paths turn parallel to the highway, as animals presumably follow the top of the rock cuts looking for a way down to lower levels, and opportunity for highway crossing.

Interestingly, the paths lead in a direction of the flow of highway traffic on that side of the highway. East-bound paths follow east-bound vehicle traffic. The paths become deeper and more established towards the downstream end of the rock cuts, but a fainter going upstream . In these observations, it appears that mammals face away from on-coming vehicle traffic, and go down to the highway on the sheltered-from-view end of the rock cuts. The implication of this is that frequently used crossing points tend to occur at the junction of highway segments where below-grade segments border on at-grade segments. Through observations, often — but not in every case — mammal crossings are at the east end of rock cuts on east-bound lanes, and on the west end of rock cuts on west-bound lanes. The majority of the road kill deer were found at such places.

There is also a funnel effect where watercourses cross the highway. While at most places the bulk of the roadbed isolates the highway from contact with various habitat types through which it crosses, watercourses penetrate the roadbed, bringing wetland habitats in particular closer to the highway. Observations, as recorded for the mammals and herptile tables, illustrate that animal activity is often seen in drainage and watercourse locations, and there are road kill occurrences at such structure locations as well.

Funnel effect - trails like those at right lead atop rock cuts to places where rock cut drops to grade level, especially at the downstream end. Animals are lead by the topography to these crossing points

Landform Divided Segment. An observation at the 3.3 km long landform divided segment of the highway west of LaRue Creek is about noise levels. Because of the rock and forest ridge between the east and west bound lanes through this segment, only half of the highway traffic can be seen and heard at one time. From a human perspective, and likely for wildlife as well, this part of the 401 appears considerably quieter than other sections. A quieter highway may be less intimidating but, this in itself may not be enough to encourage wildlife crossings, because so much of the roadbed through here is in rock cuts, the walls of which are barriers to movements. If the rock walls were not so impassible, particularly as at the south side of the west-bound lanes, the median may have value as a stepping stone in crossings. This point will be revisited in the scenario recommendation section.



Landform Divided section of 401, west of LaRue bridge. Note that LaRue Creek runs north of and parallel to 401 in this area

Crossing Points: Amphibians and Reptiles.

Crossing points for amphibians and reptiles are partially shared with mammals, but are overall more numerous. These animals are smaller than most of the mammals, and so the size requirements are less. There are many small underpass structures along the highway, particularly for drainage and watercourses.

In the literature, there is discussion that reptiles and amphibians can have seasonal requirements for different habitat types. Some simplified examples are that turtles forage and feed in wetlands, but lay eggs in dry ground, especially sand and gravel. Salamanders frequent wetlands and wet woodlands. Some frogs spend adult lives in wet meadows, but require water in tadpole stages. To that end, culverts that lead to similar habitats may have equal value to those connecting same habitats. But in any event, the culvert or other type of underpass structure is of highest value if it connects large areas of good quality habitat, while at the same time having good properties for allowing wildlife movements.

Of the 37 underpass structures quantified, all crossed the whole of the highway, either continuously or in segments. Ranking summaries are:
High value — 15
Medium value — 17
Low value - 5

In terms of potential for improvement, however, a summary is:
Good — 2
Fair - 15
Poor - 20

While those figures may seem at first contradictory, the criteria for value was based on attributes suggested in the literature for crossings. A substantial number of structures had those physical characteristics to be of good value. However, the majority of the structures were built to perform drainage functions, and there was apparently little concern for habitat connection. Therefore, the potential for improvement is poor in the majority of cases.

At the same time, there could be, with effort, upgrades in the Fair category, with restoration of habitat on both sides of the highway. Selection of these locations would come with further study of species at the wetlands and other appropriate habitats bordering the highway, and connecting to other known populations.

The two Good improvement locations were the large culvert at Stocking Hill Creek and LaRue Creek. Stocking Hill Creek would only be a locally improved area, as that creek links the Gananoque sewage lagoons to the Gananoque River. That general area is discussed in Part II b, further below.

LaRue Creek is an important waterway link, a creek that connects extensive wetlands and woodlands. Because of the nature of the construction, there is little land under the bridge at present, but that could be changed from below the bridge with landscaping work and creating suitable stream dynamics with weirs for back-eddies and calm areas.

The various potentials for the Fair improvement locations are discussed within the Herptile Table and summary.

Work done on amphibian underpasses (reptiles get little mention or attention, it seems) shows that the simple existence of an underpass structure is not enough. Modifications that would have to be made as part of the improvements process would include, according to published findings:

Lighting. Researchers showed that use of the tunnel structures dramatically increased when ambient light levels were raised. Commercially available amphibian tunnels have a grate structure on top to let light in from above. Equal or greater success was suggested with use of reflected and artificial lighting, especially where light

levels could follow day cycles. There was some discussion, inconclusive, that road surface grates increased noise levels in the tunnels.

Temperature. Underpass structures had better success and use when temperature levels inside were close to those outside. No mention was made of how that level could be raised or controlled, although solar-powered fans may be of use.

Substrate. Not all herptiles require/prefer aquatic tunnels or terrestrial tunnels. A variety of substrates, with texture and moisture levels similar to the external environment ensured the best success and use.

Guide fences. There was overall agreement that underpass structures would be of little benefit unless there was some mechanism to guide animals to it, and prevent random road crossings. Commercially built guide structures resemble half culverts, placed on edge with the concave side facing the direction of approach so that they could not be climbed. The structures would be placed to funnel animals toward the tunnel.

Approach restoration. Existing culverts are drainage-oriented, with streams and wetlands ditched near the highway to ensure waterflow. The ditches are seldom similar in character to the wetlands the drain, or drain towards. Reconnection of habitats through the use of underpass structures would require the restoration of habitat from wetlands to culvert entrances. This would have to be done so as not to diminish the capacity of the drainage works.

Two culverts of the same size are pictured. The top picture shows a culvert with better potential for improvement than the one below.

Corridor Reconnections —
Lowering the Resistance Values at Various Highway Segments

As stated in the Purpose of the study, the work here has been to quantify threats and opportunities, by valuating resistance to connectivity on segments of the highway, and for highway underpass structures. It is not the purpose of this study to enable more animals to cross onto the highway. Rather, the information learned here may enable stakeholders to improve crossing success and lower the resistance values of the highway by diverting, guiding and channeling wildlife large and small to new and/or improved structures. In the process, wildlife — vehicle collisions may be reduced, and wildlife migrations, population diversities and habitat restoration may benefit.

There are many scattered crossing points on the 401 Highway in this study area. However, track evidence, observed road kill locations, findings for a funnel effect and scores for resistance values of highway segments show that there can be focal points for improving connectivity.

Median barrier structure. The first 6.7 km of highway from the west end of the study area has a continuous length of concrete median barrier. The barrier was placed in this section because of the narrow width of the median, and where such structures are employed to reduce vehicle collisions should vehicles cross into the median and collide with vehicles of the opposite lanes. As study findings show, the barrier s unfortunate side-effect is greatly increase animal mortality, of both large and small animals. In these highway segments, the highway is for the most part at grade level, with predominantly same or similar wetland habitats on both sides of the roadway. If the barrier were not present, the majority of highway segments here would rank as High value for connectivity.

A combination of measures may improve the situation here for both wildlife and travelers. Firstly, and as recommended for the entirety of the study area (and beyond) fencing at the right-of-way/property limits of the highway must be brought up to standards proven to restrict animal trespass. From the literature research, jurisdiction upon jurisdiction has found that fencing must be minimally 2.5 m (8 feet) high, to prevent deer from jumping; and have increasingly closer mesh spacing towards the bottom, to limit small mammal penetration. Observations show that the bottom of the fence should be buried where possible, as some mammals, such as raccoons and coyotes, will dig under where they can, and create breaches in the fence. A function of the fencing is to guide wildlife to points where structures allow safe crossings. Fencing erected solely to prevent movements of animals across the highway corridor would defeat the objectives of restoring and enhancing connectivity.

Secondly, it should be realized up front that despite the best fencing work, smaller mammals such as mice, squirrels, muskrats and the indefatigable raccoon will sometimes overcome the fence barrier, and attempt to cross the highway. To that end, it is suggested that portions of the concrete barrier could be removed, and replaced with steel guard rail sections, as those used at the Cataraqui River at 401. Locations for the open rail sections would be where mapping of valuated highway segments in relation to known potential corridors and road kill observations indicate.

Underpass structures. Tables summarizing values of highway underpass structures suggest their improvement potential. Where these are fair or high, further detailed work could determine how better use of the structures could be made by animals. In determining where to focus improvements efforts, the location of the mammal and herptile underpass structures should be evaluated with the values at the highway segments, in context with mapping of potential landscape corridors. In some cases, there are notes regarding improvements within the tables.

Underpasses, now in place in many states and provinces, have also shown great reductions in collisions and mortality. Underpasses for amphibians have proven successful in locations in Europe, Australia and North America. There are commercial sources for amphibian tunnels and fencing, from Britain. Mammal tunnels have become integral with highway development projects in Florida, where they have now been built into the planning and design process.

Funnel Effect. Should there someday be projects to actually improve the safe wildlife crossings for this region, the funnel effect could be put to good use. As described above, there is a funnel effect where animals are guided by topography to the downstream ends of steeper rock cuts, so that crossing points become focused where rock cuts end and grade-level highway segments begin. However, there are seldom any existing underpass structures at places like these, which could be used to enhance movements.

There are many more examples cited for road underpasses built for wildlife than for overpasses. There are estimated to be nearly 200 specifically built wildlife underpasses but only six overpasses in North America. The utility of overpasses has been proven at Banff National Park, where in the section of the highway that two overpasses were built, highway mortality of all large species was reduced by 80%, and large ungulate collisions decreased by 96%. The cost of the overpasses is significant, and were at $1.2 million each in Banff. As suggested below, they were built in below-grade sections of highway.

On this highway across the Thousand Islands, one might assume that there is little likelihood that major new underpasses would be placed in the roadbed. Such construction would presumably interfere with traffic flow, and be very costly as a retrofit. There would seem to be more potential to build overpass structures, and in fact the topography may lend itself to that end. The funnel effect locations would have high potential for new overpass development. Rock cuts, which guide wildlife, would provide initial heights of land where specialized bridging structures could be lofted.

As discussed, watercourses that cross the highway also create a funnel effect by bringing the habitats closer to the highway. There are underpass structures at such locations, of varying sizes and values. As per the tables for mammals and herptiles, these can have improvement potential in various ways. Not discussed in the tables, though, is that for significant improvement, it may be necessary to restore habitat in the approaches to the structures. As learned from discussions with Gord Bell of MOT Kingston, a major concern of engineers in the original construction was to account for 100 year weather events to avoid flooding. Consequently, and as environmental impact statements were not in the equation, connectivity of habitats was of far less concern than controlling water flow. Ditches channeled watercourses through the roadbed and sometimes well into adjacent wetlands. Even four decades later, the ditches are very distinct in character from the wetlands they connect, but in effect separate. Restoration of wetland character in the ditches to the underpass structures, along with guide fences for small mammals and herptiles, could have beneficial impact on wildlife connectivity.

Landscape Effect. The ridges and valleys of this landscape trend northeast-southwest. This landscape is the roots of ancient mountain chains. The trend direction is almost the same as the channel of the St. Lawrence River, which floods through the landscape on its way to the sea. The 401 Highway parallels the river s course, and so for the most part lies between the ridges, cutting through errant ridges where it must. The granite ridges guide the direction of the development placed on the land, and the movements of animals as well.

The multitude of habitats of the region are also positioned by the lay of the land. Wetlands are cradled between ridges, and hemlock stands shelter in the long northern flanks of the dry-topped ridges. In the simplified diagram view of the Frontenac Arch, linking Algonquin to Adirondack regions, it would seem there is a very direct southeast-northwest corridor direction. The landscape itself weaves another story, as the topographical heights and valleys trend at about 90 degrees to the A2A corridor.

On the ground this means that the corridor is actually a zig-zag path, like a slalom course on the landscape. Animals follow the habitats that meet their requirements for food, shelter and protection, and therefore the lay of the land. This has important significance for the use of this study. Animals don t have autopilot navigation systems to lead them from the Algonquin to the Adirondack regions. They follow habitat opportunities, and therefore the lay of the land. They don t head directly for 401 as if it were a mapped hurdle to be crossed, but rather deal with it as a hurdle when they come to it.

It is important to remember that the mapped corridor lines are computer generated. They are vital indicators to the habitats that should be woven together, but they are electronic lines. The fine tuning of the corridor and connectivity is on the ground. Don t cross the bridge to you come to it; don t tackle the barrier till it s imperative. The 401 highway is an imposing barrier to southeast-northwest movements, and so animals may likely follow the southwest-northeast trending landscape until there is no other alternative but to cross. The focus here has been on the 401 as a barrier, but there are other impediments too.

Highway 137 - LaRue Creek West

Between interchange 659 at Reynold s Road and the LaRue Creek bridge, there is a complex of wetlands and dry ridges paralleling the 401, and crossing it at various points. West of the 659 interchange, and north of the Landons Bay ANIS, there is mostly open farmland with little remnant woodland and wetland running northward. Instead, the habitat corridor parallels the 401, running eastward. Animals that do not cross the 401 immediately north of Landons Bay-Fitzsimmons Mountain have a considerably larger quantity of habitat available. Presently, both immediately north and south of the 401, there is a contiguous length of wetland and forest ridge natural landscape from just west of the Rockport-Escott Road to the LaRue Mills Road. The west branch of LaRue Creek starts just east of Highway 137, south of 401, crosses 401 at the west side of the 401 — Rockport Road underpass, and then meanders eastward along the north edge of the landscape-divided 401 section. To get to that landscape, and the connections north from there, animals must stay south of 401 from the Navy-Lake Fleet chain Landons Bay area route.

A significant hurdle in that connection is Highway 137, from the 401 Highway to the Thousand Islands Bridge. Other hurdles are the Rockport — Escott Road, the LaRue Mills Road and County Road 5 from Mallorytown to Mallorytown Landing. Highway 137 is a four-lane, median-divided route which sees considerable traffic, but much less than 401. The 137 traffic is concentrated in various parts of the day, and is heaviest on particular days of the week. Truck traffic peaks from late afternoon to early evening, generally diminishing by 9 pm. During that time, trucks can be backed up and stationary the entire length of 137, and onto 401. Light vehicle traffic concentrates on Friday to Sunday, or holiday Mondays, in the middle day part. Traffic is backed up by the processes of U.S. Customs, with little prospect of being lessened until new expansion scheduled for 2009. When traffic is backed up along Highway 137, the road is more of a barrier than during the low traffic volume periods.

The other north-south routes are the proverbial roads less travelled. They interrupt the continuity of habitats and as such interrupt micro-connectivity, but generally follow the lay of the land and are built for the most part at grade level. They are passable by many animals.

Side Issues

In several jurisdictions, such as Washington State, Florida and New Brunswick, and to some degree in Ontario as at the Niagara Parkway and Long Sault Parkway, roadways are being developed or redeveloped to thread rather than cut through the landscape. In Florida, for example, there is work underway for an Ecological Highways designation, where the planning and even reconstruction of roadways would follow protocol that would lower the ecological footprint.

The days when the 401 Highway as built were the era of big projects and focus on singular purpose. Traffic capacity was that focus, and the landscape and landownership through the corridor sadly very secondary considerations. While the social conscience is better tuned to the broader issues today, the highway isn t about to go away. Perhaps there will be some willpower or mandate in the future to lower the resistance values through the use of the information above. There are, though, some fine-tuning measures that could fall into place today to begin the footprint reduction.

Litter. The quantity of trash and refuse along the shoulders and right of way is staggering. It is literally possible to walk the length of the road stepping from plastic bottle to plastic bottle. Plastic drink bottles have replaced the styrofoam cups as the number two item on the roadside. Many are half full of the most vile smelling liquid you could imagine, as if there were no rest stops from Toronto to Montreal. The most common item is fragments of tires — rusting wire and rubber chunks that are truly a solid band along the shoulders. There are work gloves every few metres, blow out of the backs of trucks, socks, tarpaulins, pieces of wrecked furniture, shoes, underwear, Tim Hortons cups, glass bottles, books, bottle caps, fast food wrappers, stir sticks, paint cans, hub caps, license plates, bungee cords, windshield wipers, paper bags, plastic bags, mattresses, sweat pants, cds, cassette tape and virtually anything one could ever imagine. The roadside is a minefield of litter and wreckage.

Typical amount of litter along the side of the 401 Highway

Introduced species. The wide band of the roadside plants is a foreign land in terms of native plants. Plantings seldom use native species, for some unknown reason, but instead use aggressive non-native stock that serves to divide habitats on either side of the highway. This is not only a wedge between native habitats, but a corridor for the introduction of foreign plants and insects to the region. Re-naturalization programs could be carried out at very low cost, and would improve and relieve the fragile ecology of the region.

Land Ownership and Strategies and Recommendations

Background.
The land through which the 401 Highway runs is owned by the Province of Ontario, under the jurisdiction of the Ministry of Transportation. The lands bordering that corridor are in a mix of private and public ownership, and the distribution and circumstances of that ownership relate to the construction of the highway. During the 1950s, to obtain clear title for the highway corridor, lands were purchased, expropriated or a right-of-way was expropriated. The highway did not follow existing concession roads here, and so the path of the highway very often divided private lands. Some of those private lands were granted to other provincial agencies, such as ministry of Government Services, Natural Resources or parcels were retained by MTO for possible future development or work. On the creation of the St. Lawrence Parks Commission, Natural Resources Lands were transferred to that agency of the province.

Private lands separated by the highway were in a few cases retained by the owners. The land along the highway was often at the backs of farms which fronted on what was then Highway 2. In other cases, the lands along 401 were at the backs of properties where owners were on the Old River Road, or Parkway. In any event, there was frequent change and adjustment of land ownership in the 401 corridor.

If it happens that any action is taken to improve the success of wildlife crossing along the 401 Highway, most certainly the Ministry of Transportation for Ontario will be involved, because of their land ownership and jurisdiction. Development of strategies to improve the porosity along various segments of the highway or by means of individual underpass structures may wish to consider the nature of the ownership of land abutting MTO lands. Where land is in private ownership, there are presently many tools and mechanisms that could be used, including conservation easements, land acquisition through purchase or donation to an enabled organization, management agreements, or purchase of rights of way.

In every scenario and strategy, it will be important to consider how landowners are affected, and how to engage them in the process. Every landowner has a unique circumstance and perspective, and may or may not wish to participate. Records of land ownership is available at the County Land Regisrty office, and properties over 2 hectares have been recorded, but not attched to this study for privacy.

Strategies.

Connectivity and corridors.
Intact corridors will depend on real landscape linkages, which be as likely to parallel the 401 Highway as to cross it at any given highway segment. A strategy for connectivity should focus on habitat connectivity and integrity, restoring habitat and habitat connections especially where this study shows linkages may exist across the highway. The 401 Highway for the most part lies between the ridges, cutting through errant ridges where it must. The granite ridges guide the direction of the development placed on the land, and the movements of animals as well.

The landscape strip from Landons Bay to Jones Creek has extensive woodland cover and long strips of wetlands. There is considerable potential for wildlife movements here, especially south of the 401 Highway. A benefit of this potential is to allow it for latitude, leeway or choice of 401 Highway crossing points. This may allow the existing (and possible future) crossing points/underpass structures to collectively contribute to north-south wildlife movements at barrier points including the 401 Highway. An important consideration for maintaining and improving wildlife movements in the region is to maintain and improve the landscape and habitat connectivity in the Landons Bay to Jones Creek section.

Because of the mosaic of habitats and the mosaic of ownership, efforts to improve and restore connectivity must

follow the lay of the land and work to engage all landowners, pubic and private. In the Landons Bay — Jones Creek section, there is a patchwork of ownership, of both government and private landowners. The sub-watersheds and forest cover is artificially subdivided by ownership. Connectivity, as with chains, is as strong as the weakest link. Restoring landscape connectivity on the east-west axis here may be equally as important as improving the north-south connectivity. Effective and workable relationships between all types of ownerships would determine the success here.

Funnel Effect.
There is a funnel effect on this landscape, where topography guides animal movements. At roadways, crossing points are focused where heights of land at rock cuts come down to roadbed grade level. One might assume that there is little likelihood that major new underpasses would be placed in the roadbed. Such construction would presumably interfere with traffic flow, and be very costly as a retrofit. There would seem to be more potential to build overpass structures, and in fact the topography may lend itself to that. The funnel effect locations would have high potential for new overpass development. Rock cuts, which guide wildlife, would provide initial heights of land where specialized bridging structures could be lofted. Suggested locations are where significant woodlands and wetlands cross the highway, at segments valuated Medium or High, and where further and precise study shows best use of the funnel effect.

Much of the literature on wildlife crossings falls under the headings of wildlife collisions . There were 13 road-kill deer among the 45 mammals in total found in the study section. These were relatively recent kills only. Collisions with deer are known to cause considerable damage on occasion, and occasionally even smaller animals may cause accidents, if drivers swerve to avoid them. As discussed above, OPP and MOT reports do not allow for a separate category of recording to allow collection of wildlife collisions in Ontario. Finding 45 recent road kills of a broad number of species suggests, though, that there is a problem for the animals themselves.

Existing Underpass Structures.
Habitat restoration at the north and south approaches to underpass structures, whether for mammals or herptiles, is as important as the improvement of the structures themselves. In the original construction of the roadbed, proper drainage was a primary consideration. The ditch work has done as much to isolate the habitats separated by the highway as the highway itself. Such restoration work will need to be done on MTO land and on the land that abuts the highway at each chosen location. Again, the landowners there will need to be engaged for that work, and to ensure that the broader property of significance is protected or managed through the future years. Improvement of as many of these structures and adjacent habitat as possible is important, as these will collectively vastly improve porosity of the highway and at the same time reduce road kill significantly.

Median Barrier.
As discussed above, the concrete median barrier in the western 6.7 km of the study area causes significant rates of wildlife mortality. Road kill rates are especially elevated in smaller mammals. MTO has determined that the barrier is necessary because of the close proximity of the east and west bound lanes and the need to prevent head-on collisions. At the same time, there is risk for accidents as motorists swerve to aviod animals trapped on the highway by the barrier. A suggested alteration to the median construct is to replace some portions of the solid barrier with an open post and rail structure, as at the Cataraqui River on 401 Highway. The precise locations for the more porous barrier would be chosen through closer study of critical habitats for small mammals and herptiles. Such endeavors would want to be tied to work on underpass structures and habitat restoration.

Fencing.
Proper fencing must be part of any corridor restoration, not to prevent animal movements and highway crossings, but to guide them to improved structures and locations. The existing fencing is entirely inadequate, and does nothing to inhibit movements of animals of any size. Proper fencing is commercially available and used by highways departments throughout North America. It must be installed to compliment other crossing measures.

Part II
Effects of 401 Highway and Urban Development
on the Gananoque Waterway Wildlife Corridor

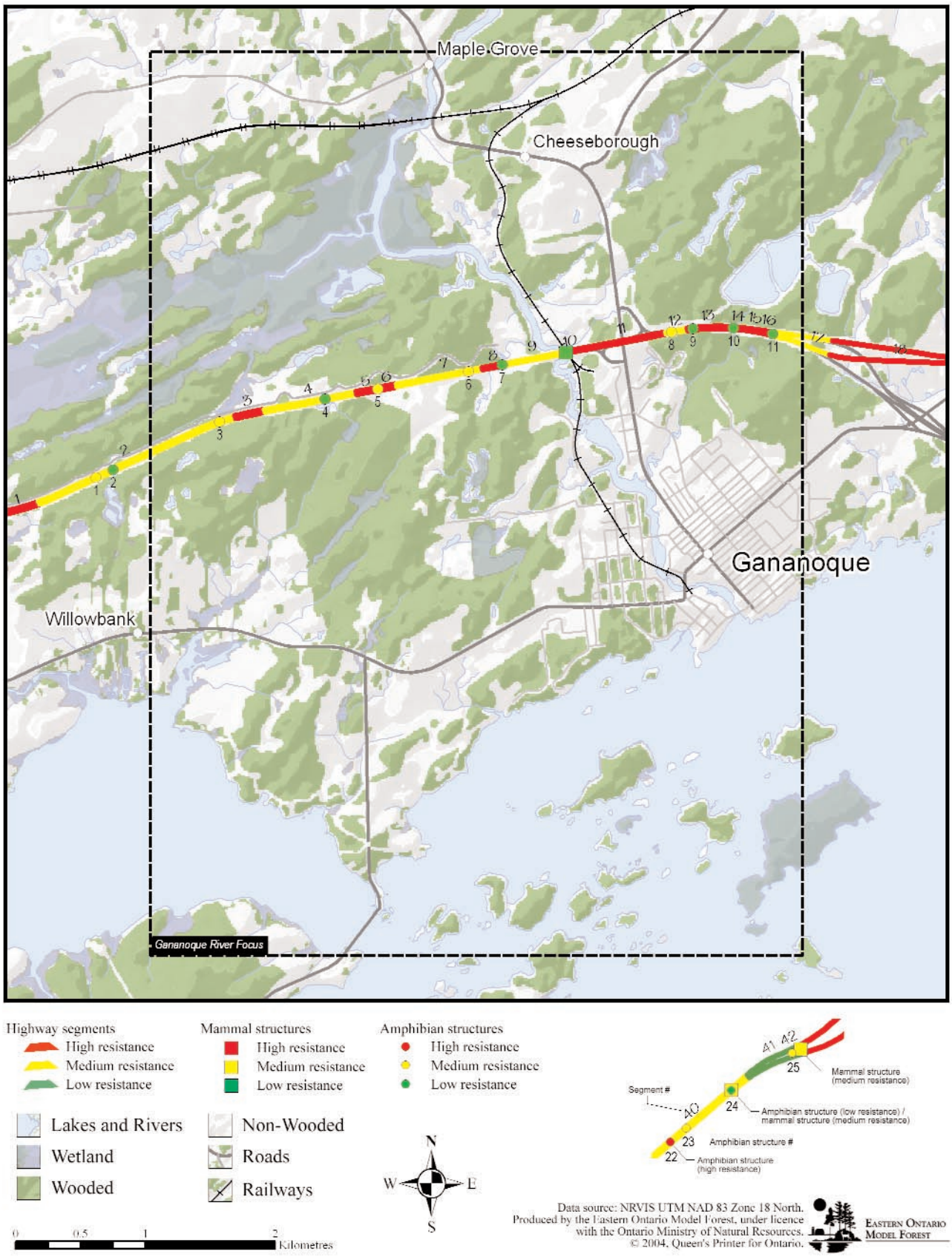
Part II a

Focus Area

Mapping developed to determine significant woodlands and wetlands of the region suggest that the Gananoque River waterway may function as an important wildlife corridor. A broad and distinct green path follows the waterway from the St. Lawrence to Charleston and neighbouring lakes, and beyond. Indeed, wildlife is known to be abundant in the area. However, the southern end of that suggested corridor may have its value and potential reduced because of the highway and urban developments. It has long been suspected that the 401 Highway is a major barrier to the continuity of the Algonquin to Adirondack corridor, and the effect of that barrier may be compounded by urban developments such as the town of Gananoque.

This portion of the study focuses on the effect of the urban and highway development on the potential wildlife corridor in the general area of the intersection of the Gananoque River with the town of Gananoque and the 401 Highway.

The map on the following page illustrates the Gananoque River Corridor focus of the study area.



Gananoque River Corridor focus of study area

Study Area

As the map shows, the Gananoque River has a well-defined primary channel to the St. Lawrence. A closer look shows that there is a broad flood plain for the Gananoque River, especially west of the river and north of the 401, where Mud Creek comes to the Gananoque. The 401 Highway cuts through the south side of the extensive wetlands of the lower part of Mud Creek. Gander Creek, Brown s Creek and another small stream originate on the south of the wetland, meandering to the St. Lawrence west of the town. As well, the lower part of the Gananoque River below the 401 is fed from small wetlands west of the river and by Stocking Hill Creek, flowing through the own sewage lagoon, east of the Gananoque River. All in all, the lower section of the Gananoque is in many places low-lying and wet.

This lower section of the Gananoque River is a broad and interconnected rather than a single defined watercourse to the river. Understanding that, it s clear that the discussion of the impact of the highway and urban developments on the river corridor must be broader focused than the simple intersection of 401 at the Gananoque River bridge. The study area in Part II is a more generalized area from the west end of the Thousand Islands Parkway, across the town of Gananoque to the Bay Road, and the Gananoque Provincial Wildlife Area.

Methods

The field work for this section of the study began in late January of 2004. the study area was hiked and cross-country skied extensively over a three week period, at a time when overland travel through the wetlands was possible. With snow cover, it was also possible to easily follow animal trails for distances that wouldn t be possible in other seasons. In addition, several landowners were interviewed for their observations of wildlife movements in the area.

The scoring of the highway and its crossing structures was done in late April, at the same time as the remainder of the highway of the study area. As the bridge over the Gananoque River at 401 was thought to have use and potential by wildlife as a highway crossing point, several visits were made there and around it.

The Setting

The town of Gananoque was located where it is because of the two rivers, the Gananoque and the St. Lawrence. The St. Lawrence was, in the Loyalist settlement era, the transportation route to the from coast to hinterland. The Gananoque, with its waterfalls so close to the St. Lawrence was an enviable source of power. The people of the town prospered early in settlement history because of the river circumstance. The town and its industries huddled around the junction of the two rivers, its footprint defined somewhat by the extent of the wetlands to the north and west.

Over the years, land transportation routes threaded over the landscape. Highway 2 looped along the St. Lawrence, connecting Lower and Upper Canada. It traced through valleys of the Thousand Islands, back from the sometimes swampy, sometimes granite-bluffed shores, but of course through the centre of the industrial centre of Gananoque. The east-west rail lines followed another route of least resistance, a little further inland, and north of the Mud Creek wetlands. The essential spur line to the town paralleled the Gananoque River banks, starting north on the west side and then crossing to the east side to avoid as many creek and marsh crossings as possible. Highway 32 evolved from footpath to cart path to roadway, an important link to the town from the farm communities to the north to the commercial, industrial, production and transportation hub of Gananoque.

The 401 was the last of the major transportation corridors to be laid across the land. The other rail and road lines had selected the easiest routes through the landscape, leaving the 401 engineers no choice but the more problematic, expensive and invasive path through wetlands and ridges. Highway 401 skirted the north edge of the

town, avoiding as much of the costly wetlands as possible and bridging the Gananoque River at a narrows that avoided industrial sites and dams.

Collectively, the roads and rail lines form a lattice of transportation routes over the lower section of the Gananoque River, and like the landform itself, defines and confines the shape of the town. Collectively, the patterns of transportation and urban development would seem to create a virtually complete barrier to wildlife movements through the area. As it turns out, those movements have been made very difficult and risky, but not impossible.

Discussion

If it were not for the low-lying lands to the north and west of Gananoque, confining the footprint of the town, the settlement pattern and web of transportation routes may likely have made north — south wildlife movements essentially impossible. However, the same web of creeks and wetlands which discouraged settlement and farming allowed a green-space corridor. Fortunate as well is that the green corridor leads along the west side of the Gananoque, where a stepping stones of islands narrows the expanse of the St. Lawrence.

There is no doubt, though, that the 401 Highway is still a very real threat to wildlife movements north and south. As discussed in Part I above, the median barrier is a very real wildlife barrier and underpass structures have less than ideal circumstance and construction to permit safe passage.

One of the very few high value underpass structures in terms of allowing wildlife passage at the 401 is the bridge over the Gananoque River. Because of the old rail line along the east bank of the river at that highway crossing point, the bridge had to have greater clearance over the river than would have otherwise been the case. The arch structure had to have a long ramp approach from the west and east, leaving some width of land under both sides of the bridge, particularly on the east side, where the now abandoned rail line ran. At other waterway crossings, such as LaRue Creek, bridges are almost at grade level, touching down bank to bank, with no land for passage underneath.

The site of the Gananoque River bridge was visited on a number of occasions, and the areas to the north and south were well explored as well. A number of observations were made:

The now abandoned rail line runs under the east side of the bridge. The rail bed crossed to the east side on a bridge just a few hundred metres south. The road bed is course crushed stone, and deeply rutted with extensive ATV traffic. Under the 401 bridge, the rail bed slopes steeply to the river, with clay, stone and sand banks. Through the winter where there was snow for tracking, no tracks of wildlife were found. In spring, no tracks of wildlife were found on any occasion in the sand or clay under the 401 bridge. One set of deer tracks was found on the snow beside the rail bed south of the 401, north of the rail bridge over the Gananoque River. It was concluded that there is little use of the east underside of the 401 — Gananoque River bridge by wildlife. Discussions with area residents supported that view, as no one recalled seeing any wildlife in that area, other than occasional raccoons.

The east underside of the 401 — Gananoque River bridge is a fairly steep slope of sand and stone, fill placed during the bridge construction. No work was apparently ever done to landscape or rehabilitate the artificial new river bank here. There are still remnants of construction, including silt tarpaulins, pipe, steel and chunks of rock. No maintenance is apparently carried out today. Underbrush of sumac and dogwood grows on the south side and there is a mix of shrubs and grass on the north side.
There is occasional use of ATVs, which travel there on the south side along the 401, and which trespass on the Mahle property as well. The traffic connects to the roadway parallel to the 401 in the Gananoque Provincial Wildlife Area.

Wildlife use of the underpass on this side of the bridge is light, but regular. Tracks of deer, coyote, fox, raccoon, mink and/or weasel are found in the snow and sand. The tracks for the most part stay closer to the water s

edge under the bridge, and approach from north and south through screening provided by the shrub cover. The approach paths are well-worn, and obviously traditional . The path under the bridge is less well defined, and animals use both the bank at and in the water, apparently staying as far below the overhead works as possible. There was, however, no road kill, even very old remnants, within several hundred metres of the bridge, suggesting the route is well established. There are no other mammal passages along this section of the 401.
There is presently little human foot traffic under this west side of the bridge. The approach from the south side is through private (industrial) land. The north side is at the extreme eastern end of the Wildlife Area. There is a proposal by a trails group from Gananoque to construct a walking trail here, to link the town with the Provincial Wildlife Area. Depending on the approach taken, this could either enhance the terrain qualities for wildlife here, or diminish them.
The river under the bridge is fairly swift, and although there is some ice cover, it is a very unreliable surface.

Properties south and east of the bridge are not developed up to the water s edge until just south of the bridge where the rail line crosses the Gananoque River. From that point and south, however, the development is substantial, leaving no natural habitat. There is no development between the rail line and the river, no immediately next to the rail line itself on the east side. Ground and shrub cover is sparse, and abused with litter and trash. As said above, there are no signs of wildlife in this area. The coarse stone of the rail bed is rutted with ATV tracks.

The lands south and west of the bridge are another matter. The property on the northwest corner of town is an industrial site. The footprint of the plant is modest in relation to the overall size of the property, and much of the land has re-naturalized. There are old field and young woodlands north and west of the factory, and wetlands at the very northwesterly corner. Those shrublands, wetlands and woodlands continue south, both inside and west of the north-south town limits, crossed only by the sparsely developed Beaver Road, to County Road 2. the similar landscape continues across #2, and especially west of the Howe Island Ferry Road, to the waterfront of the St. Lawrence.
Animal tracks, showing frequent use by their wear, were traced through these lands from the 401 to the St. Lawrence River. They were many-branched and meandering, but continuous. Property owners met along the way noted that they frequently observed deer, coyote and fox in that general area. Some acknowledged that the trails to and from the St. Lawrence, and across County Road 2 were in regular use. It was also learned from residents that winter crossings to Howe Island, and from there to Wolfe Island and into the Admiralties were regular events. Observations of tracks, and personal sitings on a couple of occasions, back that up.

The Gananoque Provincial Wildlife Area is north and west of the Gananoque River bridge. It is an extensive area of wetlands and shrublands, with very plentiful wildlife. As discussed in Part I, there are frequent crossings by wildlife onto the 401 to and from this area. Some of that traffic uses the underpass of the Gananoque River — 401 bridge.

Threats and Opportunities

The positive news is that there is a very apparent wildlife pathway system through the 401 at the Gananoque River, and north-south west of the river. This is a very complex area of land uses, however, with roadways, manufacturing, housing development and a great variety of landform types as well. There is no blanket solution here to improve wildlife movements through the area. Each aspect of that pathway must be treated, with improvement of the 401 — Gananoque River bridge only one item for the agenda. Without a comprehensive and holistic approach, there would be only marginal gains in wide scale animal movements.

The following are a view of obstacles to be overcome in improvement to the wildlife corridor in this section of the Thousand Islands. In the review are observations and suggestions for those improvements:

Gananoque River — 401 Highway bridge

This bridge has the highest potential for improvement to wildlife movements of any of the highway underpass structures of the region. Because the rail line operated at the time the 401 Highway was built here, there is potential in the width and clearance under the bridge. By far the best improvement potential is under the west side of the bridge.

~ There is no habitat to connect on the east side. The west side shows light but regular use by a wide variety of mammals.

~ Animal trails run north into the provincial wildlife area and south through old fields and woodlots and wetlands to the St. Lawrence. The path under the bridge, though, is unrefined and appears threatening.

~ Traffic noise is very loud, as the steel structure booms with the passage of trucks and cars, and clanks as wheels pass over compression plates.

~ There is no screening from any shrub cover under the bridge, and very little on the north approach.

~ The slope under the bridge is steep and sandy, with refuse from construction still in place. The approach from the south side is narrow and steep near the bridge.

~ There is occasional ATV traffic and sometimes fishermen, with fires, at the site.

~ There is considerable ATV and snow machine traffic on the east side rail bed.

An upcoming issue is a proposed walking trail on the west side of the bridge underpass, where, if the path were developed and used in animal movement time periods, it could further discourage animal traffic.

There would seem to be a number of inexpensive solutions to improving the underside of the bridge for wildlife movements. These could include:

~ Insulating the underside of the structure for sound reduction, through sprayed foam and rubber seals at expansion plates.

~ Landscaping the slopes under the bridge and at both the north and south approaches, using terraces to define level walkways, removing construction debris, and planting with low-growing shrubs and grasses appropriate to light and moisture levels and for use as screening cover.

~ Ban motorized vehicles from the underpass and wildlife area.

~ Should a hiking trail be built, construct it with separate paths for wildlife and people, and curfew human use from pre-dusk to post-dawn periods.

~ Construct a proper wildlife fence along both the north and south sides of the 401 Highway, guiding the wildlife to the underpass route and preventing road crossings. The wildlife fence would be an integral part of the plan as without it, there is no directing animal traffic and road kill rates would be only partially reduced.

County Road 2

County Road 2 is also a partial barrier and threat to wildlife movements, at a smaller scale than Highway 401. The crossing area is at the general location east and west of the #2 — Howe Island Ferry Road. That is a relatively undeveloped section of the highway, with curves limiting lengths of time animals are aware of vehicles approaching, and tree and shrub cover close to the roadways.

Solutions here would no doubt be more costly than at the 401 highway. As housing infills on that road, crossing potential would diminish. Keeping the corridor open would mean finding a way to keep that land undeveloped, and the habitat in place. This could mean any of a number of strategies could be tried, ranging from purchase, land donation, conservation easement or re-zoning of the land use to Environmental Protection through the assistance of the municipality of Township of Leeds and the Thousand Islands. As it happens, there are a very few landowners here.
Currently, the property on the south and west side of the County Road 2 and Howe Island Ferry Road intersection is listed for sale. This is a large old field and woodland property which runs nearly from #2 to the St. Lawrence, and would appear to be a priority property for conservation strategies.

Secondly, a corridor linkage at County Road 2 would be vastly improved with some type of mammal crossing structure. Presently, crossing has to be made over the road, at grade. There is no landscape opportunity to create an overpass here. An underpass large culvert, such as those in use in Florida and New Brunswick, would be appropriate. Costs for such structures are reported to be in the $500,000 range.

St. Lawrence River Shore

The St. Lawrence shoreline west of Gananoque and to the east and west of the Howe Island Ferry Road is becoming increasingly developed. So too, then, is the opportunity of animals reaching open shore with intact habitat becoming increasingly diminished.

The area reported by area residents to have the most sightings for animals crossing to the islands by swimming or over ice is between the ends of Clark Drive and Twin Oaks Lane. There are still short, undeveloped pieces of shore there. There is as well some undeveloped shore south of the golf course, east of Lindsay Point, but the water in front is seldom frozen well, because of the current strength.

To complete the corridor to the St. Lawrence from the lower Gananoque River, strategies of land conservation would have to be explored, both on the mainland and across the Bateau Channel at Howe Island. Again, these strategies range from ownership, to land donations to a trust or conservation agency, conservation easements, dedicated land stewardship and/or protective municipal zoning.

Land Use Patterns

South of 401 and west of Gananoque, all land is in private hands. Most of the land is in farm or open space use. Exceptions are the small lots for residences along County Road 2, the waterfront, Twin Oaks Lane, and Clark Drive. There is scattered and mostly isolated residential use along the Beaver Road. Currently, there are enough gaps in development that animal pathways are established and well used.

In landscape ecology, it is accepted that the degree of significance of woodlands and wetlands can be improved if gaps in forest cover can be reduced or closed, and wetlands are associated with woodlands. In order to create a corridor of value, a strategic approach in this area would be working with landowners to find the best methods of conservation strategy which fits their needs, and closes those gaps. Tools to that end would be used as best fits each owner and location, and depends on long-term agreements. Tools include conservation easements, property donations to conservation bodies, stream and woodlot restoration through land stewardship practices and programs, land ownership, municipal planning and zoning, and any combination of these and other methods. As there are actually a fairly small number of key property owners in this section of the corridor, there may be a fairly high potential for success.

Part II b
North of 401 Highway, east of Highway 32

Stocking Hill Creek flows into the Gananoque River at the northeast corner of the town. The creek is about five kilometres in length, and originates in a series of ponds in a low area which spawns at least three other streams, north of County Road 2 and west of Wilstead. Stocking Hill Creek feeds the sewage lagoons, deepened and widened ponds, that serve Gananoque.

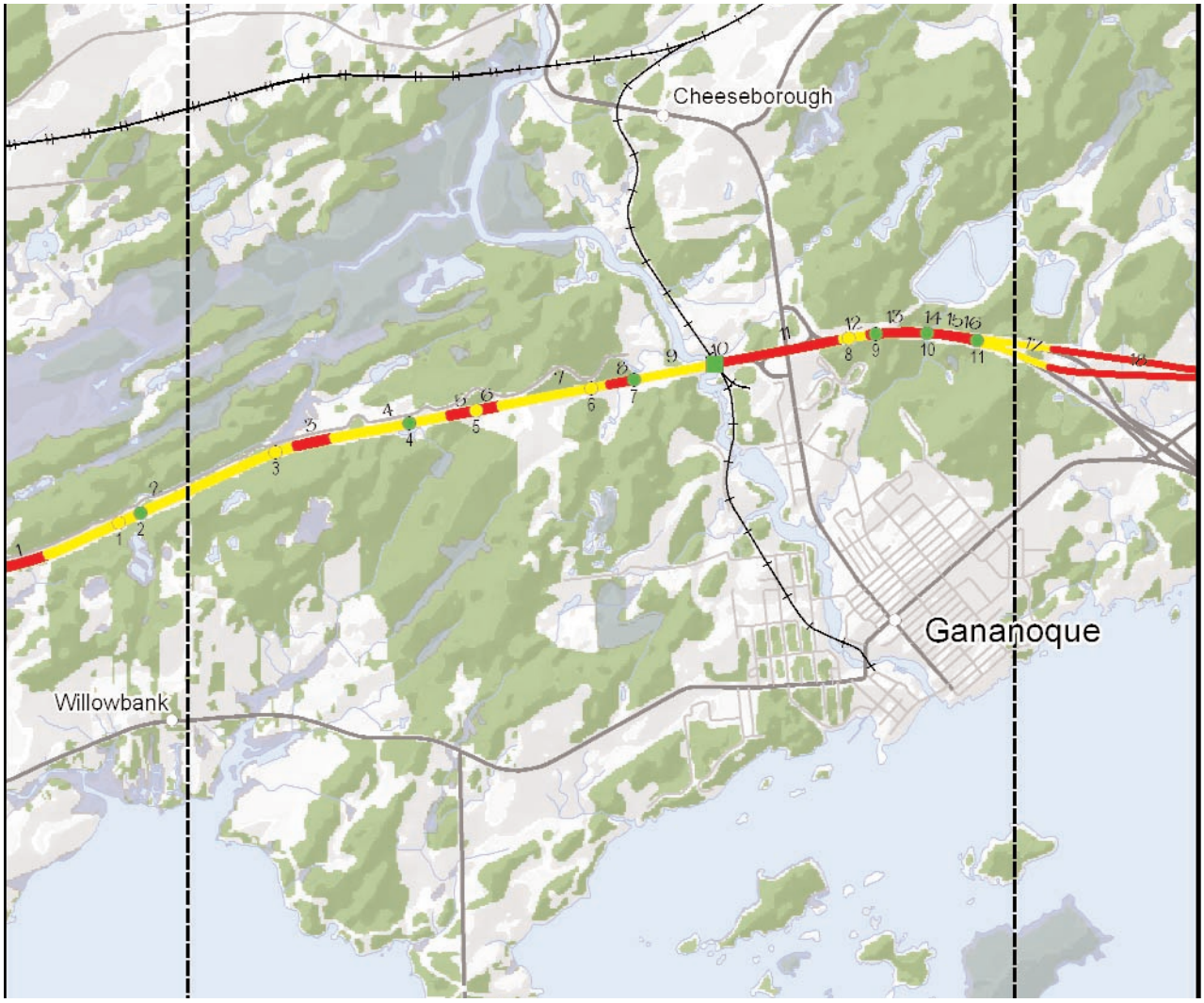
As discussed in Part I, the analysis of the 401 Highway corridor, the greatest number of road kill deer in the study area was found in the short stretch of 401 from Highway 32 to the west exit of the Thousand Islands Parkway. The seven deer were found on the south side of the 401 very close to the Stocking Hill Creek culvert. Tracks of several other animals were found at the creek as well. While the amount of animal traffic would suggest that there is a relationship to the Gananoque River corridor, it s felt that this is not entirely the case. It is more likely that there is a local population of animals here, confined at the southern part by the town of Gananoque.

Stocking Hill Creek runs through an island of woodlands and wetlands. The island is bounded by the town of Gananoque on the south, and cleared, residential strip development on roads to its west, north and east. The several streams and wetlands, and the granite ridges associated with Little Blue Mountain form a nearly 10 square kilometre area of very diverse habitats. It happens that 401 cuts across the bottom 25% of that area. The sewage lagoons are a favourite spot for birders, because of the number of wetland and wading species to be seen there. Herptile populations are large and diverse, as are mammals, based on records kept in the past by national park naturalist staff. While there is no doubt some transfer of the populations on and off the island, to the north and east, the south section is essentially a dead end, with no exit. This area would contribute to the diversity and complexity of the region, but in corridor terms, it s a cull de sac.

However, there is a very interesting footnote to be made from this example. Even though there s no where to go to the south, there is considerable animal activity across the 401 highway. This suggests that the animals are driven to risk the highway by following available habitat and not entirely, at least, by tracing established corridors. The highway is a formidable barrier, but not so much that animals will not risk the crossing. At this particular section of highway, there are interchanges east and west, a town to the south, a median wall, and both steeply raised grades and rock cuts. Nonetheless, animals venture onto the highway, and deaths are frequent. A lesson learned is that if the grass seems greener on the other side, opportunity is worth the risk. This is all the more reason to improve the safe crossings for wildlife, and for highway travelers.

Improvements to the highway crossing here could be made relatively easily. The Stocking Hill Creek culvert is large, with fair clearance for overhead space. Water marks on the inside culvert walls show that the capacity of the culvert in terms of water flow exceeds the needs. Tracks of deer, beaver, muskrat and raccoon, and others, indicate that the culvert is visible and accessible — key factors for wildlife use. The addition of a terrestrial component inside the culvert would improve potential for use. A rock layer, surfaced with a sure-footed, softer layer of coconut fibre mat, resistant to rot, would be possible. It would also be essential to place wildlife fencing along this section of highway to prevent crossings over the roadway and to guide animals to the improved culvert.

Another issue flags itself here, perhaps out of the scope of the 401 barrier study, but related to wildlife and habitat in the region. This is that Stocking Hill Creek becomes an urban stream, form the point where it enters the sewage lagoons until it enters the Gananoque River. That 1.5 km section of creek below the sewage lagoon may need all of the wetland and natural shore to help in the final filtering of nutrient and sediment before the water reaches the Gananoque River, and shortly thereafter the St. Lawrence. There is high probability for concern over the loss of buffering and habitat on the stream, as the town has few options in the direction it can expand in the future.



Discussion area for PartIIb

Part III
Gananoque River Corridor
401 Highway to Charleston Lake, and beyond

If a landscape corridor is a series of links from region to region, from woodlands to woodlands through wetlands and streams, then like a chain, it is as strong as the weakest link. In that sense, the corridor along the Gananoque River has other deficiencies beyond the 401 Highway barrier. Part III of this paper discusses some of the threats and opportunities for the corridor north of the 401.

Another look at the mapping for Significant Woodlands, Evaluated Wetlands and Potential Corridors to Core Areas shows a wide but patchy green landscape along the length of the Gananoque Waterway. A closer look, at maps showing land use patterns, as on topographic maps, shows some of the bottlenecks on the corridor. Remembering that the corridor is much broader than the river channel itself is important. the same topography that defines the river channel defines land use as well. The operating farms, settlement areas, cottage and residential locations, roads, dams and other features are guided into place by the lay of the land. So too are the remaining woodlands and wetlands. So too are the routes and pathways of wildlife.

Through most of the broad corridor of the Gananoque waterway, there are many locations which allow wildlife movements to bypass developed areas, be they farm or settlement. Here and there are problematic places, where concentrations of roads, drainage patterns, farm operations and so forth are concentrated, restricting to degrees the potential for easy wildlife movements.

In the length of that corridor, the most restricted section is just north of the town of Gananoque, from Gananoque Junction and Cheeseborough to the Maple Grove area. Strip development along the several roads, farms, the rail line and pipeline substantially interrupt the connectivity on the natural landscape through here. This presents a challenge to wildlife movements which should be met and dealt with at the same time as the work described in Part II a, at the Gananoque River — Highway 401 section.

As the ownership maps for that area show, there are many property owners. There is as well complex ownership, especially at the intersection of the Gananoque River, Highway 32 and the rail line. However within that area, there are larger sections of land where ownership extends across roadways at sections with minimal development. These would be locations to explore options to restore or improve wildlife crossing points. The tools available, again, are conservation easements, land donations to an enabling organization or agency, land ownership purchase, long term stewardship agreements, restrictive land use through municipal zoning and covenants with land owners of rail and road beds.

Methods of wildlife movement improvement would be underpass structures in this area, as the topography does not lend itself to overpass structures. On the Maple Grove Road, there is a strip of green space in the low area where Sucker Creek dips toward the road, before it enters the Gananoque River at Maple Grove. A single landowner on property 01003800 owns the land on both sides of that road and the rail line. Another opportunity may exist at the Gananoque River s east side, between the river — road bridge and the rail line underpass. There too a single land ownership situation exists. Such locations form examples of focal points where crossing points of the corridor could be explored.

From Maple Grove to Marble Rock, the Marble Rock Road parallels the Gananoque River, with a large and growing number of cottages and houses. As well, two oil and gas lines cross through that section, and cross the river; and there are operating farms which keep the land open. These forms of development are not a barrier to wildlife movements, but would diminish the quality and capacity of a corridor. The south side of the river is rather undeveloped through that section, because of the steep and rugged granite terrain. The reduction in corridor capacity is on the developed north side of the river, where the lower and more level lands would allow more ecologically rich habitats to develop, but where that same circumstance has encouraged development.

Improving the corridor capacity through this area would perhaps involve landowner participation in conserving habitats with an eye to linking them to core and stable significant woodlands and wetlands.

The remainder of the Gananoque Waterway, from the Marble Rock area, through the lakes and streams such as Wiltse Creek are presently sufficiently undeveloped to function as a corridor. Through that area, there is a broad and healthy selection of natural habitats, with little substantial interruption. This is one of the broadest green landscapes in southern Ontario.

Because of that circumstance, this is an ideal time to strategically develop a conservation approach which would enable the best corridor into the future. Currently, there are some land parcels in public ownership here. These include Cataraqui Region Conservation Authority lands at Marble Rock and Wiltse Creek; and patches of Crown Land at marble Rock, Wiltse Creek, Lost bay and The Crank on Gananoque Lake and east of Lime Lake. There are conservation lands purchased by dedicated individuals, and new interest in Land Trust activity by the Gananoque River Waterway Association. From that springboard, and drawing on the support of the several conservation partnerships already in existence through the Thousand Islands - Frontenac Arch Biosphere Reserve, there is very strong potential to realize a wildlife corridor.

After Thoughts

If there is a true connection from the Algonquin to Adirondack regions, there needs to be a real linkage through a much broader area than examined here. Hopefully, though, there are elements of this work that can be applied to other areas. The models to assess highway porosity and their relationship to connectivity on the landscape, for example, can be used on similar multi-lane highways, for both new and redvelopment construction. The assessment methods for existing highway underpass structures are based on widely agreed upon parameters, and they too may have broader application. The real work that lies ahead is in distinct parts.

~ To ground truth habitats that in GIS work appear as core areas and corridor routes.

~ To engage landowners in strategies for conservation of habitats that lie upon the corridor routes.

~ To engage highway and transportation departments which will allow access to structuring for improved porosity, including improvements to existing structures as well as building new overpass structures.

~ To attract funds to do the improvements.

~ To plan and work strategically to restore corridors, habitat and improve existing underpass structures.

The Algonquin to Adirondack corridor is a continental scale landscape connector, but in fine view, lies across the river, on islands and to and through appropriate terrain on the US and Canadian sides of that river. Here indeed is an international challenge to diminish the barriers to wildlife movements throughout the Algonquin to Adirondack landbridge.

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August, 2004

Annotated Bibliography

Response Time of Wetland Biodiversity to Road Construction on Adjacent Lands

C. Scott Findlay and Josee Bourdages

Conservation Biology, Volume 14, No. 1, February 2000

Discussion of effect of road construction on populations of species on adjacent lands. From this work and other papers cited, conclusions are that there are long term effects that are not generally measured in impact statements. The impacts may take years and decades to reveal themselves, and the affected area is broader than usually measured. The work was done on wetlands adjacent to highways in southeastern Ontario. The conclusions were:

Short-term environmental assessments of road construction on measures of wetland biodiversity are likely to substantially underestimate the real effects. Accurate estimates are integrated in cumulative impact assessment.

The negative effects of historical road densities were detected on adjacent lands up to 1 or 2 km. from the wetland. This supports the contention that current Canadian provincial and federal wetland policies are inadequate insofar as the designated buffer zones, where road construction is prohibited, as they extend at most several hundred metres from the wetland s edge. That buffer zone should be broader to protect wetland biodiversity.

The results of the study suggest that even if no new roads are constructed, wetland biodiversity will likely continue to decline in lagged responses to historical increases in road densities. In that sense, the current gloomy picture of wetland biodiversity in southern Ontario is probably rosier than it should actually be.

Biological Delineation of Terrestrial Buffer Zones for Pond-breeding Salamanders

Raymond D. Semlitsch

Conservation Biology December 10, 1997

Discussion of dependency of pond-breeding salamanders on terrestrial and wetland habitats, vs. the setback distances for buffer zones in the terrestrial section. Maintaining the connection between terrestrial and aquatic habitats of herptiles is critical to maintaining biodiversity and population health. As well, buffer zones should extend minimally 164.5 m, 534 feet, into the terrestrial area adjacent to the aquatic habitat to encompass sufficient food sources and refuge. Therefore, decisions on land use should be aware of special needs throughout the seasons, and not just the breeding season.

Anthropogenic Correlates of Species Richness in Southeastern Ontario Wetlands

C. Scott Findlay and Jeff Houlahan

Conservation Biology, Volume 11, No. 4, August 1997

Discussion of relationships of species richness and wetland area, road density and forest cover. There is a strong positive relationship between species richness and wetland area for all taxa. The species richness of all taxa except mammals was negatively correlated with the density of paved roads on lands up to 2 km from the wetland. As well, for both herptile and mammal species there was a strong positive correlation between forest cover on lands within 2 km. Therefore, road construction and forest removal on lands adjacent to wetlands pose significant risks to wetland biodiversity. This suggests that wetlands policies, related to development which focus on developments within the wetlands themselves, and/or in a narrow buffer zone around the wetlands, are unlikely to provide adequate protection for wetland biodiversity.

Effect of paved roads — An increase in extent of paved roads of 2 metres per hectare, within 1 kilometre of wetlands produces a loss of 13% of plant species richness. The same road density increase within

2 km of wetlands means a loss of 19% of species richness for herptiles and a 12% loss for mammals. That same increase within 1/2 km of wetlands means a 14% loss of species richness for birds.

Effect of Forest Cover — A 20% decline of forest cover within woodlands that are within 2 km of wetlands leads to a decline of species richness of herptiles of 17% and 11% of mammals. Another way to relate this is that a 20% loss of that woodland s forest cover is equivalent in effect of losing 50% of the wetland itself. This suggests that land use policies for width of buffer zones are currently sadly deficient; and that land use/development practices adjacent to wetlands are as important as the size of wetlands themselves.

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Discusses commercially available amphibian underpass systems and guide fence systems. See also Jackson, Scott Underpass Systems for Amphibians. Transportation-related Wildlife Mortality Seminar, State of

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3. Biological Conservation. Volume 109: 15-26

general note: In all of the literature searched, there were few discussions touching on valuation of existing structures for wildlife use, or for valuing porosity or resistance of the highways. A useful search term was wildlife collisions , as it appears as much effort has been given to avoiding vehicle collisions as to improvement of wildlife crossings.