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MAPPING AREAS SUITABLE FOR FOREST-BASED ECOTOURISM IN NORTHERN ONTARIO USING GEOGRAPHICAL INFORMATION SYSTEMS (GIS)

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INTRODUCTION

In the last two decades, the field of resource and environmental management has been revolutionized by the collection of large amounts of data using remote techniques. These data offer considerable potential for the management of resources and, to a lesser degree, for guiding the people utilizing those resources. These comments apply equally to tourism and recreation, particularly in rural and remote areas. The field of remote sensing, first developed in the 1960s, has been concerned primarily with various forms of data acquisition. However, it has not been widely applied to tourism or recreation, in part because collected data were not at a scale or resolution suitable for site management or planning (Coppock and Rhind 1991). The development of Geographic Information Systems (GIS) has provided tools and techniques to utilize these vast pools of data in ways that allow planners and managers to make better decisions about the use of natural resources (Star and Estes 1990, Aronoff 1991, Maguire et al. 1991). The application of GIS techniques to tourism and recreation is still in its infancy, but these techniques hold considerable promise for decision makers and planners in addressing conflicting demands for land and water resources. (Townshend 1991). One main advantage of GIS techniques over other forms of data manipulation is the spatial attributes of the data, which allow uses such as tourism to be analysed more effectively. This is particularly important when tourism is venturing into peripheral or sensitive areas or where the pattern of use is a significant factor (Berry 1991). When attempting to identify areas suitable for ecotourism, this point becomes relevant (Star and Estes 1990). Ecotourism, by its very nature, is drawn to and dependent upon natural areas. Often these areas may contain rare or endangered species or habitats, or they may be remote or peripheral.

The early stages of this project included defining ecotourism, noting linkages with other types of tourism and environmental management principles, describing northern Ontario as a setting for ecotourism, determining suitable criteria, and developing a GIS method. The purpose of this note is to describe the application of a GIS methodology to the identification of potential areas for ecotourism within the Wawa–Sault Ste. Marie–North Bay–Kirkland Lake study area. Emphasis is not placed upon the appropriateness of ecotourism in this specific area, nor upon the technical aspects of the GIS technology, but rather on the application of the technology to determine its suitability for this type of task. The fact that the particular application has been developed in a specific spatial context does not necessarily invalidate its application in other areas, but neither does it guarantee its suitability.

GIS AND RESOURCE INVENTORIES

The creation of spatial data analytical software has made possible the collation and manipulation of massive amounts of data covering large areas, and analysis of the complex interrelations between different elements sharing the same space (Arnoff 1991). As noted earlier, remotely sensed data has increased exponentially the amount of information available for relatively unexplored areas. While northern Ontario has been extensively mapped and surveyed on the ground, new technology allows for vastly improved surveying and analysis of many components of the landscape

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(Siderelis 1991). The Ontario Forest Research Institute has collated much digital data for this area, especially with respect to forest resources and their exploitation. These data, along with information from a variety of other sources, including transportation, settlement, and wildlife capability, can be utilized to evaluate the potential of areas for various activities.

SPANS GIS was used to produce a series of maps for the study area. These maps were essentially layers of data that could be overlaid on each other in any specified or random order (Fig. 1). The data were portrayed as numeric scores for each pixel (unit area), the size of which depended on the resolution of the data collected. As each map was added to the base, accumulated scores developed (values could be negative or positive). These were represented in total form on the final map. The output was a set of maps depicting what were termed "Ecotourism Units".

APPLICATION OF GIS

The study area, comprised of some 80 000 square kilometers, extended from Sault Ste. Marie in the southwest to North Bay in the southeast, and from the northern edge of the Lake Superior Provincial Park in the northwest to beyond Kirkland Lake in the northeast. Its boundaries were the 48th parallel to the north, Lake Superior to the west, the Ontario/Quebec border to the east, and a line extending from slightly south of Sault Ste. Marie to North Bay in the south. Using Figure 1 as the frame of reference, the characteristics of each thematic GIS layer are discussed. However, because of limitations of space, the following analysis can only offer a general description of each layer. Readers interested in a more detailed discussion of the mapping results, or in reviewing the colored plates of each of the layers, are referred to the original report.[1]

Within the study area, vegetation types were varied and fragmented in nature (Table 1 provides a description of the vegetation types); only the western portion of the region had extensive areas of Sparse Coniferous Forest with a belt of Poorly Vegetated Areas on the southern edge. Vegetation types regarded as most suitable for ecotourism (Mixed Forest) were generally found in the central and northern parts of the region. Areas of Mixed Forest Type 2 were highly fragmented and had no significant contiguous areas. Mixed Forest Type 1 vegetation occurred in more sizeable segments throughout the central and northern parts of the area. These indicated areas of high potential as attractive sites for ecotourism. With regard to the first aspect of Resource Related Activity (cutovers), a few older cuts (> than 30 years) exist in the south and southeast. More recent cuts cover the northern half of the area. The overall pattern of cutovers revealed that considerable sections in the south and west of the area had not been affected; however, this region is covered by less desirable forms of veg-

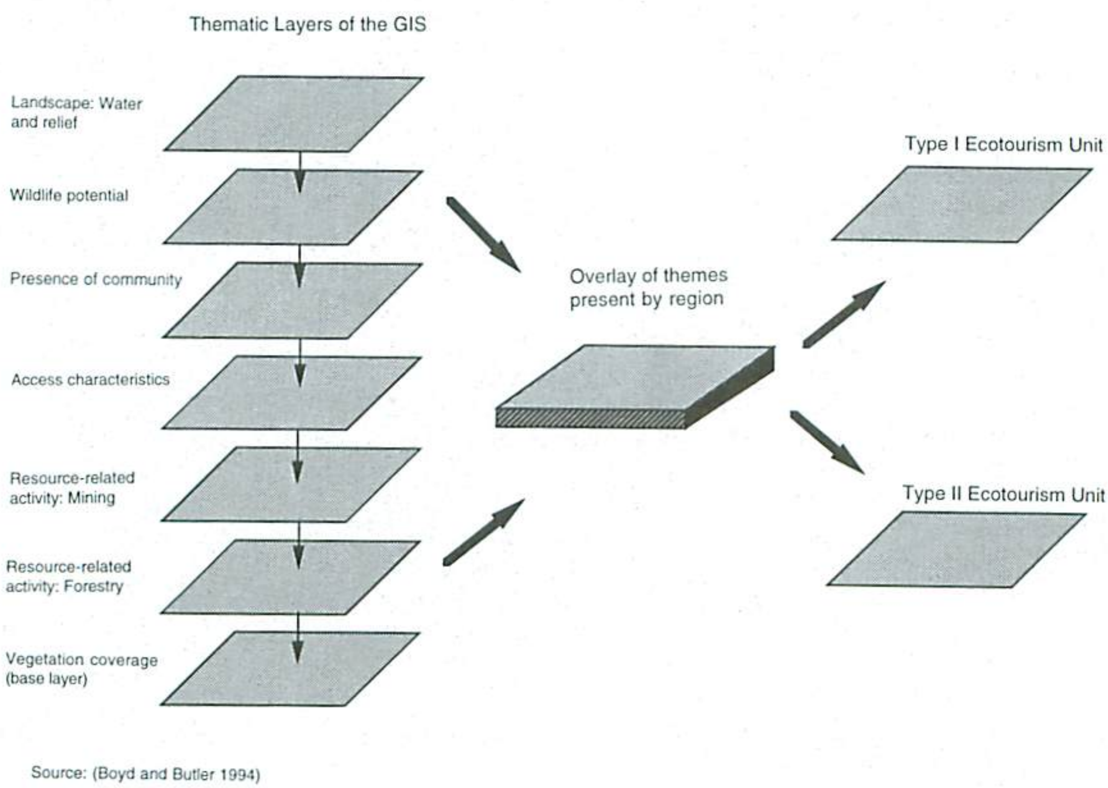

Figure 1. Overlay procedure used to identify potential ecotourism areas.

[1] Boyd, S.W.; Butler, R.W.; Bae, R.E.; Perera, A.; Haider, W. 1994. GIS mapping of potential areas for ecotourism in northern Ontario. Nat. Resour. Can., Canadian Forest Service–Ontario, Sault Ste. Marie, ON. Unpublished File Report No. 7. 31 p.

Table 1. Scores, attributes, and value range used to establish an area's "naturalness".

Scores	Attributes	Value range
	PRIMARY CHARACTERISTICS	
Presence of community		
Score	Community type	Population size
5	Absence of permanent settlement	0
3	Unincorporated communities	1–1,000
2	Small towns	1,001–10,000
1	Urban settlements (industrial based)	>10,000
Resource-related activity (forestry)		
Score	Resource type	Percent of area
5	No presence of forestry activities	100 %
3	Forestry Practices* I(cutover area)	<20 % cutover, 30–40 yrs
2	Forestry Practices II	>20 % cutover, 20–30 yrs
1	Forestry Practices III	>20 % cutover, 10–20 yrs
Resource-related activity (mining)		
Score	Resource type	Measure
5	No presence of mining	100 %
3	Mining Practices* I	Abandoned mines present
1	Mining Practices II	Operational mines present
Vegetation coverage		
Score	Vegetation Type	Percent of area
5	Mixed forest (Type 1)	> 50 % coniferous, >10 % white pine and red pine
4	Mixed forest (Type 2)	> 50 % deciduous/coniferous, > 10 % white pine or red pine
3	Dense coniferous forest	> 80 % jack pine, black spruce
2	Sparse coniferous forest burns and cutover, i.e., all others except	> 80 % deciduous, > 10 years old
1	Poorly vegetated areas, clear-cuts, burns	shrub cover, < 10 years old
Access characteristics		
Score	Type	Value range
5	Access Area* I	Areas outside of any buffers around all roads
3	Access Area II	Areas within 2 km buffer around logging roads
2	Access Area III	Areas within 5 km buffer around loose surface roads
1	Access Area IV	Areas within 10 km buffer around paved roads
Wildlife settings		
Score	Type	Value range
5	Wildlife Setting* I	ARDA Class Areas** 1–2
3	Wildlife Setting II	ARDA Class Areas 3–5
1	Wildlife Setting III	ARDA Class Areas 6–7
	SECONDARY CHARACTERISTICS	
Landscape (relief)		
Score	Characteristic	Measure
5	High relative relief	> 25 meters
3	Medium relative relief	10–25 meters
1	Little relative relief	Less than 10 meters
Landscape (water)		
Score	Characteristic	Percent of area
5	Presence of water	5–20 %
3	Presence of water	20–50 %
1	Presence of water	0–5% or < 50 %

Source: Boyd and Butler 1994.[2]

* These represent varying degrees of "naturalness".

** Land capability inventory produced under the Agricultural and Rehabilition Development Act (ARDA) in the 1960's. The smaller the number the better the capability. Maps were produced for wildlife based on waterfowl and ungulate capability. Others included maps showing recreational capability, agriculture (the principal focus of the inventory), and forestry.

[2] Boyd, S. W.; Butler, R. W. 1993. Geographical information systems: A tool for establishing parameters for ecotourism criteria. Nat. Resour. Can., Canadian Forest Service–Ontario, Sault Ste. Marie, ON. Unpublished File Report No. 6. 39 p

etation and is less attractive for ecotourism. Although many of the cutovers are small, they exist in close proximity to each other (especially in the north and central parts of the region) and affect significant portions of the overall study area.

Landscape attributes, depicted by layers within the GIS, recorded the presence of water and the absolute relief. Water bodies were present throughout, but significant concentrations were found in the central regions and toward the eastern edge of the study area. An overall north/south pattern of drainage exists for the entire region. A variation in absolute relief of almost 500 meters was found over the entire study area. The general pattern displayed in the GIS output is one of two significant features: the east and south are relatively low; and elevations rise to the north and west, except in the vicinity of the lake shore.

The potential for wildlife was inferred from the Agricultural Rehabilitation Development Act (ARDA) and capability map coverage for ungulates and waterfowl. The combined results of these two classes made up a fourth layer in the GIS. Areas with the lowest potential for wildlife were identified in the southern part, with a concentration in the central portion, of the study area. The GIS output revealed very few areas that attained a high score (high potential for wildlife) representative of ARDA Classes 1 and 2. The largest of these was located in the extreme northwest. The implication of this is that the diversity in capability for wildlife that does exist within the study area is present only at a very small scale, if at all.

The last "natural" element considered in the GIS was the presence of protected areas (provincial parks). Recreation and natural environment parks were found throughout the study area; only one waterway and one wilderness park were present. These parks were generally small, with the exception of the Missisagi River Waterway Park and the Lady Evelyn–Smoothwater Wilderness Park. Therefore, they were viewed as not particularly relevant to ecotourism unless used as campsite areas.

The remaining layers of the GIS dealt with human elements present within the region in the form of Community Type and Access Characteristics. Buffers of various sizes were placed around these elements (*see* Table 1 for buffer sizes) in order to identify areas that should remain outside all of the Ecotourism Units identified. The output of the GIS layer for the presence of communities revealed that three types exist over the study area: namely, nonincorporated communities, small towns, and cities. All major urban centers, such as Sault Ste. Marie, Elliot Lake, Sudbury, and North Bay, are located on the southern edge of the study area; fortunately perhaps, in the generally lower-scoring regions when physical or natural criteria are considered. A majority of the smaller towns are also located in the south, with the exception of those around Kirkland Lake in the extreme northeast. The belt of small, nonincorporated communities reflects to a large degree an access network that runs west to east across the northern part of the area. Overall, the vast majority of the study area was found to be unaffected by communities and urban development.

The same cannot be said when Access Characteristics and the buffers placed around them are considered (*see* Table 1 for details of buffer size), as these indicated significant human intrusion. The GIS output for the road network in the study area revealed the absence of paved roads, with the exception of three major north–south routes, including the Trans Canada Highway in the extreme west. Loose surface roads, however, were extremely dense in three regions: namely, in the northeast around Kirkland Lake, in the southeast around Sudbury and North Bay, and in the southwest around Sault Ste. Marie. For the most part such roads are representative of the spread of settlement. Logging roads followed the pattern of cutovers, were widespread and clustered, and reflected the pattern of timber development and exploitation. When buffers were applied to the access network, very little of the study area remained outside any of the buffers. A discontinuous belt of several moderately sized areas did emerge, however, in the central portion of the area. Smaller blocks were scattered over the remainder of the region.

The final element (and GIS layer) of the human impact on the landscape was mining and, as it represented an activity generally unattractive to ecotourists, was buffered to avoid being included in any potential Ecotourism Unit. In particular, two areas of major mining activity were noted: one in the northeast to the west of Kirkland Lake, and one in the south centered on Sudbury and running west to Elliot Lake.

As previously mentioned the results of all these "thematic" GIS layers, representing the physical and human elements present in the study area, were overlaid to determine the total score an area could receive. This was based on accumulating the scores for each of the attributes. As a result of this procedure, four Type I Ecotourism Units (Fig. 2), scoring between 31 and 35 points, were identified as having the most potential for ecotourism development. Not surprising, in light of the above discussion, none of these units were in the southern or western portions of the study area. One was located in the central part of the area, one in the north central region, and two in the eastern part of the area, south of Elk Lake. None of the areas were entirely homogenous—that is there were small areas within the overall units that were not of an equally high value, as shown by the empty pixels. Their shapes were generally far from symmetrical and reflected natural elements, such as water bodies and topographic features, and the absence of intrusive human impacts. The less rigorous criteria involved in delimiting Type II Ecotourism Units are reflected in (Fig. 3). A considerable proportion of the study area fell within Type II Ecotourism Units (12 areas scored between 21 and 30 points), although once again the southern part of the area received little coverage. The majority of the units were located in the central belt; however, this time there were several units in the western part of the area as well. As shown in Figure 3, the average size of these units was considerably larger than the size of the Type I Ecotourism Units, although a number of units (Numbers 7, 8, 9, and 10) had obviously been dissected

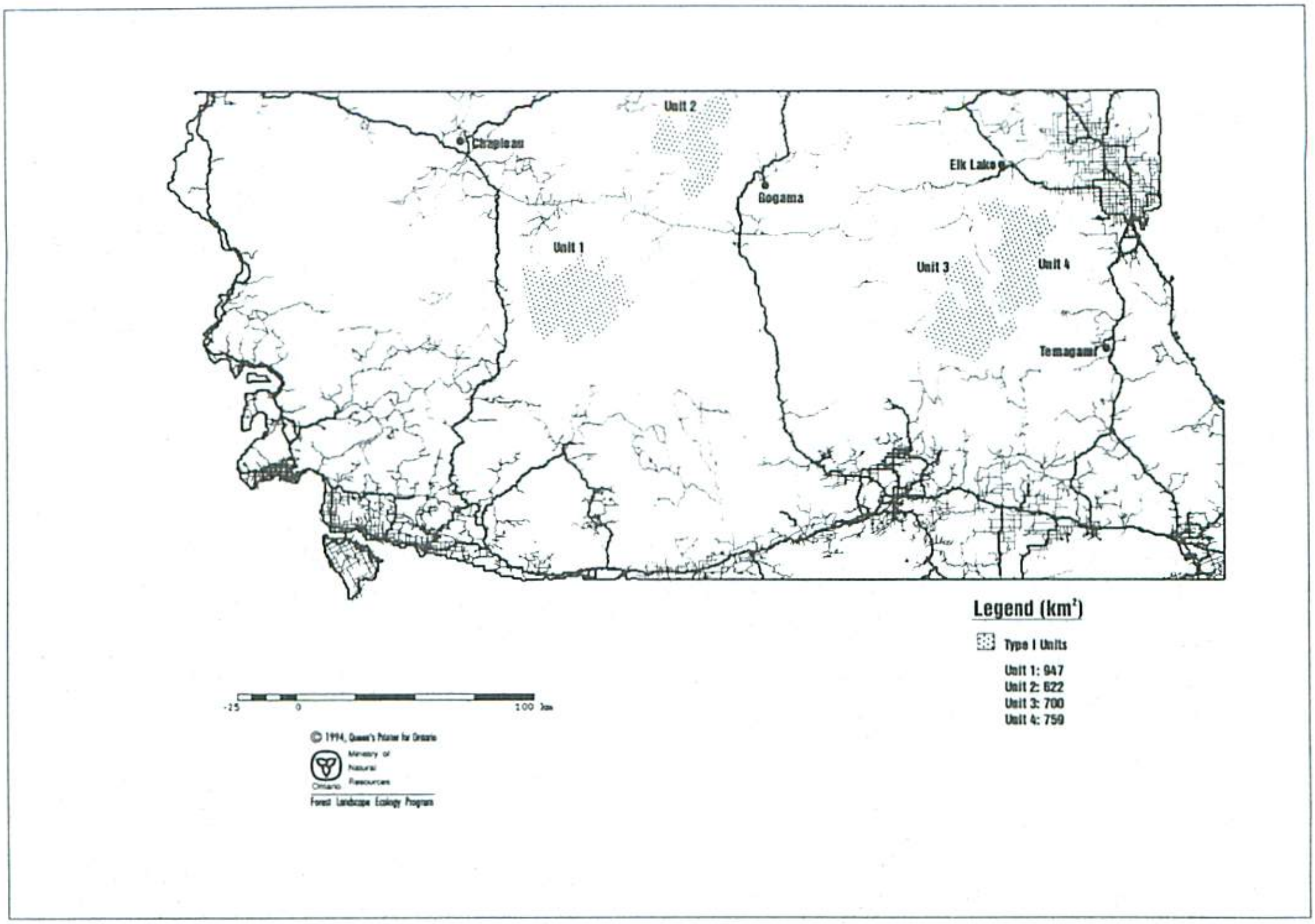

Figure 2. Type I Ecotourism Units.

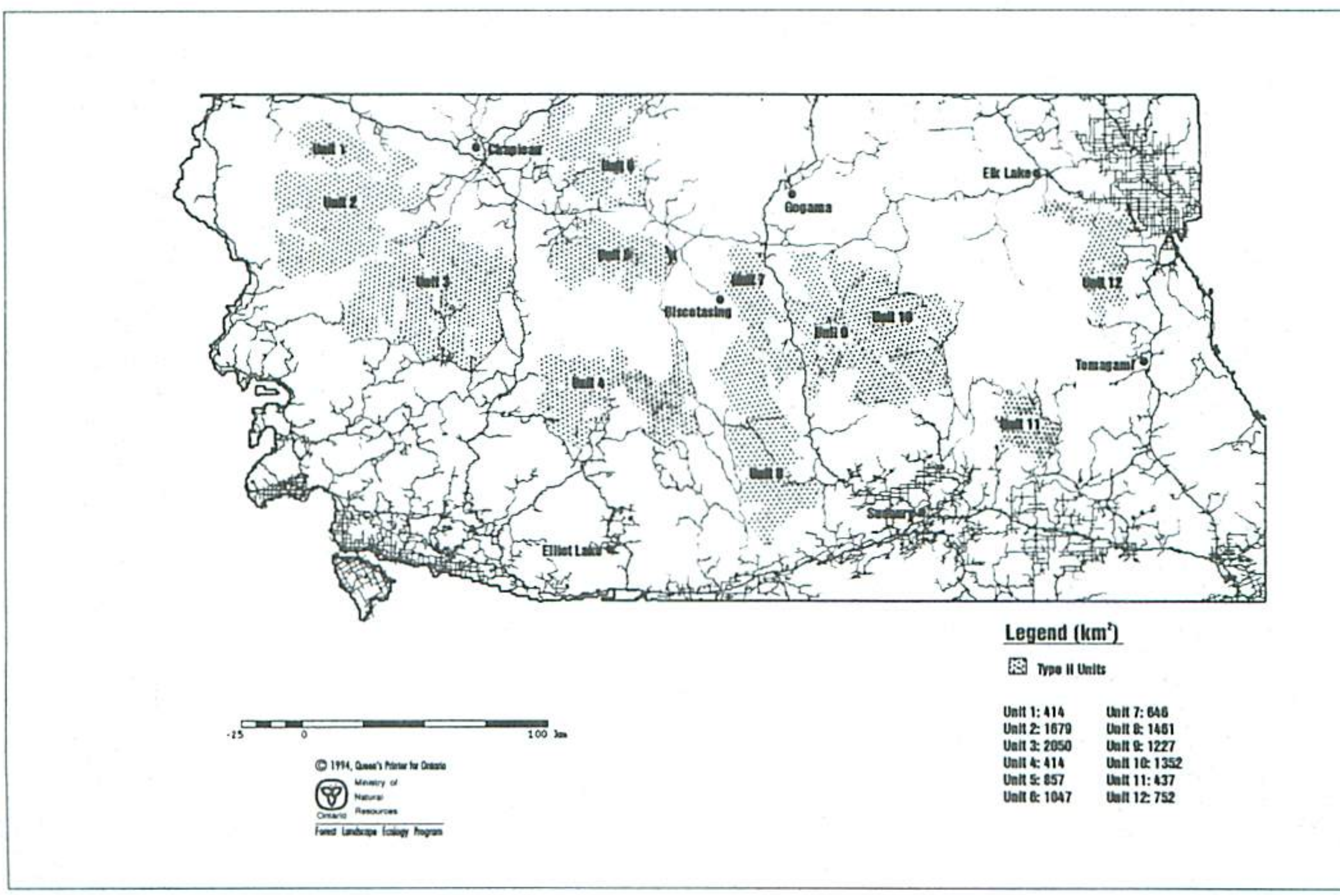

Figure 3. Type II Ecotourism Units.

by elements of the access network. The units in the northwest were found to be more contiguous and uniform than was the case for the Type I Units. Overall, Access Characteristics and Wildlife were found to be the most important criteria in shaping the ecotourism units.

CONCLUSIONS AND IMPLICATIONS

The value of GIS can best be appreciated when large data sets are available for analysis, because the costs of acquiring such data are normally very high. The availability of specific data can determine what elements or attributes can be examined and which have to be ignored. These considerations clearly influence the validity of the results of such studies and applications (Dale 1991). Being able to identify areas by matching the characteristics of a site with those attributes most appropriate for ecotourism has major implications in general to tourism operators and recreation planners. As mentioned earlier, ecotourism by its very nature will have an impact on any environment. Limiting ecotourism, which has within it the potential to become mass tourism on a small scale, to such areas where the region's characteristics are most suited for ecotourism, and which can best withstand such use, will to an extent reduce impacts compared to more fragile areas.

It should, however, be emphasized that GIS is not a decision-making tool, but rather provides information in a form from which decisions can be made. In the context of northern Ontario, the GIS application and the data produced can represent a saving of many hours of field work. As well, it allows for continuous updating and provides visual images of areas that could not have been obtained without the GIS techniques and the remotely sensed data (Aronoff 1991). If areas identified as having high potential for ecotourism are to be developed, it will require cooperation and consultation between agencies, communities, and industry in order to make decisions that are based on the interests of the various groups involved and that are in line with the characteristics of the area itself.

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