NODA FILE REPORT 6

This file report is an unedited, unpublished report submitted as partial fulfilment of NODA/NFP Project #4053, "Identifying sites/opportunities for forest-based ecotourism in northern Ontario".

The views, conclusions, and recommendations contained herein are those of the authors and should be construed neither as policy nor endorsement by Natural Resources Canada or the Ontario Ministry of Natural Resources.

NODA PROJECT 4053: Identifying sites/opportunities for forest-based ecotourism, Northern Ontario.

DRAFT

Report 2

Geographical Information Systems : A tool for establishing parameters for ecotourism criteria

prepared by

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the Canadian Forest Service

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1.0 INTRODUCTION

In the first report, ecotourism literature was reviewed to identify criteria that were suitable for ecotourism within a Northern Ontario setting. Five criteria were considered to be appropriate: naturalness, wildlife, cultural heritage, landscape and community. Some discussion was presented in the first report on these criteria, and this report builds on prior findings by offering a more detailed assessment of the above named criteria. In particular, discussion focuses on how the criteria can be incorporated into a Geographical Information Systems (GIS) framework.

The overall goals of the second phase of the project are:

- to establish parameters for criteria for ecotourism previously stated and,
- to incorporate these parameters into a GIS framework to identify potential ecotourism sites in Northern Ontario.

In the first report seven attributes of ecotourism were noted and are listed again below for purposes of further discussion:

- environmentally and socially responsible
- focused on elements of the natural environment
- managed in such a way as to have minimal environmental and social impacts
- nonconsumptive
- capable of providing desired economic benefits to local residents
- compatible with other resource uses in the area
- appropriate in scale for conditions and environment

For the most part, these attributes are qualitative in nature and do not easily lend themselves to precise measurement. They are useful only in that they help characterise the form ecotourism should take in Northern Ontario. It is proposed that identifying suitable areas for ecotourism requires that the selected criteria (naturalness, wildlife, cultural heritage, landscape and community) have attributes which can be both measured and mapped. Geographical Information Systems (GIS) technology offers a tool whereby a multiplicity of attributes can be mapped in the form of layers from which areas having more than one attribute present can be identified.

With respect to the actual process of identifying ecotourism sites, it should be pointed out that although this report focuses on establishing those parameters of criteria using measures for attributes which can be quantified, those dimensions of ecotourism which are more qualitative in nature should not be ignored. In light of this latter point, elements such as community preference and involvement, and the broader issue of how sites are managed are discussed at some length within the context of a stakeholder and decision-making framework to illustrate that any process to establish ecotourism sites must address both the qualitative and quantitative dimensions of ecotourism (see Figure 2).

The overall perspective to be taken here is that the GIS technology allows for the creation of the essential base layer of those areas where the most favourable mix of biophysical attributes for ecotourism can be found, upon which a social infrastructure necessary for ecotourism can be superimposed, or created, if desired.

This report comprises five sections. Following this introductory statement (section one), section two offers a general discussion on a number of key concepts. Section three addresses the technique of GIS and its

application within Northern Ontario. The framework in which the parameters are examined is outlined along with the proposed methodology in a fourth section. A fifth and final section notes the limitations of GIS in establishing parameters of criteria appropriate for ecotourism, addressing in particular those attributes which are qualitative in nature.

Prior to discussing GIS and its application within Northern Ontario, a few comments are necessary on what is meant by several key terms that frequently appear throughout this report.

2.0 KEY TERMS DEFINED

This section focuses on defining the following key terms: study area, ecotourism unit, naturalness, pristine and natural landscape.

2.1 Study area

The term "study area" refers to that portion of Northern Ontario which was selected for the overall project. The size of the study area was constrained in part by the extent to which a GIS database was available. The study area comprises the region of northern and northeastern Ontario that was mapped during the first phase of the Spatial Forest Data Base Project completed in 1991 and 1992 by Spectraanalysis for the Ontario Forestry Research Institute. Approximately 110,000 square kilometers in size, this region includes the area between Sault Ste. Marie and North Bay in the south, extending northward to Wawa and eastward to Kirkland Lake.

2.2 Ecotourism unit

For purposes of this report, an "ecotourism unit" is defined as a predetermined area large enough to allow for several days use and where an appropriate mix of attributes are present for ecotourism. The size of the ecotourism unit was determined in part from the size of the study area itself and the scale at which the GIS technology can identify features on the landscape. With respect to the latter, vegetation coverage can be measured at a resolution of pixels of 25 square meters, with topography having a resolution of 200 square meters. Although the technology allows for a detailed inventory of very small plots, the amount of data that would be generated at such a scale would make selecting sites a very onerous and time consuming task. This scale of operation would create a situation where the end result would be areas that

would be too small for ecotourism, and as a result perhaps not hold sufficient attraction to promote ecotourism in the long term. For purposes of this study, a preselected unit size of 500 square kilometers was chosen. It is suggested that a unit of this size is large enough to ensure several days travel can occur within it, and in which a mix of attributes for ecotourism may be present.

2.3 Naturalness

A distinction should be made between what can be termed "pristine" and what is "natural". Within the context of this study, a pristine landscape is viewed as that portion of Northern Ontario which has not been altered in any way by human activity and where the vegetation and wildlife are considered to be indigenous to the area. The extent to which an area can be viewed as pristine will change both in space and time as a result of processes at work within that landscape. For instance, changes in the area's vegetation may be altered as a result of natural fires and plant succession. As a result, the landscape will be seen to undergo a number of phases. The landscape will first be dominated by hardwoods to be followed a century or so later by conifers. Changes may often be very site specific in nature as a result of the presence or absence of specific processes evident at the ecosystem level.

It is questionable if any "pristine" areas still exist in Northern Ontario as the region has been heavily forested with extractive industries dominant on the landscape, and because of the pervading influence of pollutants, emissions and man-induced climatic change on even those areas which have not been exposed to extractive activities.

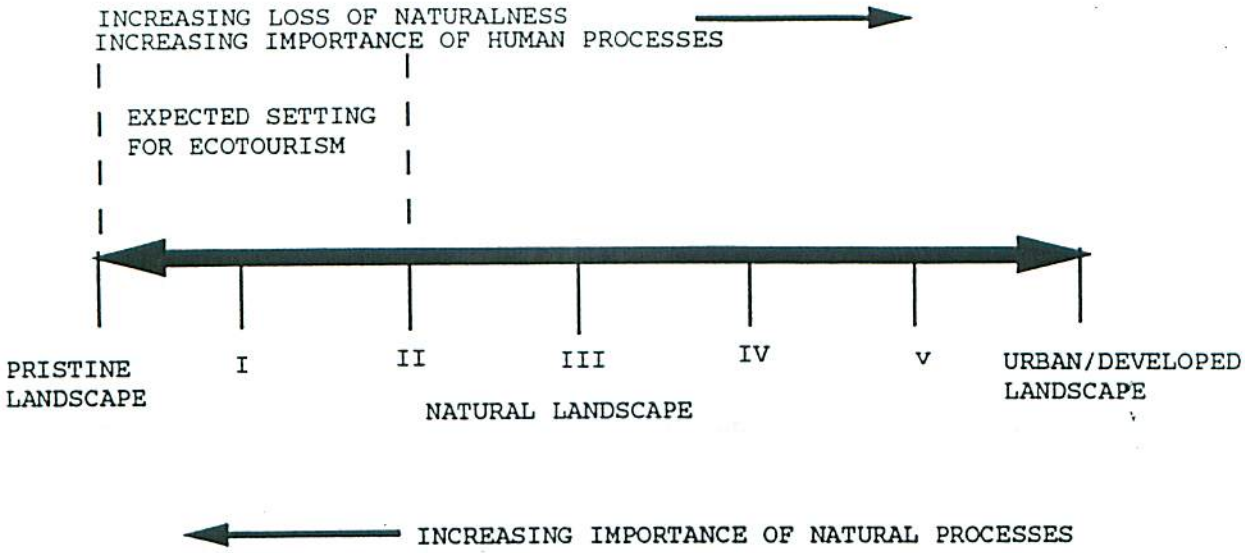
In light of the foregoing comments, it is perhaps useful to view the Northern Ontario landscape as conforming to a "natural" landscape as opposed to a "pristine" one. "Natural" here is defined to mean the present landscape

which has adjusted to human interaction and modification. Given that this interaction with and modification of the landscape will vary spatially, it is argued that there are different degrees or types of naturalness. The type of naturalness will be dependent on the extent to which those attributes of "naturalness" are found to be present. When viewed as a spectrum, it may be argued that an area's degree or type of naturalness will rank lower than "pristine" and therefore to its right on the spectrum (see Figure 1). It is suggested that an area's degree of "naturalness" can be expressed in terms of the following attributes:

- presence or absence of permanent settlement
- biophysical (vegetation) characteristics
- extent of resource-related activity present
- type of access
- presence of wildlife
- nature of recreational activity
- landscape characteristics

These attributes will be discussed at greater length in section four of this report.

FIGURE 1: NATURALNESS CONTINUUM



3.0 GEOGRAPHICAL INFORMATION SYSTEMS (GIS): APPLICATION FOR NORTHERN ONTARIO.

The purpose of this section is to outline what software and hardware will be used in the GIS component of the project, along with some discussion on the work that the Ontario Forestry Research Institute (OFRI) has undertaken in Northern Ontario.

3.1 Appropriateness of the use of GIS for Northern Ontario Land Use Analyses

Strategic policy analyses are usually based on information collected from very large areas. Because of the limitations of conventional data storage and management, strategic studies in the past have been based on abstract data. This is especially true with analyses involving very large spatial data bases. Even if data were used in a geo-referenced manner, those data had to be used at very coarse resolutions.

With the advent of spatial data analytical software, especially Geographic Information Systems (GIS), it is possible now to collate, manipulate and analyze fine-scale spatial data and their attribute data over a very large extent. For example, it is no longer inconceivable to analyze an area of 200,000 km^2, with data collected and stored at a resolution of 0.001 km^2. With GIS, it is also possible to examine many different "thematic layers" of the same space, and their complex interrelations. The vast array of GIS analytical capabilities include spatial queries of geo-referenced data, multi-thematic overlays, transformations, spatial modelling (interpolations and extrapolations), reclassification of thematic classes, changing data resolutions, and numerous distance-related analyses. Many statistical analyses also can be readily combined with GIS. These analyses provide the necessary context to develop hypotheses about fine-scaled structure and function of the systems studied.

In the Northern Ontario context, the use of GIS is necessary because of two major reasons: the vastness of the area and the remoteness of the area. The time-consuming and costly background studies can be conducted relatively inexpensively and in a more spatially accurate manner with remotely-sensed data. These data, in combination with many other thematic digital data layers, can be managed through GIS. Such a powerful database is invaluable for space-specific hypotheses generation for ground-level studies and surveys. The GIS approach is very flexible, and completely guided by the user, and even the spatial accuracy of the data and the ensuing analyses can be controlled by the user. Once the ground-level surveys are completed, GIS could be used again to validate the hypothetical models developed, or the sites selected and generate predictive extrapolations.

Use of GIS in Northern Ontario land use analyses can replace years of ground-level surveys (which usually have crude spatial accuracy) and permit very complex analyses involving many thematic data layers. To date, the Forest Landscape Ecology Unit has collated a series of digital data for Northern Ontario which has a total value over $ 1 million. The main layers are: remotely sensed data of vegetation cover (@ 0.0006 km^2 resolution) for the mapping of old growth red and white pine, past timber harvest disturbances (@ 0.0012 km^2 resolution), and past fire disturbances (@ 0.0012 km^2 resolution). During this project, it is anticipated that the road and infrastructure network will be collected along with digital elevation data for the study area.

3.2 GIS Capabilities - Forest Landscape Ecology Program

This section of the report details the hardware and software available at OFRI for the project.

3.2.1 Hardware

Platforms	Operating System/Environment
• DEC Station 5000/240 (43 mips) RISC-based UNIX workstation	• UNIX (ULTRIX)/OSF Motif
• 486/66 mHz PC (3 units, networked to the DEC Station	• DOS, OS2, Windows

Digitizer

- CalComp 33480, 48"x 36" digitizing tablet

Output	Plot/Print Size
• Seiko Colorpoint thermal transfer printer	• Letter/Tabloid (11' x 17')
• Lexmark Paintjet printer	• Letter/Tabloid (11' x 17')
• CalComp Designjet plotter	• Up to 24" x 30"

3.2.2 Software

GIS

Package	Platform
• SPANS GIS	• DEC/UNIX
• SPANS GIS	• PC/OS2
• GRASS	• DEC/UNIX
• IDRISI	• PC/DOS
• SPANS MAP	• PC/OS2
• FLY	• DEC/UNIX

Digitizing

Package	Platform
• TYDIG (SPANS)	• PC/OS2
• TYDIG (SPANS)	• DEC/OS2
• v.digit (GRASS)	• DEC/UNIX

SPANS

SPANS GIS is a powerful commercial raster-based GIS package combining strong overlay, modelling and reclassification tools with unique quadtree data compression and storage capabilities. The system can efficiently manage very large raster data sets, not possible in many conventional raster packages. It also handles vector/polygon based data, meshing well with most common vector based systems like ARC/INFO. Incorporated functionality also includes prepared algorithms to perform contouring, neighbourhood analyses, topological analyses, buffer analyses and network analyses. Attribute information is handled through a solid link with dBASE, enabling flexible manipulation of data and importing from other sources using this common database managment software. This will be the prefered package to be used in this study.

OS2 vs UNIX versions

Functionality between the two versions is basically identical with only a few platform-specific differences. The major differences between the SPANS versions lie in the processing power of the respective platforms. An operational task taking 10 hours on the PC can be performed in 20 minutes on the UNIX platform. Despite the lack of speed, the PC version is still very useful in linking more efficiently with common database systems to provide tools and products for use in this environment.

Discussion follows on other GIS software which may have potential use to the project.

GRASS

GRASS is a very powerful and flexible research oriented raster-based GIS system. While lacking quadtree compression, GRASS offers many unique capabilities. It is a true raster system allowing sophisticated pixel by pixel analyses (neighbourhood, contagion functions) and the ability to perform run time resampling of gridded data to different resolutions as analyses are performed. In addition, vector data from common sources like ARC/INFO can be handled, and image processing capabilities are also present. GRASS is as highly flexible in providing sophisticated spatial and statistical analysis tools as an engine for developing problem-specific applications.

IDRISI

IDRISI is a PC-based raster system which combines some of the benefits of commercial base systems with those of a research type GIS. As it has limitations in doing very large analyses as a result of the processing and storage capabilities of the PC/DOS platform, IDRISI will have limited use for the project.

FLY

FLY is a product from PCI which allows almost real-time rendering of 3D perspective scenes from raster/elevation data. Classified LANDSAT imagery (and other image sources) can be draped over an elevation model and viewed from any direction and elevation to visualize three dimensional relationships such as line of sight and shadowing effects. The capability of creating a 3D perspective may be viewed as useful in the latter stages of the GIS component of the project.

SPANS MAP

SPANS MAP is a PC-based, desktop GIS package. While lacking sophisticated modelling and analytical tools, it provides powerful visualization, querying and output functions for spatial data such as analysis outputs from SPANS GIS. Interactive tools to view spatial data in map, table, and graph form simultaneously, provide an efficient means of analyzing "first-cut" trends. Editing of tabular attribute data can also be carried out interactively, dynamically changing the mapped representation of the data. In addition the package provides output tools to print and plot SPANS GIS data which are superior to those found within SPANS GIS itself. These include efficient means of applying labels and cartographic symbology as well as scalable control of output for printing and plotting larger maps.

DIGITIZING

As not all the layers of data for the project are in digitized form it will be necessary to create additional attribute layers. The following represents the nature of software available to input new layers into the GIS.

TYDIG (SPANS)

TYDIG is a relatively robust digitizing package, providing tools specific to the needs of topological data input and incorporation of georeferencing to rectify data upon importing to a GIS system. Naturally, it is most suited for generating data to input directly into SPANS GIS.

v.digit (GRASS)

GRASS's digitizing module v.digit provides a menu based digitizing system, appropriate for inputting vector data into GRASS format vectors. It

also provides a direct conversion routine to convert this data into raster form. As with TYDIG, v.digit is most suited for inputting data which will be input into its host system (GRASS).

4.0 METHODOLOGY

The methodology to identify ecotourism sites/areas that is proposed consists of three stages. A first stage determines the extent to which the GIS technology can measure the criteria of naturalness, wildlife, landscape, cultural heritage and community, in terms of how they are recorded (i.e. points, lines or polygons). The second stage involves an assessment of the type of naturalness that is present over the study area. A third and final stage involves developing a filtering process to screen out negative areas and emphasize those areas that have potential for ecotourism. The methodology proposed in stage two is fashioned by the nature of research undertaken in Australia on the production of a national wilderness inventory and on the evaluation of wilderness (Lesslie and Taylor, 1985; Lesslie, Taylor and Maslen, 1993, Lesslie, Mackey and Preece, 1988; Mackey et al., 1989).

4.1 Stage one

Criteria for ecotourism can be recorded using GIS as either points, lines or areas (polygons). The first step in establishing a methodology is to identify how each criteria can best be examined within a GIS.

4.1.1 Naturalness

With respect to naturalness, the following spatial, nodal, linear and temporal dimensions are outlined for the purposes of itemizing those positive and negative elements associated with naturalness.

SPATIAL (AREA)

NEGATIVE		POSITIVE	
Feature	Frequency	Feature	Frequency
Clear Cut	Any	Old Forest	Relative, all
Mining (spoil tips)	Any	Water bodies	Relative
Urban Development	Any	Streams	Relative
Mining affected areas	Any	Historic routes	Relative, all

NODAL (POINTS)

NEGATIVE		POSITIVE	
Feature	Frequency	Feature	Frequency
Mines	All	Localised habitat	Relative
Mills	All	Viewpoint	Relative
Airports	All	Historic site	Relative, all
Dams	All		

TEMPORAL (fluctuating short and long term)

NEGATIVE		POSITIVE	
Feature	Frequency	Feature	Frequency
Logging	Any	Migratory sites	Relative
Hunting	Any	Wintering sites	Relative
Trapping	Any		

LINEAR (access)

NEGATIVE		POSITIVE	
Feature	Frequency	Feature	Frequency
Roads	All, few	Roads	Relative, few
Rail	All	Old logging roads	Relative
Used logging roads	All, relative	Rivers	Relative, all

With the above chart, it is clear that some overlapping of criteria occurs.

Clearly, the term naturalness involves several components of the other four

ecotourism criteria and as a result may be viewed as the most important of the five.

4.1.2 Remaining Criteria

The criteria of wildlife does not lend itself easily to GIS. It is more appropriate to consider the setting in which wildlife is present. This being so, wildlife settings can be recorded in terms of area by digitizing the coverage for waterfowl and ungulates from the ARDA capability maps for those regions within the study area that have ARDA coverage. Two sources that may be useful in determining the areal extent of wildlife types are the Breeding Bird Atlas of Ontario and the Mammal Atlas, the latter of which is still in production.

With respect to the criteria of cultural heritage, attributes such as historic sites may be inputed into the GIS as points where coordinates in terms of longtitude and latitude are known. Historic routes, parks and Indian reserves may be inputed as polygons (area), the areal extent of each having been determined from topographical maps of the study area.

Community, as a criteria, was previously discussed in reference to naturalness. The distance component involved with this criteria can be incorporated into the GIS by way of placing a buffer around settlements. For instance, in order to exclude all areas closer than 5 miles from any settlement, a buffer of 5 miles would be set to eliminate the immediate area from being mapped. The option of buffering around features on the landscape provides a useful technique to phase out areas which may be considered as not being aesthetically pleasing from the perspective of sight and smell. For example, where noise may be a consideration and deterrent to ecotourism, a buffer of a certain distance (e.g. 10 miles) could be placed around current extractive

activities. In terms of smell, areas closer than 5 kilometers, for example, to a pulp mill could be excluded from the GIS coverage if obnoxious smells are considered relevant.

4.2 Stage two

This stage details how an area's naturalness type may be determined. An assumption is made here that the naturalness type found in areas is an important factor in determining what areas are best suited to different types of ecotourists and ecotourism experiences. For instance, a specialist may prefer a landscape of a naturalness type I, whereas visitors for whom the ecotourism opportunity represents only one component of their overall trip itinerary may prefer a type II landscape, but because of time and therefore access restrictions, may settle for those ecotourism areas found to have a naturalness type III.

With GIS it is possible to place numeric values (scores) on the various aspects of each attribute associated with naturalness. The following is a itemized list of possible scores attributed to each attribute, a description of the various elements of each attribute and a measure to determine the score. It should be noted that not all attributes have a range from 5 to 1. The absence of one or more units is used to illustrate the relative importance of a feature being absent or present, and to distinguish between aspects that are very favourable to ecotourism and those which are not. Each of the attributes of naturalness are listed below.

4.2.1 Presence of Community

Score	Community type	Population size
5	absence of permanent settlement	0
3	hamlets/villages	less than 250
2	small towns	250-5000
1	urban settlements (industrial based)	>5000

The latest Statistics Canada data will be used to determine the population of each settlement within the study area and therefore the score it receives.

4.2.2 Resource-related activity

Score	Resource Type	% of "Area"
5	no presence of extractive activities	100 per cent
3	forestry practices (cutover area) presence of mining activities	< 20 per cent
1	multi-use area	> 20 per cent

The term multi-use denotes an area where a mix of activities are present, including forestry and mining as noted in score 3. The "percentage of area" refers to that portion of the 500 square kilometer ecotourism unit necessary in order for a resource-related activity to be coded with a score of 5, 3 or 1.

4.2.3 Vegetation Coverage

This category was created by collapsing the 12 class types (see Appendix 1) of dense and sparse forest coverage that were used to map the old growth red and white pine under the Forest Fragmentation and Biodiversity Project (OFRI). It was felt that a scoring system of 12 down to 1 would be too detailed and time consuming. By collapsing the 12 categories down to 5, the

categories are sufficiently distinct enough to imply that, for example, those areas with a mixed coverage would be best suited for ecotourism from the standpoint that with would represent areas that have a potentially wide range of wildlife species and are visually aesthetic in appeal.

Score	Vegetation Type	% of "Area"
5	Mixed forest (type 1)	>50 % coniferous >10 % white & red pine
4	Mixed forest (type 2)	> 50 % deciduous/coniferous < 10 % white 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, clearcuts, burns	shrub cover < 10 years old

4.2.4 Access Characteristics

Score	Type	Distance	Mode of Access
5	Arduous/ remote	> 10 kms. from nearest access point	Hike, canoe or air drop into area
4	Hard/rugged	0-10 kms from nearest track or trail	Hike or use of ATV
3	Difficult/ vigorous	0-2 kms from logging road access	Hike from logging roads
2	Moderate/ casual	100m-1 km off minor roads	Park and walk
1	Easy/passive	100 meters off paved road/boat access	Automobile, tour bus, power boat

In order to determine the access charactersitics of ecotourism units, it will first be necessary to add the road network into the GIS as a separate layer.

The existing road and rail network may be digitized from existing 1:50,000 topographic maps of the study area. Access routes will be linear in nature, digitized as lines. Roads may be viewed as both positive and a negative for ecotourism. They are positive as they provide access into the area, but negative as ecotourists often prefer not to see roads as they are introduced to the area as they see the presence of roads as taking away from the sense of primitive setting and remoteness. A secondary layer for the logging roads may also be added to the GIS whenever these become available. At the present time, this information is not easily obtained, but it is hoped that local ministry offices will be able to provide this information before phase three of the overall project is completed. In terms of how logging roads may be perceived by ecotourists, it is possible to suggest that those which are under present use probably will be viewed in a negative light, as they represent a component of the extractive activities present on the landscape. Conversely, old logging roads may be viewed as either neutral or as positive as they provide an additional means of moving around an area, and gaining access to regions that once were difficult to reach.

4.2.5 Type of recreational activity/type of ecotourist

The nature of the recreational activity is dependent on the length of stay in the area and the type of ecotourist travelling through the region. These are attributes that cannot be measured using GIS. A questionnaire on the characteristics of travellers, their desires and motivations would be necessary in classifying travellers as ecotourist types. A score for recreational activity may, however, be determined from existing sources such as recreational activities present within provincial parks in the study area. The proximity to areas noted for wildlife can be used to as a measure of the

possibility of some passive forms of recreation. The presence of fast flowing rivers, and other water bodies can suggest possible active forms of recreation. Furthermore, those areas which are extremely isolated, but contain landscape attributes suitable for some recreational activities can be used as another indicator regarding score. The ARDA coverage for recreation will also be used possibly by digitizing a layer for those areas which are classified as having a high recreational capability.

Score	Recreational Activity(examples)	Type of Ecotourist
5	camping, hiking canoeing viewing wildlife, photography (> 7 days)	Specialist
4	camping, hiking, canoeing viewing wildlife, photography (4-7 days)	Hard core naturalist
3	camping, hiking, canoeing viewing wildlife, photography (2-3 days/nights)	Soft core ecotourist
2	viewing culture, wildlife, photography (< 48 hours, i.e. up to 1 overnight)	Generalist
1	viewing culture, wildlife photography (several hours)	Day tripper

4.2.6 Wildlife setting

In order to determine scores, a number of existing sources may be used. The areal extent of nature reserves and provincial parks can be determined from existing maps of individual provincial parks and other protected areas (e.g. nature reserves, wildlife santuaries, wetlands, bird sanctuaries). Maps of the zones within each protected area may be can consulted in order to detail areas where wildlife are protected and where they can be viewed. Wildlife services within the study area, may be useful in determining locations of deer yards, feeding stations and wintering sites. In addition, the ARDA capability

maps for waterfowl and ungulates may be useful in determining the scores for areas (capability areas 1 and 2) with respect to wildlife.

Score	Area where wildlife are viewed
5	Species viewed in a wilderness setting (no human induced barriers restricting movement of wildlife) Viewing wildlife within protected areas (nature reserves) Viewing wildlife within certain zones within nature reserves, and other protected areas (provincial and national parks)
3	Viewing wildlife at certain uncontrolled point access (deer yards, feeding stations, wintering sites)
1	Viewing wildlife close to areas of permanent settlement

4.2.7 Landscape (Relative relief)

Score	Characteristic	Measure
5	High Relative Relief	Max. elevation - min. elevation
3	Medium relative relief	Change in elevation up to 10 meters
1	Little relative relief	Change less than 10 meters

The relative relief in Northern Ontario is not as dramatic as that found in Western Canada. It may be useful to view landscape in terms of relative relief. Within Northern Ontario, there is not much change in relative relief except for the edge of the Shield. Topography may be digitized as a number of contour lines. The above measures can be used to determine a score for relative relief for each ecotourism unit.

Landscape (Water Content)

With respect to this characteristic of landscape, an assumption is made here that ecotourism areas require a certain percentage of water coverage to be viewed as suitable sites. Too much or not enough water coverage may be viewed as being not very appropriate for an ecotourism unit, scoring a 1 overall. The 16th class (Appendix 1) in the old growth red and white pine

coverage study may be used to measure the extent of water present over the study area at the level of an ecotourism unit.

Score	Characteristic	% of Area
5	Presence of water	5-20 %
3	Presence of water	20-50 %
1	Presence of water	0-5% or > 50 %

Landscape (Rock Outcrops)

The scores for the coverage of rock outcrops for the overall study area can be determined from layer #14 in the old growth forest red and white pine study (Appendix 1). The score for rock outcrops can be determined by the percentage of an ecotourism unit in which rock outcrops are present.

Score	Characteristic	% of Area
5	Rock Outcrops	1-10 %
3	Rock Outcrops	10-50%
1	Rock Outcrops	< 1 % or 50-100 %

The scores for relative relief, water content and rock outcrops will be combined in order to determine the overall score for landscape that each ecotourism unit will receive. A cumulative value with a range between 3 and 5 will score a 1. Cumulative values in the range 7 to 11 will score a 2 whereas areas with a cumulative value of 13 to 15 will receive an overall score of 5.

4.2.8 Procedure

Once the scores for each attribute of naturalness have been selected, the following procedure will be used to measure an area's naturalness. Each ecotourism unit identified will then be labelled for identification purposes, and depending on the "units" composition, a score for each of the above seven attributes of naturalness will be recorded. An area's type of naturalness will

be determined by the cumulative score it receives for all of the attributes/biophysical characteristics present for respective areas. The following score ranges are suggested for various types of naturalness.

Type of Naturalness	Score Range anticipated/ accepted
I	31 to 35
II	21 to 30
III	15 to 20
IV	8 to 14
V	1 to 7

A veto system is employed in classifying areas. A type I is not possible if a score of 3 is recorded for two or more attributes present within the area. Type II landscapes require that no more than two attributes/characteristics have a score less than three, with at least one attribute scoring a 5. A type III landscape is not possible if a score of lower than 2 is recorded for three or more attributes. A type IV is not possible if an area scores a one for more than three attributes.

The following chart outlines example landscape characteristics for each of the naturalness types.

NATURALNESS TYPE	CHARACTERISTICS
I	• absence of permanent settlement • absence of extractive activities • mixed forest coverage • very remote landscapes • access arduous • protected areas, mixed landscape features
II	• absence of permanent settlement • no logging practices evident • some clearing as a result of natural fires • mixed forest coverage • access hard • wildlife viewing at certain uncontrolled sites

NATURALNESS TYPE	CHARACTERISTICS
III	• presence of temporary settlement • evidence of logging practices on the landscape • clearing as a result of fire (natural) and cutting (human) • similar forest coverage • access difficult to moderate • some variety in landscape features
IV	• presence of permanent settlement (small towns) • multi-use areas • sparse forest coverage, burns and cutovers • moderate access • no protection for wildlife • homogeneous landscape
V	• presence of permanent settlement (industrial based) • multi-use areas • poorly vegetated areas, recent clearcuts • access easy to moderate • homogeneous landscape features • wildlife viewing close to areas of permanent settlement

4.3 Stage three

This stage builds on the previous one. Overlays will be produced for the overall study area for the seven attributes that were used to measure an area's naturalness. Any cultural heritage areas, present for the study area, will be added as a new layer. All eight attribute layers will be treated as equal and overlayed on each other to identify those areas where the greatest mix of attributes, that are deemed suitable for ecotourism, are present. Areas which are classified as types I and II, which include components of cultural heritage may be consdered as the best option for ecotourism. The next best option areas are those regions classed as a type III landscape, with evidence of some cultural heritage features present in the landscape. Using the 16 classes listed in Appendix 1, it is possible to suggest that the most optimal areas for ecotourism would include components of the following classes: 8, 7, or 6 (mixed

forest > 10 % white, red and white and red pine, respectively), 13 (wetlands: bogs, fens and marshes) and some class 14 (bedrock outcrops: potential scenic vistas) and 16 (water: potential for viewing wildlife along with fishing).

GIS is viewed here as an adaptive and integrative technology. If areas of type I and II can not be easily identified, it may be necessary to eliminate a number of the layers and alter the sequence in which the layers are overlayed. Furthermore, if no significant areas are determined as a result of this methodology, smaller areas (those with the highest values) may be selected for more intensive examination, or the parameters for each of the eight attributes may be redefined in order to qualify more areas for ecotourism.

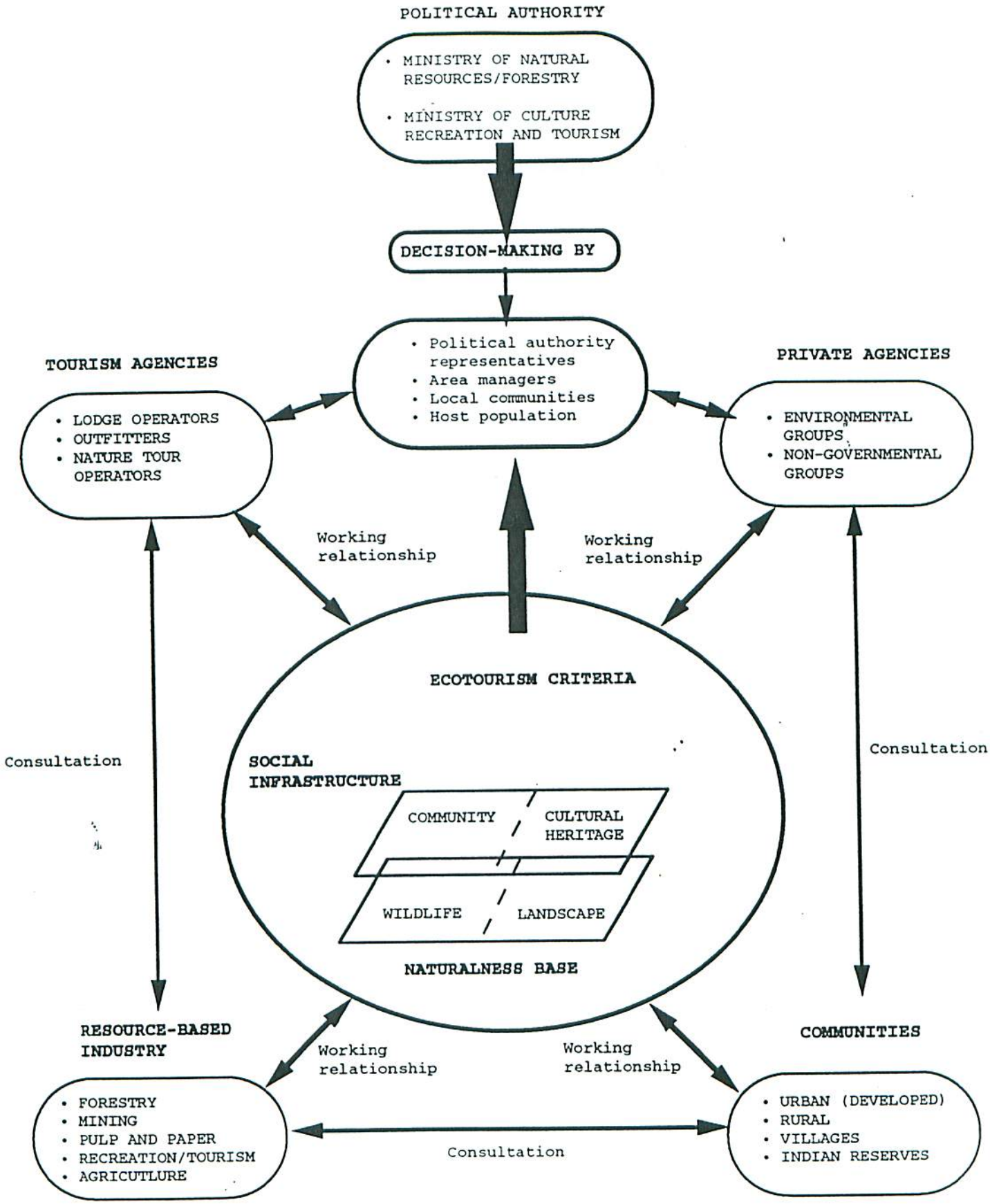
5.0 CONSTRAINTS AND LIMITATIONS OF GIS

It should be noted that the following discussion does not include any limitations which are technical in nature. Rather the emphasis here is to illustrate that GIS represents a technology which facilitates in the collection of data for an area's resource inventory. It is not a decision-making tool but rather provides the information in a form in which decisions can be made. Figure 2 explores this in detail, outlining the co-operation and consultation needed between agencies, communities, and industry in order to make decisions which are based on the interests of the various groups involved and in line with the characteristics of the area itself. A preference for decision-making which involves representatives all of interested groups (tourism agencies, private agencies, resource-based industry and communities) may be superceded by a top-down structure in which the decision-making is the sole responsibility of a political authority.

Geographical Information Systems do address the setting in which experiences and preferences may be realised, but do not address the experience and preferences themselves. For the latter, additional information is needed which is often obtained from surveys and interviews with participants.

Attributes such as quality and expectations may be based on experience and norms of preferred activity levels and number of users in order to maintain high satisfaction levels. While there are no norms for ecotourism, there are norms for river and wilderness recreation (see Appendix 2). These may be substituted for some of the activities offered in an ecotourism opportunity. A related problem is that of carrying capacity. GIS cannot determine the carrying capacity of sites. Onsite investigation is necessary in order to ensure that the capacity of areas have not been exceeded. The fact

FIGURE 2: STAKEHOLDERS AND DECISION-MAKING FRAMEWORK (modified after Millar, in press)



that ecotourism areas may be more fragile in nature than other regions, it is important to stress that although frequency of users may be low, the absence of managerial control within areas will generate problems for the whole area and the nature of the experience the region offers.

6.0 CONCLUSIONS

This report has focused on outlining how criteria discussed in the previous report can be incorporated into a Geographical Information Systems (GIS). This report has reviewed the hardware and software components of the GIS. This report has also outlined the various stages of a methodology in which eight attribute layers will be created to form overlays from which ecotourism areas may be identified. It should be noted that the methodology may change as the GIS component of the overall study is undertaken and so the methodology should be viewed as subject to ongoing refinement of ideas. The last section of this report addressed the limitations of GIS for the purposes of illustrating that although GIS may be useful in determining what areas, in terms of measureable attributes, are best suited for ecotourism, qualitative aspects such as community input, and management issues also need to be addressed in determining what areas may have potential for ecotourism.

APPENDIX 1
Land use classes

Class

Dense Forest:

1. Dense coniferous forest, > 80 % jack pine
2. Dense coniferous forest, > 80 % black spruce
3. Dense deciduous forest, > 80 % deciduous
4. Mixed forest, > 50 % deciduous; red and/or white pine, if present, < 10 %
5. Mixed forest, > 50 % coniferous; red and/or white pine, if present, < 10 %
6. Mixed forest, > 10 % white pine
7. Mixed forest, > 10 % red pine
8. Mixed forest, > 10 white and red pine

Sparse Forest:

9. Sparse coniferous forest, > 20 % deciduous
10. Sparse forest, > 80 % deciduous; burns and cutovers > 10 years old
11. Poorly vegetated areas; shrub cover on cutovers and burns
12. Clearcuts and burns < 10 years old

Non-Forest Classes

13. Wetlands: bogs, fens, marshes
14. Bedrock outcrops
15. Agriculture, built-up areas, mine tailings
16. Water

Source: Spectranalysis Inc., 1992.

APPENDIX 2

EXPERIENTIAL NORMS FOR RIVER RECREATION AND BACKCOUNTRY EXPERIENCES

Activities	Encounter levels for different settings *			
	General	Wilderness	Semi-Wilderness	Undefined Recreation
Canoeing				
- tubers	0-2.3			
- canoers	0-5.7			
-fishermen	0-7.2			
Fishing				
- floaters	0-6.5			
- boaters	0-5			
- fishermen	0-25			
- anglers				
- bank anglers	0-13			
- all river users	2 ->50			
Floating				
- floateres	0-4	1.5	3.0	2.5
- jet boaters	0-10	1.5		
- all river users		0-4	0-5	0-10
Rafting				
- all river users	0-25			
Boating				
- boaters	11			
- commercial users	4-10			
- private users	5-25			
General		1-2.3	2-4.5	2-7.5
- boaters		10	25	50
Jet Boating	0-100			
- floaters		4.4		

Wilderness Visiting

- canoers	3.5
- motor boaters	0
- backpackers	3-9.5
- horseback parties	1-8.5
- campers	1-3

* Encounter norms listed are based on case studies withinacademic literature on experiential norms.

Source: Butler et al., 1993.

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