State-of-the-Wilderness Reporting in Ontario: Models, Tools and Techniques

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Abstract—State-of-the-environment reporting is used by organizations to inform people about the status of natural resources and health of ecosystems, to recognize and respond to changing environmental conditions and to help citizens better understand their relationship with the ecosystems in which they live and work. The status of wilderness is an important part of state-of-the-environment reporting. Recent opinion polls and consultations on Crown land use planning have confirmed that Ontarians value wilderness and remain concerned about its future. This paper reviews the history of wilderness protection in Ontario and proposes a framework for state-of-the-wilderness reporting. The framework is based on a definition of wilderness and the identification of specific wilderness characteristics.

As in other parts of the world, Ontario's agricultural and industrial growth has marked the decline of wilderness. Aboriginal peoples used fire to clear land for agricultural purposes. European settlers accelerated the removal of trees, built roads and created communities in the pursuit of timber, farms and better lives. Consequently, population growth, intensive agriculture and an expanding industrial base have significantly reduced the quality and quantity of wilderness. In a mere 300 years, just 15 generations, wilderness in Ontario has been relegated to the more remote and isolated parts of the province.

Like many other societies, Ontario values wilderness for different reasons. Some Ontarians view it as a storehouse of natural resources, to be used for social and economic gain. Others see it as a living system, replete with natural wonders and opportunities for discovery, where people live in harmony with nature. Most would agree that wilderness is vast, remote and unspoiled. To many others, however, wilderness can be a small, isolated ravine or a wood lot within a highly developed urban setting.

While our opinions vary greatly, Ontarians are passionate about wilderness. Oracle Research reported in 1996 and 1998 that 97% of people polled believed that protecting wilderness areas was very important and 86% believed that as much as 20% of existing publicly owned land should be set aside for wilderness protection. In a another study, Manifest Communications (1996) reported that 81% of people polled agreed that provincial parks were very important to Ontario's identity and that wilderness is the defining characteristic in people's sense of what makes Ontario's parks special and unique.

This paper provides a brief history and status report on wilderness protection in Ontario. It outlines a framework for state-of-the-wilderness reporting; describes an ecosystem classification model used to determine the distribution, nature and status of wilderness; describes a model to identify and delineate remaining wilderness; and shows how recent Crown land-use planning has contributed to wilderness protection. The application of Ontario's Natural Resource Information System (NRVIS) and related ARC/INFO GIS tools to the framework are illustrated. The paper also presents some preliminary ideas on a wilderness quality index designed to allow natural resource managers to measure the quality and quantity of the wilderness condition and experience.

Ontario's Natural Diversity

The province's northern limits are marked by subarctic tundra along the Hudson Bay Coast. Boreal forest dominates the expansive Canadian Shield; while mixed forests surround the Upper Great Lakes. Farther south, Carolinian forest parallels the shores of Lakes Erie and Ontario. These regions include 1,068,580 km^2 of lands and waters, of which 87% is Crown-owned. They also support more than 2,000 native species of vascular plants, 450 species of mosses and liverworts, about 1,000 species of fungi, lichens and algae, thousands of invertebrate and close to 600 vertebrate species. With arctic, boreal, Great Lakes, Carolinian, prairie and coastal plain species affinities, Ontario truly represents an ecological melting pot in North America. (Beechey and Davidson, 1992).

History of Wilderness Protection in Ontario

In 1885, Alexander Kirkwood suggested that a park be created between the Ottawa River and Georgian Bay to protect the headwaters and forests of the Muskoka, Petawawa, Bonnechere and Madawaska Rivers. By 1893, Kirkwood's Algonquin Park, with an area of 3,797 km^2,

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arguably became Ontario's first wilderness park. Other large parks slowly followed, including Quetico (4,650 km^2) in 1909 and Lake Superior (1,399 km^2) and Sibley (163 km^2) in 1944 (Killan, 1993). While logging, mining and some commercial activities were permitted in these early parks, they formed the nucleus of a growing system of protected wilderness areas.

By the late 1960s, Ontario's system included 96 parks, ranging from small roadside picnic areas to vast and remote wilderness-like parks. It became evident that no one park could be all things to all people. In response, Deputy Minister G.H.U. "Terk" Bayly introduced a policy that provided for different kinds of parks, including primitive parks designed to protect large representative landscapes. These parks were to exceed 25,000 acres (10,125 hectares), include natural features in their wild condition and provide high quality wilderness recreational opportunities (Ontario Department of Lands and Forests, 1967). On April 30, 1970, Polar Bear Provincial Park (24,087 km^2) became Ontario's first primitive park.

In 1978, a new policy redefined primitive parks, as wilderness parks and proposed that one wilderness park and at least one complementary wilderness zone in another class of park be established in each of Ontario's natural regions. Quetico and Killarney (451 km^2), formerly natural environment class parks, joined Polar Bear as wilderness parks. By this time, Ontario and Canada had also reached agreement on the creation of Pukaskwa National Park (1,878 km^2). Five new wilderness parks including, Opasquia (4,730 km^2), Woodland Caribou (4,500 km^2), Wabakimi (1,550 km^2), Lady Evelyn-Smoothwater (724 km^2) and Kesagami Lake (560 km^2) were established in 1983 as part of the implementation of the new policy. By the early 1980s, substantial wilderness zones also had been created in Sibley, Lake Superior and Algonquin Provincial Parks by management plans.

The 1978 provincial park policy defined wilderness parks as: "substantial areas where the forces of nature are permitted to function freely and where visitors travel by non-mechanized means and experience expansive solitude, challenge and personal integration with nature" (Ontario Ministry of Natural Resources, 1978). Logging, mining, sport hunting and commercial fishing were prohibited, while mechanized travel, tourism facilities and other consumptive uses were controlled in wilderness parks. These parks were to average 100,000 hectares in size and, as an absolute minimum, would not be less than 50,000 hectares. Wilderness zones in other classes of park were to range from 5,000 to 50,000 hectares in size and, as an absolute minimum, would not be less than 2000 hectares.

Efforts to protect wilderness were renewed in the 1990s. A new wilderness zone was added to Algonquin (250 km^2), and a major addition to Wabakimi (7,371 km^2) created one of the largest protected areas of boreal forest in the world. A new category of protected area, called conservation reserves, also was created to help protect wilderness values. These actions were followed by the release of *Ontario's Approach to Wilderness: A Policy* that confirmed government's intent to complete a system of wilderness parks and zones, define the contribution of other designated areas to the protection of wilderness values and address the protection of wilderness values through ongoing management of undesignated areas on intervening landscape and waterscapes (Ontario Ministry of Natural Resources, 1997).

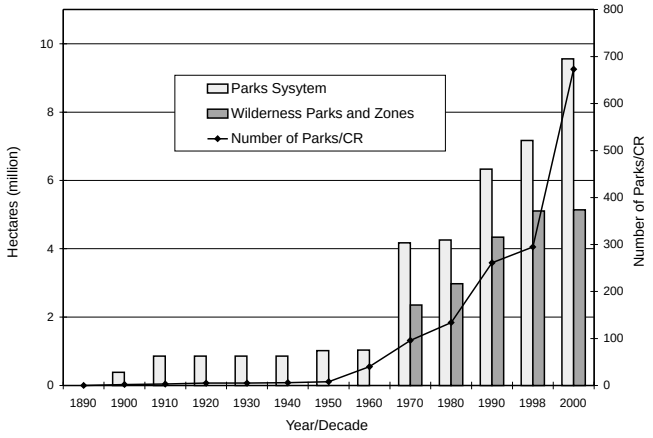


Figure 1—Growth of Ontario's wilderness parks and other protected areas.

Today, wilderness parks, including Pukaskwa National Park, are found in 10 of Ontario's 14 natural regions. Wilderness zones have been established in five natural regions. These parks and zones incorporate 5,105,866 hectares, or 4.78% of Ontario's total lands and waters. When combined with other classes of provincial parks and conservation reserves, it could be argued that as much as 7,170,868 hectares, or 6.6% of the province has been assigned to protect wilderness values (fig.1).

Towards a State of the Wilderness Report

Many large natural areas have been protected, but do we share a common understanding or definition of wilderness? Is there any real wilderness left in Ontario? If there is, how do we map it, measure it and manage it? Can more be done to protect it, restore it? Do we know the state of its health or its ecological integrity? Has society in Ontario done enough to protect wilderness? The overwhelming public support for wilderness and the expectation that as much as 20% of all public lands should be protected as wilderness would suggest that much more needs to be done.

A framework for state-of-the-wilderness reporting is presented here to help answer these questions and bridge the gap between the current state of wilderness protection and the expectations of the Ontario public. This framework is premised on the following definition of wilderness.

> In its purest form wilderness is vast and primeval. It includes pristine landscapes and waterscapes, native plants and animals and clean water and air. It is a place where nature functions freely, unencumbered by human agricultural and industrial activities. Wilderness is a place of natural wonder, a place of scientific and educational discovery and a place of solitude that has nurtured the evolution of the human body and spirit.

As part of the framework, nine fundamental wilderness principles were developed, using keywords in the definition.

These principles were used to define tangible wilderness characteristics that can be mapped and measured. Utilizing this conceptual framework, models for ecosystem classification, wilderness area identification and a wilderness quality index are being developed. Specific tools and techniques associated with each of these models also have been applied, or are under construction, as methods of measuring the quality and quantity of wilderness (fig. 2).

Specifically, the Natural Resources Values Information System (NRVIS) has been an important tool for assessing wilderness. This geographic information and database management system houses a variety of data on natural values (such as topography, forest cover, wetlands, and fish and wildlife habitats) and the impacts of human activities (including mine sites, pits, quarries, roads and timber harvest areas). NRVIS allows users to work with resource issues and programs in a number of spatial and tabular formats; supports data standardization, integration, data access and sharing; and, provides a variety of spatial frameworks in which to work. It has been invaluable in permitting us to explore, integrate and map a variety of wilderness characteristics.

Ecological Classification Model

Wilderness and its characteristics must be organized and cared for in the context of the ecosystems of which they are part. An ecologically meaningful spatial classification system is a prerequisite for reporting on the state of wilderness. The classification of ecosystems, supplemented by other scientific classifications, permits us to identify a range of representative natural and cultural features, or wilderness characteristics, and to define the diversity and interrelationships that collectively define wilderness.

Ecosystems can be very large or very small, with smaller ecosystems fitting into larger ecosystems. This hierarchical organization has been described as: "successive encompassing levels of interacting components or units" (Grobstein, 1974) that constitute a system of "discrete interactive levels" (Pattee, 1973). The task of spatially and temporally delineating and describing ecosystems is called ecosystem classification. The criteria used to identify ecosystem boundaries are based on the factors and forces that create and shape ecosystems. For example, large ecosystems can be delineated by integrating climate and physiography, while smaller ecosystems can be identified through examination of landforms and vegetation patterns.

The Ministry of Natural Resources has used an ecological land classification since Angus Hills developed a system in 1959 and updated it in 1961 and 1964. Hills' approach provided a broad-scale ecological context for resource management planning, whereby he divided Ontario into 65 smaller site districts, nested within 13 larger site regions based on climate, physiography and biological productivity. This classification has been adopted as a key part of Ontario's Provincial Park Policy. As noted earlier, the policy's intent is to establish one wilderness park and at least one complementary wilderness zone in each natural (site) region. Site districts and even smaller ecosystems, called landscape units, provide context for establishing smaller classes of park and other protected areas. (McCleary, Davidson and Beechey, 1991).

Today, a modified Hills' ecological land classification, including 67 site districts and 14 site regions, remains the standard for setting the geographic needs for parks and protected areas (Ontario Ministry of Natural Resources, 1997). Site regions characterized by their climate, physiography and biological productivity delineate large ecosystems,

KEYWORD	PRINCIPLES	CHARACTERISTICS	TOOLS and TECHNIQUES	MODELS
Science	***Founded on knowledge of nature***	Ecosystem diversity	NRVIS/GIS Ecosystem classification	**Ecosystem Classification**
Nature	***Vital force, essential quality***	Geological representation Biological representation Cultural representation	Geological classification Biological classification Cultural based classifications	
Vast	***Immense, huge, very great***	Road Density Size in Hectares	NRVIS-ARC/INFO	**Wilderness Identification**
Primeval	***Ancient, primitive, first age of the world***	Undisturbed natural areas Forest cover by age class	Gap Analysis NRVIS-FRI/ LANDSAT	
Pristine	***Old and unspoiled, fresh as new***	Presence of Old Growth Ecosystems	NRVIS/ARC-INFO/LANDSAT/FRI Inventory, monitoring & assessment	**Wilderness Quality Index**
Native	***Innate, indigenous, not exotic***	Native flora Native fauna	Inventory, monitoring & assessment NRVIS/ARC-INFO	
Clean	***Free of contaminated matter***	Clean air, water and soil	Inventory, monitoring & assessment	
Agricultural and Industrial	***Unencumbered by cultivation, rearing of animals or mechanized development***	No agricultural lands No industrial infrastructure	NRVIS/ARC-INFO	
Solitude	***Being alone, a lonely place***	Remoteness Distance form roads	Census Park user survey	

Figure 2—A framework for state-of-the-wilderness reporting.

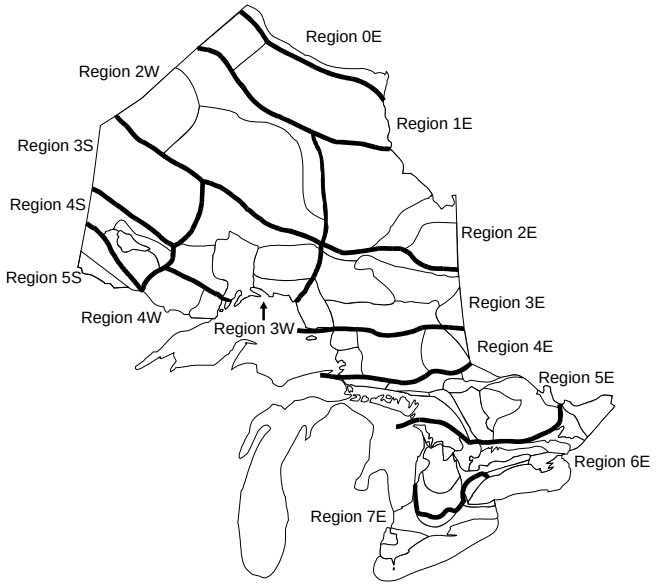


Figure 3—A modified Hills ecological land classification.

within which wilderness and wilderness characteristics are organized and measured in space and time (fig. 3). Successively smaller ecosystems - site districts and landscape units - permit the organization of Ontario's biological diversity by identifying representative or typical recurring landform and vegetation patterns and the communities and species they support (Beechey, 1981). The occurrence of these recurring patterns within wilderness areas provides a more detailed measure of the diversity and quality of Ontario's wilderness.

Ideally, one classification with which people can communicate, share knowledge and information, educate each other and make decisions is preferred. But no single classification can provide the context to address all wilderness questions and issues. The Hills' system, for example, does not adequately address aquatics, nor does it deal with geology or archaeology. Geological classification, for example, has been used to identify Ontario's representative earth science features (Davidson, 1982). As in ecological classification, the occurrence of representative earth science features can provide a measure of the overall diversity of an area. The Ministry's NRVIS and related GIS tools also permit users to select and work with any subset of themes and to overlay and interpret issues that cross both natural and administrative boundaries. Accordingly, wilderness managers must have access to a variety of other spatial classification systems.

Wilderness Identification Model

Ontario is in the enviable position of having wilderness in provincial parks and other protected areas and on intervening landscapes and waterscapes. A commitment to protect all or part of this wilderness requires managers to know how much of it is there and where it is located. To do this, a model has been developed to identify the size and extent of remaining wilderness in the province. The model is based on the keywords vast and primeval. By definition, wilderness is vast, immense, huge and very great in nature. It also is primeval, ancient and reflective of a primitive world. Wilderness characteristics selected to reflect these principles include the absence of roads, the relative size of roadless areas and the presence of undisturbed natural areas.

Roads and railroads are a reasonable indicator of how deeply our agricultural and industrial society has penetrated wilderness. Appropriately, roads and railroads are used as defining variables in the model. Using data on the province-wide distribution of primary, secondary and tertiary roads, trails and rails available in the Natural Resources Values Information System, ARC/INFO GIS software was used to identify areas without roads. Discreet roadless areas were delineated based on 1, 5 and 10 kilometer buffers from the nearest road or railroad (fig. 4). Those areas falling within the 5 and 10 kilometers buffers were then organized into roadless wilderness blocks of 2,000-5,000, 5,000-10,000, 10,000-50,000, 50,000- 100,000 and greater than 100,000 hectares in size (fig. 5).

The model indicates that in the highly developed southern landscape, only a few small fragments of wilderness remain. Across the length of the Canadian Shield, blocks of wilderness isolated by a well-developed network of highways and logging roads become more frequent and larger. Farther north, at the end of the road(s), isolated blocks gradually coalesce into one large contiguous block whose edge delineates Ontario's wilderness frontier. This evolving picture shows that as much as 514,673 km^2, or 52 percent of Ontario's lands and waters, falls within blocks of wilderness more than 5 to 10 kilometers from the nearest road. Not withstanding their limitations, these data provide a reasonable first approximation of the size and extent of Ontario's remaining wilderness.

By superimposing ecosystem classification and roadless area mapping, it is possible to determine the amount and location of potential wilderness in each ecosystem in Ontario by site region, site district or smaller ecosystems. An accounting of total potential wilderness area by site region, based on 1, 5 and 10 kilometer distances from roads, is provided in figure 6. A map of Site Region 3W, including Site Districts 3W1, 3W2, 3W3 and 3W5, also is provided to illustrate the shape and distribution of roadless blocks in a large ecosystem (fig. 7). When mapped, larger roadless wilderness blocks become meaningful as candidate wilderness parks and protected areas; while smaller roadless blocks, and patterns of roadless blocks, on intervening landscapes and waterscapes identify opportunities to manage wilderness characteristics, in the hope of retaining and restoring larger blocks over space (large ecosystems) and time.

If we assume that large roadless areas retain many of their inherent natural values, to some degree, we have addressed the primeval nature of wilderness. To embellish our search for a representative primitive world, we can apply a tool called gap analysis. Gap analysis defines representation on an ecosystem basis. It identifies landforms using existing geological maps and landcover data sets using Forest Resource Inventory (FRI) and Satellite Imagery (LANDSAT). These data sets are overlain to create a matrix of representative landform and vegetation (L/V) types at a site district level. Representative L/V types found inside protected areas are considered to be protected and removed from the equation. The remaining L/V types, or gaps, are

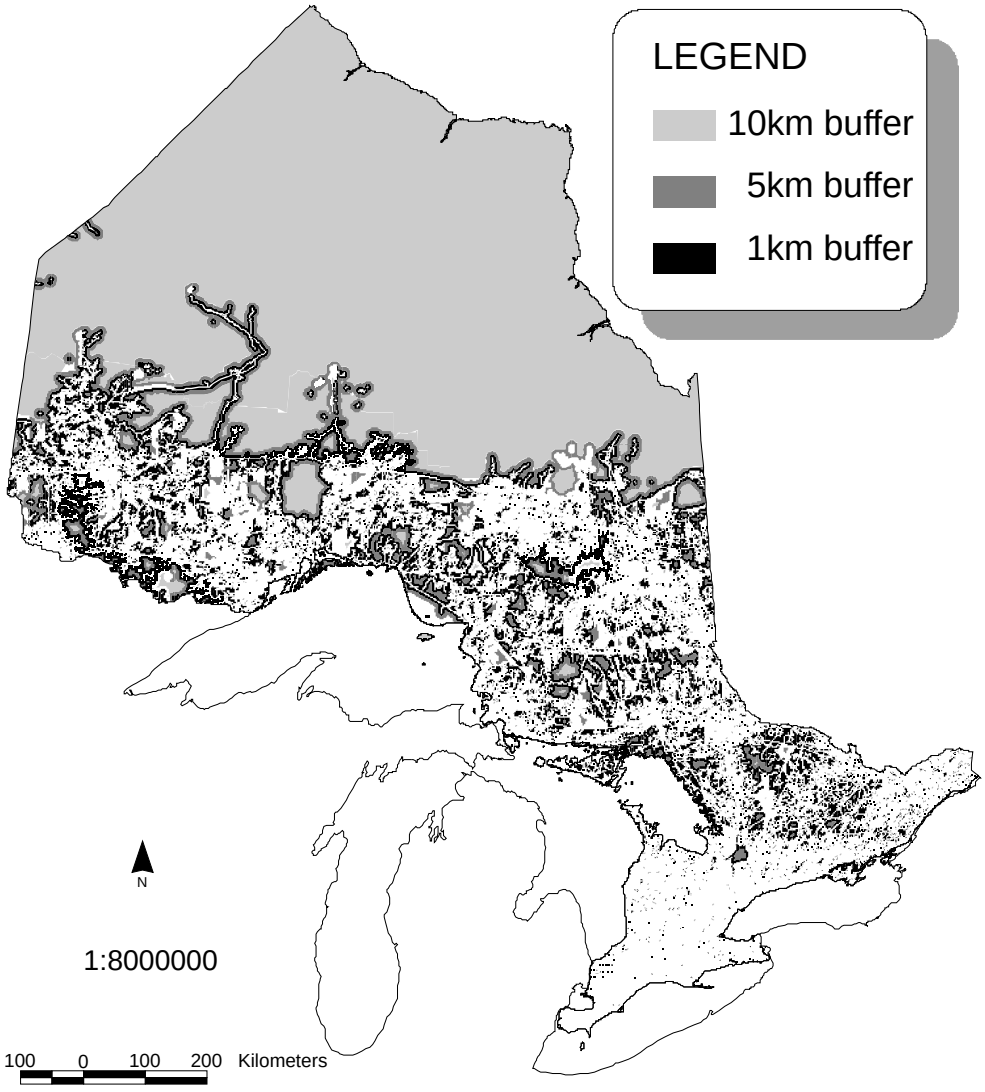


Figure 4—Ontario's wilderness frontier.

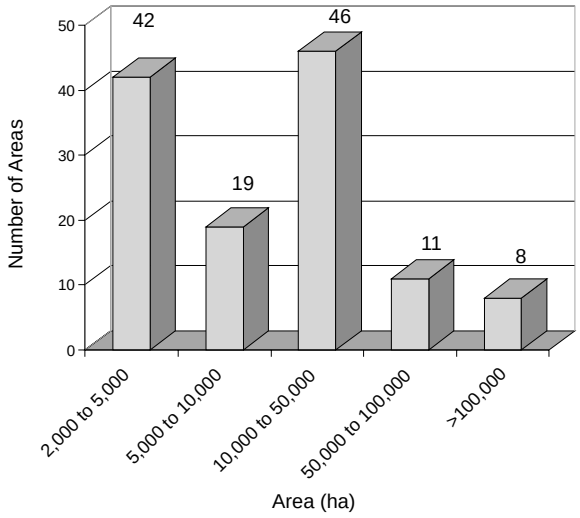


Figure 5—Roadless area blocks 5 kilometers from the nearest road.

Site Regions	10 km	5 km	1 km	Roads	TOTAL
0E	100.0%	0.0%	0.0%	0.0%	100.0%
1E	100.0%	0.0%	0.0%	0.0%	100.0%
2E	90.6%	4.4%	3.7%	1.3%	100.0%
2W	88.1%	6.0%	4.6%	1.3%	100.0%
3E	2.9%	8.2%	29.7%	59.3%	100.0%
3S	65.6%	12.7%	14.7%	7.1%	100.0%
3W	18.9%	10.9%	28.7%	41.5%	100.0%
4E	1.1%	6.4%	35.4%	57.2%	100.0%
4S	13.2%	6.9%	32.6%	47.3%	100.0%
4W	2.4%	8.3%	31.1%	58.1%	100.0%
5E	0.1%	2.2%	28.1%	69.6%	100.0%
5S	2.5%	12.1%	35.6%	49.9%	100.0%
6E	0.0%	0.4%	4.7%	94.9%	100.0%
7E	0.0%	0.0%	0.9%	99.1%	100.0%
Total	46.6%	5.7%	15.6%	32.2%	100.0%

Figure 6—Roadless areas by Site Region.

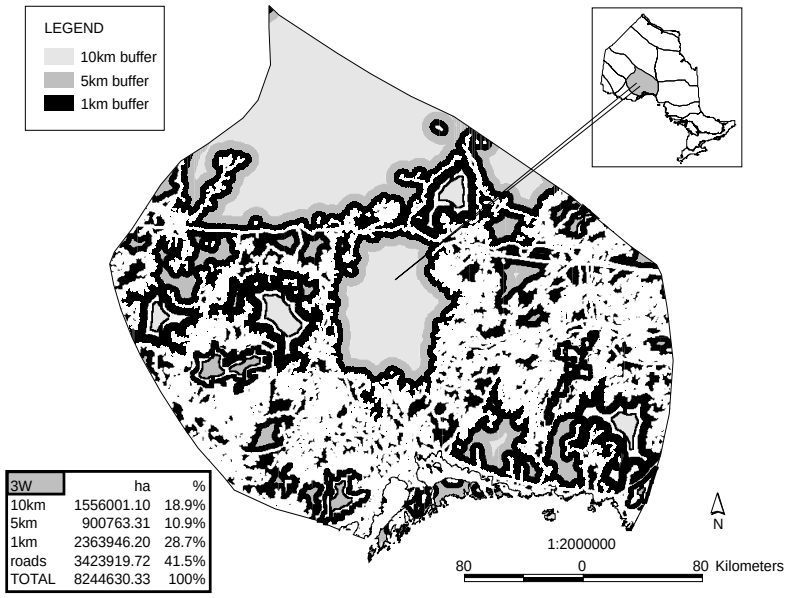


Figure 7—Roadless areas in Site Region 3W.

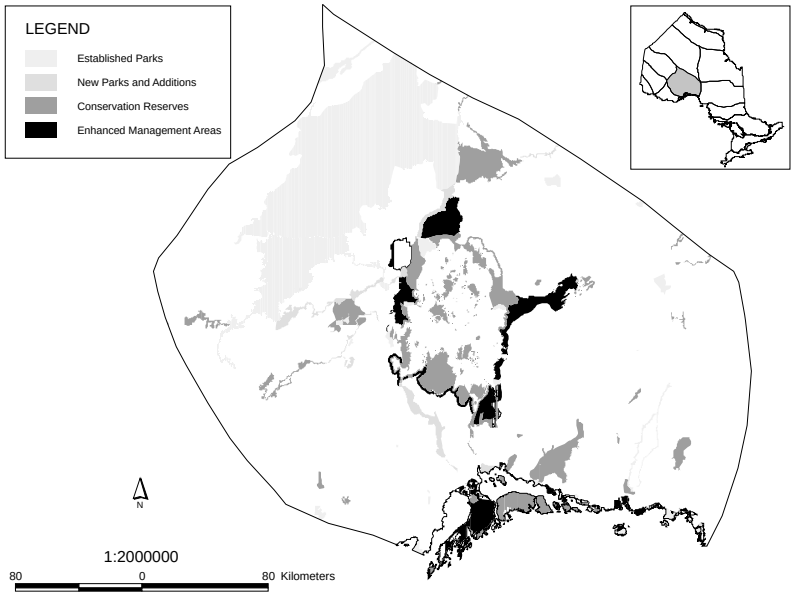


Figure 8—Land-use designations in Site Region 3W.

then screened for human disturbance and assessed for their diversity, ecological condition and special features. The best examples of the remaining L/V types are then identified and mapped using ARC/INFO (Crins and Kor, 1998). The coincidence of "large roadless blocks" and "representative gap sites" are used to help identify wilderness areas that retain their primeval wilderness characteristics.

In the last two years, ecosystem classification, gap analysis and roadless areas have played an important role in developing Ontario's Crown land use planning strategy (Ontario Ministry of Natural Resources, 1999). This strategy addresses protected areas, angling, hunting, tourism and industrial needs in an area roughly corresponding to Ontario's Canadian Shield. The strategy also proposes a variety of land use designations, including provincial parks, conservation reserves, forest reserves, enhanced management areas and general use areas. In many cases, forest reserves and enhanced management areas that either exclude or control logging and other industrial activities are nested alongside provincial parks and conservation reserves (fig. 8). This combination of new land use designation provides the opportunity to manage designated and undesignated wilderness areas and wilderness characteristics in a larger ecological context.

The land use strategy recommends 61 new provincial parks, 45 park additions and 272 conservation reserves, ranging in size from 31 to 158,729 hectares, and totaling 2,386,679 hectares of lands and waters. Many of these lands and waters fall within roadless blocks more than 5 to 10 kilometers from the nearest road. When added to the existing provincial park and conservation reserve system, Ontario's network of protected areas could grow to include as many as 629 areas and 9,424,068 hectares, or close to 9% of the province's total area. This enlarged system of protected areas would include 23 areas that exceed the 50,000 hectare minimum size standard set for wilderness parks and include more than 250 areas that exceed the 2,000 hectare minimum size standard set for wilderness zones.

Wilderness Quality Index Model

As society continues to pressure Ontario's remaining wilderness, natural resource managers will need detailed information on the variation in the quality of wilderness and on the factors that influence wilderness. We will need to know what areas have high value and the reasons for this value. To help address these needs, Ministry of Natural Resources staff are exploring the idea of a wilderness quality index to rate/rank areas for their wilderness values. A major purpose of the index would be to determine the relative condition or ecological integrity of Ontario's remaining wilderness. The index would build on the definition of wilderness and wilderness characteristics and constitute part of an overall framework for reporting on the state of wilderness. It would be the product of a procedure in which a combination of wilderness characteristics are rationalized, measured and possibly weighted, ranked and assessed using simple arithmetic.

Some preliminary thoughts on an index are presented here, as simple illustrations, in anticipation of a more systematic and rigorous approach to the design and development of wilderness indices in the future. To start, the index should be founded on some basic principles. It should be simple, logical, practical and user-friendly. It should be easily applied to defining, evaluating and monitoring wilderness characteristics. It should reflect society's values and measure physical characteristics that people attribute to wilderness. A wilderness index also should be sensitive to ecosystem size and based on readily accessible or easily recorded data and information.

Qualitative, and/or quantitative approaches, similar to those used by Parks Canada (1998), can be used to assess and measure wilderness characteristics in relation to human- induced stresses. For example, a qualitative approach can be used to identify human- induced stresses and record their presence or absence using a simple YES/NO response. The cumulative number of YES or NO responses for a geographic area can then be used as a relative assessment of wilderness value and permit the comparison and ranking of one area against another. A quantitative approach can measure the degree or severity of a selected human-induced stress, or combination of stresses, to establish their cumulative effects. If quantifiable data and information are not available, use of explicitly rationalized surrogate expert opinion could be considered. A number of possible wilderness characteristics that could be measured and some of their possible outputs are summarized in figure 9.

Wilderness characteristics were identified to reflect an areas ecological diversity, recreational values and human interference patterns. No measure is completely unique to the assessment of just one characteristic, and in some cases, several measures of a single wilderness characteristic are possible. For example, absence of water pollution can be measured using water quality standards for alkalinity, aluminum, calcium, chloride, chlorophyll a and dissolved organic carbon. One measure also can represent two or more characteristics. For example road density can, in some cases, provide information about the extent of human activity and access in an area. Therefore, it is important to acknowledge the potential for redundancies and the need to minimize them when creating an index.

A simple example of a wilderness quality index could include an estimate (on a scale of 0 to 1.0) calculated by adding together the scores for all wilderness measures and dividing the total number of points available. Three different roadless wilderness areas in Site Region 3E in northeastern Ontario, for example, were selected and evaluated using the following formula (fig. 10).

$$WI = \dot{Y}\ V_{1\text{-}15}/15$$

$$WI = V_1+V_2+V_3+V_5+V_6+V_7+V_8+V_9+V_{10}+V_{11}+V_{12}+V_{13}+V_{14}+V_{15}\ /15$$

Where Vn = 0.0 to 1.0 and 1.0 includes the highest wilderness-like qualities.

A wilderness quality index can help managers to determine the presence or absence of wilderness characteristics in a selected geographic area. This permits the ranking of wilderness areas using a common approach, or yardstick to measures the relative value of each wilderness characteristic. Once areas have been ranked, management priorities for protecting or enhancing its wilderness characteristics can be determined before or after an activity is scheduled to occur. The index can act as a benchmark, against which we can measure the current status of wilderness characteristics on intervening landscapes and waterscapes and contribute, to state-of-the-environment reporting. It also can provide a measure of the success or failure of agency or organization efforts to restore the primeval condition.

Summary and Conclusions

Ontario is truly fortunate. While much of our southern wilderness has been lost, there are still significant opportunities to explore Ontario's northern wilderness. This can be attributed to the remote and rugged nature of the north and to the passion most Ontarians have for wilderness. This passion has helped Ontario's system of provincial parks and conservation reserves grow to include 295 areas and more than seven million hectares of lands and waters. Recent Crown land use planning proposals recommend that another 333 areas and more than 2.4 million hectares be added to this total. The vast majority of these lands and waters are either formally designated and managed as wilderness or are managed to retain wilderness characteristics.

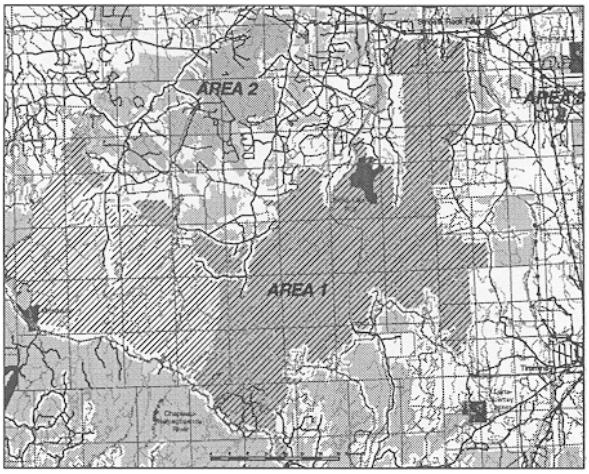
A framework for state-of-the-wilderness reporting has been proposed here to facilitate the identification, protection and management of wilderness in Ontario. This framework

Definition	+/- Wilderness Characteristic	Measurable Impacts	Qualitative Measure	Quantitative Measure
Science	Ecological Diversity	Representation	YES/NO	Number large/small ecosystems
Nature	Geological Features	Representation	YES/NO	Geological diversity
	Biological Features	Representation	YES/NO	Biological diversity
	Archaeological Features	Representation	YES/NO	Archaeological diversity
Vast	Large Area Size		YES/NO	5,000 ha. (Minimum)
Primeval	Roadless	Road Density	YES/NO	50 km of road/10km^2
		Utility Corridors	YES/NO	*x* km of corridor/10km^2
Pristine	Forest Cover	Fragmentation	YES/NO	% fragmentation/10km^2
Native	Native species	Biodiversity	YES/NO	% of total ecosystem species
	Exotic species	Ratio of Exotic to Native	YES/NO	Fraction/Percentage
Clean	Clean Air	Ground Level Ozone	YES/NO	< 50ppb
		SO_2,	YES/NO	< 11ppb
		NO_2	YES/NO	< 32ppb
		CO (Climate Change)	YES/NO	< 5ppb
		Suspended Particulates	YES/NO	< 60kpg/m^3
	Clean Water	Acid Rain	YES/NO	< 4.0pH
		PCBs	YES/NO	< 0.001ppb
		DDT	YES/NO	< 0.003ppb
		Mercury	YES/NO	< 0.2ppb
	Uncontaminated Soils	Erosion (man induced)	YES/NO	Erosion rates
		Mine Tailings	YES/NO	Numbers, size, contaminants
		Solid Wastes (Dumps)	YES/NO	Numbers, size, contaminants
Solitude	Remoteness	Population Density	YES/NO	Percent Population per 10km^2
		Backcountry Visitation	YES/NO	Interior campers/site/season
		Aircraft Flybys	YES/NO	Frequency/day/week
No Agriculture or Industrial Activities	Outdoor Recreation	Sport Fishing	YES/NO	Take by species/number
		Sport Hunting	YES/NO	Take by species/number
		Canoeing	YES/NO	Canoes/area/campsites
		Hiking	YES/NO	Hikers/length of trail/campsites
		Snowmobiles/ATV	YES/NO	Numbers/length of trails
		Park Infrastructure	YES/NO	Area developed
	Tourism	Motor Boats	YES/NO	Numbers/size of motors
		Boat Caches	YES/NO	Numbers/10km^2
		Aircraft Landings	YES/NO	Frequency/day/week
		Main Lodges	YES/NO	Numbers/10km^2
		Outposts	YES/NO	Numbers/10km^2
		Waste Disposal Sites	YES/NO	Numbers/10km^2
		Bait Fishing	YES/NO	Licenses/area covered
	Harvest	Commercial fishing	YES/NO	Licenses/take by species/number
		Commercial Trapping	YES/NO	Licenses/take by species/number
		Wild Rice Harvesting	YES/NO	Licenses/area covered
	Water Control	Dams	YES/NO	Numbers/10km^2
		Diversions	YES/NO	Numbers/10km^2
		Hydroelectric Generation	YES/NO	Numbers/10km^2
		Power Lines	YES/NO	Kilometres/10km^2
	Forestry Practices	Logging	YES/NO	Numbers/percent area logged
		Silviculture	YES/NO	% area tended
	Mining Practices	Mineral Exploration	YES/NO	Size of area/ELOs or claims
		Mining Infrastructure	YES/NO	Numbers/area patent/leases
		Mine Tailings	YES/NO	Numbers, size, contaminants
	Others	Poaching	YES/NO	Charges laid/prosecuted

Figure 9—Measuring human induced stresses.

proposes common definitions for wilderness and wilderness characteristics. It applies a spatially meaningful ecosystem classification system to identify and care for wilderness and wilderness characteristics. The framework includes a model for identifying wilderness areas and reviews the success of recent Crown land use planning in protecting wilderness. The framework also recognizes the need to record and monitor the ecological integrity of wilderness over time and space. It is proposed that a Wilderness Quality Index be developed to facilitate the monitoring of ecological integrity and the rating of a given area's value as wilderness.

The proposed ***State-of-the-Wilderness*** reporting system has direct application to the development and implementation of wilderness policy and the completion of a system of



Wilderness Characteristics	Rank		
	Area 1	Area 2	Area 3
Rare or unusual biota	.6	.4	.8
Rare or unique landform(s)	.2	.7	.2
Presence of healthy populations or habitats	.9	.3	.6
Presence of intact landform(s)	.6	.6	.1
Size of ecosystem(s)	.6	.3	.1
Absence of water pollution	.9	.2	.6
Absence of air pollution	.7	.5	.6
Absence of soil contamination	.9	.1	.8
Size of the area	.8	.5	.1
Dispersed campsites	.9	.6	.1
Human noise levels	.8	.1	.4
Human contact	.9	.3	.1
Access	.7	.5	.6
Distance from human centres	.6	.8	.1
Absence of human impacts	.9	.2	.8
Score/Potential Total	11.0	6.1	6.0
Index Value (0-1.0)	.733	.407	.400

Figure 10—Map of three roadless areas and sample index for Site Region 3E.

wilderness parks and equivalent reserves in Ontario. The system also can be used to help address the need to protect, restore and monitor wilderness characteristics on intervening landscapes and waterscapes as part of larger regional land use and forest management planning initiatives. It can serve as a powerful tool to help develop, market and manage a wilderness-based ecotourism industry.

References

Beechey, T. J. 1980. A framework for the conservation of Ontario's biological heritage. Queens Park, Toronto: Provincial Parks Branch, Ontario Ministry of Natural Resources. 286 p.

Beechey, T. J. and R. J. Davidson. 1992. Ontario's natural diversity. In: Lori Labatt and Bruce Littlejohn, editors. Islands of Hope: Ontario' Parks and Wilderness. Firefly Books. Willowdale, Ontario: 84-86. ISBN 1895565-10-3.

Crins, W. J. and P. S. G. Kor. 1998. Natural heritage gap analysis methodologies used by the Ontario Ministry of Natural Resources. In: J. G. Nelson and others, editors. Parks and Protected Areas Research in Ontario 1998. Proceedings of the Parks Research Forum of Ontario, Annual Meeting. February 5 & 6, Peterborough, Ontario: 375-392. ISBN 0-9684655-09-1.

Davidson, R. J. 1981. A framework for the conservation of Ontario's earth science features. Queens Park, Toronto. Provincial Parks Branch, Ontario Ministry of Natural Resources. 262 p.

Grobstein, C. 1974. The strategy of life. San Francisco CA: W.H. Freeman, Second Edition. 174p.

Hills, G. A. 1959. A ready reference to the description of the land of Ontario and its productivity. Maple ON: Ontario Department of Lands and Forests. Division of Research, Preliminary Report. 142p.

Hills, G. A. 1961. The ecological basis for land use planning. Toronto ON: Ontario Department of Lands and Forest, Research Report, Number 46, 204p.

Killan, G. 1993. Protected places: A history of Ontario's provincial park system. Toronto, ON: Dundurn Press in association with the Ontario Ministry of Natural Resources. 426 p. ISBN 1-55002-180-X..

Manifest Communications, 1996. Context research: Ontario Parks. Manifest Communications Inc., Toronto, ON: 33 p. plus Appendices.

McCleary, K. G., R. J. Davidson and T. J. Beechey. 1992. Protecting Ontario's natural diversity through provincial parks and areas of natural and scientific interest. In: J. H. Martin Willison and others, editors. Developments in Landscape Management and Urban Planning (7): 129-137.

Ontario Department of Lands and Forest. 1967. Classification of provincial parks in Ontario. Parks Branch. Honorable Rene Brunelle, Minister and G.H.U. Bayly, Deputy Minister. 20p.

Ontario Ministry of Natural Resources. 1978a. Ontario provincial park policy. Updated 1992. Queens Park, Toronto, ON: Provincial Parks Branch. Pamphlet 5739/1978.

Ontario Ministry of Natural Resources. 1978b. Ontario provincial park planning and management policies. Queens Park, Toronto, ON: Provincial Parks Branch.

Ontario Ministry of Natural Resources. 1992. Ontario provincial parks: planning and management policies, 1992 update. Queens Park, Toronto ON: Provincial Parks and Natural Heritage Policy Branch. 90 p. plus appendices.

Ontario Ministry of Natural Resources. 1997. Natures best: Ontario parks and protected areas: the framework and action plan. Toronto, ON: Queens Printer for Ontario. 37 p. ISBN 0-7778-6136-4.

Ontario Ministry of Natural Resources. 1997. Ontario's approach to wilderness: a policy. Version 1.0. Toronto, ON: Ontario Ministry of the Environment. Environmental Bill of Rights, Registry Number PB7E6003D.

Ontario Ministry of Natural Resources. 1999. Ontario's living legacy: land use strategy. July 1999. Peterborough, ON: Queens Printer for Ontario. 90 p, plus map.

Oracle Research. 1998. Views of Ontarians on the environment. Toronto and Sudbury ON: Oracle Research Survey Report. 22p.

Parks Canada. 1998. State of the parks 1997 report. Ottawa, ON: Canadian Heritage. Minister of Public Works and Government Services Canada. Catalogue No. R64-184/1997E. ISBN 0-662-26331-6. 190 p.

Pattee, H. H. ed. 1973. Hierarchy theory - the challenge of complex systems. New York, NY: George Braziller, Publisher.