Applying Criteria and Indicators to Assess Integrity of a Boreal National Park and Adjacent Forest Management Units

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Abstract

Assessing and evaluating ecological integrity is a complex and often subjective task. However, recent legislative changes have forced ecosystem managers to develop more quantitative techniques to measure ecological integrity, particularly in Canada's National Parks. Using a combination of measures for forest sustainability (Canadian Council of Forest Ministers Criteria and Indicators, 1995) and existing regional data sets, a suite of indicators have been structured into a hierarchical framework for monitoring broad-scale, ecological forces (referred to as "drivers of change"), as well as ecosystem, habitat and species dynamics for the Pukaskwa National Park ecosystem. The focus of this project is on the application of indicators as a means of measuring the spatial and temporal aspects of the ecological integrity of the park and its broader ecosystem.

The indicators reveal that: (1) Pukaskwa National Park may be more unique than representative of the central boreal uplands; and, (2) increasing human demand for natural resources, particularly timber, is playing a significant role in the ability of park management to maintain the park's ecological integrity. Road construction in the greater park ecosystem may play a significant role. These are important results that shape the park's management approach and priorities. Continued use of this structural framework for ecological integrity will allow Pukaskwa National Park to be used as a benchmark for environmental change and contribute to the understanding required for mitigating such changes.

Introduction

More and more, resource managers are being asked to account for actions taken on the landscape. This accountability takes such forms as sustainability, biodiversity, health, and integrity. Yet debate has raged on how to define such terms, and more difficulty, how to measure them in such a way as to ensure quantification of the resource's viability over time.

One approach is the development of indicators as a reflection of the state of a particular phenomenon. These indicators are statistics that, tracked over time, provides information on trends in the condition of a phenomenon and has significance extending beyond that associated with the properties of the statistic itself (Environment Canada, 1997). In 1995, the Canadian Council of Forest Ministers developed a series of criteria to measure forest sustainability. Within each of these criteria are a number of indicators which, combined, would be measures of forest sustainability.

Similarly, National Parks in Canada are striving to develop a series of indicators which best reflect their mandate to maintain ecological integrity. Ideally, parks are to look beyond their own administrative boundaries and view the park in terms of its broader, ecological boundary. Granted ecological integrity and forest sustainability are not identical notions, yet there are a number of overlapping indicators to reflect the state of the forest. By measuring a series of these overlapping indicators, this project hopes to facilitate an understanding of the ecological integrity of the park ecosystem. By doing so the park can begin to act as a benchmark to observe ecological changes under two distinct management regimes: a protected area and a forest management unit.

Study Area

The area selected is known as the Greater Pukaskwa Ecosystem. It is located on the north-east corner of Lake Superior and includes Pukaskwa National Park and the adjoining White River Forest. The area is predominantly a boreal mixedwood ecosystem (white birch, black spruce, jackpine, balsam fir) with a rugged topography. It exhibits other characteristics of the boreal mixedwood ecosystem such as moose, and wolf populations, plus the southern most remnant herd of woodland caribou. Pukaskwa National Park's role is to protect a significant and representative part of the Central Boreal Uplands. It was established in 1978 and measures 1,878 square kilometers, which is largely roadless. Human access is generally limited to a 2 kilometer road at the north end and the Lake Superior coastline. The White River forest is a 4,000 square kilometer area that has seen increasing forestry operations since the opening of a sawmill by Domtar Inc. in the town of White River in 1978. Harvesting has occurred concentrically out from the town and is currently within 5 km of the park boundary.

Methods

To begin understanding how to assess ecological integrity, we must first understand what it is. However, this may be more easily stated than done. Parks Canada defines ecological integrity as "a condition where the structure and function of an ecosystem are unimpaired by human induced stresses"(Bouchard, 1997). Other definitions include the maintenance of community structure for a particular locale (Cairns, 1977) or that the resident biota is the product of evolutionary and biogeographic processes (Steedman, 1994). Though there is much debate, Kimmins (1997) finds great redundancy in the term and concludes that integrity, like forest health and other terms, will inevitably be discussed and defined in the context of what society wants for its forest environments. De Leo and Levin (1997) and Noss (1995) suggest that rather than engaging in endless debates over which is the best definition of integrity, it is much more useful to provide a conceptual framework for assessing the impact of human activity on biological systems and to identify practical consequences stemming from the framework.

The framework incorporates various aspects of ecosystem management (Grumbine, 1994). This includes a hierarchical approach and feedback mechanisms. By integrating a hierarchical approach with available data, management direction and external initiatives, this report attempts to best reflect the key spatial and temporal changes throughout the Greater Pukaskwa Ecosystem (Figure 1). In doing this, it is working to answer the fundamental question for all protected areas: is the park protecting what it was established to protect? More simply, is the park, as a protected area, doing "its job?"

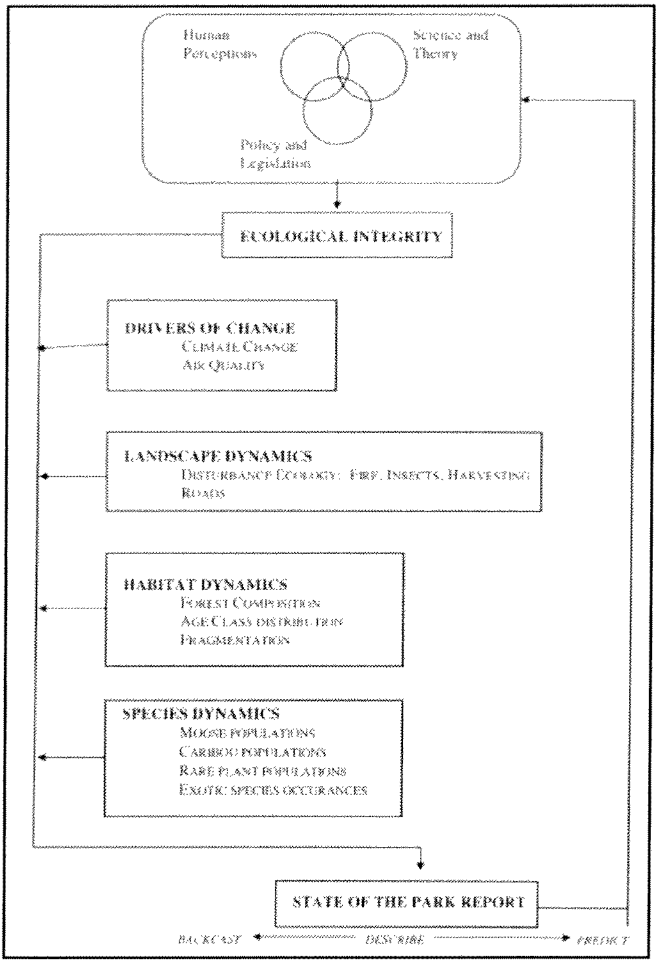

Figure 1: Framework for Assessing Terestrial Ecosystem Integrity

Indicator Selection

Establishing a framework such as this does integrate a hierarchical approach, yet there remains the subjectivity of indicators within each of these levels. To address this issue, there were five filters that assisted in selecting the appropriate indicator(s): cost, existing data, external initiatives, based in good science, and within the direction of the existing park Ecosystem Conservation Plan (Figure 2).

The premise of an indicator is that it reflects change. Thus, it has to be measured repeatedly, and therefore must be fiscally manageable so it can be done on an ongoing basis. Another cost effective means is to incorporate as much useful available data as possible which has been collected by other agencies. Environment Canada, the Canadian Forest Service, the provincial government, are just a few examples of data collecting agencies which maintain valued databases and can be of tremendous benefit to the long term integrity monitoring of the park. Not only does this approach save fiscal resources, it also provides a spatial context for

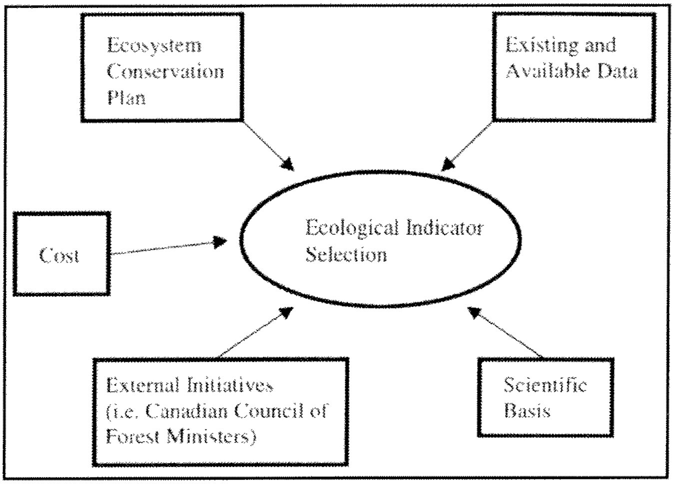

Figure 2: Filters in the selection of indicators to assess ecological integrity for Pukaskwa National Park

the park to compare itself against different adjacent management approaches. Tracking the ecological trajectory for the park itself is not enough. In order to evaluate our ability as a protected area, we must compare the park to the adjacent landbase.

Pukaskwa is also fortunate enough not to be starting from scratch. Before the establishment of the park, data has been collected regularly on a number of ecological statistics such as caribou populations, weather data, and fire. It is often easier to maintain existing programs than it is to develop new ones. Using these existing long-term databases begins to reveal some temporal changes in the park environment.

Finally, indicators should be reflected within the existing Ecosystem Conservation Plan (Geomatics, 1996). This plan provides overall direction for ecosystem planning, and was developed from a variety of sources and stakeholders. Geomatics took a very general approach and selected over 100 different potential indicators. Fiscal realities prevent this from full implementation, thus a paired down suite of indicators selected from those in the Plan provides some political validity as it is based in existing documentation.

Combined, these factors should reflect existing scientific literature to provide credibility for the ecosystem conservation program.

Results

The following briefly summarizes some of the key indicators and does not reflect all of the results to date.

Drivers of Change

It must be recognized that the ultimate "driver of change" will be continual growth in human consumption and population (Noss and Cooperrider, 1994). Humans have altered and are continuing to alter the ecosystem at alarming rates. What is most alarming is the rate of change that this population explosion and subsequent demand is creating. This will be the ultimate indicator since all ecosystems will perceive it as the largest threat (Noss and Cooperrider, 1994). Until society begins to get a handle on this, protected areas will merely be delaying the inevitable: a breakdown in the ecosystem construct, which will then become more a sum of those parts that we want, rather than what it is for synergistically.

Local scale spatial patterns in climate reveal interesting and important aspects of Pukaskwa National Park. Re-enforcing Findlay (1973) report, the coastal area is considerably warmer than the interior by about 4°C. In addition, current theory suggests that increases in CO_2 and other "greenhouse gases" are rapidly changing the climatic dynamics. It is predicted that temperatures will rise and may dramatically alter the southern boreal forest. Current data for the Pukaskwa area reveals a 0.5 ° C rise in temperature over the past 120 years.

Ecosystem Dynamics

An understanding of disturbance regimes is essential to understanding biodiversity and planning its conservation. Three large scale disturbance forces were reviewed in this report: forest fire, spruce budworm, and timber harvesting. An additional indicator, road development, was reviewed as it disturbed the landscape. Although directly associated with timber harvesting, since in that roads physically convert the ground cover and create increased human access.

Undoubtedly, fire plays a tremendous role in the boreal forest dynamics (Alexander and Dubé 1983). For Pukaskwa National Park, there has been a total of 30 fire starts over the past 75 years (1923-1998). Forest fires had their greatest influence in 1936, when over 47,000 ha were burned in one fire along the north end of the park. It is difficult to ascribe the limited role fire is playing on Pukaskwa to fire suppression alone. Whereas fire has and continues to be present within the park, with the limited number of starts, and the relatively short data set, it is difficult to estimate the significance of fire in forest development.

Increasingly, harvesting is occurring on the lands surrounding the park and it is now the primary large scale disturbance factor. Although harvesting has occurred in the past, it was limited to large river corridors and focused on white spruce. Current practices are much more extensive, with large clearcuts and efficient mechanization. The area harvested in the White River forest has tripled each decade since the 1960's with over 400,000 m^3 per year harvested in the 1990's. The cut is rapidly encroaching toward the park boundary. Future wood supply deficits will compound this problem.

What is of most concern is the encroachment of roads towards the park. Greater need to maintain wood supply has created more roads further away from the mill creating to access more timber. More than the cutting, the roads will have the greatest threat the viability of much of the Pukaskwa Ecosystem. For example, road accessibility is either directly or indirectly the principle cause of wolf mortality throughout the greater ecosystem.

Habitat Dynamics

Pukaskwa's mature forest (115+ years) and relative infrequent occurrence of any stands under 44 years of age is most likely a result of the limited stand replacing disturbance within the park. The 1936 fire of 47,000 ha in Pukaskwa National Park accounted for the rise in the 45-65 year age class. The 65 to 95 age class was also a result of past large scale, stand replacing disturbances in 1931 and 1924.

Within the White River forest, harvesting, and re-generation has allowed for the opportunity of young growth while reducing the area of older forests. The White River forest most resembles a "even" distribution for harvested forests with a predictable supply of mature forests. Pukaskwa however, reveals a much more mature forest, and is skewed to older age classes.

The overstory forest composition of Pukaskwa and the White River forest has remained fairly constant over a 10 year period (1984-1994). Spatially, however, Pukaskwa contains a much higher proportion of hardwoods than the White River forest. There is no reason to believe that this is not normal within the park. The higher fire return interval, post budworm development of the Pukaskwa forest should reveal a longer proportion of hardwood species. However, this again produces substantial differences in spatial comparisons whose implications are not completely known.

Species Dynamics

Moose population densities have been assessed since the mid-1980's both in and outside of the park. Moose maintain a social and economic importance and have a long history of being monitored throughout Northern Ontario. The moose densities within the park are less than half of what they are in the surrounding landscape. Moose are the best an indicator for small, upland conifer and mixedwood shrub at the landscape level (McLaren et al., 1998). The lower moose densities imply a lower availability of their preferred habitat as forest harvesting does not occur in the park.

Conclusion

Administrative boundaries and good intentions are not enough to protect Pukaskwa. Wise management has maintained much of the original character of the park by limiting internal development such as roads and buildings. However, with better understanding of the park ecosystem, we are beginning to understand that protecting a park does not necessarily protect its contents.

This report is part of the first investigation into how the park is changing over time. It also the first time Pukaskwa has been directly assessed in the context of within its greater ecosystem. By examining this relationship, it is being recognized that the assumptions made about the park as representative of the "Central Boreal Uplands" are not wholly accurate. The effect Lake Superior alone has on the terrestrial ecosystem, from climate to species populations, may characterize Pukaskwa as more representative of a Lake Superior forest system. This can lead to another debate about the ability of any area to represent a larger area and what is a suitable level of classification.

Ecological integrity is as much human perception as hard science allocating levels of integrity for particular geographic locations. If we agree with Kimmins (1997) that there is only a loss of integrity when the ecosystem processes are altered beyond the range that is characteristic of that system, one indicator in particular stands out: roads. There is no analogy to roads in the natural ecosystem. The greater the number and density of roads, the greater the impact on ecological processes, hence the integrity is diminished. A greater ecosystem road management strategy-including decommissioning, efficiency and improved design-is a key to the survival of the ecological integrity of Pukaskwa National Park.

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