

Developing an effective monitoring and evaluation system for biodiversity conservation: The Biodiversity At Risk Indicator Suite

Alexis J. Morgan¹

Abstract

World Wildlife Fund Canada (WWF-Canada) is in the process of developing an indicator-based tool to objectively assess biodiversity at risk at both the regional and national levels. This tool will be used to assist WWF-Canada assess and refine priority conservation actions and will form the basis for regular, ongoing reporting of national and regional progress on Canada's commitments to conserve and recover biodiversity.

The poster outlines the rationale for undertaking the work, including how it will link in with other biodiversity conservation monitoring initiatives such as the Convention on Biological Diversity and the development of the Canadian Biodiversity Index. The state-pressure-response-socioeconomic framework for the proposed indicator suite will be presented and anticipated challenges regarding the implementation and operational development of the indicator suite will be discussed.

Introduction & Background

The success of biological conservation efforts ultimately has to be measured in biological terms; measures such as changes in a species' range, its abundance, how well ecological processes are functioning, the quality of habitat and the integrity of ecosystems. However, to measure only these factors would be of limited value; there is a need to understand not only the state of biodiversity, but also the pressures it faces, how humans are responding to the state, and how socio-economic variables are playing a role in the trends.

In 2003, WWF-Canada published a report entitled "*The Nature Audit*" that sought to assess how well Canada was meeting its major international and domestic commitments to conserve biodiversity. The work was approached by performing a regional assessment of species and habitat trends in Canada, examining current pressures on our ecosystems, and assessing Canada's response to current conservation needs. This work developed an array of tools,

¹ World Wildlife Fund Canada, 410-245 Eglinton Ave. E., Toronto, ON, M4P 3J1

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including indicators to evaluate the success of efforts to conserve biological diversity in Canada.

The past decade has seen an increasing recognition of indicators for tracking progress and results as well as a proliferation of resources (UNDP, 1997). The work from *The Nature Audit* along with the development of the indicators for the Convention on Biological Diversity, and a desire for internal tracking of conservation progress has led WWF-Canada to initiate the Biodiversity at Risk Indicator Suite (BARIS).

BARIS is intended to be a tool to evaluate biodiversity recovery progress through a State-Pressure-Response-Socioeconomic framework. It aims to be deployed ecoregionally, but also be capable of reporting nationally, using scientifically-based and widely-accepted indicators. The results of the ongoing tracking are intended to highlight problematic areas and further refine biodiversity restoration and recovery efforts. Furthermore, BARIS will act as an integrated evaluation system for WWF-Canada's own efforts to determine if we are having the impact we desire and thereby improve our own effectiveness and accountability. It differs from *The Nature Audit* in that it is more regionally focused, more targeted, entirely indicator based and places less of an emphasis on long term state changes.

This paper highlights some of the successful elements derived from *The Nature Audit*, including how they operated and some of the key findings. It goes on to explain how BARIS builds on these and incorporates other measures to build a tool that is capable of effectively monitor and evaluate biodiversity conservation efforts both internally within WWF-Canada and within Canada as a whole.

The Nature Audit and its successes

Biological conservation efforts are littered with goals and aims that are all too often backed up with little or no evidence of change. One of the primary goals behind *The Nature Audit* was to explore the differences between stated political commitments and actual biological conservation trends. For this reason, *The Nature Audit* was a good example to learn from; it provided good lessons on what is simple to evaluate, what is difficult to evaluate, what works, what does not work, and how people treat the results.

In order to cope with the volume of information needing to be covered, *The Nature Audit* was largely a summary document that operated on a national to ecoregional scale. Using a state-pressure-response framework, it paid particular attention to the 1992 United Nations Convention on Biological Diversity and identified areas for action in the 1995 Canadian Biodiversity Strategy. Evaluation of these commitments formed the basis of how the document was structured.

The "State" section of the document gathered trend data from 9 major species groups (marine mammals, terrestrial mammals, butterflies and skippers, birds, freshwater fish, marine fish, orchids, reptiles and amphibians, and trees). A wide array of taxonomic experts provided estimates of historical range and abundance in an attempt to track disruptions from a pre-settlement baseline. This was one of the first attempts to generate such information and both the scientific, governmental and non-governmental sectors encouraged the effort. Ultimately, state variables are the yardstick against which the success of biological conservation efforts must be measured; an initiative is not a success if it is not saving that which it seeks to conserve.

The “Response” section evaluated key commitments that were largely political in nature to evaluate the quality of the response to date. This section was less well-received with some criticisms on lack of detailed, quantitative data. A more systematic approach that properly evaluated the range of response from intent through outcome was required with greater stakeholder input.

The intent of this paper however is not to provide a full review the successes and failures of the entire report. Rather, this paper aims to focus on one issue in particular within the “Pressure” section of the document: the creation of a system to score and map cumulative human threats to biodiversity on the landscape. Monitoring for the effectiveness of biological conservation must ultimately not only measure the response of species and systems that are being conserved, but also examine the changes to the practices that are resulting in these biological responses.

Monitoring the cumulative human pressure

Mapping and assessing the pressure humanity places on biodiversity is something of great value theoretically that is much more difficult to ascertain in applied reality.

There is a wide array of studies that examine the impacts of human infrastructure and activity on species and ecosystems (Adams and Geis, 1983; Clevenger *et al.*, 2001; Nellemann and Cameron, 1996). Most such studies are done using a reductionist approach; attempting to correlate a single activity to a type of change of a single species. Indeed, in order to associate and link the two events (human activity and a change in biodiversity) it is necessary to adopt such an approach. There has, however, been an increasing push to attempt to evaluate effects in a cumulative manner (Culp *et al.*, 2000; Schneider *et al.*, 2003). *The Nature Audit* opted to use this latter approach that is related to both environmental impact assessment (EIA) and landscape planning. It did not seek to simply create a theoretical distribution of biodiversity pressure on the Canadian landscape, but rather it sought also to create a system that would respond to and demonstrate changes in management regimes.

To create such an approach, industrial management practices were evaluated using a multi-dimensional axis to create a pressure matrix. Each axis represented a management issue. Figure 1 illustrates two such axes for the Agricultural Pressure Matrix: inputs (including pesticides and fertilizers) and land management (including soil tillage practices and environmental management plans). By constructing such a matrix, varying changes could be recorded and a gradual shifting of industry towards more “biodiversity friendly” approaches could be more easily facilitated and demonstrated.

Different groups within industries including agriculture, hydro, and forestry voiced wide support for this sort of an approach. The flexible shifting of practices, along with the recognition of varying forms of improvement were widely seen as an appealing approach to shifting practices.

Once scoring systems were in place for all of the major industries and other forms of human infrastructure, the effects needed to be spatially mapped onto the landscape. A number of studies in recent years have attempted this on a global scale (Sanderson *et al.*, 2002; UNEP, 2001).

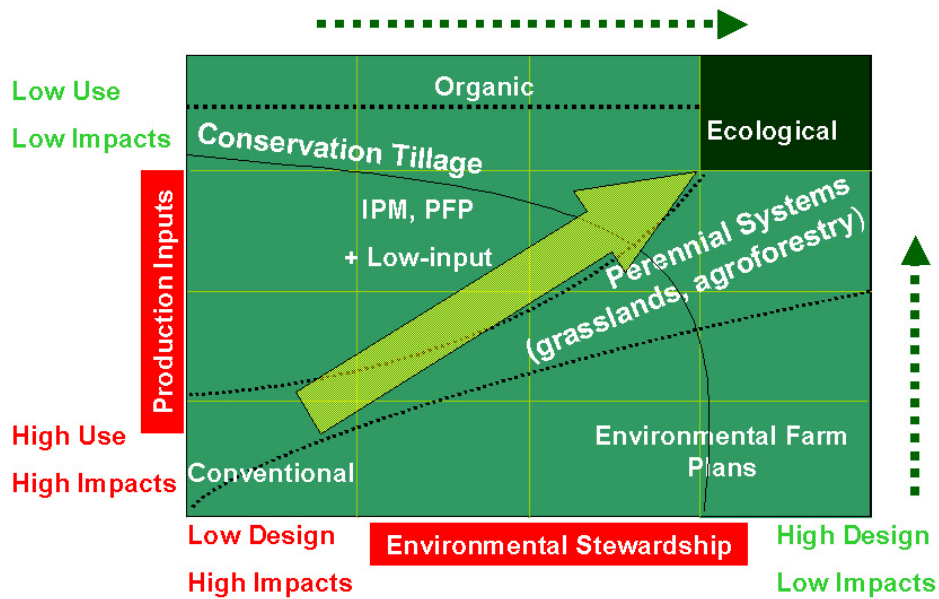


Figure 1. A sample pressure matrix for Agriculture

The Nature Audit used these works, along with the primary literature on the spatial decay of human infrastructure impacts, to form the basis of its cumulative pressure mapping. These studies informed how far the extent of any given infrastructure or practice should extend on the landscape and how quickly that impact spatially decays. To create the final score, the preliminary scores from the management approaches were imported and then the spatial decays were used to map them onto the landscape.

This work, though similar to the efforts created by Sanderson et al. (2002) and UNEP (2001), not only used higher resolution data, but a wider definition of human activities and a more sophisticated approach to modeling impacts.

Results were as expected in many cases, though a number of interesting areas did come up both spatially and in terms of management practices. From the former issue, the high road densities in Atlantic Canada drove up the impact scores. The heaviest fishing pressures were located off of the Olympic Peninsula; another area of some surprise to the authors. In terms of management practices, the considerable difference between varying jurisdictional allowable practices in the guidelines illustrated the importance of voluntary measures such as the Canadian Standards Association, Sustainable Forestry Initiative and Forest Stewardship Council certification. Considerable gains in terms of reducing the pressure score could be attained through changes in management practices.

The cumulative pressure scoring methods detailed above were intended as a ‘first draft’ towards measuring pressure on the landscape. There were deficiencies in the way they were created, and noted weaknesses in the available data. Some of these include the need for higher resolution data, a paucity of studies on certain species groups or activity types, and the consideration for a given habitat’s resilience to pressure. These will be taken into account in any future iterations of a cumulative pressure mapping effort.

BARIS and the road ahead

BARIS seeks to address some of the weaknesses noted by refining the cumulative pressure mapping and building upon its successes. However, beyond just the pressure component, BARIS also aims to re-work the state and response side of the work that was done for *The Nature Audit*. It will be focused on priority ecoregions and be explicitly an indicator tool with an aim at shorter time frames, rather than longer term biological “state” response. Furthermore, it will add in a component evaluating socio-economics in order to examine some of the value-driven issues behind biodiversity conservation and look at the linkages between the public as consumers and biodiversity. Below is a brief examination and explanation of the four components of BARIS.

STATE:

State indicators are key as they are ultimately the measurement of whether biodiversity is being lost, held steady or gained. The ecosystem-population/species-genes approach covers the range of what comprises “biodiversity” while the indicators selected cover the full range of WWF criteria for biodiversity recovery from representation and viable populations, to ensuring the operation of ecological processes and the existence large intact habitats. Most of the indicators proposed have wide scientific and institutional buy-in along with readily available data; they cover national and regional scales, and focus towards output issues. Long-term “outcome” indicators are not readily measured on annual time-scales and have therefore been omitted from the BARIS framework, but may be revisited in the future when they are likely to exhibit signs of change.

Proposed indicators: *Land cover composition, protected area representation, net primary production, critical habitat protection, IUCN Red List composition, marine trophic index, crop variety.*

PRESSURE:

An understanding of pressure on biodiversity at risk provides insight into future trends and mitigative strategies as well as helping to target response. The selected headings within the pressure section cover the main threats to biodiversity¹; habitat loss/degradation, biological invasions, climate change and pollution. While there are other areas acknowledged to contribute to biodiversity loss, these processes represent the majority of the pressure. The WWF framework suggests evaluating pressures one by one, but these will then be combined to map cumulative effects using a refined version of the process from *The Nature Audit*. The spatial scales are relatively broad, with the option of cumulative pressure being applied nationally and/or regionally.

Proposed indicators: *Cumulative effects footprint index, harvesting levels, mean temperature, mean precipitation, global CO₂, number of invasive species by ecoregion, NO_x/SO_x deposition levels.*

RESPONSE:

Of all indicators, response indicators are the least well developed and the least easy to establish. WWF suggests breaking down efforts into the interventions of the varying stakeholders (WWF, government, ENGOs, industry, etc.), while the Millennium Ecosystem Assessment process strongly emphasizes the need for context (political, institutional, social, economic and ecological) in order to provide explanations for success or failure of response. BARIS will have an emphasis on stated policy commitments (Species at Risk Act, CBD, etc).

Capacity (biodiversity knowledge, resources, etc.) is a key element that was identified by *The Nature Audit* as critical for effective conservation that will be assessed, while protected areas remain the key consideration in terms of habitat issues. Since government acts on behalf of citizens, it is a major stakeholder in terms of biodiversity preservation and recovery, and therefore most response indicators evaluate governmental action, over and above WWF, other ENGOs and industry.

Proposed indicators: *Number of species actively in Species at Risk Act (SARA) process, avg. time by species through SARA, number of hectares protected by jurisdiction, budgeted resources for SAR work, GDP, percentage of industry with SAR programs, number of taxonomic experts in Canada, WWF project-specific indicators.*

SOCIOECONOMIC:

Outside of the traditional state-pressure-response model, WWF has identified socioeconomic factors as being key to effectively monitor biodiversity conservation. Providing arguments and trends in an economic and social (health) context speaks to certain individuals and sectors of society that would not agree with the inherent value of biodiversity. In this sense, socioeconomic indicators provide a strong economic and social reason for preserving biodiversity. Typically, the field is broken down into consumptive value, non-consumptive value, 'existence' value and ecosystem service values. Adding these to BARIS provides an avenue for market-based evaluations of biodiversity, including cost-benefit analyses and further insight into social valuation of biodiversity in Canada. As the understanding of explicit linkages between economics, social well-being and biodiversity increase, so too will the range of possibilities for monitoring this important component.

Proposed indicators: *Revenue from species harvesting by sector, GDP contributions from recreation / ecotourism / hunting / angling, estimate of remaining wetland value, social polling on the value of biodiversity.*

While the proposed indicators do have widespread acknowledgement and are generally accepted by experts, numerous challenges still remain in the creation of such a suite. From the need for nationally consistent databases on protected areas, to the generation of information on invasive alien species and availability of remotely sensed data, Canada is still a data-deficient nation. Obtaining access to these data will be a key challenge in the coming years. Furthermore, bringing together stakeholder groups in each of our priority ecoregions (The Grand Banks, the Northern Boreal Forests, the Mackenzie Valley Watershed and the G200 Ecoregions of BC) and gaining acceptance of the proposed list of indicators remains a challenging, but critical task. Nevertheless, current trends on all of these fronts suggest that the opportunity to build such an effort are coming together and that such an indicator suite is viable.

Conclusion

Monitoring for the effectiveness of biological conservation is not a simple task. It requires a strong emphasis on state indicators that evaluate trends in species and habitat composition and structure as well as ecosystem integrity. However, these state variables often respond only in a longer-term time frame capable of being measured in years or decades rather than days and months. Accordingly, it is necessary to look at not only state, but pressure, response and some of the socioeconomics surrounding the issue.

The Biodiversity at Risk Indicator Suite (BARIS) is a proposed framework put forth by World Wildlife Fund Canada to track and evaluate efforts to conserve biological diversity in an ecoregional and national context. Derived from the results of *The Nature Audit*, it will use existing, accepted indicators, as well as some project-specific indicators, to assess both our own work and that of others. Furthermore, through its alignment with the Convention on Biological Diversity and the Canadian Biodiversity Index, it will help build acceptance of these indicators for measuring trends in biodiversity. Though many challenges remain, WWF believes that such a multi-dimensional and variable scale suite of indicators is viable within the next few years.

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