Representation, Focal Species and Systematic Conservation Planning for the Northern Boreal Initiative

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Abstract

Representation is a long-established goal in protected areas planning, which refers to the need for protected areas to represent, or sample, the full range of biodiversity across a given landbase. While this approach may sample biodiversity, it does not take into account the viability of the elements it is presumed to protect, nor does it address the special needs of those elements most vulnerable to threatening processes. In this paper we present a preliminary overview of an approach that has been developed for the Northern Boreal Initiative that includes the representation of a range of biodiversity surrogates and the effective consideration of focal species.

Introduction

The boreal forest of Canada represents 25% of the worlds remaining large, ecologically intact and relatively undisturbed natural forests. Some 62% of this forest system has been, or will be subject to commercial harvest (WRI, 2000). In Ontario, the boreal forest south of the 51° N latitude line is subject to commercial harvesting, while the area to the north is largely free of major extraction activities. The Northern Boreal Initiative (NBI) is the sequel to the Lands for Life Process and will result in the development and completion of the protected area system north of 51° latitude, as well as the determination of areas available for logging and mining as a result of first nations' community land-use planning. The NBI provides an incredibly rare opportunity to establish a protected areas system before a landscape is greatly compromised. This paper presents a systematic conservation planning approach for maximizing the conservation outcomes north of 51°.

Systematic conservation planning and the use of C-Plan

Systematic conservation planning requires the establishment of explicit conservation goals and priorities (Pressey *et al.*, 1994; Margules and Pressey, 2000). The Protected Areas Working Group (consisting of individuals from the Ontario Ministry of Natural Resources, First Nations and Conservation Groups) was established in 2001 to define the goals and priorities necessary to establish the protected area system for the NBI. Primary elements of these criteria include: 1) completion of representation; 2) maximizing high quality habitat for focal species; 3) the effective consideration of head waters and natural processes; and, 4) balancing these with the needs for equitable resource sharing with first nations communities. While these criteria provide the broad objectives and conservation

goals, they do not provide the explicit details and methodology required to apply these goals in a "real world" environment. This paper operationalizes key components of these criteria and provides a provisional methodology and minimum standard for the identification of candidate protected areas north of 51°.

C-Plan is a conservation-planning tool developed in Australia specifically for protected areas planning (Pressey, 1999). C-Plan enables the use of explicit, quantitative methods for prioritizing areas for incorporation into protected area systems, rather than the use of ad hoc procedures. This results in more informed choices by policy makers, and greater efficiency in the realization of conservation goals. A key feature of C-Plan and other site selection programs is the principle of complementarity, which ensures that sites chosen for a reserve network complement those already selected in satisfying specified conservation goals (Pressey, 1999). C-Plan synthesizes multiple conservation goals and priorities down to a single index of summed irreplaceability, which can be defined in two ways: 1) the likelihood that an area will be needed to achieve an explicit conservation goal; and, 2) the extent to which the options for achieving an explicit conservation goal are lost if the site is made unavailable for nature conservation. The concept of irreplaceability recognizes that there are usually many ways of constructing a system of protected areas. Some areas cannot be replaced without compromising the conservation goal, either because: 1) they contain unique features; 2) because they contain so much of a feature that other areas cannot compensate for their loss; and/or, 3) because the conservation goal specifies that all occurrences of one or more of the features they contain must be reserved or deferred. Other areas are replaceable to varying degrees, that is, there might be one or a few choices for some areas and hundreds of choices for others. In addition to allowing for the cumulative consideration of conservation targets, C-Plan also enables the incorporation of "informing" data sets, which indicate the areas considered valuable based on other sets of criteria, such as those defined by first nations, the timber and mining industries. This makes it possible for areas of high to moderate conservation value to be considered in direct relation to their potential value for other interested groups.

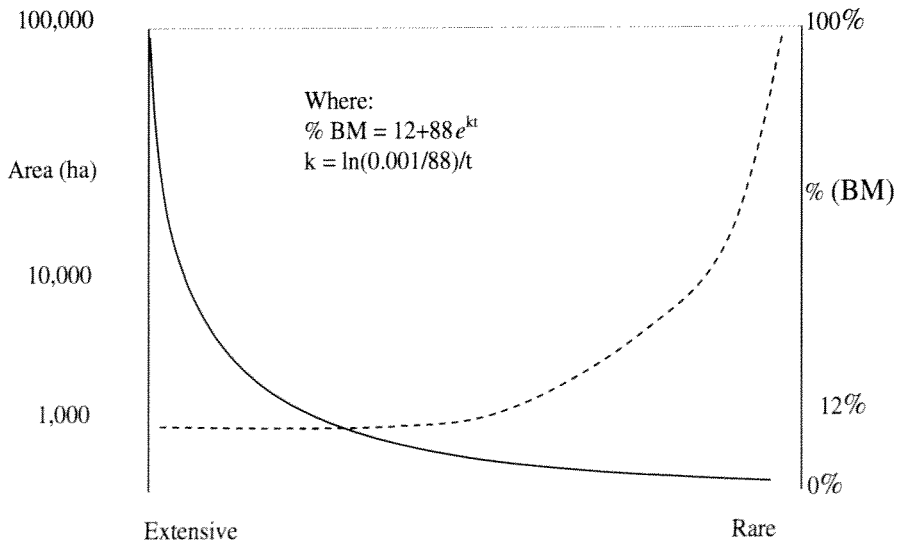
Representation

Representation refers to the need for reserves to represent, or sample, the full range of biodiversity, ideally at all levels of organization (Margules and Pressey, 2000). In the Lands for Life process, unique landform/vegetation combinations (hereafter LV types) provided the fundamental unit of biodiversity, where at least one and preferably the "best" example of each LV type was sought at the ecodistrict scale to satisfy the achievement of representation (Crins and Kor, 2000). The fundamental assumption being, that if a representative sample of all LV types is captured within a given ecodistrict, then the full range of biodiversity for that ecodistrict will be represented within the protected area system. Because the NBI forests are largely unaltered by human intervention, that is, natural processes such as fire continue to function freely, forest age will also be incorporated along with landform/vegetation type (LVAs) to classify the landscape. The Partnership for Public Lands (PPL-Federation of Ontario Naturalists, Wildlands League and World Wildlife Fund) has developed a classification methodology which involves the application of a coarse-filter assessment of ecological representation, which uses land units called

"enduring features" as a surrogate of biodiversity (Kavanaugh and Iacobelli, 1995). Given the limitations associated with both LV types and enduring features as surrogates of biodiversity, it was decided that both be used in a complimentary manner. PPL's broader spatial limits provide for a variety of physical and environmental gradients within a given unit, while LVAs provide for representation of fine scale elements across the landscape.

In 1987, the World Commission on Environment and Development (Brundtland Commission, 1987), suggested that a minimum benchmark of 12% of any given country's land base should be secured in protected areas (Noss, 1996). If we were to take the logical expression of this benchmark in terms of representation, then 12% of each LVA or enduring feature would be required to achieve representation. Because each LVA is not present in the landscape equally, that is, some elements are extensive (there are many options for representation) and some elements are rare (there is only one or few options for representation), then benchmarks are set such that those elements with the fewest options for representation are given primacy in the selection process. In this way, it is more likely that all biodiversity will be represented in a land-use planning exercise (Figure 1).

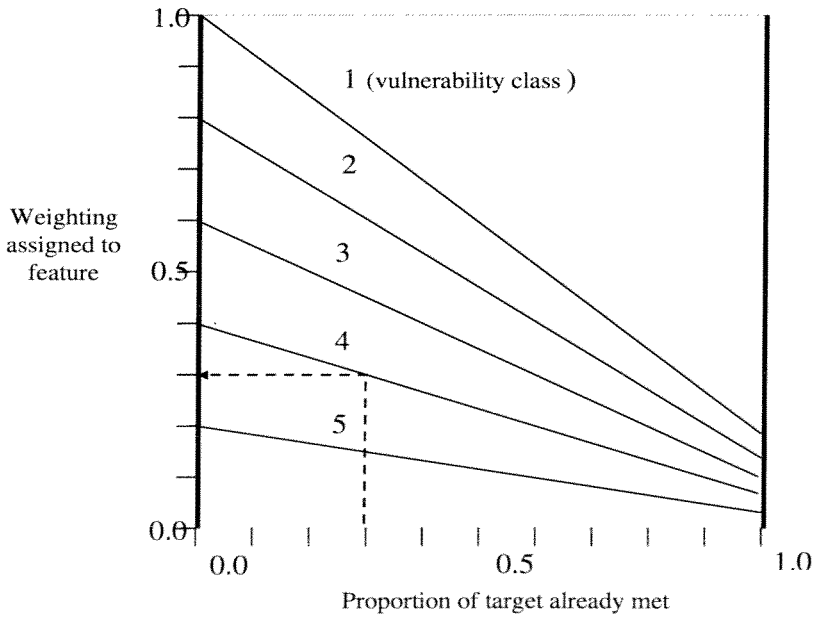
Figure 1. *Representation benchmark methodology for LVA combinations and Enduring Features for application at the ecodistrict scale, where: the solid line represents the area distribution of LVs or Enduring Features for any given ecodistrict sorted from the most extensive to the least extensive type; and the dashed line represents the % Benchmark (BM) required for each surrogate based on areal extent of each unique LVA or Enduring Feature according to the formula below. Note: t represents the expected % extent of each feature in a uniform distribution (e.g., t=100/total number of LVs in ecodistrict).*



Vulnerability

In most conservation planning exercises, the prioritization of economic values results in the marginalization of protected areas toward lands that are steep, infertile or unproductive. This means that values which tend to occur in fertile, productive or flat areas also tend to be the least represented in any protected area system. In the case of the NBI, this pattern will likely be repeated unless the issue is addressed by weighting LVAs or enduring features in accordance with their vulnerability to threatening processes. This can be achieved by providing each LVA or enduring feature with a reservation priority or vulnerability weighting, where each LVA is ranked with a score from the most (1) to the least (5) vulnerable to threatening processes and the likelihood that threatening processes will occur. For example, dense conifer > 60-100 yrs. growing on glaciofluvial outwash plains might be assigned a value of (1), because it exists in an area of high site quality and high production forest and will almost certainly be logged. Conversely, treed fens and bogs that occur on glacial till might be assigned a value of (5) as these will almost certainly not be subject to the threat of logging (Figure 2). An expert panel generally assigns relevant weightings.

Figure 2. *Illustrates the combined effect of weightings for vulnerability and proportion of target where vulnerability classes 1 to 5 are assigned weights 1.0, 0.8, 0.6, 0.4 and 0.2 respectively, and M is assigned a value of 0.2: (figure reproduced from C-Plan Manual 2001: 11).*



Each diagonal line in this graph relates to an individual vulnerability class. The weighting to be assigned to an LVA or enduring feature is equal to the relevant vulnerability class

when none of the feature's target has been met and then drops linearly to a minimum proportion (M) of this initial weighting as the target is progressively achieved (C-Plan Manual 2001). For example, consider an entity in vulnerability class 4 for which 30% of the target has been met. The weighting for this entity would be 0.4 x (1 - (0.3 x (1 - 0.2)) = 0.304 (see dotted line on graph).

Focal Species

While representation attempts to sample all elements of biodiversity in a protected area system, and vulnerability provides a weighting to ensure that those elements most in need of protection are protected; neither approach allows for the assessment of the "viability" of biodiversity. If a protected area system is to be effective, it must provide for the viability of those elements that are most sensitive to threatening processes. The focal species approach, developed by Lambeck (1997), builds on the concept of umbrella species, whose requirements are believed to encapsulate the needs of other species. It identifies a suite of "focal species" each of which is used to define different spatial and compositional attributes that must be present in the landscape and their appropriate management regimes. All species considered at risk are grouped according to the processes that threaten their persistence. These threats may include habitat loss, fragmentation and loss of specific resources. Within each group, the species most sensitive to the threat is used to define the minimum acceptable level at which that threat can occur (Lambeck, 1997; Carroll *et al.*, 2001; Sanderson *et al.*, 2002). In the case of the northern boreal forest in Ontario, wolverine (*Gulo gulo*) and forest-dwelling woodland caribou (*Rangifer tarandus caribou*) have been recognized in relation to their value as focal species. Wolverine is designated as a species of special concern nationally and forest-dwelling woodland caribou is designated as a nationally threatened species that is sensitive to habitat fragmentation. The effective inclusion of the focal species approach to a systematic conservation planning exercise requires the development of a spatial model of habitat use for each focal species, as well as the determination of how much area is enough.

Spatial Habitat Models and Habitat Quality

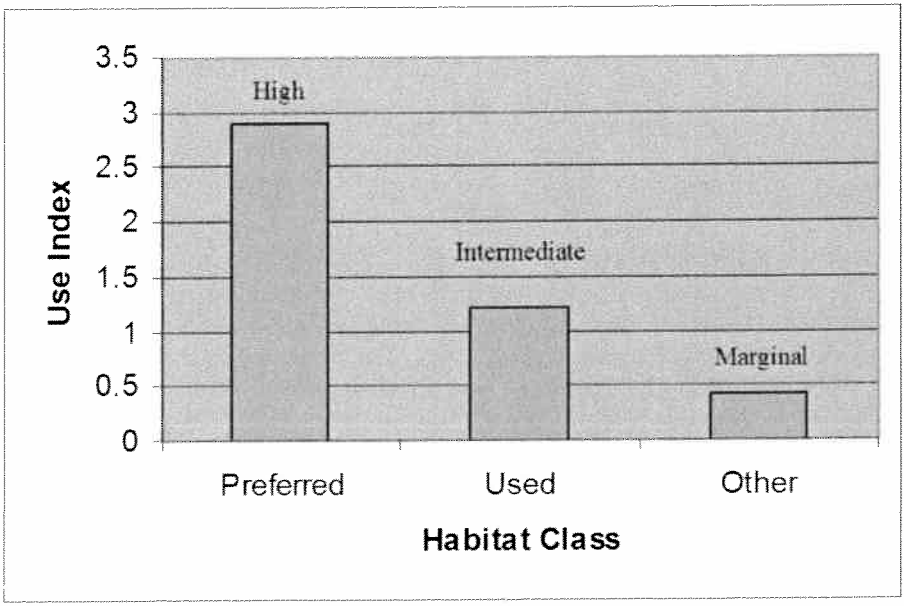
Provincial spatial models for wolverine and woodland caribou are currently being developed. We have, however, created a preliminary provincial winter habitat model for woodland caribou based on discrete forest classes within Landcover28 (satellite remote sensing data of landcover classes in Ontario) and forest age. The simple model was divided into high, intermediate and marginal quality habitat based on the occupancy of a given habitat class by the number of winter satellite locations. The different habitat classes within the model were: (1) High Quality Habitat – Dense Conifer > 40 yrs.; (2) Intermediate Quality Habitat – Mixed Conifer, Sparse Conifer and Treed Fen > 40 yrs.; and, (3) Marginal Quality Habitat – all other classes. In applying the focal species area target within C-Plan, the modeled distribution requires the assignment of weightings to habitat qualities that reflect the relative need to protect a given habitat quality. In the case of caribou we assigned weights of: (1) High Quality Habitat – 1 x grid cell (10,000 ha = 10,000 ha habitat equivalent), (2) Intermediate Quality Habitat – 0.5 x grid cell (10,000 ha = 5,000 ha

habitat equivalent) and (3) Marginal Quality Habitat – 0.05 x grid cell (10,000 ha = 500 ha habitat equivalent). In this way, C-Plan maximizes the inclusion of higher quality habitat areas.

How Much Area is Enough?

The determination of how much area is enough for a species to persist in any conservation planning exercise is an enormous challenge. In the Comprehensive Regional Assessments (CRA)/Regional Forest Agreement (RFA) process in Australia, one of the explicit criteria was the stated goal of maximizing the protection of high quality habitat and conserving "viable" populations of species throughout their natural range, an ambitious task given the huge number of species under consideration and the limited demographic data available for many taxa. The determination of target areas using population viability analyses (PVAs) provides the optimal solution (Burgman *et al.*, 1993; Groom and Pascual, 1998). However, these techniques are extremely data demanding and more often than not, much of the demographic data required is unavailable. Caught between the inadequacy of single number approaches (Soulé, 1987), and the impossibility of conducting full PVAs, Possingham and Andelman (in prep.) developed a target habitat area that gives all species an equitable chance of persistence. The formula is based on three principles: 1) short lived organisms tend to have a higher variability in populations size and hence need a bigger area; 2) species with higher reproductive variability need a larger area and in the absence of information on reproductive variability then, trophic level is used; and, 3) species with lower average densities need larger areas.

Figure 3. *Habitat use index based on habitat quality classes (ha)/ the relative occupancy of satellite locations for forest-dwelling woodland caribou in Ontario. (n=2,681 winter locations).*



The species equity target formula as applied for forest-dwelling woodland caribou is as follows:

$$\text{Target area} = 1000*T/(D*\text{sqrt}(L))$$

Where:

T = 3 - trophic level (herbivores and frugivores);
L = 10.33 yrs. - average reproductive lifespan of an adult female (Godwin 1990, Dzus 2001); and,
D = 0.000875 - the typical density (individuals/ha) of the species in the area where the target is to be applied (Godwin 1990, Dzus 2001).

This results in a Target Area for Caribou of 1,066,579 ha/ecoregion.

Figure 4 is an example of a screen shot of the initial of site irreplaceability for forest-dwelling woodland caribou across the province, based on 1 000 km^2 hexagon selection units. The top 5% would represent core areas that would need to be considered in any protected area system. If we assume that the site irreplaceability is correct, then a number of points are evident: 1) There is little suitable winter habitat available for Caribou south of 51° N latitude; 2) the continuous distribution line for caribou in the province needs to be shifted south, east of Geraldton; 3) there is limited winter habitat available in the east of the province and all winter habitat may need to be protected if caribou are to persist in this area; and, 4) the area north of 51° does not contain a limitless supply of winter habitat for caribou; that is, areas outside the boreal shield contain minimal winter habitat, which means that the decisions made within the NBI will have a profound effect on the fate of this species.

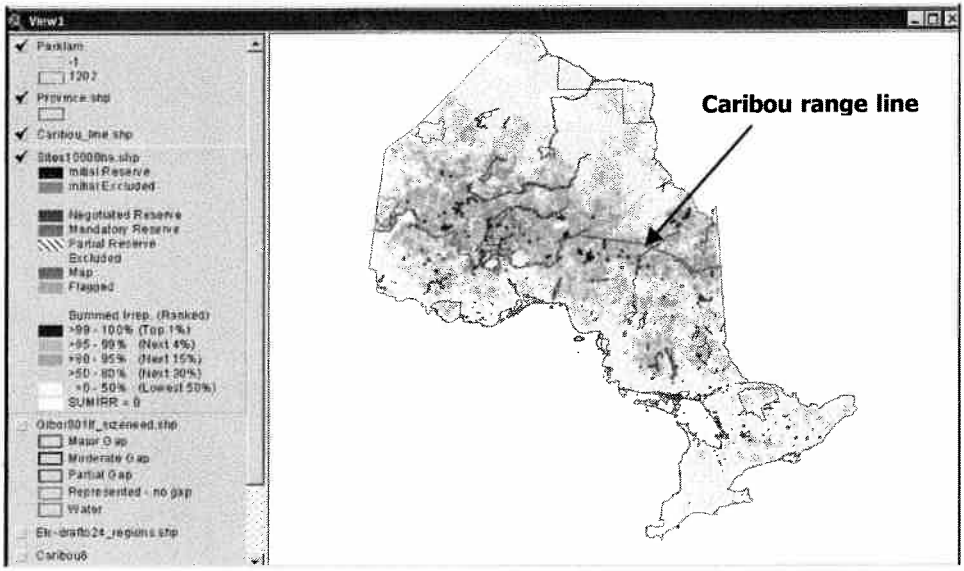
Discussion

From our preliminary evaluation of C-Plan outputs for the NBI, it was clear that different biodiversity surrogates provide different results that largely reflect the scale of the biodiversity elements under consideration. The use of LVAs enables the determination of small hotspots, the use of enduring features provides an intermediate scale and enables the effective delineation of gradients across LVAs, and the use of suitable habitat for caribou enables the identification of large landscapes suitable for supporting these area-demanding species.

In any protected area planning process there is no "best" surrogate of biodiversity. In most cases, we are dependent upon making best use of available datasets to guide decisions. The critical points when attempting to design a protected area system for the Northern Boreal Initiative, or anywhere else, is that we need to: 1) protect those elements that are most vulnerable to threatening processes; and, 2) "hedge our bets" and use a mix of different strategies (in this case, a range of different biodiversity surrogates) in order to spread the risk of the failure of any one approach (Lindenmeyer *et al.*, 2002). By predefining explicit and multifaceted conservation goals and priorities and applying these using tools like C-Plan, we can attempt to ensure that our limited conservation capital is not squandered.

In addition to allowing for the maximization of conservation outcomes in the NBI area, C-Plan is also valuable in ensuring equity for First Nations Communities. By enabling the concurrent consideration of informing data layers such as: cultural/spiritual landscapes, traditional harvest areas and areas prioritized for economic development, in conjunction with a map of biodiversity-related irreplaceability, C-Plan provides a mechanism for the effective consideration of First Nations Values. This can then be used to prioritize or exclude locations from consideration in the protected areas selection process. The ability to incorporate and prioritize First Nations' values constitutes a major step towards ensuring equity for the Aboriginal communities that rely on the forests that lie north of 51 . In allowing for the detailed and simultaneous consideration of biodiversity and Aboriginal values, C-Plan can serve as an effective tool for dealing with the complexities associated with conservation planning in the area of the NBI.

Figure 4. *Distribution of site irreplaceability for Forest-dwelling woodland caribou, where brown and orange areas represent the top 5% of Summed Irreplaceability (i.e., those areas of high quality winter habitat that would require protection). The existing line of continuous range for caribou is depicted as the line running east-west across the province. Existing Parks and Protected Areas are presented as polygons.*



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