A Comparison of Conservation Strategies to Preserve Biodiversity

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Abstract

As the number of species threatened with extinction continues to rise, the limited resources available for their protection places an added burden on conservation strategies. This pressure has shifted efforts from "ad-hoc" approaches to more systematic ones. Conservation efforts have prioritized the areas of highest biological diversity. The purpose of this study is to: 1) evaluate three conservation strategies against the four criteria of biodiversity (representation, resilience, redundancy and restorativeness), and 2) compare the strengths and weaknesses of the three strategies based on the results of the evaluation. The three strategies used in this study are Carolinian Canada's Big Picture Project, the Nature Conservancy's Ecoregional Planning Framework, and the Ontario Ministry of Natural Resources' Natural Heritage Strategy. The results indicate that none of the strategies fully incorporate all of the current theoretical concepts into its design. While the Ecoregional Planning Framework incorporates representation and resilience, the Big Picture Project's strength lies in its incorporation of restorativeness into its design. Ecoregional Planning met more of the redundancy criteria than the other strategies but all three strategies could be improved by integrating the redundancy criteria into their design. The Ontario Ministry of Natural Resources' Natural Heritage Strategy paled in comparison to the other two strategies in meeting the biodiversity criteria. It would be prudent for the conservation community to develop a collaborative and comprehensive conservation strategy that would integrate the strengths of the three strategies;

however, this would require a large degree of interagency coop-eration.

Keywords: *biodiversity, conservation strategies, landscape con-servation, biodiversity criteria, resilience, representation, redun-dancy, restorativeness.*

Background

Conservation efforts of the past have been coined as "ad hoc" because their success was incidental. In addition, they resulted in a biased distribution of conservation lands and water and did not meet the needs to maintain the regional biological diversity (Groves, 2003). With limited resources avail-able for conservation strategies, there is growing pressure to shift from "ad hoc" approaches to more systematic ones. A systematic approach allows for the framework to be replicated and peer reviewed and provides accountabil-ity and defensibility to its effectiveness in achieving its conservation goals (Groves *et al.*, 2002: Groves, 2003; Margules and Pressey, 2000).

The Canadian government's legislation and strategy to protect biodiversity (e.g., Species at Risk Act in 2002) may be a short-term option for the pro-tection of some species but to prevent the loss of biodiversity, conservation planning requires a shift toward habitat-based approaches (Franklin, 1993; Noss *et al.*, 1997).

Introduction

The purpose of this study is to evaluate and identify the attributes of conser-vation strategies that will protect biodiversity. The objectives of this study are: 1) to evaluate three conservation strategies against the biodiversity cri-teria of representation, resilience, redundancy and restorativeness; and 2) to compare the strengths and weaknesses between the three strategies based on the results of these criteria.

The three strategies compared in this study were the non-government agen-cy Carolinian Canada's *Big Picture Project*, the non-profit organization The Nature Conservancy's (TNC) *Ecoregional Planning Framework*, and the Ontario Ministry of Natural Resources' (OMNR) *Natural Heritage Strat-egy*.

What is Biodiversity?

The concept of biodiversity is evolving and will continue to change with more multi-disciplinary approaches investigating its multifarious elements. In this study, biodiversity is described as:

- the variety of reproductive life forms at various levels of organization (genetic, species, populations, community, and landscape) in the planning region;
- the interactions between and within them; and,
- the associated ecological processes needed to sustain them.

Biodiversity contains three important components of structure, composition and function and occurs at different spatial scales of: alpha (within community), beta (between communities), and gamma diversity (throughout landscape). This study emphasizes native and local identity of biodiversity (Groves, 2003; Noss *et al.*, 1997; Redford and Richter, 1999).

Methodology

This study evaluates the effectiveness of various conservation prioritization strategies to preserve biodiversity. In doing so, four criteria were selected from the literature to appraise each strategy: representation, redundancy, resilience, and restorativeness. Furthermore, elements of criteria were developed to help gauge attributes of the conservation strategies and their effectiveness at preserving biodiversity (Table 1).

The criteria can be defined as follows:

Representation: The inclusion of a full spectrum of life forms and physical features at the different levels of organization (i.e., genetic, population, species, habitats and landscape levels) in the region of planning.

Resilience: The capacity of conservation targets to persist through natural and human caused disturbances and maintain viability.

Redundancy: The inclusion of multiple representations of conservation targets within the region to avoid endangerment or extinction.

Restorativeness: The capacity to feasibly return degraded conservation targets back to a natural state or to improve their viability and level of ecological integrity (Groves, 2003; Noss *et al.*, 1997).

Results

The Nature Conservancy's framework incorporates representation and resilience, while the strength of Carolinian Canada's strategy is its incorporation of restorativeness (Table 2). The OMNR's Natural Heritage Strategy met the least number of criteria. A complete listing of results is available in Table 2.

Table 1. Criteria and sub-criteria for defining dimensions of biodiversity most relevant for conservation planning.

Criteria	Sub-criteria
I. Representation	a. integration of inventories and classification of native communities, ecosystems, populations and species from different sources or agencies
	b. comparison of present native flora range with historical(pre-settlement) native flora range to determine native flora change (patch size, shape, connectivity, fractal dimension and other landscape variables)
	c. identification of managed (protected) areas from local inventories, provincial and regional legislation, and official plans to determine the level of representation of each community type
	d. comparison of local protected/managed areas with province/state wide gap analysis to determine under-represented and unrepresented communities, ecosystems, populations and species
	e. comparison of national and regional information regarding vegetation communities with the greatest decline to identify "endangered ecosystems"
	f. integrate information from representation assessment with native flora change analyses
	g. identification of soils & substrates and their rarity
	h. identification of unique natural features
	i. identification of all G3 and S2 (and higher ranking) element occurrences documented in the planning region
	j. identification of endemic species
	k. identification of representation at different spatial scales (alpha, beta & gamma diversity)
	l. determination of contrast between patch types in the landscape matrix
II. Resilience	a. identification and characterization of the ecological processes that create and maintain habitat conditions required by conservation targets
	b. assessment of the historic and desired range of variability for ecological processes and interaction
	c. identification of mobile link (organisms or populations that actively move in the landscape and connect habitats in space and time)

	d. identify the internal ecological memory (biological legacies) of the community, ecosystem or population:
	    i. surviving organisms (residuals)
	    ii. organic materials
	    iii. biological and physical structures that serve a foci for regeneration and re-colonization

Criteria	Sub-criteria
	e. identify the external ecological memory of the community, ecosystem
	i. available sources of flora and fauna for re-colonization
	f. identify that native species composition are intact and undisturbed
	g. determine the population viability analysis (PVA)
	h. determine the vulnerability index for the community, ecosystem or population
	i. assess the proximity and extent of anthropocentric disturbances in the matrix to the habitat
III. Redundancy	a. identify conservation targets represented across environmental gradients
	b. identify conservation targets to be represented multiple times

	c. determine the vulnerability of the functional groups:
	    i. identify the limiting ecological processes in the systems of habitats or landscape and place each functional habitat (ecosystem, population or species) into functional groups
	    ii. determine the number of conservation targets within each functional group
	    iii. examine the interactions between each habitat and the effects of the loss of one of these habitats to the landscape
	    iv. determine the relative importance of the functional group to regional processes

IV. Restorativeness	a. based on previous analyses, identify potential restoration areas that will:
	    i. increase in size
	    ii. reduce the interior to perimeter ratio
	    iii. improve the complexity (and structural complexity)
	    iv. improve viability of the conservation target
	    v. increase level of ecological integrity
	    vi. improve ecological processes
	    vii. reduce the effects of anthropocentric (artificial) barriers
	    ix. create linkages with other habitats in the landscape matrix

	b. identify the existence of internal ecological memory in potential restoration site
	c. identify the existence of external ecological memory in surrounding habitats of potential restoration site
	d. determine the cost effectiveness of the restoration project
	e. identify the vulnerability of the restoration project to invasive species

(Noss and Harris, 1986; Walker, 1992; Franklin, 1993; Noss *et al.*, 1997; Nott and Pimm, 1997; Shaffer and Stein, 2000; Bengtsson *et al.*, 2003; Ludberg and Moberg, 2003)

Table 2. Biodiversity Criteria Against Conservation Strategies.

Criteria	Carolinian Canada's Big Picture Project	TNC's Ecoregional Planning	MNR's Natural Heritage Strategy
Representation			
I.a.	x	x	x
I.b.		x	x
I.c.	x	x	x
I.d.		x	
I.e.	x	x	
I.f.		x	
I.g.		x	
I.h.	x	x	
I.i.	x	x	x
I.j.		x	
I.k.	x	x	
I.l.	x	x	
Sub-total	**7**	**12**	**4**
Reslience			
II.a.		x	x
II.b.		x	
II.c.			
II.d.i.		x	
II.d.ii.		x	
II.d.iii.		x	
II.e.i.	x	x	
II.f.		x	
II.g.		x	
II.h.			
II.i.	x	x	
Sub-total	**2**	**9**	**1**
Redundancy			
III.a.	x	x	
III.b.		x	
III.c.i.			
III.c.ii.			
III.c.iii.			
III.c.iv.		x	

Sub-total	1	3	0
Criteria	Carolinian Canada's Big Picture Project	Ecoregional Planning	MNR's Natural Heritage Strategy
Restorativeness			
IV.a.i.			
IV.a.ii.			
IV.a.iii.	x		
IV.a.iv.	x		
IV.a.v.	x		
IV.a.vi.	x		
IV.a.vii.	x		
IV.a.viii.	x		
IV.b.	x		
IV.c.	x		
IV.d.	x		
IV.e.			
Sub-total	**9**	**0**	**0**
Total Criteria Met	*19*	*24*	*5*
Total Criteria	*41*	*41*	*41*

x - indicates the criterion has been met in the strategy

Discussion

The Nature Conservancy's and Carolinian Canada's strategies met some criteria and may partially protect biodiversity. The OMNR's Natural Heritage Strategy is unlikely to preserve biodiversity because it lacks the capacity to do so. These differences may exist because the non-government groups (NGOs) have more freedom to integrate new ideas into their strategies. In addition, NGOs can focus on meeting the biological requirements of conservation targets and are less susceptible to the pressures and dynamics of public political opinion.

Conclusion

This study collected ideas and concepts to provide a working definition of biodiversity and established a set of criteria through a synthesis of biodiversity literature. The results of this study found that none of the three conservation strategies examined proved to be comprehensive enough to meet

all of the outlined criteria. The Nature Conservancy's Ecoregional Planning Framework's strengths lie in meeting the representation and resilience criteria. Carolinian Canada's Big Picture Project's strength was its incorporation of restorativeness. The Ontario Ministry of Natural Resources' Natural Heritage Strategy met the least number of criteria and fails to provide a strategy that will protect biodiversity. It would be prudent for the conservation community to develop a comprehensive and collaborative conservation strategy that integrates the strengths of the three strategies and meets the criteria described in this study.

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