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LETTER

Biological vs. social, economic and political priority-setting in conservation

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Abstract

The most influential conservation priority-setting approaches emphasize biodiversity and threats when deciding where to focus investment. However, socio-economic and political attributes of nations influence the effectiveness of conservation actions. A combination of biological and sociological variables in the context of a 'return on investment' framework for establishing conservation priorities was explored. While there was some overlap between megadiversity nations and return on investment priorities, only a few countries emerged as high priorities irrespective of which factors were included in the analysis. Conversely, some countries that ranked highly as priorities for conservation when focusing solely on biological metrics, did not rank highly when governance, population pressure, economic costs and conservation needs were considered (e.g. Colombia, Ecuador, Indonesia and Venezuela). No priority-setting scheme is *a priori* superior to alternative approaches. However, the analyses suggest that attention to governance and return on investment may alter biocentric assessments of ideal conservation investments.

Keywords

Biodiversity, conservation NGOs, habitat protection, human population growth, megadiversity nations.

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INTRODUCTION

Faced with greater demand than resources, governments, international institutions and non-governmental organizations (NGOs) must make difficult decisions about where to invest in conservation. To meet this challenge, ecologists have advocated a variety of systems for establishing global conservation priorities (Myers 1988, 1990; Bibby *et al.* 1992; Dinerstein & Wikramanayake 1993; Sisk *et al.* 1994; Mittermeier *et al.* 1997, 1998; Olson & Dinerstein 1998; Myers *et al.* 2000). Most prioritization schemes focus primarily on measures of biological value and threat. Although ecoregions are often compared when establishing conservation priorities, organizations must deal with the unique regulatory agencies, legal institutions and societies of individual nations. Obviously, nations vary enormously in political, social and economic conditions. Unstable governance, lawlessness, war, high cost of operations and an absence of infrastructure can hinder well-intentioned and well-funded conservation efforts. Moreover, human activity, in a broad sense, is related to the degree of conservation threat (Kerr & Currie 1995). If conservation is considered as an investment of limited time and money, it is conceivable that some biologically high-priority locations may not, in fact, be a wise investment of conservation effort.

We attempt here to explicitly incorporate economic and political factors into conservation priority setting at a global scale. We build on a handful of earlier studies that have incorporated socio-political indicators into priority-setting exercises (Sisk *et al.* 1994; Reyers *et al.* 1998; Reyers & James 1999). Specifically, a return on investment framework was applied, but in a flexible manner because it was not obvious how much weight should be given to biodiversity value compared with socio-political constraints. By examining six different return on investment formulations, countries that robustly warrant 'high-priority' status were identified, regardless of the details of the ranking index.

METHODS

Indicators for feasibility

Data on social, economic and political factors that are likely to influence the feasibility and utility of practicing conservation within a country were compiled. One index each for governance, economics, population pressure and conservation need were then created. Data regarding governance were obtained from a World Bank project that used expert opinion and surveys to evaluate nations on six criteria illustrative of governmental quality (Kaufmann *et al.* 2002): political stability, government effectiveness, rule of law, control of corruption, accountability and regulatory quality. As these metrics were strongly intercorrelated, we reduced them into a single principle component that explained 83% of the variance. Conservation projects are most cost effective when implemented in less-developed nations (Balmford *et al.* 2003). We therefore included GDP per capita, adjusted for purchasing power parity (PPP), as an indicator of operational costs within each nation (data from World Bank 2000, supplemented by CIA 2002). High population densities indicate current threats to conservation, whereas high population growth rates indicate future threats (Cincotta *et al.* 2000). Thus, our indicator of overall population pressure was the product of population density in 2000 and the average annual population growth rate from 1990 to 2000 (data from World Bank 2000). Lastly, conservation need was measured as the percentage of total land area of a country not already protected (IUCN management categories I–V; data from WRI 2001). Past prioritization studies have adopted various indicators to measure conservation progress, including national conservation budgets, genetic stocks and reference collections, and land area protected (Reyers *et al.* 1998). Only percentage land area unprotected was used because these data were the most complete and most clearly connected to on-the-ground conservation progress.

Indicators for biological value and urgency

Indicators of biological value, such as species diversity and endemism, are strongly intercorrelated (Table 1; data from WRI 2001). The diversity of higher plants was selected as the metric of biological value because these data were most complete (147 countries) and because plant diversity was strongly correlated with plant endemism, a common arbiter of biological priority (e.g. Mittermeier *et al.* 1997; Myers *et al.* 2000).

We used data on forest loss to assess threat to biodiversity (WRI 2001). Data regarding deforestation are increasingly generated from satellite imaging, and are thus relatively unbiased by disparities in research funding (Achard *et al.* 2002). In addition, forest loss was significantly correlated with the percentage of species at risk (Table 1).

Constructing a 'return on investment' index

As variables were measured on different scales, all data were transformed to percentiles, thereby restricting them to an

Table 1 Spearman rank correlations for biological indicators of value and threat

	Higher plant species	Endemic plant species	Endemic mammal species	Total mammal species	Mammal species risk	Vertebrate species risk	Plant species risk	Total vertebrate species	Total species
Endemic plant species	0.81*								
Endemic mammal species	0.729*	0.766*							
Total mammal species	0.702*	0.466*	0.588*						
Mammal species risk	0.744*	0.621*	0.707*	0.682*					
Vertebrate species risk	0.312*	0.466*	0.334*	−0.172	0.412*				
Plant species risk	0.406*	0.488*	0.459*	0.077	0.297*	0.499*			
Total vertebrate species	0.836*	0.604*	0.711*	0.964*	0.743*	−0.055	0.179		
Total species	0.951	0.781*	0.696*	0.666*	0.645*	0.143	0.398*	0.604*	
Average annual forest change (1990–2000)	−0.233*	−0.046	−0.1	−0.485*	−0.16	0.333*	0.079	−0.487*	−0.296*

*$P < 0.05$; not corrected for multiple testing.

All data are from WRI (2001), which summarizes data from the World Conservation Monitoring Centre and the Food and Agriculture Organization of the United Nations.

identical range (0–100). We then examined what we call a return on investment (ROI) model, in which

$$ROI = \phi B + L + G + N - C \pm H \quad (1)$$

where B represents biological value (diversity of higher plants), L is loss of vegetation (rate of deforestation), H is pressure from human population growth, G is governance (principal component score), N is need for conservation effort (percengate land area unprotected), and C is cost of operations (GDP-PPP per capita). Like earlier prioritization schemes, this model awards highest priority to nations that have high species diversity combined with a high degree of threat (here measured in terms of forest loss). However, this model also gives priority to nations in which there is good governance, substantial need for conservation, and low costs of operation. Human population pressure (H) can be thought of in two contrasting ways when setting priorities. High human pressure could mean greater urgency for conservation (hence H enters as a positive factor). Alternatively, high human pressure could restrict options for conservation, and provide obstacles to setting aside land for reserves (hence H enters as a negative factor). Regardless of how H is considered, biological value (B) may be given greater weight than indices reflecting cost or feasibility. To explore various degrees of emphasis on biology, we calculated ROI using three different weightings: $\phi = 1$, 2 or 3. Altogether then, we examined six versions of the ROI model (eqn 1 with three values of ϕ crossed with $\pm H$).

Of the 160 countries with land area >10 000 km^2, we found plant diversity data for 147 nations. The remaining 13 nations were excluded. Within those 147 countries, data regarding governance, forest loss and percentage of land area unprotected were missing for 9, 23 and 5 countries, respectively. Rather than excluding these nations, missing percentile scores were set to zero, so that missing data could not contribute to a high ROI score. To examine how this treatment of missing data affected our findings, each model was re-run assuming that missing values were intermediate (50th percentile).

RESULTS

None of the feasibility or threat indices in the ROI framework were correlated with indices of biodiversity (Table 2). This lack of correlation implies that social and political factors convey information that is independent from the biodiversity metrics.

Table 3 reports the top 30 countries for the three ROI models in which human population threats were viewed as a positive indicator of conservation need ($+H$) and the three models in which human population was viewed as a negative indicator of feasibility ($-H$). For each of these alternative sets of models, we focused on nations that were consistently identified as priorities, regardless of how biological value was weighted (the 'union' columns of Table 3). Nineteen nations were consistently top priorities for the $+H$ models and 21 were consistent winners for the $-H$ models. Of the 23 countries lacking forest loss data, only two (Morocco and Afghanistan) became high priority sites when we assumed they had intermediate rates of forest loss. None of the nations lacking data for governance or percentage unprotected made the ROI union lists under this altered assumption.

The fact that the two union lists have only nine nations in common makes it clear that how one views population growth has a major effect on which countries are identified as high priorities. For example, eight nations with relatively low population threats (Argentina, Australia, Bulgaria, Republic of Congo, Italy, Kyrgyzstan, Portugal and Spain), were identified as high priorities when population pressure was assumed to detract from priority status, but did not appear on a single top 30 list when population pressure was considered as a positive indicator of conservation need.

A particularly interesting question is whether the ROI framework gives fundamentally different priorities than focusing on diversity alone. Table 3 contrasts the ROI results with Mittermeier *et al.*'s (1997) megadiversity nations, which are defined solely in terms of diversity of endemic plants. On average, only half of the megadiversity nations appeared on an ROI union list (nine of 17 for $+H$ models, eight of 17 for $-H$ models). More striking is the 35% of

Table 2 Spearman rank correlations for selected biological vs. socio-political variables

	Endemic plants	Total higher plants	Vertebrate risk	Endemic birds	Plant risk
GDP-PPP per capita	−0.091	−0.115	0.153	−0.054	0.201
Population density × growth	0.17	0.142	0.004	0.129	−0.028
Per cent land area unprotected	−0.038	−0.107	0.147	−0.046	−0.054
Governance	−0.219*	−0.225*	0.033	−0.094	0.131

*$P < 0.05$; not corrected for multiple testing.
PPP, purchasing power parity.

Table 3 Results of six different return on investment (ROI) models. Megadiversity Nations are from Mittermeier *et al.* 1997

	$+H$				$-H$				
Country	$\phi = 1$	$\phi = 2$	$\phi = 3$	Union w/$+H$	$\phi = 1$	$\phi = 2$	$\phi = 3$	Union w/$-H$	Megadiversity
Algeria									
Argentina					x	x	x	X	
Australia					x	x	x	X	X
Azerbaijan	x								
Bangladesh	x	x	x	X	x	x	x	X	
Bolivia			x		x	x	x	X	
Brazil		x	x		x	x	x	X	X
Bulgaria					x	x	x	X	
Cameroon		x	x				x		
Canada									
China	x	x	x	X	x	x	x	X	X
Colombia			x				x		X
Congo, Dem. Rep.	x	x	x	X		x	x		X
Congo, Rep.					x	x	x	X	
Costa Rica		x	x						
Cuba		x	x			x	x		
Ecuador									X
Egypt	x	x			x				
El Salvador	x								
Ethiopia	x	x	x	X					
Gambia	x								
Greece	x	x			x	x	x	X	
Guyana		x	x		x	x	x	X	
Haiti	x	x	x	X					
India	x	x	x	X	x	x	x	X	X
Indonesia			x						X
Ireland					x				
Israel	x								
Italy					x	x	x	X	
Jamaica	x	x							
Kenya	x	x	x	X					
Kyrgyzstan					x	x	x	X	
Lebanon	x								
Madagascar	x	x	x	X	x	x	x	X	X
Malaysia	x	x	x	X					X
Mauritania					x				
Mexico		x	x			x	x		X
Moldova					x				
Mozambique	x	x	x	X	x	x	x	X	
Myanmar	x	x	x	X					
Nepal	x	x	x	X					
Papua New Guinea	x	x	x	X	x	x	x	X	X
Peru	x	x	x	X	x	x	x	X	X
Philippines	x	x	x	X					X
Portugal					x	x	x	X	
Romania					x	x			
Slovenia					x				
South Africa	x	x	x	X	x	x	x	X	X
Spain					x	x	x	X	
Tanzania	x	x	x	X			x		
Thailand			x						

Table 3 *continued*

Country	+*H*				−*H*				Megadiversity
	$\phi = 1$	$\phi = 2$	$\phi = 3$	Union w/$+H$	$\phi = 1$	$\phi = 2$	$\phi = 3$	Union w/$-H$	
Tunisia	x								
Turkey	x	x	x	X		x	x		
Ukraine					x	x	x		
United States		x	x			x	x		X
Uruguay	x				x	x			
Uzbekistan	x	x							
Venezuela									X
Vietnam	x	x	x	X	x	x	x	X	

megadiversity nations that did not consistently appear on either set of ROI models. Most of these nations (Colombia, Ecuador, Indonesia and Venezuela) suffer relatively poor governance and have a high percentage of land already under protection. The exceptions are the United States and Mexico, which failed to make the top 30 lists whenever biological value was weighted weakly – in part because of the relatively high cost of doing conservation in these nations. Lastly, a handful of countries (China, India, Madagascar, Papua New Guinea and South Africa) appeared on every list, no matter which priority-setting model was used (Table 3). These nations, which are robustly favourable to conservation work, should clearly be major foci for conservation.

DISCUSSION

During the current economic downturn, conservation NGOs are coming under increasing scrutiny, and donors are pressuring organizations to think in terms of return on investment (Christensen 2002). Countries with stable, effective governance combined with low GDP will probably provide more secure investments of limited conservation dollars, whereas countries with poor governance and high GDP suggest a riskier endeavour. Expending excessive resources in favour of one biologically valuable area is irresponsible when other slightly less valuable areas are ignored or under-funded, despite having social and economic conditions more favourable to conservation projects.

All variables considered here include uncertainty, with diversity estimates and deforestation rates especially error-prone. Plant diversity data are based on habitat-based counts or sampling and are thus very approximate. For example, two recent estimates of total plant diversity of the Earth differ by over 100 000 species (Pitman & Jorgensen 2002). To deal with this uncertainty a range of weightings to plant diversity were assigned to our models. Deforestation data are also poor, with error rates of ±50% (Achard *et al.* 2002). Some countries may become higher priorities as we better measure deforestation. Thus, we do not wish to overemphasize exactly which countries appear on our priority lists. Rather we want to emphasize that an explicit consideration of socio-economic and political indicators is essential and can paint a very different picture regarding which countries should receive the most attention.

Return on investment approaches can retain biological considerations at the forefront of conservation priority setting while accounting for differences in projected feasibility. Ideally, a good feasibility model would de-emphasize countries that may be high in biological value but in which it may be exceptionally difficult to implement conservation projects. In addition, a good approach would not needlessly weed out countries that are high in biological value but happen to be low in one or two particular social or political indicators. The countries consistently identified in Table 3 as high priority places are in all cases biologically valuable, and most are under a significant amount of threat, reasonably well-governed, cost-effective and currently lacking in sufficient conservation work. Countries that fit these criteria will allow organizations to put their limited resources to their best use.

There are many ways to evaluate countries based on a combination of biological and socio-political criteria, each of which may produce a different list of high priority nations. Here we explored a limited selection of priority-setting schemes, not because these schemes provide the final word on the subject, but because they illustrate a general approach that can be tailored to individual needs. Clearly, the weightings for all parameters can be easily adjusted to reflect the missions of particular NGOs. Ultimately, conservation is needed everywhere, but where we should work first ought to be guided by effectiveness and biological value. Interestingly, the handful of countries that we identified as high-priority nations under all combinations of biological and socio-political factors are not the countries that currently receive the greatest international investment for conservation as measured by World Bank projects or by number of NGO offices (Kareiva & Marvier 2003).

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