



Essay

Acknowledging Conservation Trade-Offs and Embracing Complexity

PAUL D. HIRSCH,* WILLIAM M. ADAMS,† J. PETER BROSIUS,‡ ASIM ZIA,§ NINO BARIOLA,**,†† AND JUAN LUIS DAMMERT††,‡‡

*Center for Environmental Policy and Administration, Maxwell School of Syracuse University, Syracuse, NY 13244-1020, U.S.A., email pahirsch@maxwell.syr.edu

†Department of Geography, University of Cambridge, Downing Place, Cambridge CB2 3EN, U.K.

‡Center for Integrative Conservation Research, University of Georgia, Athens, GA 30602, U.S.A.

§Department of Community Development and Applied Economics, University of Vermont, Burlington, VT 05405, U.S.A.

**Departamento de Humanidades, Pontificia Universidad Católica del Perú, Avenida Universitaria 1801, San Miguel, Lima, Perú

††Departamento de Ciencias Sociales, Pontificia Universidad Católica del Perú, Avenida Universitaria 1801, San Miguel, Lima, Perú

‡‡Peruvian Society for Environmental Law, Prolongación Arenales 437, San Isidro, Lima, Perú

Abstract: *There is a growing recognition that conservation often entails trade-offs. A focus on trade-offs can open the way to more complete consideration of the variety of positive and negative effects associated with conservation initiatives. In analyzing and working through conservation trade-offs, however, it is important to embrace the complexities inherent in the social context of conservation. In particular, it is important to recognize that the consequences of conservation activities are experienced, perceived, and understood differently from different perspectives, and that these perspectives are embedded in social systems and preexisting power relations. We illustrate the role of trade-offs in conservation and the complexities involved in understanding them with recent debates surrounding REDD (Reducing Emissions from Deforestation and Degradation), a global conservation policy designed to create incentives to reduce tropical deforestation. Often portrayed in terms of the multiple benefits it may provide: poverty alleviation, biodiversity conservation, and climate-change mitigation; REDD may involve substantial trade-offs. The gains of REDD may be associated with a reduction in incentives for industrialized countries to decrease carbon emissions; relocation of deforestation to places unaffected by REDD; increased inequality in places where people who make their livelihood from forests have insecure land tenure; loss of biological and cultural diversity that does not directly align with REDD measurement schemes; and erosion of community-based means of protecting forests. We believe it is important to acknowledge the potential trade-offs involved in conservation initiatives such as REDD and to examine these trade-offs in an open and integrative way that includes a variety of tools, methods, and points of view.*

Keywords: conservation policy, decision theory, politics, REDD

Reconocimiento los Trade-offs de la Conservación y Atención a la Complejidad

Resumen: *Cada vez hay un mayor reconocimiento de que la conservación a menudo conlleva trade-offs. Un enfoque en los trade-offs puede abrir el camino hacia una consideración más completa de los efectos positivos y negativos asociados con las iniciativas de conservación. Sin embargo, al analizar los trade-offs de la conservación es importante atender las complejidades inherentes al contexto social de la conservación. En particular, es importante reconocer que las consecuencias de las actividades de conservación son experimentadas, percibidas y comprendidas de manera diferente desde perspectivas diversas, y que estas perspectivas se insertan en sistemas sociales y relaciones de poder preexistentes. Ilustramos el papel de los trade-offs en la conservación y las complejidades que implica su entendimiento con debates recientes en torno*

de REDD (Reducción de Emisiones por Deforestación y Degradación), una política de conservación global diseñada para crear incentivos para reducir la deforestación tropical. A menudo descrito en términos de los múltiples beneficios que puede proporcionar – disminución de la pobreza, conservación de biodiversidad y mitigación de cambio climático – REDD puede implicar trade-offs sustanciales. Las ganancias de REDD podrían implicar la reducción de incentivos para que los países industrializados reduzcan sus emisiones de carbono; la reubicación de la deforestación en sitios no afectados por REDD; el incremento de la inequidad en lugares donde la gente que vive de los bosques no tiene certeza sobre la tenencia de la tierra; la pérdida de diversidad biológica y cultural que no se alinea directamente con los esquemas de REDD; y la erosión de los medios comunitarios para la protección de bosques. Consideramos que es importante reconocer los trade-offs de las iniciativas de conservación como REDD y examinarlos de manera abierta e Integradora que incluya una variedad de herramientas, métodos y puntos de vista.

Palabras Clave: política, políticas de conservación, teoría de decisión, REDD

Introduction

Conservation initiatives are often developed to simultaneously meet conservation goals, alleviate poverty, and provide economic development. These initiatives are designed to respond to common threats to human well-being and the environment and to build on synergies between cultural and ecological resilience. Nevertheless, evidence and hindsight highlight losses associated with many of these initiatives, including loss of access to resources, loss of development opportunities, and changes in ecological dynamics and in human populations and behavior that negatively affect species and ecosystems (e.g., Songorwa 1999; McShane & Wells 2004; Sunderland et al. 2008).

As evidence gathers that initiatives designed to simultaneously advance ecological conservation and social development have fallen short of one or both these objectives, there has been a spate of scholarship and a proliferation of analytical tools that focus attention on conservation trade-offs (e.g., Brown 2004; Stoorvogel et al. 2004; Garnett et al. 2007; Nelson et al. 2009). Although this work is diverse in both theory and method, approaches to understanding and examining trade-offs share the effort to simultaneously examine both gains and losses in particular conservation contexts.

McShane et al. (2010) argue that thinking and communicating in terms of trade-offs is a positive step for conservation because it moves beyond the rhetoric of multiple benefits with no losses (or win-win scenarios in popular parlance). This multiple-benefits perspective, although powerful from the standpoint of gaining funding and support, can fuel a cycle of optimism and disenchantment as successive supposed panaceas fail to fulfil their promise (Brosius & Russell 2003; Ostrom 2007; Redford & Adams 2009). Over the long term, if losses are experienced where only gains were expected, the trust and good will necessary to achieve conservation objectives can erode (McShane et al. 2010).

Realistic acknowledgment of losses as well as gains need not imply inaction or policy paralysis. On the contrary, identification and analysis of trade-offs can invite

and promote dialog, creativity, and learning; allow for more comprehensive planning; and reduce the probability of disappointment and disillusionment associated with a policy or initiative that yields mixed outcomes. The identification of trade-offs can furthermore allow for the acknowledgment of conflicting views and interests and thus facilitate deliberation and concerted negotiation (Brechtin et al. 2003). Acknowledging trade-offs can also help legitimize the possibility of choosing not to adopt a given policy or participate in a certain program, which in turn increases the legitimacy of policies that are ultimately adopted. Acknowledging trade-offs may help decision makers and those to whom they are accountable confront and take responsibility for difficult choices. Finally, thinking in terms of trade-offs—understanding that some loss is inevitable—may allow for progress toward conservation and human well-being objectives to be made even though no alternative meets all interests and values.

As calls to analyze, measure, and calculate trade-offs in conservation are heeded, however, a contradiction has begun to arise. On the one hand, tools and procedures to identify and calculate trade-offs between conservation and other social goals can help conservation professionals confront difficult choices and provide methods for doing so. On the other hand, the trade-offs concept can itself be applied in ways that oversimplify or obscure important issues, often by reducing the analytical challenge to one of aggregating and comparing the quantifiable costs and benefits of conservation initiatives. This can obscure values and interests that are difficult to quantify in a widely agreed upon manner or are not comparable in socially meaningful ways. Also obscured by methods that focus only on costs and benefits are distributional issues: who loses, who pays, and who benefits. Furthermore, overly narrow approaches to trade-off analysis can fail to take into account the role of perspective and otherwise detract from the integrity of decision processes by shifting the focus toward technical issues and away from the social context within which conservation and conservation trade-offs are embedded.

We contend that, although the move to trade-off thinking and analysis in conservation is important, this move

should not be construed too narrowly. On the contrary, tools, methods, and approaches for acknowledging trade-offs in conservation should be accompanied by tools, methods, and approaches that embrace the complexity of conservation's social and political context. We considered how trade-off thinking shapes conservation policy and describe some of the possibilities and pitfalls in analyzing conservation trade-offs in their social context. As an example, we drew on the debates surrounding a set of conservation policies known as REDD (Reducing Emissions from Deforestation and Degradation).

REDD and Trade-Offs

The design and communication of policies that link conservation, economic development, and poverty alleviation are exemplified by an emerging climate-change reduction policy known broadly as REDD. A type of "payment for ecosystem services" (Wunder 2008), REDD is a set of mechanisms for reducing carbon emissions through which landowners or governments in countries or areas within countries are paid to lower their rates of deforestation and conversion of forest to other land-cover types that sequester less carbon. Reductions in carbon emissions are measured by comparing deforestation activity under REDD with a historical (or projected future) baseline of deforestation. Most of the money to pay for REDD will come from industrialized countries in the form of donations or from funds linked to carbon markets.

REDD has been portrayed as an ideal mechanism for reducing the magnitude and undesirable effects of climate change because it is thought to alleviate poverty, conserve biological diversity, and reduce atmospheric carbon (e.g., Nabuurs et al. 2007; Boucher 2008; UN-REDD 2009). The release of carbon dioxide from tropical deforestation contributes from 17% to 25% of global greenhouse gas emissions (e.g., Houghton 2003; Baumert et al. 2005; Metz et al. 2007). Incentives to protect tropical forests are presumed to have the additional benefit of leading to protection of ecosystems and species. Furthermore, the compensation of people, groups, or countries for their efforts to reduce deforestation and forest conversion is a potential stimulus for economic development at local and national levels.

Despite these prospective gains, however, there are losses that could result from REDD policies. Some writers think REDD may serve as an impetus for industrialized countries to reduce efforts to minimize carbon-emitting behaviors or to reduce investment in clean and renewable energy technologies (Levin et al. 2008; Thies & Czebiniak 2008). Also of concern is that although REDD programs may protect forests in some areas, they may result in forest loss in other areas, and in some circumstances

may lead to reduction in species richness if monocultures of fast-growing trees are promoted at the expense of diverse species of slower growing trees (Levin et al. 2008). The social goals REDD is designed to promote may not be realized if the wealthy, who have more secure tenure than the poor and access to larger areas of forest, benefit disproportionately from REDD payments (Levin et al. 2008; Campbell 2009). Also, REDD policies could result in the loss of control of forest resources by local communities if newly valuable forests are appropriated by governments or other powerful interests. This could then lead to more deforestation, particularly in cases where community-based forms of forest management have been shown to be more effective than other alternatives (Agrawal et al. 2008).

Although both the prospective gains and losses involved in REDD are the subject of ongoing debate and REDD policies continue to be refined, we believe REDD will involve both gains and losses with respect to multiple values and from a variety of points of view. Here we use the case of REDD to discuss what it entails to acknowledge that policies such as REDD involve trade-offs and what it entails to identify and subsequently analyze these trade-offs in an open and integrative manner that does not hinder debate by framing trade-offs in narrow or technical ways.

Acknowledging Trade-Offs and the Role of Policy Narratives

Acknowledging trade-offs involves acknowledging the possibility that a policy or project will lead to some losses, which can be difficult when political interests or funding opportunities are at stake. Nevertheless, to the extent that policy narratives are constructed by framing solutions as win-wins or that trade-offs are construed merely as quantifiable benefits compared with quantifiable costs, policy debate—and decision-making processes more generally—will be deficient in that essential problem elements will be obscured or ignored.

Emery Roe (1991, 1994) pointed out that policy makers usually draw on policy narratives; stories, or scenarios that enable or persuade citizens and decision makers to respond to problems in particular ways. Policy narratives often describe what will happen if certain events occur. The win-win narrative, for instance, says that implementing REDD policy will produce positive results in the form of poverty reduction, ecosystem protection, and climate-change mitigation. Policy narratives are often devised by or draw from the work of researchers and consultants and are written into popular scientific syntheses. They become the standard explanations of problems in successive policy documents and are absorbed by policy

makers through training, the development of institutions, and the funding of research.

Through their use of narratives, those involved in policy making convince each other that their understanding of a problem is the correct understanding and their choice of solutions is appropriate (Leach & Mearns 1996). They also strive to control (or appear to control) uncertainty and hence provide a secure basis for policy debate and action. Certain narratives offer generalized explanations of what is wrong and what needs to be done so as to legitimize immediate action without further research or consultation. Policy narratives are extremely useful, for without simplifications of both problem and context policy making and action would be paralyzed (Leach & Mearns 1996). Nevertheless, most situations have multiple, conflicting policy narratives. As a result, analytical approaches to understanding problems are often plagued by multiple “objective” analyses of a problem that can yield multiple conclusions and fail to provide useful information on which to base social choices and actions.

At first glance, focusing on the positive outcomes of a policy may be understood as a viable way of constructing a policy narrative that unifies disparate perspectives. We suggest, however, that by precluding discussion of possible negative outcomes, this win-win framing can in fact increase polarization and proliferation of competing narratives. That is, if the experiences, interests, and values of some actors lead them to focus on the negative outcomes of a policy, their best alternative may be to develop or contribute to an alternate policy narrative (or counter narrative, Roe 1991) in which multiple goals are deemed incompatible and one goal is presented as dominating others. Thus, in the case of REDD, the Indigenous Environmental Network has reworded the acronym as “Reaping Profits from Evictions, land grabs, Deforestation, and Destruction of Biodiversity,” thereby creating a counter narrative that asserts the negative effects and profit-driven motives of REDD policies (Indigenous Environmental Network 2010).

A policy narrative constructed from an acknowledgment of trade-offs, by contrast, may reduce the potential for polarization by recognizing the possibility of negative outcomes and dissatisfied actors. Although trade-offs framing does not obviate the need to make difficult choices, it may increase the probability of open and deliberative communication (Habermas 1984) and of ongoing learning and adaptive management (Norton 2005).

Framing policy narratives in terms of trade-offs does not, however, eliminate the possibility that policy choices will be monopolized by simplistic ways of presenting problems that marginalize alternatives. Trade-off thinking, and the analytical tools that go with it, are not a panacea, and their application to conservation has several pitfalls.

Avoiding Pitfalls and Embracing Complexity

The central pitfall to be avoided in framing conservation in terms of trade-offs is obscuring the fact that real people in communities, organizations, and countries will be affected positively or negatively. If understood as a means of defining problems in objective and neutral terms, trade-off framing can hide the political dimensions of contemporary conservation issues (Ferguson 1994; Li 2007). With respect to REDD, or any global conservation issue, positive and negative effects occur against a backdrop of inequality and ongoing disputes among the poor, between poor and elite groups, and among poor and elite groups and government (Wilson 2002). Framing a problem in terms of trade-offs, therefore, can obscure differences in the ability to exercise power that make it difficult for some actors to voice their interests in decision processes. In the case of REDD, potential groups that will be negatively or positively affected are as disparate as the World Bank, the United States, China, developing countries, and communities and indigenous groups within developing countries. Clearly, these groups have dramatically different abilities to be heard and negotiate solutions that are favorable to them.

Another pitfall to be avoided in the application of trade-off thinking to conservation issues is the tendency to assume that because problems can be defined in terms of trade-offs, everything can indeed be traded off. On the contrary, many actors in complex conservation scenarios, such as those related to REDD, may feel quite strongly that certain values (e.g., individual rights, cultural heritage, species protection) should not be traded off at all. From this perspective, for one actor to frame a problem in terms of trade-offs is to undermine another's ability to protect what they value (O'Neil et al. 2007).

A related pitfall is the possibility that trade-off analysis will collapse multiple incommensurable forms of value for the sake of generating a definitive solution (Norton & Noonan 2007). Many analytical tools for evaluating trade-offs, such as benefit-cost analysis, assume values can be quantified and compared according to a single metric—usually money. In benefit-cost analysis, the identification of trade-offs can become conflated with the economic analysis of opportunity costs. The costs of the avoided deforestation activities promoted by REDD policies, for example, are often conceived as the economic costs incurred by not converting forests to land uses such as crops or pasture. Although measures of opportunity cost, and benefit-cost analyses more generally, yield important information and insights, they are unlikely to cover—or provide an agreed-upon basis for comparing—the range of values and potential effects that are relevant to people affected by REDD. Given the potential effect of a policy such as REDD on values and ideals such as, sovereignty, identity, and natural and cultural heritage, it therefore seems unlikely that single-metric forms of valuation can

accurately represent the trade-offs involved (Norton & Noonan 2007).

Trade-off framing can also be used in ways that render invisible the larger contexts in which conservation and development issues unfold. Researchers, analysts, and policy makers interested in the relations among climate, conservation, and society are a part of the systems they study and act in at every level, from the biological to the political. Phenomena such as climate change, deforestation, and ecosystem services are not natural categories that can be engaged with clinically or understood purely in objective terms. They are embedded in systems of meanings, narratives, and beliefs. To even begin to formulate a conservation problem as a trade-off (e.g., between species and ecosystem services or between conservation and economic development) is to engage in a realm of contested and often conflicting assumptions and ways of understanding (Adams et al. 2003). At this level, the terms conservation professionals use—*biological diversity*, *ecosystem services*, *adaptation*, and *mitigation*—can function to silence or marginalize those who do not view the world in the same categories (Escobar 1998). With respect to REDD, if trade-offs are not presented with some regard for the way analytical processes are embedded within larger social and political contexts, attention may be diverted from drivers that might in fact be paramount, such as the ways in which the demand from developed countries for timber and other products has affected changes in tropical forests. If the purposes of REDD are to reduce deforestation and promote equity, it is important to discuss these issues.

Trade-Off Analysis

Given a desire to conserve species and ecosystems, it is increasingly important to think through and make explicit trade-offs among different conservation goals and between conservation and other social goals, such as poverty alleviation and economic development. We think trade-off thinking and analyses are important for understanding and communicating the multiple dimensions of conservation initiatives. Offering overly optimistic scenarios that simultaneously promote multiple conservation and development objectives might seem strategic by conservation professionals seeking funding. Nevertheless, ignoring or obscuring trade-offs can contribute to the profound disappointment and even alienation of important partners in conservation.

Acknowledging trade-offs requires resisting the temptation to obscure political realities, flatten multiple dimensions of value into a single term, or ignore marginalized interests or ways of knowing. As researchers and practitioners develop methods to identify and calculate trade-offs (e.g., Brown 2004; Garnett et al. 2007;

Stoorvogel et al. 2004; Nelson et al. 2009) or adapt tools and methods from other disciplines for use in conservation, we propose that an open and integrative approach to acknowledging trade-offs and embracing complexity would be useful.

First, an open and integrative approach to acknowledging trade-offs and embracing complexity would start with the assumption that no single perspective recognizes all dimensions of an issue. Furthermore, such an approach would recognize and expose ways in which people with particular perspectives (e.g., disciplines, organizations, cultures) not only have partial views of the complexity of conservation issues, but also tend to oversimplify or take for granted the ways in which *others* understand complexity.

Second, recognizing that all views of a complex problem are partial—what can be called universal partiality—an open and integrative approach to acknowledging trade-offs and embracing complexity would systematically engage multiple partial perspectives. This would entail but go beyond the inclusion of a variety of disciplines, country representatives, and organizations. It should be a deep form of pluralism in which multiple epistemologies (Miller et al. 2008), valuation methods (Norton 2005; Norton & Noonan 2007), and ways of knowing (Schneider & Ingram 2007) are encouraged and allowed to interact.

Third, an open and integrative approach to acknowledging trade-offs and embracing complexity would not aim to provide a unified output that justifies one policy choice over another to all potential audiences. If the idea of deep pluralism is taken seriously, it must be accepted that a single and final understanding of a sufficiently complex issue is inherently over simplistic. The identification of trade-offs should thus be viewed as an iterative process of understanding the multiple implications of conservation decisions as seen from multiple perspectives.

Fourth, and perhaps most importantly, an open and integrative approach to acknowledging trade-offs and embracing complexity would not yield paralysis, but would instead provide insight and the opportunity for genuine reflection, honest communication, and responsible action.

Acknowledgments

This essay derives from the research and experience of the authors as part of a multiyear initiative called Advancing Conservation in a Social Context (ACSC): Working in a World of Trade-Offs. The ACSC initiative is supported by the John D. and Catherine T. MacArthur Foundation through a grant to the Global Institute of Sustainability at Arizona State University. We are grateful to T. McShane and S. O'Connor for creating the space in which people from a variety of countries, organizations, and disciplinary perspectives could come together and

develop these ideas, and to our colleagues in the ACSC initiative for ongoing and rich discussions that stimulated and shaped development of these ideas. We are grateful to the editors of *Conservation Biology* and to anonymous reviewers for comments on earlier drafts of this manuscript.

Literature Cited

- Adams, W., D. Brockington, J. Dyson, and B. Vira. 2003. Managing tragedies: understanding conflict over common pool resources. *Science* **302**:1915–1916.
- Agrawal, A., A. Chhatre, and R. Hardin. 2008. Changing governance of the world's forests. *Science* **320**:1460–1462.
- Baumert, K., T. Herzog, and J. Pershing. 2005. Navigating the numbers: greenhouse gas data and international climate policy. The World Resources Institute, Washington, D.C.
- Boucher, D. 2008. Out of the woods: a realistic role for tropical forests in curbing global warming. Union of Concerned Scientists, Cambridge, Massachusetts.
- Brechin, S., P. Wilshusen, C. Fortwangler, and P. West. 2003. Contested nature: promoting international biodiversity with social justice in the twenty-first century. State University Press of New York, Albany.
- Brosius, J. P., and D. Russell. 2003. Conservation from above: an anthropological perspective on transboundary protected areas and ecoregional planning. Pages 39–66 in U. M. Goodale, M. J. Stern, C. Margoluis, A. G. Lanfer, and M. Fladeland, editors. *Transboundary protected areas: the viability of regional conservation strategies*. Food Products Press, Binghamton, New York.
- Brown, K. 2004. Trade-off analysis for integrated conservation and development. Pages 232–255 in T. McShane and M. Wells, editors. *Getting biodiversity projects to work: towards more effective conservation and development*. Columbia University Press, Chichester, New York.
- Campbell, B. 2009. Beyond Copenhagen: REDD+, agriculture, adaptation strategies and poverty. *Global Environmental Change* **19**:397–399.
- Escobar, A. 1998. Whose knowledge, whose nature? Biodiversity, conservation, and the political ecology of social movements. *Journal of Political Ecology* **5**:53–82.
- Ferguson, J. 1994. The anti-politics machine: development, depoliticization, and bureaucratic power in Lesotho. Cambridge University Press, Cambridge, United Kingdom.
- Garnett, S. T., J. Sayer, and J. Du Toit. 2007. Improving the effectiveness of interventions to balance conservation and development: a conceptual framework. *Ecology and Society* **12**(1): <http://www.ecologyandsociety.org/vol12/iss1/art2/>
- Habermas, J. 1984. The theory of communicative action. Volume 1. Reason and the rationalization of society. Translated by T. McCarthy. Beacon Press, Boston.
- Houghton, R. 2003. Why are estimates of the terrestrial carbon balance so different? *Global Change Biology* **9**:500–509.
- Indigenous Environmental Network (IEN). 2010. Reaping profits from evictions, land grabs, deforestation, and destruction of biodiversity. IEN, Bemidji, Minnesota. Available from <http://www.ienearth.org/REDD/index.html> (accessed June 2010).
- Leach, M. and R. Mearns. 1996. The lie of the land: challenging received wisdom on the African environment. James Currey and Heinemann, Oxford, United Kingdom.
- Levin, K., C. McDermott, and B. Cashore. 2008. The climate regime as global forest governance: can reduced emissions from Deforestation and Forest Degradation (REDD) initiatives pass a 'dual effectiveness' test? *International Forestry Review* **10**:538–549.
- Li, T. 2007. Practices of assemblage and community forest management. *Economy and Society* **36**:263–293.
- McShane, T., et al. 2010. Making trade-offs between biodiversity conservation and human well-being. *Biological Conservation*: <http://dx.doi.org/10.1016/j.biocon.2010.04.038>
- McShane, T., and M. Wells. 2004. *Getting biodiversity projects to work: towards more effective conservation and development*. Columbia University Press, Chichester, New York.
- Metz, B., O. Davidson, P. Bosch, R. Dave, and L. A. Mayer. 2007. *Climate change 2007 synthesis report: summary for policymakers*. Cambridge University Press, Cambridge, United Kingdom.
- Miller, T., T. Baird, C. Littlefield, G. Kofinas, F. S. Chapin III, and C. Redman. 2008. Epistemological pluralism: reorganizing interdisciplinary research. *Ecology and Society* **13**(2): <http://www.ecologyandsociety.org/vol13/iss2/art46/>
- Nabuurs, G. J., et al. 2007. Forestry. Pages 541–584 in B. Metz, O. Davidson, P. Bosch, R. Dave, and L. A. Mayer, editors. *Climate change 2007: mitigation. Contribution of Working Group III to the Fourth assessment report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom.
- Nelson, E., et al. 2009. Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales. *Frontiers in Ecology and the Environment* **7**:4–11.
- Norton, B. G. 2005. *Sustainability: a philosophy of adaptive ecosystem management*. University of Chicago Press, Chicago.
- Norton, B. G., and D. Noonan. 2007. Ecology and valuation: big changes needed. *Ecological Economics* **63**:664–675.
- O'Neil, J., A. Holland, and A. Light. 2007. *Environmental values*. Routledge, New York.
- Ostrom, E. 2007. A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences* **104**:15181–15187.
- Redford, K., and W. Adams. 2009. Payment for ecosystem services and the challenge of saving nature. *Conservation Biology* **23**:785–787.
- Roe, E. 1991. 'Development narratives' or making the best of development blueprints. *World Development* **19**:287–300.
- Roe, E. 1994. *Narrative policy analysis: theory and practice*. Duke University Press, Durham, North Carolina.
- Schneider, A., and H. Ingram. 2007. Ways of knowing: implications for public policy. (Paper presented at the annual meeting of the American Political Science Association.) Consortium for Science and Policy Outcomes, Arizona State University, Phoenix. Available from http://www.cspo.org/documents/ways_of_knowing.pdf (accessed June 2010).
- Songorwa, A. N. 1999. Community-based wildlife management (CWM) in Tanzania: are the communities interested? *World Development* **27**:2061–2079.
- Stoorvogel, J. J., J. M. Antle, C. C. Crisman, and W. Bowen. 2004. The trade-off analysis model: integrated bio-physical and economic modeling of agricultural production systems. *Agricultural Systems* **80**:43–66. (Also available from <http://www.stoorvogel.info/tradeoffs/download/2004%20Stoorvogel%20et%20al%20agsys.pdf>.)
- Sunderland, T. C. H., C. Ehringhaus, and B. M. Campbell. 2008. Conservation and development in tropical forest landscapes: a time to face the trade-offs? *Environmental Conservation* **34**:276–279.
- Thies, C., and R. Czebiniak. 2008. *Forests for climate: developing a hybrid approach for REDD*. Greenpeace International, Amsterdam.
- UN-REDD Programme. 2009. *Multiple benefits: issues and options for REDD*. United Nations, New York. Available from <http://tinyurl.com/multiple-benefits-report> (accessed March 2010).
- Wilson, J. 2002. Scientific uncertainty, complex systems, and the design of common-pool institutions. Pages 327–360 in E. Ostrom, editor. *The drama of the commons*. National Academy Press, Washington, D.C.
- Wunder, S. 2008. Payments for environmental services and the poor: concepts and preliminary evidence. *Environment and Development Economics* **13**(3):279–297.