

# Defining biocultural approaches to conservation

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**We contend that biocultural approaches to conservation can achieve effective and just conservation outcomes while addressing erosion of both cultural and biological diversity. Here, we propose a set of guidelines for the adoption of biocultural approaches to conservation. First, we draw lessons from work on biocultural diversity and heritage, social–ecological systems theory, integrated conservation and development, co-management, and community-based conservation to define biocultural approaches to conservation. Second, we describe eight principles that characterize such approaches. Third, we discuss reasons for adopting biocultural approaches and challenges. If used well, biocultural approaches to conservation can be a powerful tool for reducing the global loss of both biological and cultural diversity.**

## Transcending conservation debates

The methods and scope of biodiversity conservation have been a source of constant debate. Arguments have centered on the role of human communities, particularly ones in close proximity to areas of conservation interest, and the degree to which interests of these people should define conservation [1–4]. These debates have focused on the real or potential impacts that people have on biodiversity, the degree to which benefits and costs of conservation should be shared, across what groups should this sharing occur, and who should control the conservation process [5,6].

The discussion, in its starkest form, has pitted advocates of people-free or ‘fortress conservation’ against those in favor of people-centered conservation [3]. In reality, the practice of conservation today encompasses a spectrum of approaches, which vary in the degree to which they balance objectives of biodiversity conservation with those emphasizing human livelihoods [7,8]. However, heated debates continue to surface in the conservation literature and popular press. Most recently, arguments have erupted over the potential for a ‘new conservation science’, the degree to which past approaches have been successful, and the extent to which conservation should serve human welfare [9,10].

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Here, we argue that a set of conservation practices, which we term ‘biocultural approaches to conservation’, provide a path forward by addressing a central theme from these debates: how conservation can lead to effective and just outcomes within different social–ecological contexts. In turn, we contend that biocultural approaches to conservation can serve as a powerful tool for confronting the rapid global loss of both biological and cultural diversity. We propose a set of guidelines for adopting biocultural approaches to conservation. We first define these conservation approaches and establish a set of key principles, before arguing their merits and discussing the main challenges that these approaches might face.

## What are biocultural approaches to conservation?

Biocultural approaches to conservation provide a unique way forward for conservation by drawing lessons from previous work on biocultural diversity and heritage, social–ecological systems theory, and different models of people-centered conservation [6,11–13] (see [Glossary](#); [Figure 1](#)). The

## Glossary

**Adaptive governance:** : formal and informal institutions designed to evolve in response to changes within the social–ecological context [60].

**Biocultural approaches to conservation:** : conservation actions made in the service of sustaining the biophysical and sociocultural components of dynamic, interacting, and interdependent social–ecological systems.

**Biocultural heritage:** : knowledge, innovations, and practices of indigenous and local communities that are collectively held and inextricably linked to, and shaped by, the socioecological context of communities [19].

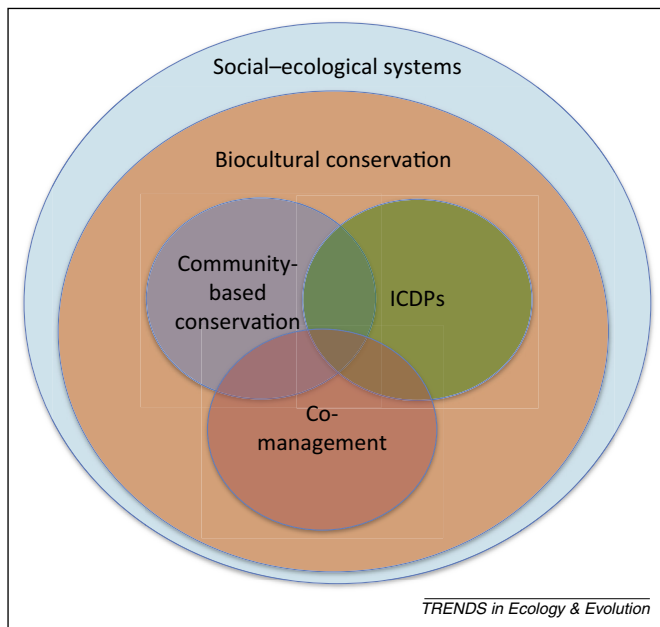
**Co-management:** : ‘a situation in which two or more social actors negotiate, define and guarantee amongst themselves a fair sharing of the management functions, entitlements and responsibilities for a given territory, area or set of natural resources’ [61] (p. 1). Co-management tends not to be a fixed state, but an iterative, deliberate, problem-solving process [62].

**Community-based conservation:** : a range of activities that includes natural resource management or biodiversity protection done by, for, and with, the local community, and recognizes ‘the coexistence of people and nature, as distinct from protectionism and the segregation of people and nature’ [63].

**Integrated conservation and development programs:** : seek to link conservation and human community livelihood objectives [64].

**Multilevel institutions:** : formal and informal rules, norms, and/or strategies at multiple levels (i.e., local, national regional, and international) that structure social, political, and economic interactions [26,54].

**Social–ecological systems:** : coupled human and natural systems that are complex, dynamic, unpredictable, and heterogeneous at multiple spatial and temporal scales, shaped by reciprocal feedback loops, and characterized by nonlinear dynamics, time lags, thresholds, and linked social and ecological processes [24].



**Figure 1.** Conceptual model of foundations for biocultural approaches to conservation. Biocultural approaches to conservation draw lessons from previous work on different models of conservation (co-management, integrated conservation and development, and community-based conservation) and are embedded within social-ecological systems. Abbreviation: ICDP, integrated conservation and development project.

study of biocultural diversity has emphasized the interdependence of biological and cultural diversity via coevolution processes, common threats, and geographic overlap [14–18]. Biocultural heritage encompasses indigenous and local community knowledge, innovations, and practices, which are developed within, and linked to, the social-ecological context [19]. A focus on biocultural heritage also stresses the recognition of multiple worldviews that serve as the foundation for different sets of knowledge about the natural world and our species' place in it [19,20]. Conserving diverse sets of knowledge can provide human and biological communities with greater adaptive capacity to cope with current and future disturbances [16,19]. Several authors have also noted the importance of securing the rights of indigenous and local people and a focus on social justice [18,19,21]. The study of biocultural diversity has led to the call for the development of approaches that seek to maintain and revitalize biocultural heritage [19,22,23]. We argue that biocultural approaches to conservation can achieve this goal.

The mix of success and failure that has resulted from different people-centered approaches to conservation, including co-management, community-based conservation, and integrated conservation and development, can also guide future conservation planning. For example, research on these models of conservation demonstrates the importance of balancing trade-offs among a variety of stakeholder objectives [7], the value of shared and flexible governance systems, and the importance of relations among key stakeholders as the basis for social learning and improved management [13].

We also incorporate key lessons from the field of social-ecological systems theory. Conservation programs are embedded within these systems, which are complex, dynamic,

unpredictable, shaped by feedback loops across multiple scales and levels, and characterized by linked social and ecological processes [24]. No one institutional arrangement or knowledge system has the capacity to manage these systems in all locations [25]. Instead, successful conservation requires approaches to governance and management that are context specific, nested, multilevel, and adaptive in nature [13,26].

We assert that the lessons from previous conservation work that we have outlined above can be combined to create more synthetic and holistic approaches to conservation. We define these biocultural approaches to conservation as 'conservation actions made in the service of sustaining the biophysical and sociocultural components of dynamic, interacting and interdependent social-ecological systems'. This definition emphasizes that the biophysical and sociocultural components of social-ecological systems are linked, and can be sustained through the process of biocultural conservation. We also recognize the need for different actions in different contexts and, therefore, we use the plural: biocultural approaches to conservation. These actions encompass all phases of the conservation process, including management, and also governance more broadly.

### Principles of biocultural approaches to conservation

We define eight principles of successful biocultural conservation initiatives (Box 1), and discuss each of them in turn below.

#### *Acknowledge that conservation can have multiple objectives and stakeholders*

Conservation almost always involves multiple stakeholders who promote a range of objectives. For example, in a sample of ten conservation-development projects from the Equator Initiative of the United Nations Development Program ([www.equatorinitiative.org](http://www.equatorinitiative.org)), local people and groups had a range, and different mixes, of economic, political, social, and cultural objectives, in addition to conservation objectives [27]. These objectives can pull in different directions, leading to the need to make trade-offs in the design of conservation approaches [7]. Biocultural conservation approaches should recognize the presence of multiple objectives, design mechanisms for incorporating them, weigh trade-offs, and establish conflict resolution mechanisms that are fair to all parties.

#### **Box 1. Principles of biocultural approaches to conservation**

- 1 Acknowledge that conservation can have multiple objectives and stakeholders
- 2 Recognize the importance of intergenerational planning and institutions for long-term adaptive governance
- 3 Recognize that culture is dynamic, and this dynamism shapes resource use and conservation
- 4 Tailor interventions to the social-ecological context
- 5 Devise and draw upon novel, diverse, and nested institutional frameworks
- 6 Prioritize the importance of partnership and relation building for conservation outcomes
- 7 Incorporate the distinct rights and responsibilities of all parties
- 8 Respect and incorporate different worldviews and knowledge systems into conservation planning

### *Recognize the importance of intergenerational planning and institutions for long-term adaptive governance*

Sustainable management of social–ecological systems will require long-term solutions. In general, these are enabled by the presence of flexible and adaptive institutions. These institutions will have several characteristics, such as: mechanisms to enable social learning; responses to shifts in ecosystem dynamics; and the flexibility to cope with hybrid and novel approaches to conservation [11,28,29]. Approaches to biocultural conservation should also seek to match the timescale of the system in question, which is often over generations rather than shorter periods.

### *Recognize that culture is dynamic, and that this dynamism shapes resource use and conservation*

Culture, as manifested in multiple worldviews, languages, and sources of knowledge, is a critical facet of approaches to biocultural conservation. However, as is the case with ecosystems [24], culture is dynamic, and planning the ‘conservation’ of culture risks seeking to fix it in place and time [30,31]. Instead, biocultural approaches to conservation should allow for the adaptation of cultural systems, including the formation of novel and hybrid institutions for the management of diversity [11].

### *Tailor interventions to the social–ecological context*

Blueprint solutions designed for universal application are inappropriate and ineffective for conservation. Social and ecological changes are felt at a local level, and drivers of these changes are mediated through complex and multi-level institutions and organizations [6]. Therefore, biocultural conservation approaches must seek to integrate multiple levels of governance, and promote horizontal (within same level) and vertical (between levels) institutional linkages that start from the bottom up [32]. In particular, biocultural approaches to conservation should focus on crafting new, multilevel institutions that allow governance to adapt to the specific contexts in which conservation is embedded [26,33,34].

### *Devise and draw upon novel, diverse, and nested institutional frameworks*

Although a bottom-up focus is critical for biocultural conservation approaches, multiscale linkages should be in place to connect local realities with regional and global institutions [22,29]. This is currently demonstrated in protected areas such as Ramsar sites (linking national and global levels) and World Heritage Sites (local, regional, national, and international). Enabling policy environments can legitimize social movements, maximize the capacities of actors at multiple levels, and lead to negotiations around the different objectives of different rights holders [26]. Nested governance arrangements, where institutions are organized in multiple nested layers that are formally independent but act in a coherent manner [34], are more likely to incorporate multiple knowledge systems and adapt to local social–ecological contexts [35]. In turn, these governance arrangements can result in more equitable and sustainable conservation outcomes [26,36]. Moreover, if resource users have the right to devise

their own interventions without extensive interference from the state, they can, and are more likely to, enforce rules themselves [33].

### *Prioritize the importance of partnership and relationship building for conservation outcomes*

Partnership is the sharing of power between and across multiple levels of governance, and is an important aspect of biocultural conservation approaches. Although discourses of ‘partnership’ and ‘participation’ are regularly used to justify a variety of conservation actions, most projects do not begin with the presumption that true power sharing will be necessary [37,38]. Successful biocultural conservation approaches should seek partnership that prioritizes joint responsibility, active relation management, environmental justice, and the sharing of governance and stewardship responsibility [13,22,36]. For example, in Inner Mongolia, a genuine partnership between Mongolian herders, a conservation nongovernmental organization (NGO) and local government has led to increased conservation success [39]. Continuous negotiation among stakeholders will be necessary to build and support successful partnerships.

### *Incorporate the distinct rights and responsibilities of all parties*

Biocultural conservation approaches should delineate and recognize the rights and responsibilities of all stakeholders. In particular, these approaches should recognize and respect the rights of indigenous and local people to natural resource use and to continued presence on their homelands [16,19]. Biocultural conservation approaches should also recognize that multiple partners have vested interests, and that true equality is rarely present at the negotiating table [4,40]. Designation of rights and responsibilities should also follow the principle of Free Prior Informed Consent [41], which is central to the United Nations Declaration on the Rights of Indigenous Peoples (cf. UNDRIP Article 19; [http://www.un.org/esa/socdev/unpfi/documents/DRIPS\\_en.pdf](http://www.un.org/esa/socdev/unpfi/documents/DRIPS_en.pdf)). One example of bridging power is *Arapaima* management in Mamiraua Reserve, Brazil, where local knowledge of monitoring was combined with government science and management [42]. Another example can be found in a biosphere reserve in southern Sweden, where the local bridging organization (the Ekomuseum) helped coordinate local interests and knowledge to give direction to the management of the reserve [28].

Globally, indigenous peoples have a unique status in terms of conservation and natural resource management activities. Many indigenous peoples share experiences of colonialism and marginalization, which have often been amplified by conservation activities [5,43,44]. Moreover, indigenous peoples are custodians and landowners of much of the biodiversity worldwide [45,46], while also representing a significant proportion of the cultural diversity of the world [21]. Therefore, biocultural conservation activities are inseparable from wider issues, including self-determination, autonomy, food sovereignty, and environmental security, which are often major concerns for indigenous peoples.

### *Respect and incorporate different worldviews and knowledge systems into conservation planning*

Environmental knowledge and resource management practices are embedded within worldviews, which serve to mediate experience of the environment [47]. A diversity of worldviews contributes a variety of ways of understanding the environment, and an array of means for solving environmental problems [17,48]. For example, sacred sites can be effective modes of conservation, but are not easily translatable to many national-level resource management categories [49]. Therefore, biocultural conservation approaches should recognize and work with different worldviews.

Conservation programs have historically relied on scientific knowledge for setting priorities and designing actions. However, there are other sources of knowledge, in particular, indigenous environmental knowledge, which complement and extend scientific knowledge [42,47]. Systems of indigenous knowledge represent human interaction with local environments over long time periods, and often represent rich, nuanced, and locally adapted knowledge systems that can be well suited to good environmental governance. While the methods and motives for the integration of scientific and indigenous knowledge systems remain topics of debate [50,51], acknowledging the validity of other knowledge systems is a critical step for biocultural conservation.

This principle is also supported by the Convention on Biological Diversity, which has been ratified by 168 nations and is the most significant international legal instrument for conservation. Article 8(j) of the convention requires that parties: ‘respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity.’ Biocultural conservation approaches should give full effect to the content and intent of article 8(j) by designing conservation interventions to explicitly account for traditional knowledge and practice.

### **Why biocultural approaches to conservation?**

We argue that conservation practitioners should embrace biocultural approaches for social justice, legal, and practical reasons. Most importantly, conservation actions should respect and uphold human rights. This includes laws and regulations set forth by international accords, which include (but are not limited to): Agenda 21, the Convention on Biological Diversity, the Universal Declaration of Human Rights, the International Covenant on Economic, Social and Cultural Rights, the International Covenant on Civil and Political Rights, and the UNDRIP. These agreements have established several rights, including: the right to self-determination, the right to not be deprived of property or forcibly removed from one’s land, the rights to traditional lands, territories, and resources, respect for knowledge and practices that ‘contribute to sustainable and equitable development and proper management of the environment’, and the right to participate in decision-making [41]. The principles of biocultural conservation that we outline here will ensure that conservation actions respect these rights, in particular by adopting inclusive governance mechanisms, incorporating multiple worldviews

and knowledge sets, and ensuring access to traditional lands and resources.

It is also critical to note that conservation is embedded within particular social–political contexts [4,5,52]. Conservation outcomes are context specific and shaped by histories of place. When conservation planning ignores social–political context, success rarely ensues. For example, protected areas in many parts of the world have a fraught history with indigenous and local peoples due to forcible removal from traditional lands and denial of access to traditional resources and governance representation [53]. These conservation approaches have often not only been unjust and clear violations of human rights, but also created heated conflicts as disenfranchised populations develop a vested interest in working against protected areas. As an alternative, we argue for biocultural approaches to conservation are based on partnerships and long-term relation building. A focus on relations has greater potential to reduce conflict and ensure more effective conservation action. Although conflicts can still arise, if partnerships are based on equitable sharing of benefits, costs, and power, then such conflicts can be embraced as a step in social learning rather than an insurmountable barrier to conservation [13].

Biocultural approaches will also increase the adaptive capacity of conservation by involving more stakeholders with a vested interest in success. In turn, these approaches incorporate a wider range of human resources and capacities and pursue common solutions. Biocultural approaches seek to integrate the worldviews and resource management frameworks that form the basis of multiple knowledge systems. These multifaceted approaches bring more options to the table and increase the chances of long-term success, given the uncertainty inherent in complex and dynamic social–ecological systems [29,52].

### **What challenges are faced by biocultural approaches to conservation?**

A shift towards biocultural approaches to conservation is likely to face at least four challenges: (i) barriers to meaningful sharing of power across institutional levels; (ii) obstacles to integration of diverse sets of knowledge; (iii) limited funding; and (iv) a struggle to adjust to the dynamic nature of social–ecological systems. Managing human behavior is fundamental to conservation, and institutions, as ‘humanly devised constraints that structure political, economic and social interactions’ [54] (p. 97), provide critical frameworks that guide behavior. In turn, functioning institutions are a necessary precursor to conservation success [40]. However, conservation targets (whether they are strictly focused on biodiversity or include sociocultural components) and threats to conservation vary in space and time. Therefore, local institutions must not only be diverse and relevant to the context, but also be supported by institutions at regional, national, and international levels.

To achieve this goal, there must be sufficient devolution of power to allow for local institutional innovations, which can drive sustainable endogenous development [26]. The challenge comes when these local priorities, goals, and institutions are in conflict with priorities, goals, and

institutions at other spatial and institutional levels [55], or when collaboration across institutional levels is hindered by poor relations among stakeholders (e.g., via historical grievances over land tenure [56]). Successful adoption of a nested governance models will require all stakeholder groups to willingly share power, maintain strong working relations based on trust, accountability, and open communication, and participate in deliberative processes that work through conflict and promote social learning [6,29,36].

Biocultural approaches to conservation recognize the need to respect and incorporate multiple knowledge systems into conservation planning. However, these diverse sets of knowledge are based on distinct epistemologies, and bridging the gaps between them poses a unique challenge [35]. The power imbalances evident in many conservation processes can also legitimize certain forms of knowledge at the expense of others [57]. Recent work by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services has addressed this challenge by calling for the development of frameworks that promote synergies among different sets of knowledge [58]. For example, the multiple evidence base (MEB) framework recognizes the value that each knowledge base has within its context, the impossibility of accurate translation across knowledge systems, and the need to focus on complementarity among knowledge systems [57].

Conservation projects are usually limited in scope due to funding constraints [59]. Biocultural approaches to conservation might be seen as broadening the scope of conservation and bringing additional commitments to social-cultural agendas. This can be viewed as an unnecessary use of limited funds. Although we recognize that engaging with additional objectives might require more time and funds, we contend that these short-term costs are far outweighed by the long-term advantage of producing more sustainable, effective, and just conservation actions.

Social-ecological systems are inherently dynamic, and resilience within these systems requires continual adaptation to changing social and ecological conditions. The human agency that drives cultural change adds further credence to the need for local empowerment within biocultural approaches to conservation. In addition, biocultural approaches to conservation will only be successful if they incorporate multiple forms of adaptation. As local conditions change over time, institutions need a certain degree of autonomy to innovate solutions to emerging challenges [26]. Likewise, as the multiple knowledge sets engaged in biocultural conservation initiatives grow and adapt, and as stakeholder relations drive social learning, governance models will be more effective if they also adapt to embrace the changing landscape of stakeholder capacities and relations [29].

### Concluding remarks

Overall, we contend that the benefits of biocultural approaches to conservation are significant and will outweigh the major challenges that we have noted above. What is now needed is sustained research attention to processes and specific methods for addressing these

challenges, backed by long-term and forecasted funding for research and practice of biocultural approaches to conservation. The scientific community has known for decades that cultural and biological diversity are facing numerous, urgent, and inter-related challenges, but we still lack sufficient tools to address drivers of diversity loss and global homogenization. We hope that a well-documented expansion of biocultural approaches to conservation will assist in slowing these trends.

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### References

- 1 Dowie, M. (2009) *Conservation Refugees: The Hundred-year Conflict Between Global Conservation and Native Peoples*, MIT Press
- 2 Schwartzman, S. et al. (2000) Rethinking tropical forest conservation: perils in parks. *Conserv. Biol.* 14, 1351–1357
- 3 Wilshusen, P.R. et al. (2002) Reinventing a square wheel: critique of a resurgent ‘protection paradigm’ in international biodiversity conservation. *Soc. Nat. Resour.* 15, 17–40
- 4 Adams, W.M. and Hutton, J. (2007) People, parks and poverty: political ecology and biodiversity conservation. *Conserv. Soc.* 5, 147–183
- 5 Brechin, S. et al. (2002) Beyond the square wheel: towards a more comprehensive understanding of biodiversity conservation as a social and political process. *Soc. Nat. Resour.* 15, 41–64
- 6 Berkes, F. (2007) Community-based conservation in a globalized world. *Proc. Natl. Acad. Sci. U.S.A.* 104, 15188–15193
- 7 McShane, T.O. et al. (2011) Hard choices: making trade-offs between biodiversity conservation and human well-being. *Biol. Conserv.* 144, 966–972
- 8 Sarkar, S. and Montoya, M. (2011) Beyond parks and reserves: the ethics and politics of conservation with a case study from Peru. *Biol. Conserv.* 144, 979–988
- 9 Kareiva, P. et al. (2012) Conservation in the Anthropocene: beyond solitude and fragility. *Breakthr. J.* Winter 2012. <http://thebreakthrough.org/index.php/journal/past-issues/issue-2/conservation-in-the-anthropocene>
- 10 Doak, D.F. et al. (2014) What is the future of conservation? *Trends Ecol. Evol.* 29, 77–81
- 11 Berkes, F. (2004) Rethinking community-based conservation. *Conserv. Biol.* 18, 621–630
- 12 Garnett, S.T. et al. (2007) Improving the effectiveness of interventions to balance conservation and development: a conceptual framework. *Ecol. Soc.* 12, 2
- 13 Armitage, D.R. et al. (2009) Adaptive co-management for social-ecological complexity. *Front. Ecol. Environ.* 7, 95–102
- 14 Janzen, D.H. (1988) Tropical ecological and biocultural restoration. *Science* 239, 243–244
- 15 Baer, A. (1989) Maintaining biocultural diversity. *Conserv. Biol.* 3, 97–98
- 16 Maffi, L. (2001) *On Biocultural Diversity: Linking Language, Knowledge, and the Environment*, Smithsonian Institution Press
- 17 Rozzi, R. (2013) Biocultural ethics: from biocultural homogenization toward biocultural conservation. In *Linking Ecology and Ethics for a Changing World* (Rozzi, R. et al., eds), pp. 9–32, Springer
- 18 Wolverton, S. et al. (2014) Ethnobiology, political ecology, and conservation. *J. Ethnobiol.* 34, 125–152
- 19 Davidson-Hunt, I.J. et al. (2012) Biocultural design: a new conceptual framework for sustainable development in rural indigenous and local communities. *Sapiens* 5, 33–45
- 20 Rozzi, R. et al. (2008) Field environmental philosophy and biocultural conservation. *Environ. Ethics* 30, 325–336
- 21 Maffi, L. (2005) Linguistic, cultural and biological diversity. *Annu. Rev. Anthropol.* 29, 599–617
- 22 Rozzi, R. et al. (2006) Ten principles for biocultural conservation at the southern tip of the Americas: the approach of the Omora Ethnobotanical Park. *Ecol. Soc.* 11, 43
- 23 Maffi, L. and Woodley, E. (2012) *Biocultural Diversity Conservation: A Global Sourcebook*, Routledge

- 24 Liu, J. *et al.* (2007) Complexity of coupled human and natural systems. *Science* 317, 1513–1516
- 25 Ostrom, E. (2007) A diagnostic approach for going beyond panaceas. *Proc. Natl. Acad. Sci. U.S.A.* 104, 15181–15187
- 26 Andersson, K.P. and Ostrom, E. (2008) Analyzing decentralized resource regimes from a polycentric perspective. *Policy Sci.* 41, 71–93
- 27 Berkes, F. (2013) Poverty reduction isn't just about money: community perceptions of conservation benefits. In *Biodiversity Conservation and Poverty Alleviation: Exploring the Evidence for a Link* (Roe, D. *et al.*, eds), pp. 270–285, John Wiley & Sons
- 28 Olsson, P. *et al.* (2004) Social-ecological transformation for ecosystem management: the development of adaptive co-management of a wetland landscape in southern Sweden. *Ecol. Soc.* 9, 2
- 29 Folke, C. *et al.* (2005) Adaptive governance of social-ecological systems. *Annu. Rev. Environ. Resour.* 30, 441–473
- 30 Pretty, J. *et al.* (2009) The intersections of biological diversity and cultural diversity: towards integration. *Conserv. Soc.* 7, 100–112
- 31 Durie, M. (2010) Outstanding universal value: how relevant is indigeneity. In *Maori and the Environment* (Selby, R. *et al.*, eds), pp. 239–251, Huia Publishers
- 32 Young, O.R. *et al.* (2008) *Institutions and Environmental Change: Principal Findings, Applications, and Research Frontiers*, MIT Press
- 33 Ostrom, E. (1990) *Governing the Commons: The Evolution of Institutions for Collective Action*, Cambridge University Press
- 34 Ostrom, E. (2010) Polycentric systems for coping with collective action and global environmental change. *Glob. Environ. Change Hum. Policy Dimens.* 20, 550–557
- 35 Reid, W.V. *et al.* (2006) *Bridging Scales and Knowledge Systems: Concepts and Applications in Ecosystem Assessment*, Island Press
- 36 Lebel, L. *et al.* (2006) Governance and the capacity to manage resilience in regional social-ecological systems. *Ecol. Soc.* 11, 19
- 37 Reed, M.S. (2008) Stakeholder participation for environmental management: a literature review. *Biol. Conserv.* 141, 2417–2431
- 38 Mead, A.T.P. (2013) Sharing power: Māori and protected areas. In *Governance and Leadership in Future Challenges for Māori: He Kōrero Anamata* (Katene, S. and Mulholland, M., eds), pp. 195–204, Huia Publishers
- 39 Tang, R. and Gavin, M.C. (2010) Traditional ecological knowledge informing resource management: saxoul conservation in Inner Mongolia, China. *Soc. Nat. Resour.* 23, 193–206
- 40 Barrett, C.B. *et al.* (2001) Conserving tropical biodiversity amid weak institutions. *Bioscience* 51, 497–502
- 41 Kothari, A. *et al.*, eds (2012) *Recognizing and Supporting Conservation by Indigenous Peoples and Local Communities*, Secretariat of the Convention on Biological Diversity
- 42 Castello, L. *et al.* (2009) Lessons from integrating fishers of Arapaima in small-scale fisheries management at the Mamirauá Reserve. *Amazon. Environ. Manage.* 43, 197–209
- 43 Smith, L.T. (1999) *Decolonising Methodologies: Research and Indigenous Peoples*, University of Otago Press
- 44 Mead, A.T.P. (2004) He Pua, He Korowai, Me Nga Waahi Tapu/a shellfish, a woven cloak, and sacred places: Maori and protected areas. *Cultur. Surviv. Q.* 28, 61–64
- 45 White, A. and Martin, A. (2002) *Who Owns the World's Forests? Forest Tenure and Public Forests in Transition*. Forest Trends
- 46 Sobrevilla, C. (2008) *The Role of Indigenous Peoples in Biodiversity Conservation: The Natural but often Forgotten Partners*, The World Bank
- 47 Berkes, F. (2012) *Sacred Ecology: Traditional Ecological Knowledge and Resource Management*. (3rd edn), Taylor & Francis
- 48 Rozzi, R. (2007) Future environmental philosophies and their biocultural conservation interfaces. *Ethics Environ.* 12, 142–145
- 49 Pungetti, G. (2012) Sacred species and sites: dichotomies, concepts and new directions in biocultural diversity conservation. In *Sacred Species and Sites* (Pungetti, G. *et al.*, eds), pp. 13–27, Cambridge University Press
- 50 Gagnon, C.A. and Berteaux, D. (2009) Integrating traditional ecological knowledge and ecological science: a question of scale. *Ecol. Soc.* 14, 19
- 51 Sillitoe, P. (2007) *Local Science Vs. Global Science: Approaches to Indigenous Knowledge in International Development*, Berghahn Books
- 52 Berkes, F. *et al.* (2003) *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*, Cambridge University Press
- 53 Cronon, W. (1996) *Uncommon Ground: Rethinking the Human Place in Nature*, W.W. Norton & Co
- 54 North, D.C. (1991) Institutions. *J. Econ. Perspect.* 5, 97–112
- 55 Gruby, R.L. and Basurto, X. (2014) Multi-level governance for large marine commons: politics and polycentricity in Palau's protected area network. *Environ. Sci. Policy* 36, 48–60
- 56 Coombes, B.L. and Hill, S. (2005) 'Na whenua, na Tuhoe. Ko D.o.C. te partner': prospects for comanagement of Te Urewera National Park. *Soc. Nat. Resour.* 18, 135–152
- 57 Tengö, M. *et al.* (2014) Connecting diverse knowledge systems for enhanced ecosystem governance: the multiple evidence base approach. *Ambio* 43, 579–591
- 58 Thaman, R. *et al.* (2013) *The Contribution of Indigenous and Local Knowledge Systems to IPBES: Building Synergies with Science*, UNESCO/UNU
- 59 McCarthy, D.P. *et al.* (2012) Financial costs of meeting global biodiversity conservation targets: current spending and unmet needs. *Science* 338, 946–949
- 60 Carpenter, S.R. and Folke, C. (2006) Ecology for transformation. *Trends Ecol. Evol.* 21, 309–315
- 61 Borrini-Feyerabend, G. (2000) *Co-management of Natural Resources: Organising, Negotiating and Learning-by-Doing*, Kasperek Verlag
- 62 Carlsson, L. and Berkes, F. (2005) Co-management: concepts and methodological implications. *J. Environ. Manage.* 75, 65–76
- 63 Western, D. *et al.*, eds (1994) *Natural Connections: Perspectives in Community-based Conservation*, Island Press
- 64 Salafsky, N. and Wollenberg, E. (2000) Linking livelihoods and conservation: a conceptual framework and scale for assessing the integration of human needs and biodiversity. *World Dev.* 28, 1421–1438