Conservation Biology

Conservation Practice and Policy

Successes and Challenges from Formation to Implementation of Eleven Broad-Extent Conservation Programs

ERIK A. BEEVER,* BRADY J. MATTSSON,† †† MATTHEW J. GERMINO,‡
MAX POST VAN DER BURG,§ JOHN B. BRADFORD,¶ AND MARK W. BRUNSON**

*U.S. Geological Survey, Northern Rocky Mountain Science Center, Bozeman, MT, U.S.A., email ebeever@usgs.gov
†U.S. Geological Survey, Western Ecological Research Center, Sacramento, CA, U.S.A.
‡U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID, U.S.A.
§U.S. Geological Survey, Northern Prairie Wildlife Research Center, Jamestown, ND, U.S.A.
¶U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, AZ, U.S.A.
**Department of Environment and Society, Utah State University, Logan, UT, U.S.A.

Abstract: *Integration of conservation partnerships across geographic, biological, and administrative boundaries is increasingly relevant because drivers of change, such as climate shifts, transcend these boundaries. We explored successes and challenges of established conservation programs that span multiple watersheds and consider both social and ecological concerns. We asked representatives from a diverse set of 11 broad-extent conservation partnerships in 29 countries 17 questions that pertained to launching and maintaining partnerships for broad-extent conservation, specifying ultimate management objectives, and implementation and learning. Partnerships invested more funds in implementing conservation actions than any other aspect of conservation, and a program's context (geographic extent, United States vs. other countries, developed vs. developing nation) appeared to substantially affect program approach. Despite early successes of these organizations and benefits of broad-extent conservation, specific challenges related to uncertainties in scaling up information and to coordination in the face of diverse partner governance structures, conflicting objectives, and vast uncertainties regarding future system dynamics hindered long-term success, as demonstrated by the focal organizations. Engaging stakeholders, developing conservation measures, and implementing adaptive management were dominant challenges. To inform future research on broad-extent conservation, we considered several challenges when we developed detailed questions, such as what qualities of broad-extent partnerships ensure they complement, integrate, and strengthen, rather than replace, local conservation efforts and which adaptive management processes yield actionable conservation strategies that account explicitly for dynamics and uncertainties regarding multiscale governance, environmental conditions, and knowledge of the system?*

Keywords: adaptive management, ecological, social and political uncertainty, hierarchical scales, learning management objectives and actions

Éxitos y Retos de la Formación a la Implementación de Once Programas de Conservación de Amplio Alcance

Resumen: *La integración de alianzas de conservación a través de las fronteras geográficas, biológicas y administrativas cada vez es más relevante porque los conductores del cambio, como alteraciones climáticas, trascienden estas fronteras. Exploramos los éxitos y retos de los programas de conservación establecidos que abarcan cuencas múltiples y que consideran preocupaciones tanto sociales como ecológicas. Le hicimos 17*

††*Current address: Department of Integrative Biology and Biodiversity Research, University of Natural Resources and Life Sciences, Vienna, Austria*
Paper submitted June 8, 2012; revised manuscript accepted August 11, 2013.

Conservation Biology, Volume 00, No. 0, 1–12

DOI: 10.1111/cobi.12233

preguntas a representativos de un conjunto diverso de 11 alianzas de conservación de amplio alcance en 29 países sobre el lanzamiento y mantenimiento de la alianza para la conservación de amplio alcance, especificando los objetivos del manejo y la implementación y el aprendizaje. Las alianzas invirtieron más fondos en implementar acciones de conservación que en cualquier otro aspecto de la conservación, y el contexto del programa (extensión geográfica, E.U. vs otros países, país desarrollado vs país sub-desarrollado) pareció afectar sustancialmente el acercamiento del programa. A pesar del éxito temprano de estas organizaciones y los beneficios de la conservación de amplio alcance, los retos específicos relacionados a las incertidumbres en la ampliación de la información y a la coordinación frente a diversas estructuras de gobierno aliadas, objetivos conflictivos y vastas incertidumbres con respecto a dinámicas de sistemas futuros dificultaron el éxito a largo plazo como se demostró por las organizaciones focales. Involucrar a las partes interesadas, desarrollar medidas de conservación e implementar el manejo adaptativo fueron retos dominantes. Para informar a las investigaciones futuras sobre la conservación de amplio alcance, consideramos varios retos cuando desarrollamos preguntas detalladas, como cuáles cualidades de las alianzas de amplio alcance aseguran que complementen, integren y fortifiquen, en lugar de remplazar, esfuerzos locales de conservación y cuáles procesos de manejo adaptativo rinden estrategias de conservación accionables que respondan explícitamente por las dinámicas e incertidumbres con respecto a una multi-escala de gobernabilidad, condiciones ambientales y conocimiento del sistema.

Palabras Clave: aprendizaje, escalas jerárquicas, incertidumbre ecológica, social y política, manejo adaptativo, objetivos y acciones de manejo

Introduction

Land managers and conservation practitioners increasingly realize that fine-scaled ecological processes are influenced by surrounding landscapes and that local-scale conservation actions can influence broader scale processes. This realization prompted some organizations to form partnerships and integrate conservation across large areas (Pressey & Bottrill 2009; Jacobson & Robertson 2012). Scale considerations are recognized in ecological theory (Wiens 1989) and conservation biology (Peterson et al. 1998). Addressing widespread, far-reaching stressors such as desertification, land-use change, climate change, invasive species, and airborne contaminants requires a broad-extent perspective and spatially coordinated conservation (Lee & Jetz 2008; Worboys et al. 2010). Many ecosystems and related services (e.g., diverse genetic resources, healthy pollinator communities, carbon sequestration) are best characterized and conserved by managing and monitoring across broad areas that cross ecological and jurisdictional boundaries (Lopez-Hoffman et al. 2010). A broad focus may help maintain ecosystem services in the face of broad-extent system change. Effective conservation with limited resources and complex conservation problems requires cost sharing, leveraging grant funds, and collaborative multidisciplinary application of science-based solutions across jurisdictions, agencies, and ecosystems (Lauber et al. 2011). Uncoordinated efforts, by contrast, are often inefficient (but see Bode et al. 2011).

Cross-scale dynamics, phenotypic plasticity, and context-dependence of ecological responses to environmental processes and conservation actions complicate land management and conservation delivery across broad extents. Furthermore, the identity and strength of ecological drivers and stressors can differ markedly across landscapes, topographic and climatic gradients, and species' life histories; such differences can undermine the broad applicability of conservation indicators (Lindenmayer et al. 2000; Carroll et al. 2010). One conservation approach that addresses these complexities focuses on planning, analysis, action, and learning at scales that span jurisdictions, species ranges, and ecosystems (Worboys et al. 2010). Other than for migratory-animal conservation, broad-extent approaches have only recently been adopted because of numerous ecological, social, and political difficulties. We focused on geographical extensiveness of programs but acknowledge that broad-extent conservation almost necessarily also involves a coarser-resolution focus.

Broad-extent conservation programs often generate research and monitoring data that enable extensive domains of inference for managing resources at scales typically finer than that at which most drivers of such resources operate. When studies have comparable designs and methods, their results can be combined (e.g., via meta-analyses) to increase sample size, statistical power, and ability to detect ecological changes relevant to conservation. Operating broadly also allows for better discrimination of coarse-resolution patterns from local differences and ultimately leads to improved understanding of systems and enhanced likelihood of conservation success (Hein et al. 2006). Effectively implemented broad-extent approaches can enable improved coordination among partners and stakeholder engagement and enhance detection and identification of cross-scale dynamics, synergistic interactions, and ecological thresholds (Peterson et al. 1998; Beever & Woodward 2011), which are critical for informing robust, adaptive decision making.

Implementing broad-extent conservation also requires collaboration among diverse stakeholders with sometimes opposing interests and divergent mandates and authorities (Lauber et al. 2011; Susskind et al. 2012). This requires compromises, which can narrow what a broad-extent conservation partnership can achieve. However, the spatial and temporal robustness of implemented conservation may increase with a broad-extent approach. The challenge then involves integrating coarse-resolution or common objectives with individual-stakeholder objectives. Regardless of the degree to which associated conservation programs are nested, broad-extent partnerships (henceforth partnerships) must also persist amidst dynamic and uncertain budgets and ecosystem drivers and dynamism and uncertainty within and among governments and conservation organizations. This social and ecological complexity presents opportunities and challenges for conservation science and practice.

Responding to both ecosystem and social and political uncertainty is a crucial prerequisite for successful conservation (Lee 1993; Grumbine 1994). Within this context, broad-extent conservation involves conceiving, selecting, and delivering on-the-ground actions that can be adapted toward achieving conservation objectives (Holling 1978; Hansen et al. 2010). Establishing and maintaining a partnership, identifying shared objectives, and coordinating and implementing actions toward these objectives across ecological and jurisdictional scales constitute substantial challenges (Polasky et al. 2005). Two general questions, then, are which steps are most challenging in developing and implementing broad-extent conservation and which steps have been most critical for success among established partnerships?

Collaborative conservation of ecosystems has primarily focused on watershed or finer scales (e.g., Grumbine 1994; Salafsky et al. 2002). Less is known about advancing broad-extent partnerships that aim to conserve multiple taxa or whole ecosystems across multiple watersheds and jurisdictions while considering social constraints and concerns. Some work has focused on institutional arrangements for broad-extent conservation (Worboys et al. 2010; Robinson et al. 2011), but it gives little attention to adaptive management across broad extents. Successful broad-extent partnerships may benefit from lessons learned by existing programs around the world. These lessons may be especially timely in the United States, where Landscape Conservation Cooperatives are being developed as a continental network of partnerships for broad-extent conservation (Jacobson & Robertson 2012).

By exploring roadblocks to and benefits of these partnerships, we aimed to identify interdisciplinary research needs for overcoming the multifaceted challenges of broad-extent conservation. Therefore, we gathered information from representatives of a diverse set of existing broad-extent conservation partnerships worldwide; summarized the challenges and successes of these partnerships; and devised research questions to further examine the ways in which broad-extent conservation partnerships can be successful. Rather than constructing social-science theory about achieving conservation at this scale, we sought to examine a set of existing approaches and practices that may help future researchers develop such theories for successful operation of broad-extent conservation partnerships. Our approach differs from previous approaches because we considered the entire cycle of broad-extent conservation—conception, planning, implementation, and evaluation—and explored the scientific, administrative, political, ecological, logistical, and fiscal challenges and benefits of broad-extent conservation.

Methods

We developed several a priori criteria, based on our own experience, to select broad-extent conservation partnerships for examination. Partnerships had to: span jurisdictional, political, and watershed boundaries (Fig. 1); address conservation of multiple species or whole ecosystems; explicitly consider human benefits as part of the conservation program and reflect principles of ecosystem management; have focal areas or ecosystems encompassing common dynamics as a result of shared resources, drivers, and broad-ranging phenomena, thus excluding projects at scales above that of an individual continent; and have ties to land-management decisions, conservation practitioners, or both. Of nearly 40 candidate programs we identified through internet and literature searches and conversations with colleagues worldwide, we contacted over 20 programs that fit these criteria; 11 programs responded (Table 1). From each partnership, we asked each organization to select individuals who could speak both to the overarching mission and to the on-the-ground management actions and learning processes of their organization. When the partnership was represented by one individual (8 of 11 cases), it was a staff member in a leadership or upper-administrative role. For the 3 multiple-respondent teams (2–5 individuals per partnership that responded; e.g., Fig. 2), spatial and jurisdictional (i.e., agency and national) representation typically occurred. In these instances, responses were based on consistency among respondents. For logistical reasons, we allowed participants to respond orally or in writing rather than requiring real-time interviews. We sent the questionnaire to identified individuals at least one week in advance of an interview to prepare them and allowed for the option of providing written responses. Interviews were conducted over the telephone between an author and the partnership representative(s) (Table 1). When written responses were provided ($n = 8$ programs), we asked for clarifications during the interview or in

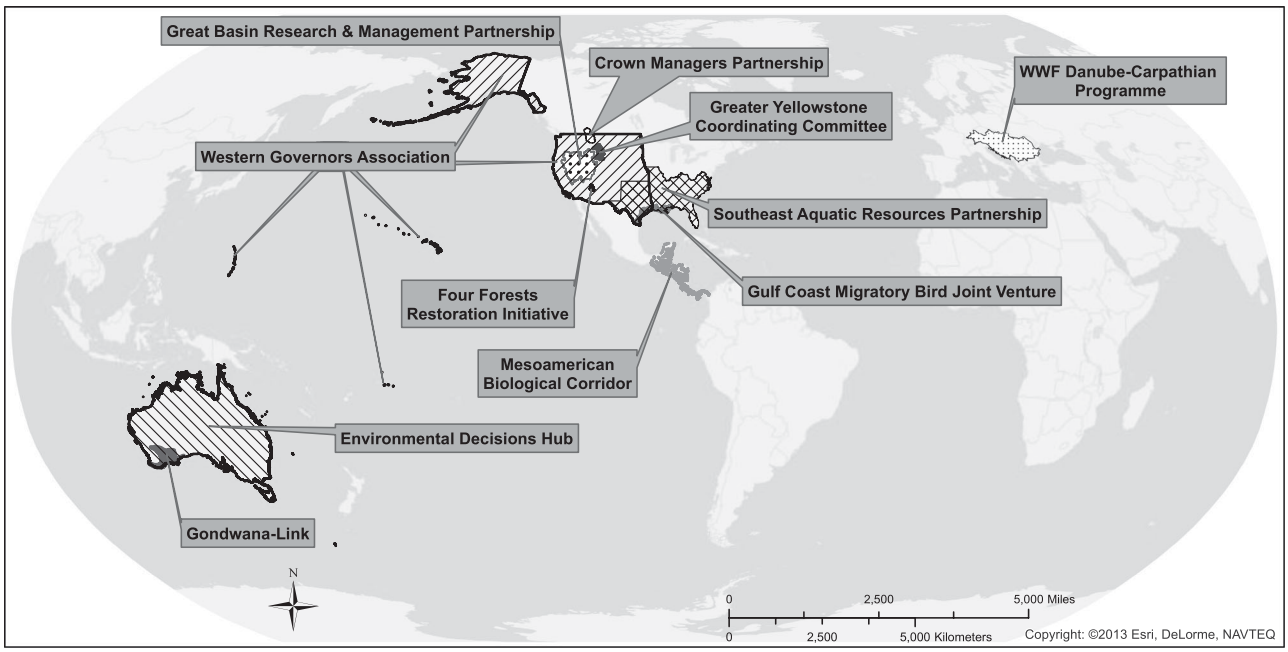

Figure 1. Locations, sizes, and shapes of areas covered by 11 focal conservation partnership programs (WWF, World Wildlife Fund). The map is centered on 96°W longitude.

subsequent email communications. If no written responses were provided, the author elicited responses verbally and clarified uncertainties through follow-up email.

Our measurement instrument contained 17 questions (Supporting Information) that, based on our experiences working with conservation practitioners, we saw as pertinent to addressing our overarching question: What are the challenges and successes of broad-extent conservation partnerships? We organized questions under 6 sections reflecting major tasks of broad-extent conservation: launching and maintaining the partnership; developing ultimate management objectives; identifying management actions; deciding which actions to take toward accomplishing the ultimate objectives; implementing actions; and learning, adaptive management, and filling information gaps. These sections were followed by 2 summary questions that integrated these 6 components of broad-extent conservation. Of the 17 questions, 15 offered non-mutually exclusive multiple-choice options that encompassed our experience of broad-extent conservation contexts and practices while allowing open-ended responses where appropriate. By offering respondents opportunities to elucidate their choice verbally, we expected this would compensate for biases potentially induced by us specifying options (Krosnick 1999) and allow us to compare responses by summarizing which options were chosen. We pilot-tested the questionnaire with colleagues who hold similar broad-extent practitioner roles.

Because most questions allowed respondents to select more than one choice, we analyzed the data by counting the number of partnerships (of 11; Table 1) that selected each possible answer. Although we recognize that quantitatively analyzing responses from this small sample cannot allow generalization beyond our sample, we explored commonalities and differences among these partnerships to inform more-extensive studies. One question asked respondents to rank multiple responses (regarding which factors were most important for successful implementation of management actions), and another question required respondents to indicate the amount invested in each aspect of their program. We also utilized the narrative responses to generate further insights into successes and challenges.

Results

We gathered data from 11 partnerships, spanning 29 nations on 3 continents (Fig. 1), that work on broad-extent conservation. The geographic extent of each program ranged from ~10,000 km^2 to an entire continent (Table 1). A minority of partnerships (e.g., Environmental Decisions Hub) focused on supporting management through research and had little direct management of land. Although most partnerships had direct influence on land management ($n = 8$), specific objectives varied considerably (Supporting Information [Appendix 2:Q3]). Our sample of conservation partnerships reported

Table 1. Key characteristics of 11 focal programs focusing on broad-extent conservation.[a]

Program or effort	*Geography*	*Primary coordinating entities*	*Additional partners and stakeholders*	*Period from formation to conclusion*	*Extent of partnership (km^2)*	*References and websites*
Mesoamerican Biological Corridor	Southern México through southern Panamá	heads of state in Mesoamerica, through the Central American Commission of Environment and Development	companies, NGOs, silvicultural or agricultural producers (e.g., coffee, honey, cocoa, livestock), rural and indigenous landowners, ecotourism-oriented groups	1997–2006; continues to the present in some countries	467,000	Sarkar et al. 2009; Miller et al. 2001
Crown (of the Continent) Managers Partnership	Northern Rocky Mountains of USA and Canada	First Nations/tribes; federal, provincial, and state agencies; universities; and local governments	examples: NGOs, industry, and citizens of the Crown of the Continent Ecosystem	2001–present	72,000	www.crownmanagers.org
Greater Yellowstone Coordinating Committee	Greater Yellowstone Ecosystem of USA	NPS, USFS, USFWS, and BLM	examples: state- and local-government agencies and NGOs	1964–present	60,666	fedGYCC.org
Great Basin Research and Management Partnership	Great Basin Physiognomic Province of USA	BLM, USFS, FWS, other land-managing agencies	universities and anyone affected by land management in the Great Basin	2006–present	582,750	Chambers et al. 2008
Western Governors Association: Wildlife Program	western USA	state offices, federal land managers, private landowners	citizens of the western USA	1984–present	259,000	www.westgov.org; many documents exist, on website
Gondwana-Link	Southwest Australia	NGOs, government, private landowners	private and public land owners of southwest Australia	2002–present	100,000	Soule et al. 2004

Table 1. (continued).

Program or effort	*Geography*	*Primary coordinating entities*	*Additional partners and stakeholders*	*Period from formation to conclusion*	*Extent of partnership (km^2)*	*References and websites*
Four Forests Restoration Initiative	Montane areas of Arizona (USA)	USFS, State of Arizona	anyone interested in wildfire; examples: citizens, recreationists, USFS	2008–present	9712	http://www.fs.usda.gov/main/4fri/home
World Wildlife Fund Danube-Carpathian Programme	Danube & Carpathian (WWF) ecoregions of eastern Europe	World Wildlife Fund	NGOs, all levels of government, for-profit groups	1998–present	798,882	http://wwf.panda.org/what_we_do/where_we_work/black_sea_basin/danube_carpathian/danube_carpathian_office/
Gulf Coast Joint Venture	coastal areas along northern Gulf Coast (USA)	USFWS	other state, federal, and private organizations, corporations, and private landowners	1988–present	108,537	www.gcjv.org
Southeast Aquatic Resources Partnership	southeast region of USA including coastal oceans	state, federal, and private conservation organizations of the GCJV Board	private industry, NGOs, federal agencies, and public interest groups	2001–present	2,381,976	www.southeastaquatics.net
Environmental Decisions Hub (EDH)	Australia	Australian government	state and local governments	2011–present	Australia	http://www.nerpdecisions.edu.au/

[a]*Key: BLM, Bureau of Land Management (USA); GCJV, Gulf Coast Joint Venture (USA); NGO, non-governmental organization; NPS, National Park Service (USA); USFS, U.S. Forest Service; USFWS, U.S. Fish & Wildlife Service; WWF, World Wildlife Fund.*

spending up to US$15 million annually on implementing management actions (Supporting Information [Q16]). Budget allocations varied considerably. There was an inverse relationship between areal extent and funding and costs. The mean budget was $0.2 million for programs with the largest areal extents, $2.8 million for the 3 medium-sized programs, and $5.2 million for the 6 smallest programs.

Launching and Maintaining the Partnership

Engaging partners was a commonly reported challenge (Supporting Information). Likewise, communication and outreach between the partnership and stakeholders were identified as challenges (Supporting Information [Qs7, 8, 9, 11]). Many narrative responses about challenges centered on difficulties with maintaining broad-extent partnerships, such as staff turnover or trust and communication among organizations (Supporting Information). Funding was a commonly reported limitation to setting conservation objectives for the partnership and for filling information needs (Fig. 3 & Supporting Information [Q15]). Developing institutional frameworks at the partnership level and incorporating science into management plans were less-challenging areas for partnerships (Supporting Information [Qs2,15]). Four of the 7 U.S. programs noted that defining their mission, scope, focal issues, and approach constituted a challenge, whereas none of the programs from other nations noted this (Supporting Information [Q2]).

Ultimate Management Objectives

Ecosystem structure and function were more commonly referenced as conservation objectives than were attributes of species or assemblages (Supporting Information [Qs3,12]). This is consistent with an ecosystem-level approach to conservation and a broad-extent focus. Over half of the partnerships identified improving human satisfaction, well-being, or both as an objective. Broad-extent objectives originated most commonly from land managers via facilitated meetings and to a lesser extent from legislative or regulatory bodies or funding sources (Supporting Information [Qs4,6]). The latter finding contrasted with funding limitations evidenced in answers to other questions (Supporting Information [Qs2, 7] & Fig. 3). Of the 11 partnerships, 4 had developed measurable indicators for conservation objectives; indicators included population sizes, severe-wildfire intervals, and hectares under land stewardship. The remaining partnerships were either developing indicators or chose administrative metrics such as number of partners engaged in the partnership. Four of the 7 U.S. programs indicated more than 2 reasons for selecting ultimate objectives, indicating that some combination of regulations, land managers, funding, or scientists influenced objectives, whereas programs from the other countries selected only one or 2 of these influences (Supporting Information [Q4]). Similarly, U.S. programs reported a greater number of challenges in developing objectives and metrics of success and used a greater diversity of processes for defining objectives than the 4 programs in other nations.

Narrative responses indicated additional challenges related to agreeing on conservation objectives. These challenges stemmed from the diverse missions across organizations, struggles to identify measurable objectives, and difficulties in reconciling trade-offs among competing objectives (Supporting Information). Some partnerships suggested that the inability to effectively sample or directly measure identified conservation objectives was limiting. Some reported having difficulty identifying social and ecological tipping points to inform decision making, and others had difficulty identifying metrics that would be directly responsive to management actions.

Management Actions and Predicted Consequences

Direct-management activities varied among partnerships and included combinations of restoration, managing disturbance (e.g., prescribed burns), stewardship incentives, and land acquisition. Direct management of animals was uncommon. Outreach and education were identified by the most partnerships as tools for achieving objectives, particularly in the 3 programs with the largest areal extents. Most other partnerships also engaged in at least one direct-management activity to affect ecosystem attributes (Supporting Information [Q8]). Narrative responses (Supporting Information [Qs7,8]) indicated that predicting consequences of management actions relative to ultimate management objectives is complicated by the strength of connection between scientists and land managers and by contrasting data-collection, data-storage, and data-analysis protocols among organizations.

Choosing Actions to Accomplish Objectives

Conservation partnerships used multiple criteria for choosing among management actions, relying on quantitative measures where feasible. Consensus, reached through iterative discussion and negotiation, was used most commonly for making ultimate decisions about which management recommendations to implement (Supporting Information [Q10b]). Ecosystem management and adaptive management were the concepts of conservation science most commonly used to develop management recommendations among the partnerships, whereas the single-large or several-small concept (for reserve design) and alpha, beta, and gamma diversity were least used (Supporting Information [Q12]). Challenges to making management recommendations involved, with approximately equal frequency, uncertainties in translating science into management actions, urbanization and human land use, climate change, and efficacy of

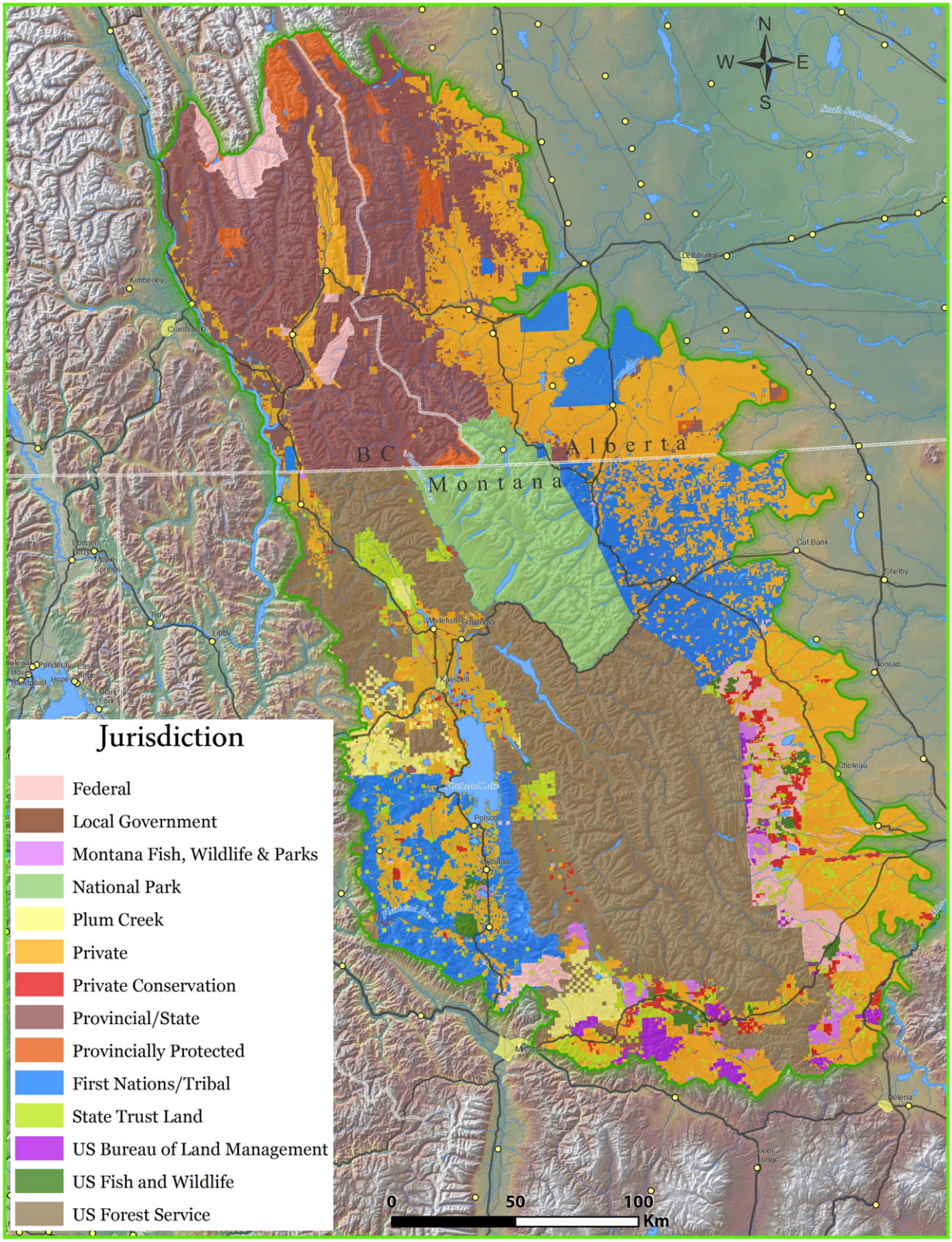

Figure 2. Jurisdictions within the Crown of the Continent ecosystem of the western United States and Canada, which is where the Crown Managers Partnership (CMP) works. Map courtesy of CMP.

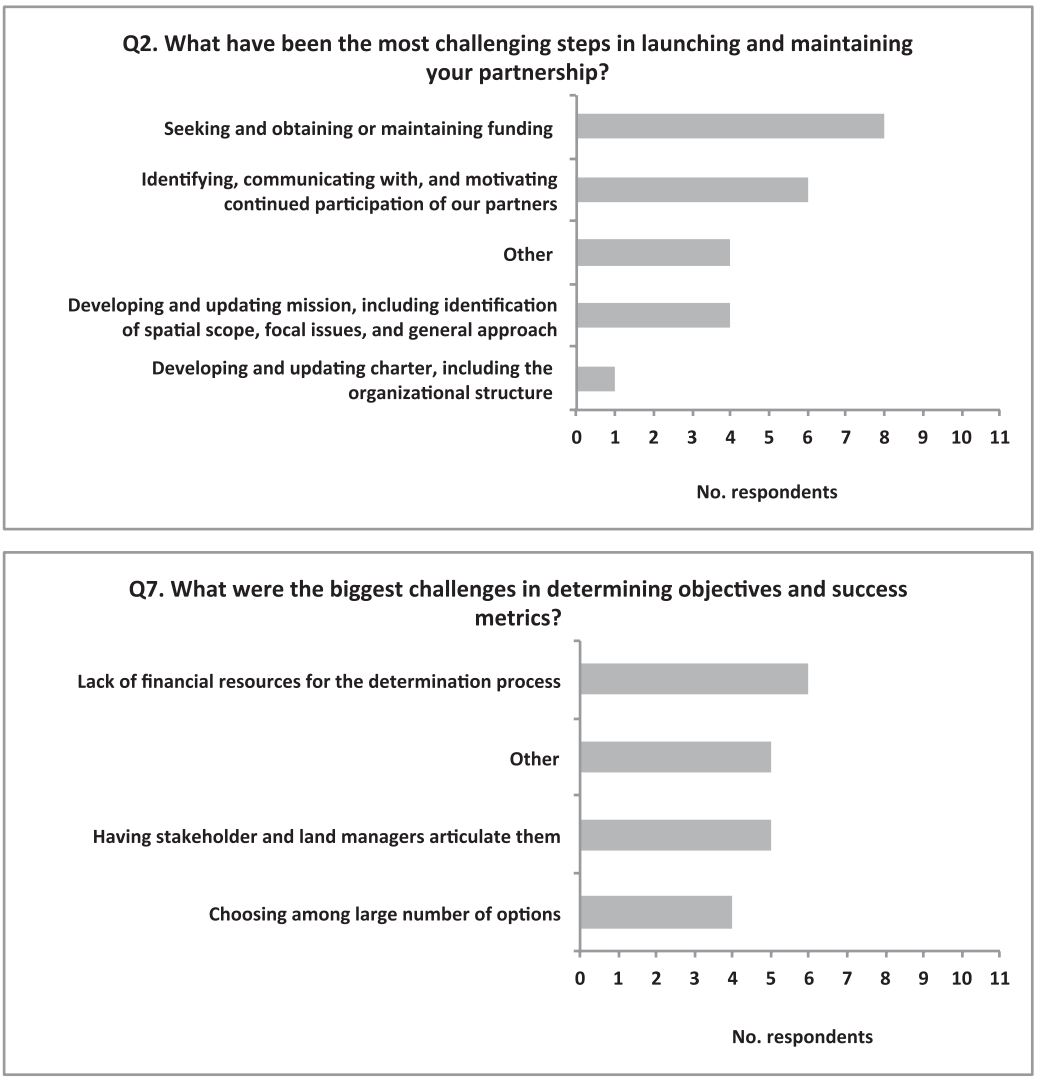

Figure 3. Example summaries of responses to 2 multiple-choice questions. Questions and most responses are written in an abbreviated form. The complete questionnaire and results from the remaining questions are in Supporting Information.

management in attaining objectives (Supporting Information [Q12]).

Implementing Actions

Acceptance of recommended management actions by affected partners, coordination with and among managers, funding, and completion of legal or regulatory processes were all identified as precursors for successful implementation of management actions (Supporting Information [Qs9,11]). No partnership indicated that managers always implemented recommendations at face value (i.e., without consulting the partnership and regardless of whether the manager agreed with the recommendation), even with adequate funding. Challenges indicated by narrative responses largely concerned a mismatch between policies on paper and implementation on the ground, which in turn likely reflected diverse management schedules among management partners, weak enforcement of some policies, and lack of trust among organizations (Supporting Information [Qs9,11]). Respondents also asserted that broad-extent partnerships provided substantial conservation benefits by building social and political momentum and informing management actions and implementation across entire regions (Supporting Information [Qs9,11]).

Learning

Most partnerships reported employing adaptive management. They used research and monitoring to link management actions to objectives, decide among management actions, or revise objectives (Supporting Information [Q14]). Although the integration of conservation planning, implementation, and learning raised substantial

challenges, this also represented a key potential advantage of enacting broad-extent conservation (Supporting Information [Q17]). In particular, social and political will was sometimes lacking for developing and implementing broad-extent conservation. Communication challenges associated with abundant and diverse sets of managers and stakeholders were noted. One innovation involved integrating economic benefits with ecological benefits as an objective, which helped motivate and perpetuate program funding and fostered successful implementation of conservation actions. Incorporating learning through research and adaptive management was identified as essential for broad-extent conservation and was the second greatest investment behind implementing conservation actions (Supporting Information [Q16]).

Discussion

We identified prominent, diverse conservation successes, ranging from establishment of corridors, to creation of novel shared databases, to integration of conservation planning, implementation, and learning across ecological and jurisdictional boundaries (Supporting Information). Challenges of broad-extent conservation included communication among partners and stakeholders, developing measurable objectives, and implementation of adaptive management (Supporting Information). Although these challenges have been previously identified individually (Koontz & Bodine 2008; Susskind et al. 2012), here we discovered them as a collective challenge to broad-extent conservation. Knowledge of these challenges may help improve existing broad-extent conservation partnerships, inform emerging ones, and enhance long-term outcomes for such partnerships. Despite the challenges, broad-extent conservation may result in marked changes to the design, implementation, and evaluation of conservation; it holds potential for informing decisions about allocating resources among and within scales and jurisdictions of management ranging from local to ecoregional and beyond. Although mechanisms for cross-scale conservation exist for individual species (e.g., Mattsson et al. 2012), this has yet to be developed for multiple taxonomic groups or multiple ecosystem services. From our conversations with people involved in coordinating these programs and our own experience, we distilled the 6 major tasks in broad-extent conservation (see Methods) to 3 essential elements: launching and maintaining the partnership, specifying ultimate management objectives, and implementing and learning.

Launching and Maintaining the Partnership

Factors limiting success as reported by respondents to our survey generally reflected the complexity of stakeholders, jurisdictions, and scales involved. Addressing these sources of complexity collectively requires significant funding but is necessary for implementing conservation across large areas. Areal extent was not positively associated with budget size, probably because the largest programs invested more in outreach and education than in more-expensive actions such as land acquisition and restoration. Our results suggest that partnerships were most successful in implementing and learning from conservation actions when full engagement and integration across multifarious entities was achieved. Robinson et al. (2011) found that larger-scale conservation partnerships are typically launched through formal mandate, whereas local-scale efforts rely more on local social networks. If so, such formal agreements may benefit from being crafted in ways that accommodate best practices for maintaining the partnership (e.g., transparency, trust).

Although these partnerships have unique traits and foci, common keys to their success were funding, stakeholder engagement, and forming lasting relationships and trust among partner organizations. Means to achieve lasting funding and communication included integrating multiple collaborators' objectives (e.g., economic benefits, provisioning of ecosystem services) into conservation plans and ensuring regular engagement with partner organizations and stakeholders. The importance of engaging partners and stakeholders is consistent with assessments of over 20 broad-extent conservation programs on 5 continents (Pressey & Bottrill 2009; Worboys et al. 2010). Approaches that include policy-driven, strategic-decision, and tactical (field-level, stakeholder-driven) forms of conservation action, combined with a capacity to learn and adjust management actions through time, may constitute a more-effective yet infrequently enacted approach (Dietz et al. 2003; Susskind et al. 2012).

Specifying Ultimate Management Objectives

These partnerships were often challenged to develop measurable objectives, which may arise from the multiscale, multijurisdictional nature of broad-extent partnerships. Not only is it difficult for management partners to conceptually agree on conservation objectives, but finding and agreeing on metrics representing those concepts requires iterative investigation and dialogue among managers, stakeholders, and scientists (Salafsky et al. 2002; Redford et al. 2003). Compared with other countries, programs in the United States indicated greater diversity in types of partners influencing objectives. The lack of measurable attributes for management objectives was evident from many of our focal programs and is a shortcoming in prominent broad-extent conservation partnerships, notably in the Chesapeake Bay and the Colorado River (e.g., Wiersema 2008), and in conservation-monitoring programs generally (e.g., Sutherland et al. 2004). Metrics

of success help communicate the effectiveness of broad-extent conservation programs (Sarkar et al. 2006).

Implementing and Learning

Partnerships reported using an ecosystem-management approach (Grumbine 1994; Chapin et al. 2010), with restoration and outreach as key components. Actual implementation of land-management actions is typically necessary to realize broad-extent conservation (i.e., except when employing purely protectionist actions), and our respondents suggested that this implementation was often limited by jurisdictional complexity and diversity of stakeholders. A transparent approach linking management actions to ultimate conservation objectives across multiple scales and jurisdictions can promote implementation. Many tools have been designed to facilitate decision making under uncertainty in multistakeholder settings (e.g., Mendoza & Martins 2006; Lynam et al. 2007), but providing partnerships capacity to operate these tools remains a challenge. Predicting consequences of management actions is further complicated by temporal, spatial, social, and political uncertainties (Robinson et al. 2011).

Modest investment in learning and adaptive management by these partnerships likely reflects a trade-off between allocating to conservation actions while engaging researchers to develop relevant science at multiple scales. Improving linkages between scientists and practitioners via a focus on broad-extent conservation is a challenge. Thus, direct stakeholder participation in establishment of conservation objectives and articulation of research priorities provides the potential to link science and management at appropriate scales (Lauber et al. 2011). Because adaptive-management approaches can be flexible in stakeholder involvement, they may enhance the robustness of social and ecological communities facing an uncertain future (e.g., West et al. 2009). However, there are considerable hurdles to overcome, and failing to appreciate the complexities involved in multistakeholder problems may hinder broad-extent conservation (Thomas et al. 2006).

Future Research Avenues Regarding Broad-Extent Conservation Partnerships

Based on our conversations with participants in 11 focal programs, we present the following avenues for future research that, if pursued, could help inform and support emerging broad-extent conservation partnerships and assessments of their efficacy.

To launch and maintain broad-extent conservation partnerships, it is critical to determine what qualities of the partnership will ensure that it will complement, integrate, and strengthen, rather than replace, local conservation efforts. It is also important that studies assess how to identify the appropriate number and types of stakeholders (e.g., private landowners, public agencies, NGOs) and at which stage of partnership formation they should become engaged. We urge further research on the importance of partnership context (e.g., areal extent, aquatic vs. terrestrial ecosystems, developed vs. developing nations).

Regarding development of ultimate management objectives, first, future investigations should consider examining how partnerships can identify objectives that reflect a vision of broad-extent conservation and under what conditions the focus should be on concerns about the ecosystem, human dimensions, or a combination. Second, it would be valuable to investigate how scales of objectives can be chosen to fit particular broad-extent conservation issues (e.g., aquatic vs. terrestrial ecosystems, direct-anthropogenic vs. climate-change effects, hazard response vs. proactive planning) or contrasting governance and political contexts. Third, researchers should determine which approaches and criteria can be used to design effective metrics of success for particular kinds of objectives and what the bases for these criteria are. Finally, future research should consider addressing whether setting an objective regarding administration of the partnership generates benefits.

To predict consequences of management strategies and external drivers, first it is important to determine how to identify a level of complexity in models that incorporates sufficient multidimensionality to encompass diverse stakeholder objectives, concerns, and actions and yet avoids loss of engagement of partners as the models address increasing numbers of parameters. Second, future studies should investigate in what decision contexts quantitative models are necessary for overcoming the complexity of working across jurisdictions and watersheds.

To implement broad-extent conservation, it is valuable to determine which adaptive-management processes most effectively result in actionable conservation strategies that account for changing social and political or environmental conditions and improved knowledge of the system. For example, because large-scale partnerships are often enmeshed in higher-level government structures (Robinson et al. 2011), one must determine how to buffer partnerships against pressures derived from changes in political-power dynamics. Future research might also evaluate how roadblocks to implementation of adaptive strategies vary across continents and social and political conditions.

Acknowledgments

We are profoundly indebted to A. Beckmann, K. Bradby, R. Herrera, J. Chambers, B. Dolan, I. Dyson, S. Finn, D. Fleishman, M. Holland, C. Miske, H. Provencio, M. Riddle,

S. Robinson, E. Sexton, M. West, B. Wilson, and B. Wintle for answering the focal-program questionnaires. In addition, Y. Converse and S. Olliff provided input to Appendix 3. We thank D. Blahna, S. Brechin, N. Chambers, S. Finn, R. Fris, M. Olson, R. Sojda, G. Tabor, B. Wilson, and 2 anonymous reviewers for reviews of earlier drafts. T. Chesley-Preston created Fig. 1. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Supporting Information

The complete text of the questionnaire (Appendix 1), the number of programs that selected each option for all questions in the questionnaire (Appendix 2), and lists of challenges and successes experienced by focal practitioners (Appendix 3) are available online. The authors are solely responsible for the content and functionality of these materials. Queries (other than for absence of the material) should be directed to the corresponding author.

Literature Cited

Beever, E. A. and A. Woodward. 2011. Design of ecoregional monitoring in conservation areas of high-latitude ecosystems under contemporary climate change. Biological Conservation **144:**1258–1269.

Bode, M., W. Probert, W. R. Turner, K. A. Wilson, and O. Venter. 2011. Conservation planning with multiple organizations and objectives. Conservation Biology **25:**295–304.

Carroll, C., J. R. Dunk, and A. Moilanen. 2010. Optimizing resiliency of reserve networks to climate change: multispecies conservation planning in the Pacific Northwest, USA. Global Change Biology **16:**891–904.

Chambers, J., C. N. Devoe, and A. Evenden. 2008. Collaborative management and research in the Great Basin—examining the issues and developing a framework for action General Technical Report RMRS-GTR-204. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Chapin, F. S., III, et al. 2010. Ecosystem stewardship: sustainability strategies for a rapidly changing planet. Trends in Ecology & Evolution **25:**241–249.

Dietz, T., E. Ostrom, and P. C. Stern. 2003. The struggle to govern the commons. Science **302:**1907–1912.

Grumbine, R. E. 1994. What is ecosystem management? Conservation Biology **8:**27–38.

Hansen, L., J. Hoffman, C. Drews, and E. Mielbrecht. 2010. Designing climate-smart conservation: guidance and case studies. Conservation Biology **24:**63–69.

Hein, L., K. van Koppen, R. S. de Groot, and E. C. van Ierland. 2006. Spatial scales, stakeholders and the valuation of ecosystem services. Ecological Economics **57:**209–228.

Holling, C. S. 1978. Adaptive environmental assessment and management. Wiley, London.

Jacobson, C., and A. L. Robertson. 2012. Landscape Conservation Cooperatives: bridging entities to facilitate adaptive co-governance of social–ecological systems. Human Dimensions of Wildlife **17:**333–343.

Koontz, T. M., and J. Bodine. 2008. Implementing ecosystem management in public agencies: lessons from the US Bureau of Land Management and the Forest Service. Conservation Biology **22:** 60–69.

Krosnick, J. A. 1999. Survey research. Annual Review of Psychology **50:**537–567.

Lauber, T. B., R. C. Stedman, D. J. Decker, and B. A. Knuth. 2011. Linking knowledge to action in collaborative conservation. Conservation Biology **25:**1186–1194.

Lee, K. N. 1993. Compass and gyroscope: integrating science and politics for the environment. Island Press, Washington D.C.

Lee, T. M., and W. Jetz. 2008. Future battlegrounds for conservation under global change. Proceedings of the Royal Society B: Biological Sciences **275:**1261–1270.

Lindenmayer, D. B., C. R. Margules, and D. B. Botkin. 2000. Indicators of biodiversity for ecologically sustainable forest management. Conservation Biology **14:**941–950.

Lopez-Hoffman, L., R. G. Varady, K. W. Flessa, and P. Balvanera. 2010. Ecosystem services across borders: a framework for transboundary conservation policy. Frontiers in Ecology and the Environment **8:**84–91.

Lynam, T., W. De Jong, D. Sheil, T. Kusumanto, and K. Evans. 2007. A review of tools for incorporating community knowledge, preferences, and values into decision making in natural resources management. Ecology and Society **12:** http://www.ecologyandsociety.org/vol12/iss1/art5/.

Mattsson, B. J., et al. 2012. A modeling framework for integrated harvest and habitat management of North American waterfowl: case-study of northern pintail metapopulation dynamics. Ecological Modelling **225:**146–158.

Mendoza, G. A. and H. Martins. 2006. Multi-criteria decision analysis in natural resource management: a critical review of methods and new modelling paradigms. Forest Ecology and Management **230:** 1–22.

Miller, K. E. Chang and N. Johnson. 2001. Defining common ground for the Mesoamerican Biological Corridor. World Resources Institute, Washington, D.C.

Peterson, G., C. R. Allen, and C. S. Holling. 1998. Ecological resilience, biodiversity, and scale. Ecosystems **1:**6–18.

Polasky, S., E. Nelson, E. Lonsdorf, P. Fackler, and A. Starfield. 2005. Conserving species in a working landscape: land use with biological and economic objectives. Ecological Applications **15:**1387–1401.

Pressey, R. L. and M. C. Bottrill. 2009. Approaches to landscape- and seascape-scale conservation planning: convergence, contrasts and challenges. Oryx **43:**464–475.

Redford, K. H., et al. 2003. Mapping the conservation landscape. Conservation Biology **17:**116–131.

Robinson, C. J., R. D. Margerum, T. M. Koontz, C. Moseley, and S. Lurie. 2011. Policy-level collaboratives for environmental management at the regional scale: lessons and challenges from Australia and the United States. Society & Natural Resources **24:**849–859.

Salafsky, N., R. Margoluis, K. H. Redford, and J. G. Robinson. 2002. Improving the practice of conservation: a conceptual framework and research agenda for conservation science. Conservation Biology **16:**1469–1479.

Sarkar, S., et al. 2006. Biodiversity conservation planning tools: present status and challenges for the future. Annual Review of Environment and Resources **31:**123–159.

Sarkar, S., V. Sánchez-Cordero, M. Cecilia Londoño, and T. Fuller. 2009. Systematic conservation assessment for the Mesoamérica, Chocó, and Tropical Andes biodiversity hotspots: a preliminary analysis. Biodiversity and Conservation **18:**1793–1828.

Soule, M. E., B. G. Mackey, H. F. Recher, J. E. Williams, J. C. Z. Woinarski, D. Driscoll, W. C. Dennison, and M. E. Jones. 2004. The role of connectivity in Australian conservation. Pacific Conservation Biology **10:**266–279.

Susskind, L., A. E. Camacho, and T. Schenk. 2012. A critical assessment of collaborative adaptive management in practice. Journal of Applied Ecology **49:**47–51.

Sutherland, W. J., A. S. Pullin, P. M. Dolman, and T. M. Knight. 2004. The need for evidence-based conservation. Trends in Ecology & Evolution **19:**305–308.

Thomas, J. W., J. F. Franklin, J. Gordon, and K. N. Johnson. 2006. The Northwest Forest Plan: origins, components, implementation experience, and suggestions for change. Conservation Biology **20:**277–287.

West, J. M., S. H. Julius, P. Kareiva, C. Enquist, J. J. Lawler, B. Petersen, A. E. Johnson, and M. R. Shaw. 2009. US natural resources and climate change: concepts and approaches for management adaptation. Environmental Management **44:**1001–1021.

Wiens, J. A. 1989. Spatial scaling in ecology. Functional Ecology **3:**385–397.

Wiersema, A. 2008. A train without tracks: re-thinking the place of law and goals in environmental and natural resources law. Environmental Law http://ssrn.com/abstract=1144242.

Worboys, G. L., W. L. Francis, and M. Lockwood, editors. 2010. Connectivity conservation management: a global guide. Earthscan, Washington, D.C.