1-1-2016

Networks and landscapes: a framework for setting goals and evaluating performance at the large landscape scale

R.P. Bixler

S. Johnson

K. Emerson

T. Nabatchi

M. Reuling

See next page for additional authors

Authors
R.P. Bixler, S. Johnson, K. Emerson, T. Nabatchi, M. Reuling, C. Curtin, Michele Romolini, and J.M. Grove

Networks and landscapes: a framework for setting goals and evaluating performance at the large landscape scale

R Patrick Bixler[1]*, Shawn Johnson[2], Kirk Emerson[3], Tina Nabatchi[4], Melly Reuling[5], Charles Curtin[5], Michele Romolini[6], and J Morgan Grove[7]

The objective of large landscape conservation is to mitigate complex ecological problems through interventions at multiple and overlapping scales. Implementation requires coordination among a diverse network of individuals and organizations to integrate local-scale conservation activities with broad-scale goals. This requires an understanding of the governance options and how governance regimes achieve objectives or provide performance evaluation across both space and time. However, empirical assessments measuring network-governance performance in large landscape conservation are limited. We describe a well-established large landscape conservation network in North America, the Roundtable on the Crown of the Continent, to explore the application of a social–ecological performance evaluation framework. Systematic approaches to setting goals, tracking progress, and collecting data for feedback can help guide adaptation. Applying the established framework to our case study provides a means of evaluating the effectiveness of network governance in large landscape conservation.

Front Ecol Environ 2016; 14(3): 145–153, doi:10.1002/fee.1250

Once primarily used in conservation efforts for migratory animals (Beever *et al.* 2014), large landscape conservation is now considered an effective strategy for addressing a range of large-scale management challenges, including climate change, land-use planning and land conservation, water management, biodiversity protection, and wildfire mitigation (see Scarlett and McKinney 2016 for a discussion of large landscape conservation). As such, large landscape restoration and management projects are becoming more common not only in North America but also around the world. Notable large landscape conservation projects include "Yellowstone to Yukon" in the US and Canada (Chester 2015) and "Habitat 141°" in Australia (Wyborn 2015). Some urban initiatives are also considered as large landscape conservation, including the Chicago Wilderness (Imperial *et al.* 2016) and the Baltimore Ecosystem Study (Romolini *et al.* 2013). Similar to regional-scale (Soule and Terborgh 1999), landscape-scale (Trombulak and Baldwin 2010), and connectivity (Crooks and Sanjayan 2006) conservation strategies, large landscape conservation is a science-based approach that advances the concepts of ecological integrity, ecological connectivity, habitat cores and corridors, and landscape heterogeneity. Projects focus on ecological processes that transcend jurisdictional boundaries and target desired outcomes in the landscape (Rouget *et al.* 2006).

To design and implement large landscape conservation projects, individuals and agencies are increasingly organizing into networks to facilitate the exchange of ideas, build relationships, identify common interests, and solve problems of mutual interest in a landscape (see Panel 1 in Scarlett and McKinney 2016). In the absence of a single

In a nutshell:

- Considerable progress has been made in conceptualizing and analyzing network governance in large landscape conservation, but evaluating the actions, outcomes, and adaptation of networked efforts remains complicated
- Unique challenges to evaluating network governance include attributing outcomes and characterizing the social–ecological systems at meaningful scales
- A performance matrix is useful in setting social and ecological goals for large-scale landscape conservation projects
- Social network analysis can be used to help understand how network structures influence network performance (and vice versa) over time

[1]*Institute for Renewable Natural Resources, Texas A&M University, College Station, TX* *(rpbixler@tamu.edu); [2]*Center for Natural Resources & Environmental Policy, The University of Montana, Missoula, MT;* [3]*School of Government and Public Policy, The University of Arizona, Tucson, AZ;* [4]*Department of Public Administration and International Affairs, Syracuse University, Syracuse, NY;* [5]*The Center for Large Landscape Conservation, Bozeman, MT;* [6]*Center for Urban Resilience, Loyola Marymount University, Los Angeles, CA;* [7]*Northern Research Station, USDA Forest Service, Baltimore, MD*

organizational authority or jurisdiction, networks have emerged as the predominant governance mechanism for large landscape conservation efforts. Although not entirely absent, accountability is often dispersed within the network (Jedd and Bixler 2015); this complicates traditional performance evaluation, which typically rely on assessments of a single entity that is accountable for outcomes. Coordinating the actions of a diffuse, networked system to specific conservation outcomes poses unique challenges to measuring performance (Cumming *et al.* 2006; Bodin *et al.* 2014), including agreeing upon shared objectives and implementing actions across ecological and jurisdictional boundaries (Sternlieb *et al.* 2013; Heffernan *et al.* 2014; Wyborn 2015). The question of how success or failure can be assessed so that both social and ecological indicators of performance are accounted for also remains unresolved. We describe an evaluation framework that uses social and ecological indicators in the context of a well-established large landscape conservation network, the Roundtable on the Crown of the Continent.

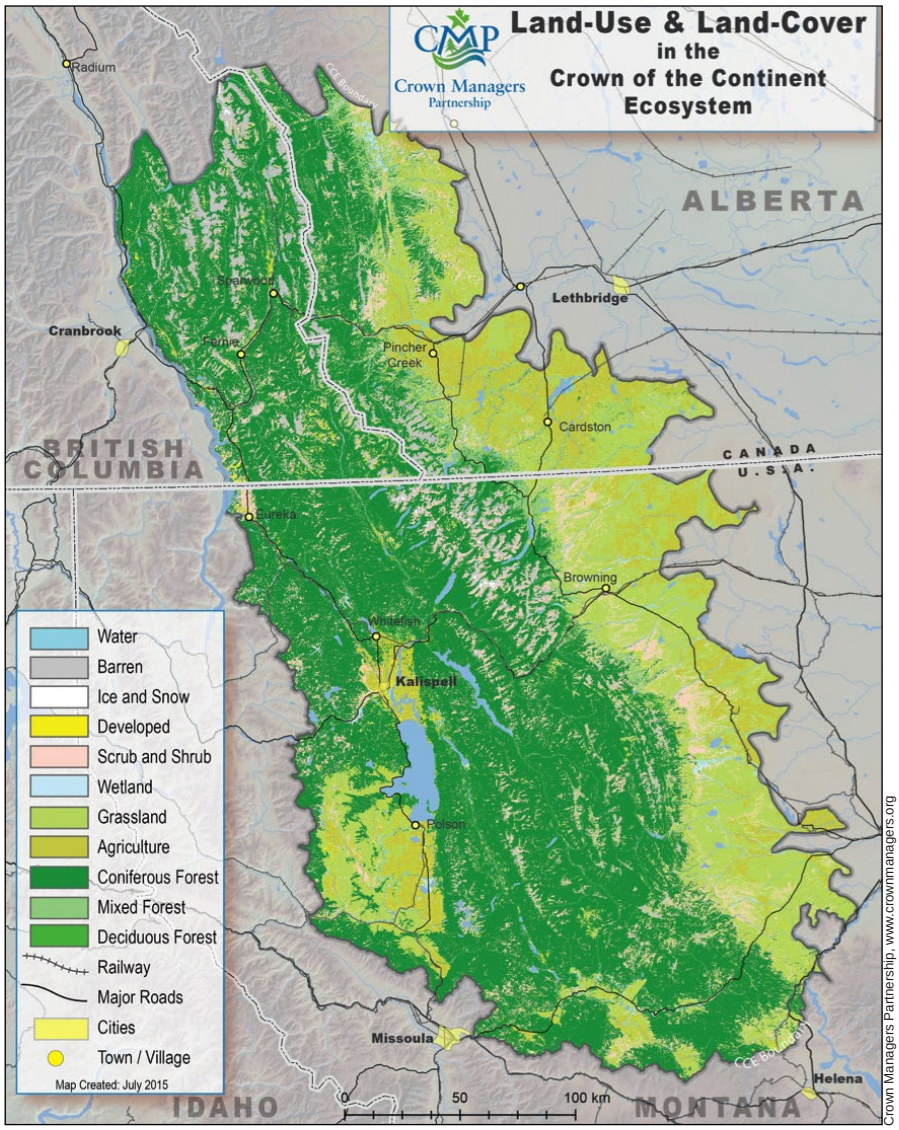

Figure 1. *Map of the Crown of the Continent ecosystem, showing land-use and land-cover types.*

The Crown of the Continent (hereafter, the Crown) landscape covers approximately 44 000 km^2 (16 000 square miles or 18 million acres) of northwest Montana, southeast British Columbia, and southwest Alberta. It comprises protected areas such as the Bob Marshall Wilderness Complex in the US and the Waterton–Glacier International Peace Park that straddles the US–Canada border (Figure 1). This large landscape represents a unique ecological intersection, where plant and animal communities from the Pacific Northwest, eastern prairies, Rocky Mountains, and boreal forests converge. Three major North American rivers – the Missouri/Mississippi, the Columbia, and the Saskatchewan/Nelson – originate in the glacier-carved mountains of the Crown. This landscape retains a complement of native habitat and native predators – grizzly and black bears, gray wolf, coyote, red and swift fox, wolverine, American marten, mountain lion, bobcat, and lynx – as well as large populations of bighorn sheep, pronghorn, moose, white-tailed and mule deer, and elk (Figure 2; Prato and Fagre 2007). Although the landscape is relatively intact, multiple and diffuse impacts from ex-urban residential development in the wildland–urban interface, oil and gas development, unsustainable land-management practices, the spread of invasive and noxious weeds, bark beetle infestations, high-severity wildfires, and climate change threaten its ecological integrity.

Eighty-three percent of the Crown landscape is composed of public land, which is administered by national, state/provincial, tribal, and municipal governments, with the remaining 17% being privately owned. The resulting fragmented ownership pattern poses management challenges that require landscape-level engagement and nested, cross-boundary collaboration (Wyborn and Bixler 2013). Given the numerous public and private jurisdictions in the Crown that manage recreational uses, protection of biodiversity, water supply, timber extraction, and maintenance of aquatic and terrestrial habitat (Pedynowski 2003), many different organizations are working across spatially defined areas within the landscape. In an effort to

span these jurisdictional and ownership boundaries, practitioners in the Crown have implemented a network approach to communicate and coordinate conservation efforts throughout the region, which is discussed further in the background section.

One of the key challenges faced by the practitioners in the Crown is collectively measuring their conservation impact. There are a variety of strategies and tools for measuring performance toward social goals (Provan and Milward 2001; Emerson *et al.* 2012) and a different set of literature for measuring ecological outcomes (Stem *et al.* 2005; Kapos *et al.* 2008). However, very little guidance exists for large landscape conservation initiatives that include multiple organizations working across many boundaries. The social–ecological performance evaluation framework we discuss in this paper begins to address this gap. Below are principles that inform the evaluation matrix:

- Performance evaluation should emphasize learning, feedback loops, continuous improvement, and the ability to adapt (Walker *et al.* 2006; Cundill and Fabricius 2009; Curtin 2014).
- Evaluation tools should be capable of assessing outcomes across jurisdictional and organizational boundaries (Sternlieb *et al.* 2013).
- Evaluation should occur at different levels and units of analysis, and must distinguish actions from outcomes and impacts (Provan and Milward 2001; Koontz and Thomas 2006, 2012).
- Evaluation should assess cross-scale effects of local-scale conservation action with broad-scale goals (Bixler 2014; Alexander *et al.* 2016).

We follow Cash *et al.* (2006) in defining "scale" as the spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon. We acknowledge that scale is socially constructed and that the conceptualization of scale brought to any specific case by particular players is mutable and can be adapted to fit the environmental management task at hand (Sternlieb *et al.* 2013). As such, scale becomes a key concept in large landscape conservation as networks of actors discuss, negotiate, and define the boundaries within which they work, and collectively come to understand the scales over which the ecological processes of interest function and the most appropriate scale for management intervention.

Using these guiding principles, we offer a social–ecological performance evaluation framework to organize social and ecological goals, track progress toward meeting those goals, and collect data for feedback to facilitate adaptation. In the case of the Crown and other large landscape conservation networks, effectively evaluating collective efforts is critical to the persistence and long-term sustainability of the network. This sustainability is dependent on conservation investors, foundations, and practitioners realizing a return on investment. The framework is composed of (1) social network analysis and (2) a performance matrix. Each will be elaborated upon and applied to the Roundtable on the Crown of the Continent (hereafter, the Roundtable).

Figure 2. *Typical landscape in the Crown of the Continent.*

Network governance performance in large landscape conservation

Background

The Roundtable (http://crownroundtable.org) emerged in 2007 as a "big tent" forum, where people and organizations from throughout the region could begin to envision the Crown as a shared landscape. The mission of the Roundtable is to provide a means to connect the 100+ government agencies, tribal and First Nations agencies, non-governmental organizations, and community-based partnerships that are working to sustain and enhance the area's cultural and natural heritage and resources. The Roundtable is designed to: (1) work across the 18-million-acre region; (2) consider all perspectives and include all communities; (3) focus on connecting people, facilitating communication, and catalyzing action; and (4) promote sustainable communities and landscapes, all of which is accomplished through workshops, forums, adaptive management projects, policy dialogues, and conferences. The Roundtable is not a government commission, nor is it a new organization, but rather a "network of networks" overseen by a Leadership Team comprising representatives of the region's leading conservation, community, and cultural organizations. The Roundtable maintains a focus on enhancing the "three Cs" of the region: conservation, community, and cultural values.

One of the Roundtable's keystone programs is the Adaptive Management Initiative (AMI; www.crownroundtable.org/adaptive-Management-initiative.html), a climate-adaptation program that consists of a collection of local-scale projects selected by the Leadership Team of the Roundtable and funded by a pass-through grant from the Kresge Foundation. The AMI is administered by the Roundtable Leadership Team and represents a subset of the larger Roundtable network. Both the Roundtable and the more narrowly focused AMI follow a network approach. The resulting network of AMI participants

includes a suite of organizations and agencies that work on specific local-scale projects but share a common goal of disseminating lessons learned and moving toward broader-scale objectives.

The social network map of this AMI network, which includes the core participants and their project partners (network members are listed in WebTable 1), is illustrated in Figure 3. The color scheme in the figure denotes organizations that first became involved in Year 1 and Year 2 (green and blue, respectively), as well as the project partners of AMI-grantee organizations (red). The size of the "nodes" in the map illustrates the degree of centrality, or the cumulative incoming and outgoing ties among individual members of the network. This is an important indicator of activity within the network (Wasserman and Faust 1994). The links between two organizations (an "edge" in network terms) were identified based on the responses of project participants to a survey question of "Who do you actively collaborate with to achieve the goals of your AMI project?" The thickness of the edges shown in Figure 3 reflects the reported frequency of interaction, with thicker connections representing more frequent interaction. Project grantees participate in a learning network that assesses and pursues opportunities to link efforts, a type of network governance that is known to build communities of practice and strengthen place-based networks through the leveraging of network synergies (see Goldstein and Butler [2010] for a discussion on the Fire Learning Network).

In the following sections, we discuss the objectives, methods, and application of a social–ecological performance evaluation framework in the context of the AMI network. This framework has been developed, refined, and implemented by a small team that includes an applied researcher, the coordinator of the Roundtable, and the lead staff for the AMI program, all of whom contributed to this paper.

Purpose

Traditional approaches to evaluation in public administration apply a rather linear logic, where program inputs produce (or fail to produce) measurable outcomes. To measure overall network impact, it has been suggested that analysts move away from traditional approaches of evaluation by placing "a new emphasis on integration rather than simply delivery of services, changed perceptions about each other's contribution to the whole, and recognition of the value of relationship building" (Keast *et al.* 2004). This logic applies to a context where relationships connect people in geographically dispersed landscapes. Assessing the performance of a network is very different from assessing the performance of a single organization (Conley and Moote 2003; McKinney and Field 2008). Moreover, the social and ecological feedbacks that lead to cumulative outcomes over spatial and temporal scales

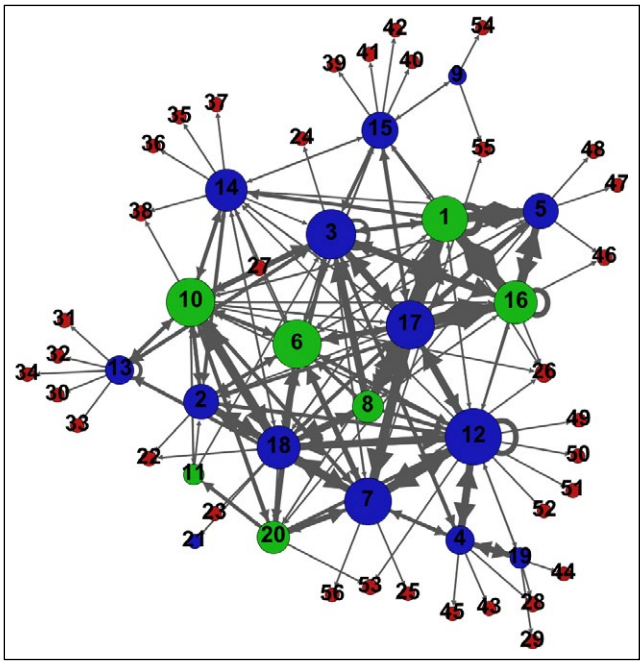

Figure 3. *Network analysis map of the Roundtable on the Crown of the Continent's Adaptive Management Initiative (AMI). See WebTable 1 for organization names and corresponding identification numbers.*

make evaluating network productivity different from evaluating other collaborative initiatives. This is the crux of the challenge of evaluating network governance and large landscape conservation.

The social–ecological performance evaluation framework outlined here fits well with the literature on adaptive governance that theoretically guides the practice of large landscape conservation (Folke *et al.* 2005; Armitage *et al.* 2008). Dietz *et al.* (2003) used the term "adaptive governance" as an umbrella phrase for collaborative, participatory alternatives to top-down decision making. This term embodies the key dimensions of evaluation that we believe are important: continual generation and integration of knowledge; social learning and refinement of the chosen approach, based on new information; flexible institutions and multi-level governance to foster shared responsibility and collaboration within a social network; and development of adaptive capacity to address uncertainty and change (Folke *et al.* 2005; Jacobson and Robertson 2012).

In spite of the continued refinement of systems models that include the social and ecological processes of adaptation, change, and complexity (Gunderson and Holling 2002; Walker and Salt 2012), ecological and social measures that can be used to direct the evaluation process have not yet been developed or agreed upon. Useful performance evaluation requires demonstrating not only that networks result in more sustainable and effective social outcomes, but also that the chosen approach results in tangible actions on the ground, including better conservation science and lasting positive ecological change.

Evaluation methods

Deciding what to count – not to mention deciding who gets to decide what to count – has been a persistent challenge in evaluating network governance performance. There has been limited work and little agreement on what constitutes effective performance in general (Provan and Milward 2001), within the sphere of public participation and deliberation (Nabatchi 2012), and in natural resource management (Emerson *et al.* 2012; Koontz and Thomas 2012; Emerson and Nabatchi 2015). Provan and Kenis (2008) defined network effectiveness as "the attainment of positive network level outcomes that could not normally be achieved by individual organizational participants acting independently". Identifying network-level goals and tracking progress toward those goals is therefore a collective process.

Network effectiveness can be assessed in several different ways, many of which depend on the relative maturity and development of the network (see Imperial *et al.* 2016). Provan and Milward (2001) noted various ways to consider effectiveness, such as (1) "tracking the ebb and flow of organizations…networks obviously need to attract and maintain members", (2) "by the extent to which services that are actually needed by clients are provided by the network", and (3) "to assess the strength of the relationships between and among network members".

One specific evaluation tool that can be used in applied contexts is social network analysis (SNA; Cross *et al.* 2009; Kapucu and Demiroz 2011; Guerrero *et al.* 2013). Social network analysis provides an analytical lens that can be used to assess structural patterns between organizations and to examine the relationships among actors, how the actors are positioned within a network, and how the relationships are structured into overall network patterns (Wasserman and Faust 1994; Bodin and Prell 2011). Network analysis maps – such as the one shown in Figure 3 – characterize the organizations that share similar interests, the direct and indirect relationships among organizations, and the relationship between structures, collaborative processes, and resources embedded in the network (Mandarano 2009), thus providing an overall picture of the network and illustrating the linkages between local and regional conservation efforts. This approach has been applied to make conservation planning and prioritization more strategic (Guerrero *et al.* 2013; Mills *et al.* 2014).

In addition to network analysis, a broader assessment of effectiveness, efficiency, and equity is helpful (Provan and Milward 2001). With this in mind, Emerson and Nabatchi (2015) developed a 3 × 3 performance matrix to assess the productivity of collaborative governance regimes (for our purposes, we have adopted the term "network governance" rather than "collaborative governance regimes"). This framework distinguishes among three levels of performance (actions, outcomes, and adaptations) at three units of analysis (participant organizations, the network itself, and target goals; see WebTable 2 and Emerson and Nabatchi [2015]). The matrix suggests that networks produce actions (intermediate or end products) that have particular outcomes (both intermediate and end outcomes) that in turn may lead to adaptations (responses to those outcomes) or changes in the network itself, in the members of the network, and in the system context (in this case, ecological conditions) being targeted for change (see Emerson *et al.* [2012] and Emerson and Nabatchi [2015] for more detailed information about the nine performance dimensions).

Fully assessing the performance of networks includes evaluating each of these three levels. This chain of actions, outcomes, and adaptations – which Emerson and Nabatchi (2015) referred to as "productivity performance" – fits well with adaptive governance of social–ecological systems (eg Armitage *et al.* 2008; Walker and Salt 2012). Recognizing that large landscape governance networks develop and perform over time, assessing these nine dimensions can occur at various points in time and may be measured comprehensively or discretely, depending on the purpose of the evaluation.

The application of these tools in the context of network governance at the large landscape scale is illustrated in Figure 4. Moreover, by expanding the target goals in the matrix, we can further conceptualize the types of

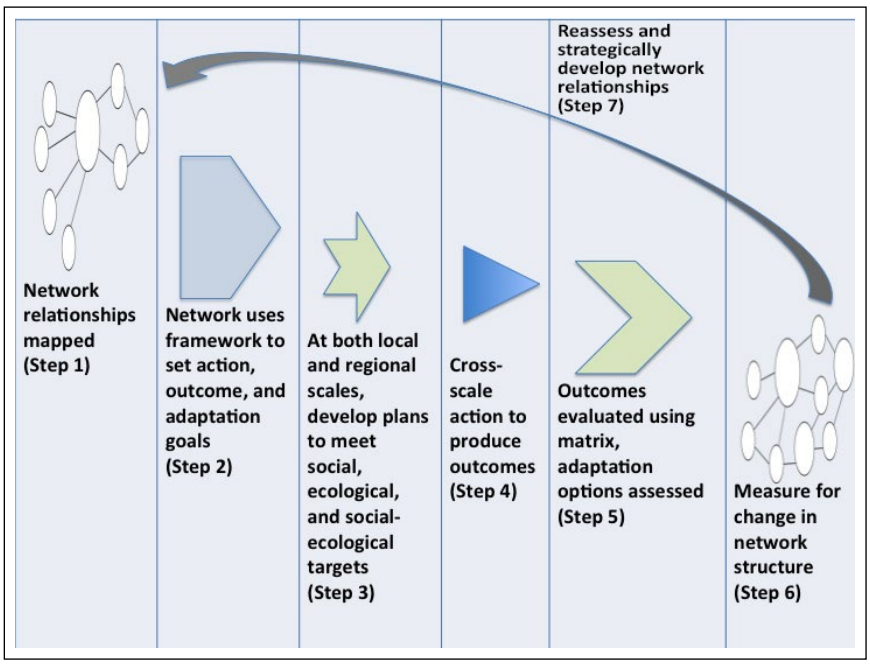

Figure 4. *General application of the social–ecological performance evaluation framework, which combines social network analysis and the performance matrix.*

questions to ask when setting and measuring social, ecological, and social–ecological goals of a large landscape conservation network (Table 1).

Application and results

In this section, we examine three examples from the Roundtable's AMI using the integrated approach presented in Figure 4.

Example 1: developing shared knowledge of baseline conditions

Actions

One current AMI project aims to link two mature Crown-wide partnerships that focus on climate adaptation – the Crown Managers Partnership (CMP) and the Crown of the Continent Conservation Initiative (CCCI) (nodes 6 and 7, respectively, in Figure 3) – with subregional forest restoration efforts.

Outcomes

The CMP has been developing a series of landscape-wide ecological indicators by producing models of large-area habitat and connectivity for selected wildlife species. These species, which include the grizzly bear (*Ursus arctos horribilis*), wolverine (*Gulo gulo*), and cutthroat and bull trout (*Oncorhynchus clarkii* and *Salvelinus confluentus*, respectively), are key gauges of terrestrial and aquatic integrity in the Crown region. With the establishment of baseline ecological indicators, landscape-level monitoring can be undertaken through different subregional forest restoration efforts. Over time, the process of collaboration has led to the integration of data that are meaningful to wildlife biologists and managers across the landscape.

Social network analysis indicates that the CMP – the organization involved in developing ecological indicators – plays a central and active role in the network. Knowing where relationships are strong and weak is informative when considering both the monitoring of indicators and the transfer of indicator data among actors. Using SNA at regular intervals can track changes and thus illustrate the evolution of the network's relationships over time, as well as identify areas that would benefit from additional connections. When combined with information from the performance matrix, SNA becomes an invaluable component of network evaluation practice (Provan and Lemaire 2012).

Adaptations

One challenge to this process has been the acquisition, integration, and synthesis of GIS data across the different jurisdictions in the Crown landscape. Federal and state agencies collect and code these data differently, and in many places data are sparse. By leveraging network resources (ie funding, coordination, and relationships), the CMP and Roundtable partners were able to collectively decide what data were available and what new data needed to be collected. Through a process of internal evaluation and communication with other AMI projects, the CMP adapted their original objectives to focus on metrics that were practical (given data constraints) and relevant to all AMI participants.

Example 2: managing invasive species

Actions

In 2014, invasive species management emerged as a central issue for the Roundtable network. It was

Table 1. Questions that can guide the development of ecological, social, and social–ecological goals

	Actions	*Outcomes*	*Adaptations*
Ecological	What conservation action is the network taking? What organizations are in the network? Are we monitoring? At what scale? What should we monitor? What do we not know? Are there questions we should ask of science? Do we need a gap analysis (ie where are things not happening on the landscape)?	What do we hope to achieve? How do we correlate these actions to outcomes?	Are we building resilience into the landscape? Ability for resources to resist? Respond? Adapt?
Social	Is shared learning happening? Are we reaching out to new groups? Building new relationships? Reducing conflict? Are network subgroups becoming more cohesive? Who is not at the table?	How do we build social capital? How do we build trust? How do we correlate action to outcomes?	Is the network resilient to fluctuations in funding and politics? Are member organizations resilient to fluctuations in funding and politics?
Social–ecological	Is there cross-pollination between projects/organizations that work on different resources? Are we identifying where social capacity overlaps with ecological need?	Are we achieving both social and ecological goals?	Are networks and/or organizations working through a systems framework to understand impacts and outcomes?

recognized that watershed managers in the Crown landscape were working only within their respective watersheds, but little coordination was occurring at the scale of the Crown landscape. The Roundtable and its partners began assembling an inventory of existing efforts to serve as a mechanism for individuals and organizations to share best practices, identify needs and gaps, and link local activity to the setting of landscape-scale planning priorities. Through the AMI, the Rocky Mountain Front Weed Roundtable, a local community-based conservation organization, enacted a weed management plan (ecological, social, and social–ecological actions; see WebTable 3), conducted outreach to neighboring communities, and engaged in monitoring, the results of which it shared with other actors.

Outcomes

In the second year of funding, the Rocky Mountain Front Weed Roundtable was able to expand its influence and partner with the Blackfeet Nation and coordinate noxious weed control activities across political and administrative boundaries. In addition to larger scale weed control, the Blackfeet Nation realized economic savings by sharing the burden and cost of biocontrol agents. Other outcomes included a landscape-scale mapping project of noxious weeds and engagement of additional communities throughout the Crown, which are being tracked and mapped using SNA.

Adaptations

The invasive species inventory provides information to people in the network so that they can interact in meaningful ways, based on localized needs and resources. Social network analysis has provided a useful tool for tracking the iterative and evolutionary changes in the network structure as the actions–outcomes–adaptations cycle continues. The AMI has tracked the changes in the program by mapping the participating organizations as the program has evolved over time. Importantly, the SNA reveals not only where connections are occurring but also where there are gaps. This evaluation led to the incorporation of the Blackfeet Nation as the project adapted.

Example 3: the Roundtable's AMI program

Actions

From a network-level perspective, the AMI is using both SNA and the performance matrix. The Roundtable has been tracking the impact of the AMI program by monitoring changes in the strength of relationships and network structure between participant organizations, via SNA and periodic progress reports that detail activities and outcomes at a project level. In addition to relationship information, AMI participants have been reporting the actions and outcomes over the past 2 years. The framework has guided the AMI leadership in setting goals for the program and has been useful for evaluating progress toward those goals.

Table 2. AMI network analysis findings

	*Pre-AMI**	*AMI Year 1*	*AMI Year 2*	*AMI Year 2, plus partners†*
Number of organizations	12	12	21	56
Number of connections	19	64	169	214
Average ties per organization	3.8	5.33	8.4	3.8
Density	–	0.53	0.401	0.069
Number of network subgroups	–	2	2	6

Notes: *Pre-AMI data were collected using interviews and network relationships were coded through qualitative analysis. AMI Year 1 and Year 2 data were collected using standardized survey protocol; statistics comparing Pre-AMI with Year 1 and Year 2 are therefore for descriptive purposes only. †Figure 3 represents Year 2 AMI organizations plus project partners.

Outcomes

Network analysis indicates that the number of relationships between organizations has increased from 19 (prior to the start of the AMI) to 64 (Year 1) to 169 (Year 2; Table 2). From this, we can conclude that the *action* of implementing the AMI has, at the very least, led to the *outcome* of increasing social connectivity between organizations working in the Crown (see also average connections per organization in Table 2).

Figure 5 illustrates how network-level performance provides feedback about the strengthening of connections between local conservation organizations. By tracking these changes through time (comparing only Year 1 and Year 2; pre-AMI data were amassed using a different data-collection tool), SNA can be used to aid in identifying and understanding the relationship between stakeholders, pinpointing hubs of social connectivity, and helping to ensure that multiple scales of action are linked or coordinated.

Adaptations

The AMI adapted the granting process for participant organizations in 2015 based on the application of this framework.

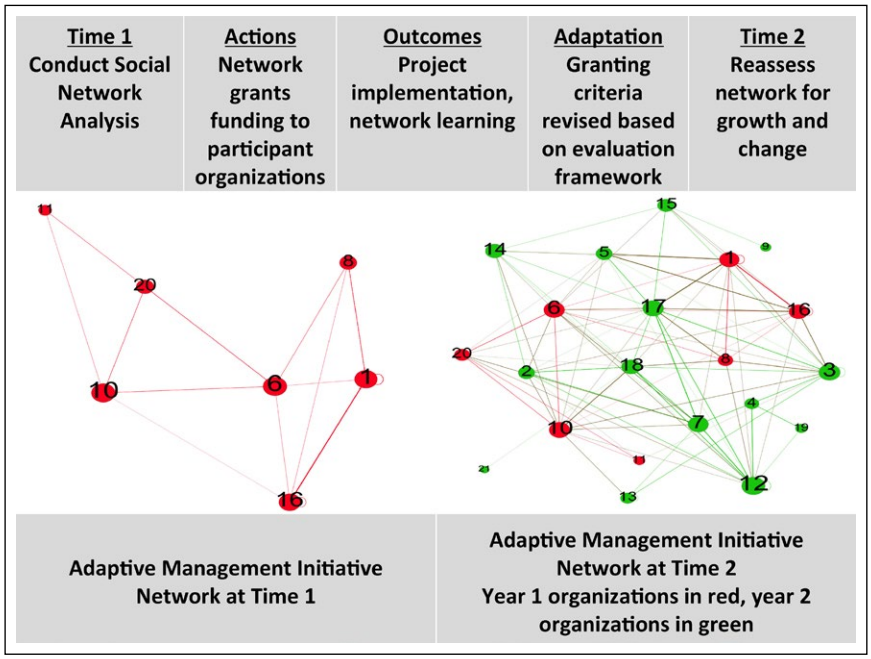

Figure 5. *The AMI network structure from Year 1 to Year 2, illustrating the actions–outcomes–adaptations chain.*

Conclusions

Traditional organizational performance evaluation, such as measuring tasks and activities or conservation outcomes, may be inadequate for determining the effectiveness of an entire network (Mandell and Keast 2007; McGuire and Agranoff 2011). This failure can be attributed not only to the complexity inherent in evaluating characteristics of social interaction, but also to the challenge of determining causal links between effective network governance and improved social–ecological outcomes.

We suggest that the development and application of a social–ecological performance evaluation framework that incorporates findings from SNA and that examines social and ecological dimensions at various scales and among diverse actors moves us closer to refining an approach for evaluating networks engaged in large landscape conservation. Application of this integrated performance framework to date suggests that it fulfills a central purpose of evaluation – providing feedback to the network so that members can identify what is working and what is not, and make adjustments as needed. As such, the framework represents an important tool that can help shape our understanding of the role and function of network governance in large landscape conservation, and provide new insight into the core question of how to rescale institutions to address large conservation challenges (Scarlett and McKinney 2016).

Acknowledgements

We thank A Barrett for reviewing and editing this manuscript.

References

Alexander SM, Andrachuk M, and Armitage D. 2016. Navigating governance networks for community-based conservation. *Front Ecol Environ* **14**: 155–64.

Armitage DR, Plummer R, Berkes F, *et al.* 2008. Adaptive co-management for social–ecological complexity. *Front Ecol Environ* **7**: 95–102.

Beever EA, Mattsson BJ, Germino MJ, *et al.* 2014. Successes and challenges from formation to implementation of eleven broad-extent conservation programs. *Conserv Biol* **28**: 302–14.

Bixler RP. 2014. From community forest management to polycentric governance: assessing evidence from the bottom-up. *Soc Natur Resour* **27**: 155–69.

Bodin Ö, Crona B, Thyresson M, *et al.* 2014. Conservation success as a function of good alignment of social and ecological structures and processes. *Conserv Biol* **28**: 1371–79.

Bodin Ö and Prell C (Eds). 2011. Social networks and natural resource management. Cambridge, UK: Cambridge University Press.

Cash DW, Adger WN, Berkes F, *et al.* 2006. Scale and cross-scale dynamics: governance and information in a multi-level world. *Ecol Soc* **11**: art8.

Chester CC. 2015. Yellowstone to Yukon: transborder conservation across a vast international landscape. *Environ Sci Policy* **49**: 75–84.

Conley A and Moote MA. 2003. Evaluating collaborative natural resource management. *Soc Natur Resour* **16**: 371–86.

Crooks KR and Sanjayan M (Eds). 2006. Connectivity conservation. Cambridge, UK: Cambridge University Press.

Cross JE, Dickman E, Newman-Goonchar R, and Fagan JM. 2009. Using mixed-method design and network analysis to measure development of interagency collaboration. *Am J Eval* **30**: 310–29.

Cumming GS, Cumming D, and Redman C. 2006. Scale mismatches in social–ecological systems: causes, consequences and solutions. *Ecol Soc* **11**: art14.

Cundill G and Fabricius C. 2009. Monitoring in adaptive co-management: toward a learning based approach. *J Environ Manage* **90**: 3205–11.

Curtin CG. 2014. Resilience design: toward a synthesis of cognition, learning, and collaboration for adaptive problem solving. *Ecol Soc* **19**: art15.

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

Emerson K, Nabatchi T, and Balogh S. 2012. An integrative framework for collaborative governance. *J Publ Adm Res Theor* **22**: 1–29.

Emerson K and Nabatchi T. 2015. Evaluating the productivity of collaborative governance regimes: a performance matrix. *Public Perform Manage Rev* **38**: 717–47.

Folke C, Hahn T, Olsson P, and Norberg J. 2005. Adaptive governance of social–ecological systems. *Annu Rev Env Resour* **30**: 441–73.

Goldstein BE and Butler WH. 2010. Combining multi-stakeholder collaboration and communities of practice in a learning network. *J Am Plann Assoc* **76**: 238–49.

Guerrero AM, McAllister RRJ, Corcoran J, and Wilson KA. 2013. Scale mismatches, conservation planning, and the value of social-network analyses. *Conserv Biol* **27**: 35–47.

Gunderson LH and Holling CS (Eds). 2002. Panarchy: understanding transformations in human and natural systems. Washington, DC: Island Press.

Heffernan JB, Soranno PA, Angilletta MJ Jr, *et al.* 2014. Macrosystems ecology: understanding ecological patterns and processes at continental scales. *Front Ecol Environ* **12**: 5–14.

Imperial MT, Johnston E, Pruett-Jones M, *et al.* 2016. Sustaining the useful life of network governance: life cycles and developmental challenges. *Front Ecol Environ* **14**: 135–44.

Jacobson C and Robertson A. 2012. Landscape conservation cooperatives: bridging entities to facilitate adaptive co-governance of social ecological systems. *Hum Dimens Wildl* **17**: 333–43.

Jedd T and Bixler RP. 2015. Accountability in networked governance: learning from a case of landscape-scale forest conservation. *Env Policy Governance* **25**: 172–87.

Kapos V, Balmford A, Aveling R, *et al.* 2008. Calibrating conservation: new tools for measuring success. *Conserv Lett* **1**: 155–64.

Kapucu N and Demiroz F. 2011. Measuring performance for collaborative public management using network analysis methods and tools. *Public Perform Manage Rev* **34**: 549.

Keast R, Mandell MP, Brown K, and Woolcock G. 2004. Network structures: working differently and changing expectations. *Public Admin Rev* **64**: 363–71.

Koontz TM and Thomas CW. 2006. What do we know and need to know about the environmental outcomes of collaborative management? *Public Admin Rev* **66**(S1): 111–21.

Koontz TM and Thomas CW. 2012. Measuring the performance of public–private partnerships: a systematic method for distinguishing outputs from outcomes. *Public Perform Manage Rev* **35**: 769–86.

Mandell M and Keast R. 2007. Evaluating network arrangements: toward revised performance measurements. *Public Perform Manage Rev* **30**: 574–97.

McGuire M and Agranoff R. 2011. The limitations of public management networks. *Public Admin* **89**: 265–84.

McKinney M and Field P. 2008. Evaluating community-based collaboration on federal lands and resources. *Soc Natur Resour* **21**: 419–29.

Mills M, Alvarez-Romero J, Vance-Borland K, *et al.* 2014. Linking regional planning and local action: towards using social network analysis in systematic conservation planning. *Biol Conserv* **169**: 6–13.

Nabatchi T. 2012. A manager's guide to evaluating citizen participation. Washington, DC: IBM Center for the Business of Government.

Pedynowski D. 2003. Prospects for ecosystem management in the Crown of the Continent ecosystem, Canada-United States: survey and recommendations. *Conserv Biol* **17**: 1261–69.

Prato T and Fagre D (Eds). 2007. Sustaining Rocky Mountain landscapes: science, policy, and management for the Crown of the Continent ecosystem. Washington, DC: Resources for the Future.

Provan KG and Kenis P. 2008. Modes of network governance: structure, management, and effectiveness. *J Publ Adm Res Theor* **18**: 229–52.

Provan KG and Lemaire RH. 2012. Core concepts and key ideas for understanding public sector organizational networks: using research to inform scholarship and practice. *Public Admin Rev* **72**: 638–48.

Provan KG and Milward HB. 2001. Do networks really work? A framework for evaluating public-sector organizational networks. *Public Admin Rev* **61**: 414–23.

Romolini M, Grove JM, and Locke DH. 2013. Assessing and comparing relationships between urban environmental stewardship networks and land cover in Baltimore and Seattle. *Landscape Urban Plan* **120**: 190–207.

Rouget MR, Cowling RM, Lombard AT, *et al.* 2006. Designing large-scale conservation corridors for pattern and process. *Conserv Biol* **20**: 549–61.

Scarlett L and McKinney M. 2016. Connecting people and places: the emerging role of network governance in large landscape conservation. *Front Ecol Environ* **14**: 116–25.

Soule M and Terborgh J. 1999. Conserving nature at regional and continental scales: a scientific program for North America. *BioScience* **49**: 809–17.

Stem C, Margoluis R, Salafsky N, and Brown M. 2005. Monitoring and evaluation in conservation: a review of trends and approaches. *Conserv Biol* **19**: 295–309.

Sternlieb F, Bixler RP, Huber-Sterns H, and Huaska C. 2013. A question of fit: reflections on boundaries, organizations, and social–ecological systems. *J Environ Manage* **130**: 117–25.

Trombulak SC and Baldwin RF (Eds). 2010. Landscape-scale conservation planning. New York, NY: Springer-Verlag.

Walker B, Gunderson L, Kinzig A, *et al.* 2006. A handful of heuristics and some propositions for understanding resilience in social–ecological systems. *Ecol Soc* **11**: art13.

Walker B and Salt D. 2012. Resilience practice. Washington, DC: Island Press.

Wasserman S and Faust K. 1994. Social network analysis: methods and applications. Cambridge, UK: Cambridge University Press.

Wyborn C and Bixler RP. 2013. Collaboration and nested environmental governance: scale dependency, scale framing, and cross-scale interactions in collaborative conservation. *J Environ Manage* **123**: 58–67.

Wyborn C. 2015. Cross-scale linkages in connectivity conservation: adaptive governance challenges in spatially distributed networks. *Env Policy Governance* **25**: 1–15.

Supporting Information

Additional, web-only material may be found in the online version of this article at http://onlinelibrary.wiley.com/doi/10.1002/fee.1250/suppinfo

