

# Understanding Effectiveness in its Broader Context: Assessing Case Study Methodologies for Evaluating Collaborative Conservation Governance

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## ABSTRACT

Collaborative forms of governance are increasingly favored in conservation and potentially offer a range of practical and outcome-based benefits. However, tools for critically assessing whether and how collaboration enhances the attainment of conservation objectives are lagging behind the enthusiasm. We use a framework that considers effectiveness in relation to capacity of key actors and institutions to achieve outcomes and respond to emergent problems, robustness over time (i.e. adapting to changes while still achieving objectives), context-specific drivers of change, and the structure of networks and institutions to assess common approaches for evaluating effectiveness. Network analysis performs well in terms of structure, while action research and the diagnostic method offer deep insights into capacity and context. Scenario planning performs well in understanding robustness and context but performs better when combined with a diagnostic. The evaluation reveals important insights for approaching and standardizing investigations of collaborative governance regimes and their effectiveness.

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**KEYWORDS** Adaptive governance; biodiversity conservation; collaborative governance; effectiveness; methodologies

## Introduction

Collaborative forms of governance are increasingly the norm in conservation. Collaboration is borne out of practical need, as ecological challenges cross jurisdictions, scales, tenures and sectors; and achieving objectives requires involving multiple stakeholders (Cumming, Cumming, and Redman 2006; Guerrero et al. 2013; Wyborn and Bixler 2013). The popularity of collaboration also aligns with broader changes in the public realm, where authority and responsibility are increasingly dispersed (Armitage and Plummer 2010). Top-down and command-and-control approaches are increasingly replaced with partnerships and preferential use of non-regulatory approaches often executed via collaborative partnerships (Gunningham 2009). Combined with government austerity, moves towards devolved responsibility and alternative funding models (Sullivan et al. 2013), these changes require, at the very least, increased coordination between actors to achieve objectives.

Collaboration is also thought to increase conservation effectiveness. Larger-scale partnerships and connectivity initiatives are proposed alternatives to piecemeal and species-based approaches to conservation (Bixler et al. 2016). In such initiatives, improving coordination is said to improve performance by responding to political opportunities, focusing effort on landscape-scale processes and higher order conservation objectives, achieving outcomes in a more cost-effective and efficient manner (Bode et al. 2011; Neeson et al. 2015). Collaborative governance may also increase resources, enhance social capital, augment capacity, expand institutional knowledge, facilitate conflict man-

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agement, enhance policy compliance and encourage experimentation (Emerson and Nabatchi 2015). In conservation, collaborative governance can increase effectiveness through improving socio-ecological fit (c.f. Folke et al. 2007; Armitage and Plummer 2010). Social-ecological fit enables management decisions to be geographically aligned with the spatial extent of relevant ecological processes, with the functional linkages of ecosystems, and to respond to the rate of environmental change (Cumming, Cumming, and Redman 2006). Thus, a high level of social-ecological fit can provide the flexibility, adaptive capacity, and conditions for learning required for effective conservation (Folke et al. 2007; Guerrero, McAllister, and Wilson 2015; Clement et al. 2017).

The enthusiasm and spread of collaborative initiatives have outpaced academic understanding of how, when, and in what specific ways collaborative governance can be effective in achieving social and ecological objectives. The relationship between the level of collaboration and effectiveness is not linear. Collaboration exists on a spectrum from basic coordination and information sharing to more extensive cooperation in the delivery of activities and planning and power sharing (Zbicz 2003). While theory suggests higher levels of collaboration are essential for conservation, the evidence for its merits are often centered more on process, e.g. improving the democratic aspects of governance (Lockwood et al. 2010) and qualities such as social capital, stakeholder empowerment, and trust (Imperial 2005; Huijtema et al. 2009; Lockwood et al. 2015). Collaborative processes can enhance learning (Bodin 2017; Suškevičs et al. 2018[AQ2]), thus it is also posited that collaboration can increase adaptive capacity through creation of new networks for sharing information, learning and experimentation, and flexible implementation pathways (Chaffin, Gosnell, and Cosens 2014). This relationship again is not linear, as adaptive capacity can be limited due to other institutional constraints, even where collaboration is robust (Clement, Moore, and Lockwood 2016; Gupta et al. 2016). Transaction costs and trade-offs between organizational and collective goals must also be considered (Agrawal and Goyal 2001; Bode et al. 2011), and collaboration can also introduce procedural challenges e.g. exacerbating conflicts, increasing complexity, and obscuring accountability (Sullivan et al. 2013; McAllister and Taylor 2015).

Studies of effectiveness have shown mixed results depending on the methods used and features of collaborative governance assessed. Understanding how collaboration actually improves environmental outcomes is particularly challenging (Bäckstrand et al. 2010). Although some case study research links improvements in environmental outcomes to specific aspects of collaborative governance, these are generally based on stakeholder perceptions of outcomes, which tend to be more optimistic than measured improvements (Koontz and Newig 2014; Plummer et al. 2017; Sayles and Baggio 2017). Environmental outcomes often take time to become evident, but some conclusions can be drawn from studies examining collaboration and social learning, with some evidence of increased uptake in behaviors that can improve environmental outcomes (Cvitanovic et al. 2015; Barnes et al. 2016; Matous and Todo 2018). QualitativeQuantitative methods offer some potential to assess collaborative governance across a large number of cases, enabling systematic analysis of outcomes independent of perceptions, but such methods do not consider the influence of a range of contextual and institutional attributes important for understanding robustness (Morrison 2017). Such studies are also generally focused on typologies of governance (c.f. Oldekop et al. 2016) or limited in the governance attributes they can evaluate (i.e. those that are easily quantified or mapped). For example, in evaluating the link between outcomes and collaborative governance in 357 watersheds, Scott (2015) found that having groups with responsibility for management activities (as opposed to just coordination and/or planning) correlated with better outcomes, but could not find a relationship with the other collaborative attributes tested (i.e. group formalization, increased goal specificity, or greater stakeholder diversity). Large *n* reviews are critical but have so far left questions about what features of collaborative governance matter.

Whether the methods are in-depth and qualitative or broad and quantitative, the many variables affecting environmental conditions make evidencing links between collaboration and outcomes methodologically complex. Consequently, effectiveness tends, in most cases, to be evaluated on policies (is it the right mix of policies); institutions (are the required institutions and resources in place); or compliance (are parties abiding by the established norms and rules) (Bäckstrand et al. 2010). Such a definition focuses on outputs – the mix of policies emerging from decision-making rather than outcomes – the ability of the policies to affect environmental change.

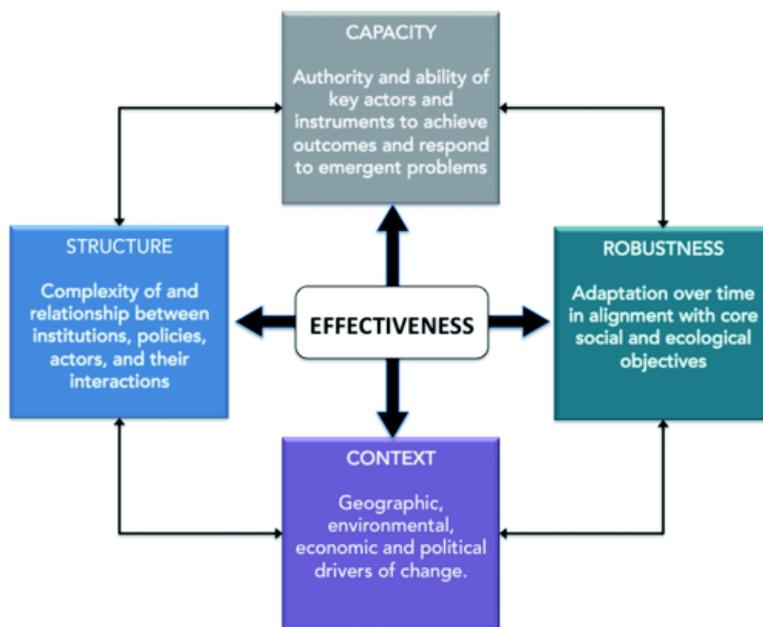
While this growing body of literature provides insights into the relationships between collaboration and various dimensions of effectiveness, it largely neglects methods for evaluating effectiveness. This paper evaluates four common methods for assessing the effectiveness of collaborative governance, using the analysis to provide insights on how methods can be combined and adapted to provide deeper insights.

## Evaluating Effectiveness

The various frameworks developed to organize evaluations of collaborative governance define and measure effectiveness differently. Most frameworks focus on outputs rather than outcomes of collaborative processes. For example, Marek et al (2015) [AQ3] developed a framework that assesses effectiveness primarily as a product of the function and structure of the collaboration itself. Emerson and Nabatchi (2015) consider “effectiveness” in terms of participant satisfaction and internal improvements attributable to the collaborative regime. Similarly, in the environmental governance literature, a number of frameworks integrate collaboration and effectiveness into a much broader evaluation of governance (c.f. Ostrom and Cox 2010).

Many frameworks omit context in evaluating effectiveness. This is problematic in complex social-ecological systems, where a range of causal factors affects interactions between institutions and ecosystems (Young, King, and Schroeder 2008). Methods using quasi-experimental design offer promising options to disentangle the effects of specific factors, such as collaboration, on effectiveness; however, within these nascent approaches, causal effects remain difficult to isolate (Macura, Secco, and Pullin 2015). Such methods are also expensive, challenging politically, and often unrealistic in a complex real-world context. Collaboration is largely studied in live case studies or retrospectively, so effectiveness cannot be tested in isolation from broader contextual and institutional factors. Consequently, we selected a framework that incorporates context to assess different methodologies (Figure 1).

Figure 1. Conceptual framework used to assess methods for evaluating conservation effectiveness (adapted from Morrison 2017).



We extend a framework developed by Morrison (2017) by drawing on sustainability and policy sciences literature. Developed to evaluate the robustness of polycentric regimes, this framework is useful for conservation in complex social-ecological systems because of its focus on robustness (i.e. the ability to adapt to changes over time), essential to achieving conservation objectives (Grantham et al. 2010). Moreover, a focus on structure provides insight into how processes and patterns of collaboration impact on actors’ abilities to address conservation problems (Bodin 2017). Structure is important because certain structural characteristics facilitate processes such as learning and coordination across governance levels. Morrison (2017) defines effectiveness as the authority and ability of key actors and instruments to respond to emergent problems, which we have relabeled “capacity”. Under this definition, the framework can capture administrative competence as well as both general and adaptive capacity, all of which are essential to achieving conservation objectives in complex social-ecological systems (Clement, Moore, and Lockwood 2016). Further modifications involve a holistic focus on how the sum total of all elements provides insight into the central focus on effectiveness. Ultimately, the framework aims to capture all substantive and procedural factors endogenous to the

governance system that impact on environmental outcomes (Morrison 2017). In doing so, it illustrates that effectiveness requires the capacity to address key drivers, a robust governance regime, and is also a function of network structure and influenced by various social and biophysical features in the SES context. Although “process” is not a separate element or a defining focus as in the work discussed above, it is embedded within the framework as one way in which factors such as capacity, robustness, and structural linkages can be built (or undermined).

This framework is also sufficiently broad to encompass all types of collaborative activities, from basic coordination to mature collaborative partnerships. This is important because the level of collaboration even within a single conservation initiative will vary depending on the activity. For example, invasive species management may rely largely on coordinating readily agreed upon activities, whereas climate change adaptation options are more varied and politically contested, requiring much broader stakeholder engagement. Further, the need for collaboration often varies over time depending on the stage of the process (e.g. setting of shared goals, trust formation stage), resourcing, and political priorities (McAllister and Taylor 2015; Morgans et al. 2017).

## Method

Here we translate the categories of the collaboration effectiveness framework (Morrison 2017) into queries (Table 1), which were used to assess the performance of different methods. The methods are only a subset of those used in collaborative governance research. We have chosen these because they are commonly applied in this field, within the case studies the methods were chosen based on a range of criteria, mainly to do with data and resource availability, the stage of the collaboration under investigation, the expertise of the teams undertaking the resource, and the research questions under investigation.

Table 1. Criteria used evaluate methodologies. Table Layout

Framework component	Criteria
Robustness	To what extent does the method provide an understanding of: <ul style="list-style-type: none"> <li>• Longitudinal change/adaptation</li> <li>• Longitudinal stability</li> <li>• How stability and change align with social and ecological objectives</li> </ul>
Context	To what extent does the method provide a way to interrogate and/or understanding: <ul style="list-style-type: none"> <li>• Geographic and environmental drivers of change</li> <li>• Economic drivers of change</li> <li>• Social and political drivers of change</li> </ul>
Structure	To what extent does the method provide an understanding of: <ul style="list-style-type: none"> <li>• Structural attributes that facilitate actors addressing different governance challenges (e.g. co-management of shared ecosystems, ecological connectivity)</li> <li>• Relationship between institutions, policies, and actors</li> </ul>
Capacity	To what extent does the method provide an understanding of: <ul style="list-style-type: none"> <li>• Authority of key actors to achieve regime goals</li> <li>• General and adaptive capacity of key actors to achieve outcomes and respond to emergent problems</li> <li>• Alignment/fit of institutions and policies with social and ecological objectives</li> </ul>

These queries were used to assess four methodological approaches for evaluating collaborative governance: action research, network analysis, institutional diagnostics, and an SES approach to scenario planning. These methods were

applied to five collaborative conservation governance case studies in Australia. A brief description of these methods is provided below and summarized in Table 2. While this paper focuses on the methods themselves, the referenced papers (column 4) provide more detail on methodological design and results. Not all methods were applied to each case study due to the resources and investment required which made this prohibitive.

Table 2. Summary of methodological approaches assessed. Table Layout

Methodological approach	Specific methods	Case Studies	Context	Example results
Social-ecological network analysis	<ul style="list-style-type: none"> <li>• Semi-structured interviews</li> <li>• Online survey</li> <li>• Social network analysis</li> <li>• Exponential random graph models</li> </ul>	Connectivity Conservation Initiative: Gondwana Link in Australia	A bottom-up collaborative initiative between government, non-profit organizations, and landholders to restore ecological connectivity across more than 1000 kilometers in a sparsely populated, remote area of southwestern Australia,	The collaborative <b>structure</b> [AQ20] in place enabled the co-management of shared ecosystems but was not conducive to effectively addressing challenges related to ecological connectivity. Results provided evidence for governance actors' <b>capacity</b> to respond and adapt to changing conditions, given the overrepresentation of certain network <b>structures</b> (those facilitating the coordination or responses within and between different scales of management). However, this capacity was limited due to the underrepresentation of other structures (i.e. those that facilitate detection ecological feedbacks).
Action research	<ul style="list-style-type: none"> <li>• Semi-structured in-depth interviews</li> <li>• Document analysis</li> <li>• Participant observation</li> </ul>	Connectivity Conservation Initiatives: Habitat 141° in Australia	A network of public, private and civil society actors seeking to align conservation actions dispersed across large spatial scales. Focused on connecting a 700-km stretch of diverse habitat across South Australia, Victoria, and New South Wales.	<b>Capacity</b> to adapt and respond to challenges was being built through a focus on process and shared rules, but it was fragile and lacked institutional structures to make it <b>robust</b> . Complex <b>structures</b> and a lack of coordinating mechanisms meant weak linkages across vertical and horizontal scales. <b>Contextual</b> and procedural issues influenced capacity and robustness, such as trust; competition; different modes of operating; conflicting mandates; lack of resources; and power disparity among actors all undermined effectiveness [authors refs [AQ7]].

Methodological approach	Specific methods	Case Studies	Context	Example results
Institutional Diagnosis	<ul style="list-style-type: none"> <li>• Semi-structured in-depth interviews</li> <li>• Focus groups</li> <li>• Document analysis</li> <li>• Institutional Grammar Tool (Ostrom 2005)</li> <li>• Secondary data analysis of social and ecological data</li> </ul>	Landscape-scale Conservation Governance: Tasmanian Midlands and Australian Alps	The Australian Alps is a 1.2 million hectare bioregion of unique mixed alpine and sub-alpine habitats, comprised of state government managed protected area. The Tasmanian Midlands is an agricultural region with highly valued grassland ecosystems managed entirely by private landholders, but supported by government agencies and non-profits.	In the Alps, informal collaborative <b>structures</b> were in place, and they were providing a critical forum for building <b>capacity</b> . However, such networks only had a weak influence in adaptation at a landscape scale, failing to overcome jurisdictional boundaries and effectively deal with <b>contextual</b> political and environmental drivers of change (e.g. fire, invasive species, changing governments). While some jurisdictions were <b>robust</b> , as a unit the collaborative networks and procedures were ineffective at larger scales and in periods of intense change. In the Midlands, there were strong collaborative networks and effective processes for engaging relevant groups and landholders at local levels, but the <b>structure</b> of the networks, particularly linkages across scales and across institutional regimes weakened effectiveness. <b>Capacity</b> was undermined by weak authority and ineffective procedures for dealing with key drivers of decline. Economic drivers (e.g. commodity markets) and political instability were among the <b>contextual</b> factors adding to the pressure of increasing agricultural intensity. While capacity and willingness to adapt was present, it could not be deployed because of these weaknesses, among others, affecting <b>robustness</b> (Wyborn 2015a; 2015b) [authors refs [AQ6]].

Methodological approach	Specific methods	Case Studies	Context	Example results
SES-based Scenario Planning	<ul style="list-style-type: none"> <li>• Resilience Assessment</li> <li>• SES modeling</li> <li>• Scenario planning workshops</li> <li>• Expert interviews</li> <li>• Secondary data analysis of social and ecological data</li> </ul>	Landscape-scale Conservation Governance: Tasmanian Midlands and Australian Alps	As above	As above

### **Social-Ecological Network Analysis**

A network approach focuses on the interactions between governance actors, and their interactions with the ecological system. The approach recognizes that social processes needed in collaborative governance (such as coordination and knowledge sharing) depend on particular types of actor interaction. For example, a network configuration where actors can interact with one another facilitates knowledge sharing, whereas a more centralized structure is favorable for coordination (Borgatti et al 2009[AQ4]), for example when activities need to be implemented across jurisdictions and thus coordination is needed at higher levels of governance (McAllister et al. 2015). It also recognizes that governance effectiveness is partly dictated by ecological complexity and how governance arrangements are structured to account for such complexity. Specifically, the approach places emphasis on patterns of social-ecological interactions that make it possible for governance actors to address key governance challenges related to institutional fit (i.e. shared management of ecological features, management of interconnected ecological resources, and cross-scale management; Guerrero, McAllister, and Wilson 2015).

This approach was applied to data on Gondwana Link, a large-scale conservation initiative, which aimed to restore ecological connectivity across more than 1000 kilometers in southwestern Australia. The research gathered information on the social network (collaborative interactions) and the ecological network pertinent to the collaborative conservation initiative (i.e. connectivity of parcels of vegetation based on species dispersal thresholds), and used it to determine how well the observed patterns of stakeholder interactions (i.e. who collaborates with whom) reflect the types of network structures that make it possible for actors to address the governance challenges associated with institutional fit. For example, parcels of vegetation that are connected ecologically require actors managing each parcel to collaborate. This can be represented by network structures that link governance actors to their managed ecological units as well as to other actors managing ecological units connected to their own).

### **Action Research**

In action research, researchers and stakeholders design and undertake cooperative, iterative cycles action, reflection, and research. The aim is to define the desired goal and undertake actions that will expand knowledge, enhance competencies and overcome challenges to realizing that goal (Rogers et al. 2013[AQ5]). Action research thus embeds implementation activities into the research process and encourages active reflection on them. For this research, action research involved a working group with a mandate to develop governance arrangements for a collaborative conservation initiative, Habitat 141°, the primary subject of the research. The research adopted a conceptual framework that examined the capacities that enabled the collaboration to move scientific knowledge into practical action (authors own Wyborn 2015b[AQ6]). This framework considered: (1) material capacities – human and financial resources and structures to sustain relationships between different actors; (2) cognitive capacities – the processes of generating knowledge and turning that into action; (3) social capacities – those which enabled the group to develop and sustain equitable governance; and (4) normative capacities – the underlying values that inspired actors to work towards a common goal.

## **Institutional Diagnosis**

A diagnostic asks a series of questions with increasing specificity to determine the sources of institutional problems related to an environmental issue in order to recommend appropriate solutions (Young, King, and Schroeder 2008). Here the approach was operationalized through a conceptual framework that frames salient characteristics of conservation as a policy problem, seeking to understand how institutional practices are aligned (or maligned) with these characteristics (Clement et al. 2016a). The framework specifically examines collaboration, and considers effectiveness in terms of competence and two types of capacity: (1) adaptive capacity, or the ability of institutions to withstand and respond to change (Armitage and Plummer 2010) and (2) general capacity, or the ability to identify and solve problems and deploy knowledge and skills (Virji, Padgham, and Seipt 2012). Effectiveness was considered alongside contextual factors (e.g. politics, players, problem framing) (Clement et al. 2016a). The diagnosis was used to identify areas where current processes, policies, and practices were failing and to develop reforms to address these deficiencies (Clement et al. 2015).

## **SES-based Scenario Planning**

Scenario planning is a method for anticipating a change that enables governance actors to collectively use creative visioning and unconstrained thinking in times of uncertainty (Chermack 2004). A two-stage approach to scenario planning was used to incorporate detailed information about governance influences into SES models for the case studies:

- A conceptual SES model that broadly corresponds to the early stages of a resilience assessment (Resilience Alliance 2010). The SES model was developed based on secondary data (e.g. biophysical monitoring, ecological and climate models), and expert interviews, then refined and simplified in a workshop of practitioners and experts. The model identified the most important social, economic, governance, and biophysical drivers of change and how they influenced the ecosystem of interest. The drivers with the greatest level of uncertainty concerning their future state were used to develop scenarios assuming governance remains as is. Predictions for the scenarios were based on ecological and climate modeling, as well as published data and expert predictions (Mitchell et al. 2015a; Mitchell et al. 2016a).
- Governance reforms were then tested to see if they could make a difference to social and ecological futures in a second workshop with experts and practitioners. The method asked participants to consider how changing governance practices, processes, and policies might affect the key drivers of change in the SES model (Mitchell et al. 2015b; Mitchell et al. 2016b).

## **Underlying Assumptions**

These approaches to evaluating effectiveness have different epistemological roots, and thus have differing assumptions about the nature of knowledge and the role of stakeholders in assessing effectiveness. The action research approach married ontological realism with epistemological constructionism. In doing so, this approach acknowledged the immutable and material aspects of reality existing (Midgley 2000), while appreciating that knowledge is mutable and contextual, produced through interactions within and between the biophysical and social realms (Crotty 2001). The result is an emphasis on how knowledge interacts with the social context and is continually framed and re-framed by actors. This translates into an approach where the voices of stakeholders and their perspectives on effectiveness are central to the research inquiry and integral to any assessments of effectiveness that are made. An emphasis on iterative, ongoing dialog provided a place in the research for the conversations with academics, practitioners, public servants and landholders central to shaping the research direction and the ways that the research assessed questions of effectiveness. This approach rejects notions of research as expert-led production of unequivocal statements about reality. Framing research as a dialog emphasizes the many voices shaping the process while emphasizing the continual evolution of research and practice (Flyvbjerg 2001).

The institutional diagnostic approach here adopted a very similar epistemology but was situated within pragmatism. As an epistemology, pragmatism also represents a middle ground between realism and anti-realism, emphasizing a limited realism where knowledge is gained through practical experience and adjusted through observation, experimentation, and conscious reflection on knowledge, habits, and beliefs (Haack 2004; Ansell 2011). The diagnosis was guided by the conceptual notion of 'fit' between ecosystems and institutions (Young, King, and Schroeder 2008),

which relies heavily on scientific data and the knowledge of experts. At the same time, the emphasis on pragmatism meant that there was a strong focus on how knowledge is filtered through administrative structures, with organizational routines, adjustments to those routines, and indeed even interpretations of what constitutes effectiveness being important to the evaluation. While this meant a strong role for experts in assessing effectiveness, pragmatism draws attention to collaborative problem solving that bridges the public-private divide and learning through experience on the ground (Brunner et al. 2005; Ansell 2011). From this perspective, the knowledge of those who engage in conservation – no matter their status as experts – are particularly valuable in complementing and contextualizing expert evaluations of effectiveness.

In contrast, both the SES scenario planning and the network analysis approaches emerge from positivist roots, reflected in their methodological emphasis on modeling, hypothesis testing, and prediction. These aspects of evaluating effectiveness heavily emphasized scientific data and relied primarily on the knowledge and predictions of experts. However, as applied here they were strongly informed by literature on environmental governance, which draws attention to how facts are interpreted in different contexts and through networks of actors and the deliberation of values. By drawing attention to the structure of interactions between actors and how social structures facilitate or constrain agency and are transformed through the interaction of actors, they are more aligned to critical realism (Archer 1995; Buch-Hansen 2014[AQ8]). Like positivism, critical realism accepts there is an objective reality to be studied, but emphasizes that access to reality is incomplete. It emphasizes the role of theories in helping researchers come closer to the truth and analyzing causal mechanisms of social phenomena, which are embedded in social structures and not separate from them (Fletcher 2017). For example, the importance of social structures and relations to the explanation of social phenomena is a key assumption of social network analysis (Wasserman and Faust 1994). By drawing on theories of collective action and social networks, the analysis considers how actors are embedded in multiple relations of interests and thus their decisions are made in the context of complex relations of dependence and power (e.g. kinship and networks; Ostrom 2010; Saunders 2014). Likewise, the scenario planning approach used here draws attention to the complex interaction between social processes and ecosystem dynamics, with interplay dynamics strongly influencing measured outcomes but amenable to change through human agency (Vatn and Vedeld 2012). The two approaches diverge in the way non-experts are incorporated. While this form of network analysis does not incorporate non-expert knowledge, in scenario planning the knowledge of non-experts engaged in conservation is particularly valuable for exploring how dynamics between actors influence effectiveness. As a collaborative planning methodology, the knowledge of both experts and non-experts is useful for exploring feasible ways to influence system dynamics and enhance effectiveness through governance reform.

## Results

None of the methodological approaches excelled in every element of the framework, but they all excelled in at least one (Table 3 and Supplemental material). In the first case study, a network approach provides rigorous data on the structure and a moderate amount of data on robustness and capacity but provides limited data on context. In contrast, the action research approach provided deep insights into context, capacity, and robustness over several years, but it was weaker in terms of understanding structure and maintaining those deep insights over time. The institutional diagnosis, which provided in-depth understanding about the context and capacity and a moderate amount of detail on robustness, but it only provided limited, qualitative insights into the structure. The scenario planning approach provided limited detail on structure but provided moderate detail on the other elements and a novel way of understanding how specific governance drivers and collaborative processes might affect outcomes.

Table 3. Summary of assessment\*. Table Layout

Frame-work component	Social-ecological network analysis	Action research	Institutional diagnostic	SES-based scenario planning
Robustness	As applied, the method does not incorporate longitudinal analysis, however the method is well equipped for these types of analyses, and thus investigation of robustness is possible.	As applied, action research does not have a strong focus on longitudinal analysis. Method is flexible enough to allow more in-depth investigation of robustness, although this would be limited by data availability and would likely rely in part on perceptions.	As applied, the diagnosis did not have a strong focus on longitudinal analysis. Method is flexible enough to allow more in-depth investigation of robustness, although this would be limited by data availability.	The approach includes both historical analysis of robustness and future analysis, with comparisons between current and reformed governance providing novel insights.
Context	The method can provide some understanding on each criterion when combined with other methods but was not a focus of the research design.	The action research method as applied here had a strong focus on understanding how governance does (and does not) fit with the context. This understanding is largely qualitative but deep, but can be triangulated with published data.	The diagnostic method has a strong focus on understanding how governance does (and does not) fit with the context. This understanding is largely qualitative but deep, but can be triangulated with published data.	The focus of this method is on understanding all of the key drivers and influences in the system and the relationships between them.
Structure	The focus of this method is on assessing the structure of the governance system. As applied, the method assessed network characteristics and the relationship between actors, and between actors and the ecological system.	The action research approach adopted here had a strong focus on understanding the how the governance structures enabled the collaborative to reach their goals, but measuring these was not a focus in these studies.	Diagnosis, as originally conceived and applied, has a strong focus on understanding the players involved and dynamics between them, but measuring these was not a focus in these studies.	The method on its own does not focus on the structure of networks or the relationship between actors, although the resilience assessment provides some insight into these and the SES model illustrates, in a limited way, relationships between key institutions and policies.
Capacity	This method provides some insight into capacity, particularly capacity to respond to emergent problems.	The action research method applied here had a strong focus on capacity as it related to solving environmental problems. Data collected for this component is largely qualitative but deep, but can be triangulated with published data.	The diagnostic method has a strong focus on capacity as it related to solving environmental problems. This focus was strengthened by the use of a framework designed with capacity in mind. Data collected for this component is largely qualitative but deep, but can be triangulated with published data.	The method provides some data on each criterion, but the understanding is not deep.

\*More detail on this assessment, which is based on expert evaluation of the methods as applied in particular case studies, is provided in the supplementary material.

## Network Analysis

The network approach has a strong focus on structure, thus the method performed well in this element of the effectiveness framework, as well as in some capacity aspects i.e. those related to network structure. Most available examples of social-ecological network approaches analyze data at a single point in time and thus provide limited information about robustness, as was the case with Gondwana Link, although the method itself does not preclude longitudinal research (see Section 4). In the case of Gondwana Link, the method was combined with qualitative interview data to understand how contextual factors affected the effectiveness of the collaborative governance initiative (see Appendix 1 in Guerrero et al 2015 authors under review 2015 [AQ6]), as well as to assess the effects of the collaboration on the performance of on-ground conservation activities. This provided a way to link governance assessment to outcomes (based on stakeholder knowledge).

## Action Research

Action research can be applied to any context, using a diversity of methods and foci. Here, the approach was applied using a combination of qualitative methods (interviews, participant observation, and document analysis) with a conceptual framework that had an explicit focus on capacity. Moreover, action research is inherently connected to the context of action, thus the approach performed well in these two areas of the effectiveness framework. With respect to robustness, action research is firmly situated within a particular time and context. Action research can only provide a snapshot in time, relying on the recall of study participants – accessed through interviews, and document analysis – to gain insight into longitudinal change and stability. The study focused on the capacity of a governance structure to facilitate alignment between actors, and thus in this case, the approach performed well in this element of the effectiveness framework. Structural properties were not measured quantitatively, however, qualitative data provided rich insights into network characteristics and relationships between institutions, policies, and actors.

As applied in this context, the approach relied heavily on qualitative data and participant observation. In this case, being embedded within a working group provided rich insights into the challenges faced by the group through first-hand experience (Wickson, Carew, and Russell 2006). This enabled the researcher to analyze effectiveness from a very practical and pragmatic standpoint.

Depending on the methods and foci, action research can easily incorporate data on outcomes. In the case of Habitat 141°, the desired outcome was the capacity of the working group to develop governance arrangements that would enable diverse conservation actors to align efforts across a landscape. The group functioned on the assumption that such alignment would lead to more effective conservation outcomes, however, this assumption was not being empirically tested by the group, nor was it a focus of this research. This is a critical weakness of the action research approach adopted here, as it did not test the efficacy of the assumption that would have provided insight into the relationship between collaboration and conservation outcomes.

## Institutional Diagnosis

Using a combination of qualitative methods (interviews, document and secondary data analysis), data collection was structured by a conceptual framework that had a strong focus on context and capacity, thus the method performed well in this element of the effectiveness framework. This level of performance, however, is highly dependent on the conceptual framework and/or questions asked, which will vary across a diagnosis. As applied, this method provided a moderate detail on robustness, although this could be explored in more depth using a different diagnostic framework. The weakest area of this method is in its utility for understanding structure. The focus of a diagnosis is generally not on understanding network structure but instead on identifying areas where policies and actions are a poor fit, given the characteristics of the context and environmental problem.

It is notable that all effectiveness criteria are highly reliant on perceptions of individuals participating in the governance regime and tends to focus on a particular snapshot in time. For both case studies, prominent aspects of the current political climate were likely weighted more heavily as negatively impacting effectiveness. In the Tasmanian Midlands, there was a strong focus on one specific area of the collaborative governance regime, i.e. the development of an irrigation scheme and associated political challenges of collaborating with public and private actors and across governance levels, with the development of an effective regime for mitigating the effects on biodiversity secondary to this. In the Australian Alps despite a long history of effective collaboration and one of the longest-running cooperative management programs in Australia, government policies and political challenges likely colored participant perceptions and influenced assessment of effectiveness.

While the diagnosis can readily incorporate data on outcomes, the characteristics of the regime that participants felt were problematic or preventing actors from achieving conservation objectives can only be correlated with the socio-economic and environmental outcomes published in secondary data. Where approaches varied across jurisdictions, as was the case in the Australian Alps, this actually provided a quasi-experimental condition, but the data showed the key differences were more a result of different policies rather than variation in collaborative processes.

## Scenario Planning

The SES-based scenario planning methodology was applied to the same case studies as the institutional diagnosis. As part of this approach, the resilience assessment and governance modeling provided limited insights into network structure or relationships between actors, although developing the model provided some understanding of institutional relationships. The approach excels in understanding context, given the focus on understanding system dynamics. The review of historical data combined with future scenarios provided a novel way to understand robustness, and testing reforms as compared to current governance provided insights into the specific collaborative governance variables that are likely to make the biggest difference to socio-economic and ecological outcomes.

## Discussion

None of the methods excelled across all framework elements. There are, however, ways in which the methods could be combined to create a rigorous research design for evaluating the effectiveness of collaborative governance. For example, combining the scenario planning method with the institutional diagnosis method (Clement et al 2015; Mitchell et al. 2016b (authors-2015 and-2016[AQ6])), can provide a much richer understanding of capacity and institutional context, although this approach required a wide range of expertise and is time and labor intensive. The network analysis approach can be combined with other methods to provide insights into the structure. While the three other methods were able to capture some qualitative data on network structure, this was not always explicitly linked to governance effectiveness. Given that action research is agnostic about methods, it could easily be combined with any of the methods outlined here to be applied in a context where the research insights are actively linked to change processes in the sites of study, thus providing a direct avenue for research insights to be connected to improvements in outcomes.

It is also worth differentiating between the limitations of each method in general and those emerging from the specific research design of each study. For example, despite the strength of the network approach in assessing structure, the approach used here did not cover all elements of structure and can be expanded to also focus on the relationships between key institutions and policies (Ekstrom and Young 2009). The assessment of the longitudinal dimensions of robustness was limited in three of the methods, but this was primarily due to challenges with resourcing and study design (e.g. the cost and time involved to gather longitudinal data), rather than a limitation of the method itself. The network analysis method has the capability for longitudinal analysis and some examples exist (e.g. Ingold and Fischer 2014). In addition, the approach can include network configurations that act as “preconditions” for adaptation and transformation – two key characteristics of robust governance systems (see Table 2 and Barnes et al. 2016). Longitudinal analysis is also possible with diagnostic and action research methods, although this requires several labor-intensive periods of a research. While the SES-based scenario approach was stronger, this strength comes with the caveat that how predictions are made can vary widely. Here they were based on ecological and climate models, as well as expert judgments about the future state of model variables, so while they are subject to uncertainties in models and expert prediction biases, the use of multiple sources provided a stronger evidence base than one source alone.

The vexed issue of evaluating outcomes still remains with each method. The collaboration effectiveness framework used here draws attention to the achievement of stated objectives (or, originally “core regime goals”, Morrison 2017). This focus on outcomes rather than objectives is an important distinction, as it is a matter of practicality that much governance literature assumes that achieving stated objectives will ultimately lead to desired social and ecological outcomes. It is also worth noting that all methods relied at least to some extent on perceptions of achievement and how these relate to outcomes because of the long timescales over which such outcomes may emerge. Perceived improvements tend to be more optimistic than measured improvements; however, they can be useful in comparative research if it is assumed that the margin of error is similar across cases (Koontz and Newig 2014; Sayles and Baggio 2017; Plummer et al. 2017). The methods evaluated here, particularly the SES scenario planning and network approach, could be adapted to rely less on expert judgments in evaluating attainment of objectives. The use of expert

judgments should not be eliminated entirely, however, as they are central to the cultural-cognitive dimensions of institutions, underpinning both perceptions and behavior of actors and thus influencing outcomes (Cleaver 2012, DeCaro et al. 2017). The diagnostic and action research approaches could rely more on published data and modeling; however, such efforts should not undermine the importance of understanding actors' perceptions of decision-making and action in relation to examining the relationship between collaboration and effectiveness.

Both strengths and weaknesses can be addressed through improved research design, and lessons here are key for researchers. The conceptual frameworks used strongly drive the results in the action research and diagnostic approaches. Here their performance can be partly attributed to the conceptual frameworks, given their focus on context and capacity, rather than an inherent feature of the method itself, so researchers interested in evaluating effectiveness may use frameworks such as the one used here to ensure they are covering all relevant areas. On the other hand, for the network and scenario-based approaches as applied here, concepts from the SES literature were integrated with specific features from the adaptive governance literature known to impact robustness and capacity, but the focus was necessarily limited to governance attributes that could be represented within models. While the diagnostic and action research approaches more readily lend themselves to studying contexts in more detail because they are not constrained by models, it is still possible to address these weaknesses with additional qualitative and secondary data, where available, to adjust the models and analyze results. Integration of other modeling methods, such as agent-based modeling can also enhance SES understanding and produce more dynamic models that could more accurately link governance attributes to behavior, especially for the network approach and scenario planning (Forrester et al. 2014). The purpose of the evaluation will also influence which definition of effectiveness is used and research design. For example, teasing out the relationships between collaborative processes and conservation outcomes might be the main goal scientifically. In the nearer term, strongly process-oriented metrics discussed earlier (c.f. Emerson and Nabatchi 2015) can be used for government and funder accountability purposes. Such metrics might not directly relate to outcomes, but process improvements within collaborative regimes is a reflective form of learning, which may improve performance if it is used to change practice (Lockwood et al. 2010).

The methods evaluated here are commonly applied individually in case studies on collaborative governance but are stronger when combined. Attending to research design issues at this level will improve the rigor of larger systematic reviews of collaborative governance and effectiveness. While teasing out causal relationships between collaborative processes and outcomes will remain a challenge, these methods can draw on additional data and methods to provide some insights into relationships between governance and outcomes. The SES-based scenario planning methods used here are one way to approach this, and the two-staged approach in the research design allows exploration of how implementing specific collaborative governance features might increase effectiveness in terms of achieving social and ecological outcomes. While the SES approach is based on modeling, intentional experimentation and quasi-experimental designs could enable real-time testing of interventions and specific collaborative processes. As noted in the diagnostic method results, quasi-experimental data was available for one of the case studies, although variation appeared to be due to different policies rather than different governance processes. While the use of such data is not an inherent feature of the diagnostic method (but rather a result of the socio-political context of the area under investigation), it demonstrates the power of using mixed methodologies for teasing out complex phenomenon.

There are other options for quasi-experimental design. Most promising is a comparison of cases across countries where institutional arrangements create a natural variation that mimics experimental conditions. Extraneous variables are, however, rarely controlled enough to overcome issues of attribution and studies generally focus on specific policy interventions rather than collaborative processes (Huitema et al. 2009), even in climate change governance where more systematic reviews and global experimental designs are emerging (Jordan et al. 2015). Combining systematic reviews and quasi-experimental designs with a selection of deeper case studies using the methodological approaches may be a useful way forward for effectiveness research, at least until our understanding of which aspects of capacity, robustness, context, and structure is more advanced.

The collaboration effectiveness framework used here could also be further refined to better understand and evaluate effectiveness and tailored depending on the metrics of interest. First, while the framework largely focused on capturing social data, our modifications capture both social and ecological objectives, yet we only briefly touched on outcomes. Which "outcomes" matter will indeed vary across different case studies, and thus which are measured, could vary widely. Even when outcomes are measured and incorporated into effectiveness evaluations, significant variation will persist given that collaborative process outcomes are influenced by context, independent of the governance research methods used. Second, the relationship between each component is still not understood. For example,

if robustness is high and capacity goes down, it is not clear what this means in terms of overall effectiveness. Here, additional empirical research could help; with a focus on methods provide better insights on relationships between the variables, as has been done for the IAD and SES Frameworks (c.f. Ostrom 2005; Ostrom and Cox 2010[AQ9]). Third, further refinements of the framework could focus on exactly what aspects of structure, robustness, and context matter most. We have added several nuances to structure (Table 1), and the conceptual frameworks (Wyborn 2015b; Clement et al. 2016a) ~~authors under review 2015 and 2016~~ [AQ6] used alongside each method provided detailed guidance on what elements of capacity were most salient. However, focused research into exactly what variables in each of these categories are most relevant for collaborative governance would provide for more rigorous evaluations of effectiveness. Given the significance of process and the wealth of metrics for its evaluation, it may be worthwhile to consider this as a separate category of the framework. There is an added benefit here that this would allow inclusion of a much wider range of existing case studies in a much-needed review of collaborative effectiveness. Although the procedure is not everything, it is a widely studied factor and one that may benefit from additional attention.

## Conclusion

Social-ecological network analysis, diagnostic approaches, action research, and SES-based scenario planning all have value in understanding collaborative effectiveness. Researchers must decide whether they are able to investigate each aspect of the framework used here in depth (i.e. robustness, structure, context, capacity), or whether resources, time, and data availability are sufficient to allow a thorough investigation of each. Even with this level of forethought, mixed methodologies are required, and there will inevitably be trade-offs between depth and breadth. Gathering longitudinal data is possible with almost any method but remains challenging for practical reasons; and rather than being based on entirely original empirical data, it is often necessarily based on historical data of varying quality and predictions based on modeling and expert judgment, which also introduces a degree of uncertainty. None of the methods as applied here dealt adequately with the issues of cause-and-effect relationships between governance and outcomes, but collating case study data, systematic reviews, and quasi-experimental designs are likely to hold the most promise here. Finally, although the approaches used here (and especially the scenario planning method) posit how outcomes might change if governance attributes are changed to improve fit, the veracity of these assumptions and predictions can only be tested after reforms are actually implemented, which should be considered in future research designs.

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**Response:** There is no volume or page number. It is online, ahead-of-print.

**Query:** AQ18: Please provide the missing website details for the "Resilience Alliance 2010" references list entry.

**Response:** URL: <https://www.resalliance.org/resilience-assessment>

**Query:** AQ19: The reference "Wyborn 2015" is listed in the references list but is not cited in the text. Please either cite the reference or remove it from the references list.

**Response:** Resolved

**Query:** AQ20: Please provide the significance of bold words in Table 2.

**Response:** Bolded words refer to components of the framework (Figure 1). The above statement could be added as a footnote to the table,

**Query:** AQ21: The ORCID details of the authors have been validated against ORCID registry. please check the ORCID ID details of the authors.

**Response:** Resolved

## COMMENTS

**C1** Author: Insert reference: Marek, Lydia I., Donna-Jean P. Brock, and Jyoti Savla. 2015. Evaluating collaboration for effectiveness: Conceptualization and measurement. *American Journal of Evaluation* 36(1): 67-85. doi: 10.1177/1098214014531068; :

**C2** Author: The reference is now in text, but it should be 2016. I have listed it as 2016a in the text, but can't change it here.; :

**C3** Author: This should now be 2016b; :

**C4** Author: Please insert this reference: Guerrero, A. M., & Oumlj. Bodin, R. R. J. McAllister, and K. A. Wilson. 2015. Achieving social-ecological fit through bottom-up collaborative governance: an empirical investigation. *Ecology and Society* 20(4):41. <http://dx.doi.org/10.5751/ES-08035-200441>; :

**C5** Author: This reference should become 2015a, and this reference should be added: Wyborn, C. A. 2015b. Connecting knowledge with action through coproductive capacities: adaptive governance and connectivity conservation. *Ecology and Society* 20(1): 11. <http://dx.doi.org/10.5751/ES-06510-200111>; :

**C6** Author: Insert reference above: Rogers, K. H., R. Luton, H. Biggs, R. Biggs, S. Blignaut, A. G. Choles, C. G. Palmer, and P. Tangwe. 2013. Fostering complexity thinking in action research for change in social–ecological systems. *Ecology and Society* 18(2): 31. <http://dx.doi.org/10.5751/ES-05330-180231>; :

**C7** Author: Insert the following authors own references: Mitchell, M., Lockwood, M., Moore, S. A., & Clement, S. 2015a. Incorporating governance influences into social-ecological system models: a case study involving biodiversity conservation. *Journal of Environmental Planning and Management*, 58(11), 1903-1922. doi: 10.1080/09640568.2014.967387 Mitchell, M., Lockwood, M., Moore, S. A., & Clement, S. 2015b. Scenario analysis for biodiversity conservation: A social–ecological system approach in the Australian Alps. *Journal of environmental management*, 150, 69-80. doi: 10.1016/j.jenvman.2014.11.013 Mitchell, M., Lockwood, M., Moore, S.A. and Clement, S., 2016a. Building systems-based scenario narratives for novel biodiversity futures in an agricultural landscape. *Landscape and Urban Planning*, 145, pp.45-56. doi: 10.1016/j.landurbplan.2015.09.003 Mitchell, M., Lockwood, M., Moore, S. A., Clement, S., Gilfedder, L., & Anderson, G. 2016b. Using scenario planning to assess gov-

ernance reforms for enhancing biodiversity outcomes. *Land Use Policy*, 50, 559-572. doi: 10.1016/j.landuse-pol.2015.10.020; :

**C8** Author: Insert the following authors own reference: Clement, S., Moore, S. A., Lockwood, M., & Mitchell, M. 2015. Using insights from pragmatism to develop reforms that strengthen institutional competence for conserving biodiversity. *Policy Sciences*, 48(4), 463-489. doi: 10.1007/s11077-015-9222-0; :

**C9** Author: This article has no doi. Here is the stable url: [www.jstor.org/stable/26267849](http://www.jstor.org/stable/26267849); :

**C10** Author: This article seems to have no DOI. Here is the stable URL: <https://www.jstor.org/stable/26268026>; :

**C11** Author: doi: 10.5751/ES-07203-200137; :

**C12** Author: Insert the following reference: Borgatti, S. P., Mehra, A., Brass, D. J., & Labianca, G. 2009. Network analysis in the social sciences. *Science* 323(5916): 892-895. doi: 10.1126/science.1165821; :

## **Supplementary Material**

Here we provide more detail on the selection of the case studies and methods and how the evaluation was completed.

### Selection of the case studies

The five case studies selected were selected because they are five key large-scale conservation initiatives in Australia. Australia is a mega-diverse country with a high degree of endemism under threat, and there has been a concerted effort to shift to landscape-scale and connectivity initiatives, with requisite shifts to collaborative forms of governance to deal with the on-ground realities of land management and the country's cooperative federalist system (Clement et al. 2015). The five case studies represent some of the most advanced landscape-scale initiatives in the countries and cover a wide spectrum of collaborative conservation initiatives in terms of land tenure, mixture of habitats, and the range of actors involved.

### Selection of methods

The selection of methods for each case study was based on a range of practical and theoretical considerations. In the case of the network analysis, this method aligned well to the research on structured decision-making being undertaken in the region, which also provided the necessary data to populate the models alongside the mixed methods undertaken in the Gondwana Link case study (Guerrero, McAllister, and Wilson 2015; Guerrero et al. 2015). The use of action research aligned well with the stage of development for the Habitat 141 study, as the collaboration was in its early stages of complementing its many on-ground projects and programmes with procedural rules and structures for collaboration. This offered an opportunity to study the collaboration in depth, in real time (Wyborn 2015a; 2015b). For the Australian Alps and Tasmanian Midlands, the selection of institutional diagnostics (Clement, Moore, and Lockwood 2016; Clement et al. 2017) and SES scenario planning (Mitchell et al. 2015a; 2015b; 2016a; 2016b) fit well within the interdisciplinary research hub, where teams were analysing existing monitoring data and undertaking ecological, economic, and climate modelling. Alongside the governance research, the diagnosis allowed for an in-depth exploration of fit, a key feature of this approach, and provided a rich source of data to ensure the SES model was accurate and future predictions within the range of possibilities predicted by the biophysical and economic data.

### Evaluating the Methods

The queries provided in Table 1 (main text) provided a guide for the researchers to revisit their data and reflect on the data they collected with respect to each query. These were coded as described in the following tables (S1-S4), and coloured based on this qualitative evaluation, with green suggesting all queries were fulfilled, yellow indicating that some were not or only partially, and orange indicating that most were not or were only partially. This evaluation is based only on the method as applied, as discussed in the main text.

Table S1. Assessment of social-ecological network analysis

Framework component	How the method addressed each criterion	Performance
Robustness	<p><b>R1</b> Longitudinal change/adaptation: not addressed</p> <p><b>R2</b> Longitudinal stability: not addressed</p> <p><b>R3</b> How stability and change align with core regime goals: not addressed.</p>	<p>As applied, the method does not incorporate longitudinal analysis, however the method is well equipped for these types of analyses, and thus investigation of robustness is possible.</p>
Context	<p><b>Co1</b> Geographic and environmental drivers of change: secondary analysis documents, and expert involvement in interviews provided some insights into contextual factors affecting effectiveness.</p> <p><b>Co2</b> Economic drivers of change: same as Co1</p> <p><b>Co3</b> Social and political drivers of change: same as Co1.</p>	<p>The method can provide some understanding on each criterion when combined with other methods.</p>
Structure	<p><b>S1</b> Network characteristics: interviews and online surveys were used to measure a variety of network measures to assess whether the collaborative governance approach was structurally equipped to address key governance challenges (i.e. shared management of ecological resources, management of interconnected ecological resources, and cross-scale management).</p> <p><b>S2</b> Relationship between institutions, policies, and actors: same as Co1.</p>	<p>The focus of this method is on assessing the structure of the governance system. As applied, the method assessed network characteristics and the relationship between actors, and between actors and the ecological system.</p>
Capacity	<p><b>Ca1</b> Authority of key actors: expert involvement in interviews provided some insights into issues of participation and power, but this was not an explicit focus.</p> <p><b>Ca2</b> General and adaptive capacity of key actors: same as Ca1.</p> <p><b>Ca3</b> Alignment/fit: Not addressed.</p>	<p>This method can provide insight into capacity, particularly participation and power, but this was not a focus of the research design.</p>

Table S2. Assessment of action research approach

Framework component	How the method addressed each criterion	Performance
Robustness	<p><b>R1</b> Longitudinal change/adaptation: interviews with participants in the collaboration region; document-based review to understand emergence of initiative in the context past regional conservation efforts.</p> <p><b>R2</b> Longitudinal stability: interviews with participants in the collaboration and document-based to understand the degree to which approaches and goals have remained consistent.</p> <p><b>R3</b> How stability and change align with core regime goals: interviews with participants in the collaboration to understand whether objectives have been met</p>	As applied, action research does not have a strong focus on longitudinal analysis. Method is flexible enough to allow more in-depth investigation of robustness, although this would be limited by data availability and would likely rely in part on perceptions.
Context	<p><b>Co1</b> Geographic and environmental drivers of change: documents, and interviews provided extensive insights into the key drivers of concern.</p> <p><b>Co2</b> Economic drivers of change: interviews provided some insights into the key drivers of concern although this was not a focus of the inquiry.</p> <p><b>Co3</b> Social and political drivers of change: interviews provided extensive insights into the key drivers of concern.</p>	The action research method as applied here had a strong focus on understanding how governance does (and does not) fit with the context. This understanding is largely qualitative but deep but can be triangulated with published data.
Structure	<p><b>S1</b> Network characteristics: qualitative description based on documents and interviews, but these characteristics were not measured or explicitly mapped.</p> <p><b>S2</b> Relationship between institutions, policies, and actors: documents, interviews and participant observation, especially data collected relating to governance options and structures provided a qualitative understanding of these relationships and where relationships were not fit-for-purpose.</p>	The action research approach adopted here had a strong focus on understanding the how the governance structures enabled the collaborative to reach their goals but measuring these was not a focus in these studies.
Capacity	<p><b>Ca1</b> Authority of key actors: interviews and participant observation drew attention to a range of issues relating to authority and power.</p> <p><b>Ca2</b> General and adaptive capacity of key actors: interviews and participant observation provided insights into whether actors are achieving regime goals and respond to emergent problems.</p> <p><b>Ca3</b> Alignment/fit: interviews and document analysis provided strong insight into the ability of the governance arrangements to facilitate alignment between actors.</p>	The action research method applied here had a strong focus on capacity as it related to solving environmental problems. Data collected for this component is largely qualitative but deep but can be triangulated with published data.

Table S3. Assessment of institutional diagnostic approach

Framework component	How the method addressed each criterion	Performance
Robustness	<p><b>R1</b> Longitudinal change/adaptation: document-based review of historical policies and interviews with long-term actors to understand how approaches and goals have changed.</p> <p><b>R2</b> Longitudinal stability: document-based review of historical policies and interviews with long-term actors to</p>	As applied, the diagnosis did not have a strong focus on longitudinal analysis. Method is flexible enough to allow more in-depth investigation of

Framework component	How the method addressed each criterion	Performance
	<p>understand which approaches and goals have remained consistent.</p> <p><b>R3</b> How stability and change align with core regime goals: review of secondary data and interviews with experts to understand whether objectives have been met</p>	robustness, although this would be limited by data availability.
Context	<p><b>Co1</b> Geographic and environmental drivers of change: secondary analysis of data, documents, and interviews provided extensive insights into the key drivers of concern.</p> <p><b>Co2</b> Economic drivers of change: secondary analysis of data, documents, and interviews provided extensive insights into the key drivers of concern.</p> <p><b>Co3</b> Social and political drivers of change: secondary analysis of data, documents, and interviews provided extensive insights into the key drivers of concern.</p>	The diagnostic method has a strong focus on understanding how governance does (and does not) fit with the context. This understanding is largely qualitative but deep but can be triangulated with published data.
Structure	<p><b>S1</b> Network characteristics: qualitative description based on documents and interviews, but these characteristics were not measured or explicitly mapped.</p> <p><b>S2</b> Relationship between institutions, policies, and actors: documents and interviews, especially data collected relating to interplay, provided a qualitative understanding of these relationships and where relationships were not fit-for-purpose.</p>	Diagnosis, as originally conceived and applied, has a strong focus on understanding the players involved and dynamics between them, but measuring these was not a focus in these studies.
Capacity	<p><b>Ca1</b> Authority of key actors: document analysis and especially the Institutional Grammar Tool, along with interviews drew attention to a range of issues relating to authority and power.</p> <p><b>Ca2</b> General and adaptive capacity of key actors: all methods were tailored to have a strong focus on understanding these elements, with interviews and secondary data analysis especially providing insights into whether actors are achieving regime goals and respond to emergent problems.</p> <p><b>Ca3</b> Alignment/fit: the diagnostic method was specifically developed to have a strong focus on evaluating institutional fit to regime goals, and here interviews and secondary data analysis were especially useful for understanding fit.</p>	The diagnostic method has a strong focus on capacity as it related to solving environmental problems. This focus was strengthened by the use of a framework designed with capacity in mind. Data collected for this component is largely qualitative but deep but can be triangulated with published data.

**Table S1. Assessment of SES-based scenario planning approach**

<b>Framework component</b>	<b>How the method addressed each criterion</b>	<b>Performance</b>
Robustness	<p><b>R1</b> Longitudinal change/adaptation: historical analysis is part of the resilience statement and provides data on how the SES has changed, and there was a specific focus on governance drivers in this approach. Secondary data, document analysis and expert interviews were incorporated into the SES model representing the current state, and then used to predict changes into the future as part of the scenarios developed in the collaborative workshops. Testing reforms enabled data to be collected on which governance attributes most affect robustness.</p> <p><b>R2</b> Longitudinal stability: same as R1.</p> <p><b>R3</b> How stability and change align with core regime goals: review of secondary data and the knowledge of experts in each system were used to understand the relationship between governance variables and socio-economic and environmental outcomes.</p>	The approach includes both historical analysis of robustness and future analysis, with comparisons between current and reformed governance providing novel insights.
Context	<p><b>Co1</b> Geographic and environmental drivers of change: secondary analysis of data, documents, and expert involvement in interviews and workshops provided extensive insights into the key drivers of concern.</p> <p><b>Co2</b> Economic drivers of change: same as Co2</p> <p><b>Co3</b> Social and political drivers of change: same as Co2.</p>	The focus of this method is on understanding all of the key drivers and influences in the system and the relationships between them.
Structure	<p><b>S1</b> Network characteristics: limited data on this criterion. Any understanding of these characteristics would be incidentally gained through understanding the system.</p> <p><b>S2</b> Relationship between institutions, policies, and actors: resilience assessment, document analysis and expert input via workshops and interviews provides some insights into this and is used to develop the SES, which illustrates these relationships in a simplified way.</p>	The method on its own does not focus on the structure of networks or the relationship between actors, although the resilience assessment provides some insight into these and the SES model illustrates, in a limited way, relationships between key institutions and policies.
Capacity	<p><b>Ca1</b> Authority of key actors: the resilience assessment and development the SES model requires some discussion of authority to understand which variables can be influenced by management and governance, but this is not an explicit focus.</p> <p><b>Ca2</b> General and adaptive capacity of key actors: same as Ca1.</p> <p><b>Ca3</b> Alignment/fit: same as Ca1.</p>	The method provides some data on each criterion, but the understanding is not deep.

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