The impacts of trust, cost and risk on collaboration in environmental governance

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Abstract
1. Collaborative approaches to environmental governance are drawing increased interest in research and practice. In this article we investigate the structure and functioning of actor networks engaged in collaboration.
2. We specifically seek to advance understanding of how and why collaborative networks are formed as actors engage in addressing two broad classes of collective action problems: coordination and cooperation. It has been proposed that more risk-prone cooperative problems favour denser and more cohesive bonding network structures, whereas less risky coordination problems favour sparser and more centralized bridging structures.
3. Recent empirical findings, however, cast some doubts on these assumptions. In building on previous work we propose and evaluate a set of propositions in order to remedy these ambiguities. Our propositions build on the assumption that bridging structures could, if actors experience sufficient levels of trust in the collaborative process, adequately support both cooperation and coordination problems.
4. Our empirical investigation of four UNESCO Man and Biosphere Reserves gives initial support for our assumptions, and suggests that bridging structures emerge when actors have trust in the collaborative endeavour, and/or when the cost of collaborative failure is deemed low. While caution is warranted due to data limitations, our findings contribute to improved policies and guidelines on how to stimulate and facilitate more effective collaborative approaches to environmental governance.

KEYWORDS
collaborative governance, environmental studies, social networks, social—ecological systems, UNESCO Man and Biosphere Reserves

INTRODUCTION

Environmental governance involves reconciling a balance between a multitude of actors with different stakes and interests in natural resources (e.g. Dietz, Ostrom, & Stern, 2003), while simultaneously acknowledging the resources that themselves are characterized by complex dynamics and inherent uncertainties (Ostrom, 2007). Collaborative approaches, that is, where these different actors and stakeholders are jointly involved in collectively addressing environmental problems, are often suggested as an effective means to
govern the environment (Armitage et al., 2009; Bodin et al., 2016; Folke, Hahn, Olsson, & Norberg, 2005; Lubell, 2015). But the challenges are plentiful, and although numerous studies across different contexts have been devoted to study collaboration (and participation), a thorough understanding of if, when, and how collaboration can lead to desired governance outcomes remains elusive (Ansell & Gash, 2007; Armitage et al., 2009; Emerson, Nabatchi, & Balogh, 2012; Folke et al., 2005; Koontz & Thomas, 2006; Newig, Challies, Jager, Kochskaemper, & Adzersen, 2017; Scott, 2015). One factor contributing to this deficit of understanding is whether collaboration is effective in solving any kind of environmental problem, or if certain aspects of collaboration are more conducive for addressing certain kinds of problems (Bodin et al., 2019).

To address this gap, we focus attention here on how actors engage in collaboration when confronted with two distinct but broadly applicable types of collective action problems: coordination and cooperation (Berardo & Scholz, 2010; McAllister, Taylor, & Harman, 2015; Snidal, 1985). Coordination problems mainly involve finding effective ways for disparate actors to accomplish a generally agreed upon objective through, for example, efficient resource allocation, synchronization of different activities and a suitable division of labour for common tasks (Berardo, 2014). The cost inflicted upon actors, if others choose not to engage nor contribute to the collective problem, is relatively low. Cooperation problems, as we use the term here, involves actors and coalitions of actors with opposing interests seeking and finding agreeable ways to solve collective problems and dilemmas where their different interests are at stake, and where a solution often requires actors to make some sacrifices (Bodin, 2017). Hence, actors that choose to engage in solving cooperative problems can face relatively high losses if other actors choose not to engage (cf. defect). Furthermore, since cooperation is an enterprise focused on finding ways to prevent underlying conflicts of interest from escalating to a state where open conflicts effectively prevent actors from addressing problems together (cf. Fearon & Laitin, 1996), we also assert that contexts characterized by relatively high levels of conflicts and differences of opinion and interest are associated with cooperation problems. In contrast, contexts with lower conflict levels, where actors are mostly engaged in solving common problems in efficient and well-orchestrated ways, are associated with coordination problems.

Two important elements that distinguish between these collective action problems are thus risk and cost. In Berardo’s and Scholz’s seminal paper on the ‘risk hypothesis’ (Berardo & Scholz, 2010), their conceptualization of risk was based on the cost and probability that some actors might choose to free ride on others’ efforts. Recent work has broadened Berardo’s and Scholz’s conceptualization of risk as related to free riding to also, for example, include risks associated with profit sharing in joint ventures (McAllister et al., 2015), or when negotiating conflicting goals (Bodin, Sandström, & Crona, 2017). Irrespective of the specific conceptualization of risk, in coordination problems the risk actors face is low, while the risk associated with cooperation problems is relatively high. These distinctive differences suggest that what might be beneficial for addressing coordination problems is not necessarily conducive for cooperation problems, and vice versa. In line with this, Berardo and Scholz (2010) propose and empirically demonstrate that coordination problems instigate disparate actors to connect across different boundaries leading to the formation of bridging social network structures. A network is partly defined by its social ties, and Berardo and Scholz used a broad and inclusive conceptualization of a tie based on two actors relying on each other’s support in addressing environmental problems. In contrast to coordinating problems, cooperative problems instigate the formation of close-knit bonding network structures where an abundance of direct and indirect social ties would favour mutual commitment through enhanced monitoring and exertion of social control to comply (Berardo & Scholz, 2010). Hence, implicitly this suggests that bonding network structures are conducive for cooperation problems, whereas coordination problems are better addressed through bridging network structures. This assumed relationship comes with significant implication for environmental governance. Essentially, it suggests that we should strive to establish different kinds of collaborative networks for different kinds of environmental problems (cf. there is no single blue-print; Bodin, 2017).

Subsequent studies have shown that collaborative approaches to environmental governance tend to simultaneously develop both bonding and bridging network structures, and that the extent to which one of these structures dominates over the other appears to relate to more factors than costs and payoffs associated with actors’ engagements in collaboration (Angst & Hirsch, 2017; Berardo, 2014; Lubell, Robins, & Wang, 2014; McAllister, Robinson, Maclean, Perry, & Liu, 2017; McAllister et al., 2015). This suggests that the original risk hypothesis might be too simplistic in cases where actors do not have just one but several collective action problems to address in parallel (Berardo & Lubell, 2016; Bodin & Nohrstedt, 2016), and/or the very nature of a collective action problem involves elements of both coordination and cooperation thus occupying a spot on a gradient linking these two extremes (McAllister et al., 2017), and/or actors’ propensities to engage in collective action is largely driven by their perceptions on their potential collaborators and less on the nature of the collective problem itself (Nohrstedt & Bodin, 2019).

In this study we address this ambiguity by proposing and empirically evaluating three propositions that together seek to remedy observed divergences. To be clear, we do not fundamentally question the assumed relationship between bridging and bonding network structures, and their abilities to address coordination and cooperation collective action problems, respectively. Rather, we aim to provide plausible explanations for observed divergences by extending the scope of the risk hypothesis by more clearly accounting for context and agency—by focusing specifically on trust, conflicts, costs, system-level social–ecological stability and engaged facilitation. We use the next section to elaborate and theoretically justify our propositions.

Four biosphere reserves (UNESCO Man and Biosphere Programme areas, in short BRs), two in Sweden and two in Canada, constitute the empirical basis for our study. Collaboration is a multifaceted concept, encompassing for example, communication, conflict
resolution, consultation and consensus building (Margerum, 2011). Each of the BRs was selected due to their relative good performance in terms of facilitating multiple aspects of collaboration and stimulating learning among a broad set of public and private actors (Baird, Plummer, Schultz, Armitage, & Bodin, 2019; Plummer, Baird, Dzyundzyak, et al., 2017). Hence, as we argue, they present relevant empirical examples of collaborative environmental governance. While the cases are similar in many ways, they differ in terms of their social–ecological context, the number and severity of conflicting issues (which implies that the cases display varying degrees of coordination vs. cooperation problems), and in the underlying reasons why they were established in the first place. Hence, they provide enough variability to provide insights about the validity of our propositions.

2 | THEORY

The core of our propositions is that the relative utility of bonding versus bridging network structures for coordination and cooperation problems also depends on how much trust actors collectively attribute to others in them contributing to collective problem-solving. The originally proposed risk hypothesis states that actors' beliefs in how others will act will influence their perceived risk of engaging in collaboration (Berardo & Scholz, 2010). Here we make this assumption more explicit by stating that actors’ perceived risk of collaboration is determined both by the specific payoff structure of the collective problem (the nature of the collective problem, i.e. if it is a coordination or a cooperation problem), and by their trust in others to also collaborate (Figure 1a). We acknowledge that the crucial role of trust was articulated by Berardo and Scholz, however, it was bundled together with the notion of how much actors could gain or lose from engaging in collective problem-solving. By clearly separating the issue of trust from the payoffs and costs associated with the collective action problem, we seek to advance a more precise understanding of how and why collective action problem-solving can be associated with certain network structures, and in particular, how these relationships depend on actors’ perceptions of costs and benefits associated with engaging in collaboration and how much trust they have in others to contribute in collaborative endeavours.

Furthermore, we adhere to a previous conceptualization of trust as a network- or group-level variable (Buskens, 1998; Provan & Kenis, 2007) while elaborating a definition of trust we find particularly suitable in a collective action context. Specifically, we define (network-level) trust as the participating actors’ overall level of belief in the collaborative working environment to stimulate others to contribute in collective problem-solving, and conversely disincentives actors from seeking to achieve personal benefits that would be seen as illegitimate. This does not contradict an assumption of collective action as an enterprise where actors seek to solve collective problems while at the same time bargaining to maximizing their own benefits (e.g. Lubell et al., 2014). Rather, this

![FIGURE 1](image-url) (a) Schematic model of the underlying theoretical assumption. Trust reduces the perceived risk in collaboration, whereas conflict severity is associated with the relative cost of others defecting, which in turn increase the perceived risk (Proposition 1 [P1]). Increased perceived risk makes actors more prone to engage in bonding over bridging network structures. Social–ecological stability and the presence of engaged facilitators are proposed to increase trust, which in turn reduce the perceived risk and subsequently will make actors more prone to engage in bridging structures (Propositions 2-3 [P2–P3]). Factors represented by striped squares represent latent variables, and/or variables not explicitly measured and assessed in this study. In (b), the relationships in (a) are compressed and only include the measured variables along with Propositions 1–3 (P1–P3).
kind of network-level trust implies that actors trust others to ‘play fair’, and that they believe not doing so will lead to consequences for such defectors. Hence, in relation to Provan and Kenis’ conceptualization of network-level trust (Provan & Kenis, 2007), this definition of trust focuses on the collaborative environment and thus indirectly on existence of and compliance to social norms, and not on how trustful interpersonal relationships are distributed among the participants (although we acknowledge these are related since, for example, an highly uneven distribution of trustful relationships would most likely reduce actors’ overall perception of the collaborative environment’s ability to for example, sanction against undesirable behaviours). Also, the higher the level of trust in the collaborative process, the higher the overall level of interpersonal trust, since these have been found to strongly correlate (Leach & Sabatier, 2005). Furthermore, this conceptualization of trust also overlaps with what been described as dispositional and procedural trust (Stern & Coleman, 2015). The former refers to the general tendency to trust others in a particular context, and the latter refers to perceptions of a collaborative process that enhance confidence in predictions on how others will behave.

Furthermore, in line with the original risk hypothesis, we assume that both trust and the nature of the collective problem are contributing to the perceived risk. It could even be plausible to assume that if the collective problem is strongly related to high stake cooperation, it will be perceived as risky even though actors experience high levels of trust. Although this reasoning suggests an interaction effect between trust and collective problem characteristics, to avoid overstretching the scope of our study, we refrain from elaborating if and to what extent these two factors contribute by themselves in an additive manner, and/or if there exist any multiplying effects (i.e. interaction).

These assumptions are difficult to verify or falsify, since measuring and assessing network-level trust and, in particular, perceived risk of collaboration is empirically challenging. One could even argue these factors constitute latent (unobservable) variables. To remedy this, we formulated two propositions explicating some factors that are associated with trust, but as we argue are easier to measure and assess, and to actively influence through management activities and through policy change and development (Figure 1b). We, however, first explicate a baseline proposition carrying the assumption that it is only the nature of the collective action problem that influences the perceived level of risk, and not trust (thus essentially constituting a simplistic baseline proposition).

**Proposition 1** The nature of the collective action problem, that is, to what extent it is a coordination or cooperation problem, will be the sole determinant of the collaborative network structure, where the relative share of bridging over bonding structures will be higher the more the nature of the problem resembles coordination.

Trust is not a static condition; it develops as a result of various social processes. If actors start to engage in collaborative activities, they would inevitably spend more and more time together, and continuous interacting over time typically stimulate the development of trust and acceptance of actors’ different viewpoints and interests (see e.g. Edelenbos & van Meerkerk, 2015). There are, however, some caveats to that simple assertion that deserve attention. First, the assumption that engaging in collaboration will increase the general level of trust is contingent upon the actors to actually succeed with their collaborative tasks, no matter how simple or difficult they might be initially (cf. small wins, see Ostrom, 1990). If not, collaborative effort can actually decrease the overall trust (cf. Castro & Nielsen, 2001), and any further attempts to solve collective action problems becomes even more challenging since the perceived level of risk would increase as trust decreases (Figure 1). This implies that the overall level of trust would increase more in contexts where there are plenty of possibilities to succeed with initial collective actions problems, and that actors are given enough time to successfully address these ‘low hanging fruits’. Consequently, it also implies that if a collaborative undertaking experiences a major disturbance, the actors can in effect be brought back to square one in terms of their perceptions of trust, and thus how risky they perceived it would be to engage in collective action (cf. Marin, Bodin, Gelich, & Crona, 2015). Our second proposition therefore builds on the idea that actors develop more trust over time in a stable environment. Furthermore, we acknowledge that the direction of the causal relationship between trust and stability might go both ways. If trust is present, actors are generally more able to address exogenous and endogenous disturbances (Ostrom, 2010), thereby maintaining stability. No matter what direction is strongest, our assertion of stability as a relevant way to empirically assess trust still holds. Also, we do not assume that the relationship between trust and stability is inherently deterministic. Hence, there could be cases where instability drives trust, albeit we would argue that in such cases trust might aggregate among subset of actors that choose to join forces as a means to mediate system-level uncertainty and instability (cf. Fischer, 2015). We summarize our second proposition as follows:

**Proposition 2** Stable social–ecological contexts increase actors’ perceptions of trust, which in turn decreases perceived risks, and thus increases the relative share of bridging over bonding structures in the collaborative networks.

Before continuing with our third proposition, we believe clarification is required in relation to previous literatures on network evolution. In their seminal work, Provan and Kenis (2007) suggest that collaborative networks often develop more centralized (bridging) structures over time. That, however, largely rests on an assumption of network growth, that is, that the size of the network increases over time (in turn seen as a result of the network succeeding in effectively delivering various benefits). No such assumptions are present here.

Even if the social–ecological context remains reasonably stable, the development of trust and subsequently the development of more bridging structures might not just naturally emerge in a
predetermined manner. The development of trust over time could, as we argue here, benefit from certain deliberate or even unde-liberate interventions. This reasoning touches upon the field of network governance, that is, studies focusing on how networks can be managed to better deal with different collective challenges (Klijn, Steijn, & Edelenbos, 2010; Provan & Kenis, 2007). This notion of ‘management’ particularly applies in cases where the number of actors is high, and where active and deliberative network interventions might be needed to avoid collective action failures. There are many studies supporting the benefit of designating specific actors as network coordinators, with a special mandate to facilitate collaboration (Lubell, Jasny, & Hastings, 2017; Österblom & Bodin, 2012; Provan & Kenis, 2007; Raab, Mannak, & Cambre, 2015). Actors would become less reliant on finding each and every other actor trustworthy, if they feel that there is a trusted and designated party that facilitates the collaborative process. And the facilitation itself can help to mitigate conflicts of interests, and thus stimulate actors to take steps to collaborate with former opponents (Österblom & Bodin, 2012). These facilitators can be appointed, but can also emerge informally when certain actors step forward and take responsibility for group-level outcomes (sometimes referred to as champions or social/policy/institutional entrepreneurs, see e.g. Westley et al., 2013). These considerations are summarized in our third proposition:

**Proposition 3** When some actors take on the role as facilitators though their active engagement, actors’ perceptions of trust increases, which in turn decreases the perceived risks and thus increases the relative share of bridging over bonding structures in the collaborative networks.

Some actors might, however, take on a role as facilitators without necessarily being driven by engagement in many activities. Such actors might be perceived as particularly trustworthy, and these actors could then provide the ‘social glue’ that facilitates more troublesome and/or risky collaborations where trust might be lacking. Furthermore, since these specific actors might be there to help out with the difficult cooperation problems, the other actors can engage more in the easier and less risky coordination problems. In line with this, McAllister and colleagues demonstrated that in their study of joint-venture partnerships for developing new urban residential projects, state government actors were, more than others, engaged in bonding structures linking actors of different kinds (McAllister et al., 2015). They suggested that these actors were seen as trustworthy among a broad range of actors, and therefore they were engaged as a trusted third party when actors of different kinds engaged in riskier cooperation (them being a ‘risk mediator’, constituting one of the three actors in a fully connected, that is, closed, network triangle). As a comparison, state governments were much less engaged in coordinating (bridging) structures linking actors of different types (local governments seemingly took that role instead). Hence, different actors took on different roles, facilitating coordination or cooperation within or across groups of actors of different kinds. What types of organizations these mediating/facilitating actors represent would, however, differ between contexts. Hence, we refrain from explicating any specific proposition around what types of actors might serve as risk-mediators in our empirical cases.

3 | METHOD

3.1 | The empirical context

UNESCO’s Man and the Biosphere Programme was established to initiate a new form of protected areas supporting learning and understanding of the nature, but also as areas (or venues) where different public and private actors can engage in fruitful collaborations managing the local environment striking a balance between conservation of natural resources and sustainable societal development. To date more than 700 biosphere reserves have been established around the globe, and they have been studied quite extensively as their programmatic similarities provide fertile ground for comparative research approaches across different contexts. The four cases at focus here were deliberately selected in 2012 due to their relative good performance as established through a survey-based investigation gathering information from more than 100 different BRs (Schultz, Duit, & Folke, 2011). Furthermore, they have been fairly stable in that the number of involved actors has not changed drastically over the last several years (i.e. the collaborative networks have not changed significantly in size, although there has been a turnover of some actors). Hence, the previous findings presented above on common network evolutionary pathways as they grow and develop over time (Provan & Kenis, 2007) were less applicable for this study since the sizes of all networks remained essentially constant. Hence, the feasibility of evaluating our specific propositions was high. However, besides network sizes, the BRs differ in terms of how long they have been operational without experiencing any major changes and disturbances. Thus, they provided us with varying levels of social-ecological stability (Proposition 2).

The four BRs have been described extensively in other studies (e.g. Plummer, Baird, Dzyundzyak, et al., 2017), thus here we only give a very brief description of the cases. The two cases from Sweden are the ‘Kristianstad vattenrike’ (KVA) and ‘Östra Vätternbranterna’ (OV). The former represents a coastal urban area based in the south of Sweden around the wetlands around the ‘Helgeå’ river that are of interest both from a recreational and an agricultural perspective and has been studied quite extensively (e.g. Hahn, Olsson, Folke, & Johansson, 2006; Olsson, Folke, & Berkes, 2004), while the latter represents an area located next to the second largest inland lake in the midst of Sweden where both forestry and tourism constitute important livelihoods for the inhabitants (Jonegård, 2011). The Canadian cases are ‘Frontenac Arch’ (FA) and ‘Georgian Bay’ (GB). Both are located in Ontario, with FA at the intersection of five forest regions and along a major river, the St. Lawrence Seaway, where agriculture, forestry and tourism are major economic drivers (Canadian Thousand Islands Heritage Conservancy, 2002). GB is located along
the eastern shore of Lake Huron and includes the well-known ‘30,000 islands’. Its population can increase up to 25 times in summer, supporting a very large tourism and summer resident industry (Georgian Bay Biosphere Reserve Inc., 2004).

3.2 | Empirical data

The empirical data consist of two datasets; detailed patterns of collaboration (i.e. social networks) among the most active and leading actors in the different BRs, and qualitative data characterizing the different cases in terms of social-ecological stability over time, if and how they have managed to address various conflicts, and their differences in terms of the magnitude and severity of actors’ conflicts of interests. All of these assessments are made on the BR level, and not on the level of individual actors. Both these datasets were collected during 2014 and have been described and used in other studies (e.g. Plummer, Baird, Dzyundzyak, et al., 2017). The qualitative dataset is mostly based on interviews with a large number of actors and stakeholders in the areas (116 in total, and some actors were interviewed more than once; Plummer, Baird, Armitage, Bodin, & Schultz, 2017). The social relational data are drawn from surveys, and the quantitative analyses of the social networks are combined with and put in relation to the qualitative findings when we interpret and discuss our findings in light of our propositions.

Of importance are the types of social relations being at focus. In line with previous work we assessed relationships that would likely be used for various purposes, for example information exchange, deliberation, negotiation etc.; thereby being of importance for a broad range of aspects related to collaboration such as communication, conflict resolution, consultation and consensus building (Margerum, 2011). But asking too broadly defined questions can affect data reliability since the respondents might perceive the questions very differently. Hence, we opted for asking two distinctive and rather narrowly formulated questions about their social ties based on information exchange and bi-lateral agreements. Some descriptive analyses of the two acquired networks revealed that the information exchange and bi-lateral agreements networks were highly correlated (correlation coefficients between 0.74 and 0.80 for all cases). We also fitted our statistical models (described further down) to both networks for one of the cases, and no notable differences were found. We interpret these similarities as both types of relationships largely represent a common and more general notion of a tie capturing one actor deriving collaborative benefits by interacting with the other actor (similar as in (Berardo & Scholz, 2010)). Hence, we only used the information exchange networks for all subsequent analyses.

The social network data were gathered in surveys administrated to all actors (i.e. individuals) participating in scoping workshops held in each BR during 2014. The actors were pre-selected based on their strong involvement in the areas, and we consulted local experts as well as key actors in each BR (e.g. the BR coordinator) to define those lists of important actors (the number of key actors in each BR ranged from 18 to 40). Most actors are representing an organization, but in this study we maintain a focus on the individuals since they were the ones that were identified as the entities from where different activities were initiated and shaped (i.e. an actor was defined as an individual, not an organization). The actors (respondents) were asked to answer a large number of questions, but at focus here are the social relational questions that allow us to reconstruct the social networks of each BR. In each survey we listed the names of all the pre-specified actors, and we asked each and every respondent to indicate if and to what extent ‘never’, ‘sometimes’, ‘often’ they (a) exchanged information with these actors on the list, and (b) bilaterally agreed on common standpoints for some issue being addressed in their respective BR, with any of the actors on the list. Hence, we relied on respondents’ abilities to recognize collaborating partners when assessing their social relations; a method that is more effective than recall-based methods in gathering both strong and weak social relationships (Marsden, 1990). Furthermore, we decided to indiscriminately include all ties that were either weak or strong (corresponding to frequency of exchange being either ‘sometimes’ or ‘often’) in subsequent analyses. In that way we captured all collaborating ties. We also allowed the respondents to name other actors not on the list, but these were omitted for the purpose of this study, mainly to avoid built-in biases when constructing the different social networks from the survey responses. For example, if we had included actors not on the pre-specified list, our constructed social networks would include actors that have not themselves responded to the survey, and hence not all actors have been given the same opportunity to identify their collaborating partners. This would, among other things, create a bias in terms of individual actors’ number of social ties. For the same reason, we also omitted those actors on the pre-specific list that did not respond to the survey. Overall, these measures resulted in effective response rates varying from 62% to 67% for the four BRs.

In addition to the network ties, we gathered information about the actors themselves (i.e. their attributes). The attributes we investigate here capture the actor type in terms of whether the organization they represent is, for example, a public agency or a non-governmental organization (see full list in Table 1). Also, we distinguished between actors operating on different geographical scales (Table 1). These attributes were chosen since they capture some basic and important differences between the actors, how they operate and who they represent and their geographical frames. Finally, we assessed how many collaborative activities an actor had been engaged in (projects or tasks related to implementation, decision-making, both or neither). The activity score, that is, the total number of activities and tasks, thus captures an actor’s level of time and energy investments in the work of BR (Proposition 3).

The qualitative interviews were transcribed, uploaded to NVivo 11 (QSR International Pty Ltd. Version 11, 2015) and reviewed for references to conflict and collaboration. Relevant text was selected to illustrate the themes emerging from the analysis.

The Canadian case studies were evaluated and approved through an ethics review process at Brock University (reference number: REB...
TABLE 1  Actor attributes (categorized as scale and organizational type)

| Scale                      | Organizational type                      |
|----------------------------|-----------------------------------------|
| Sub-BR (local or sub-focal scale and smaller than the boundaries of the BR) | State/government (representative of organization) |
| BR (i.e. focal scale)      | Non-governmental and non-profit NGO NFP (representative of organization) |
| Regional (provincial in Canada/county in Sweden—anything between BR and national) | Private business/landowner (individual represents self) |
| National                   | Other                                    |

Attributes that were specifically tested for having more/less incoming/outgoing social ties (alter/ego effect).

13-026-PLUMMER). The Swedish case studies were conducted in the same way as the Canadian studies. We adhered to the research procedures and practices of the European Code of Conduct for Research Integrity in that, for example, all the participants gave their explicit consent, anonymity was ensured when data and analytical results were made public and no sensitive information (as defined by Swedish laws) were collected.

3.3  Social network analysis

Empirical investigations of how and in what ways actors engage (or not) in collaboration with each other in order to address environmental problems (often called collaborative networks, governance network, policy networks, etc.) represent one research approach that is gaining interest (Alexander, Andrachuk, & Armitage, 2016; Barnes, Kalberg, Pan, & Leung, 2016; Bodin, 2017; Bodin & Prell, 2011; Henry & Vollan, 2014; Ingold & Fischer, 2014; Lubell et al., 2014; Robins, Bates, & Pattison, 2011). Analysis of social network data is in many ways different from ‘standard’ statistical analyses of other types of datasets. This difference mostly derives from the assumption of data independence that is paramount in commonly used statistical methods, but which rarely holds, by definition, in network analysis (a network is created based on patterns of interdependencies). Exponential Random Graph Models (ERGM) represent a class of stochastic models that have been developed specifically for analyses of networks, and are therefore designed to account for various data interdependencies (Lusher, Koskinen, & Robins, 2013). Conceptually, ERGM are often used to model and describe a network in terms of certain micro-level structures (often called configurations or motifs). A configuration represents a simple structure or micro-level network, and ERGM aim to characterize a network in terms of how important these configurations are in explaining the structure of the network. In a sense, ERGM are thus conceptually similar to multivariate regression models in that the dependent variable (the observed network) is understood as the results of a set of independent variables (different micro-level configurations). Technically, ERGM use maximum likelihood simulation techniques to fit a parameter vector \( \theta \) to a stochastic network model (Lusher et al., 2013):

\[
P(X = x) \propto \exp(\theta s(x)),
\]

where \( X \) is a random network (\( x \) is the empirical network), and \( s(x) \) is a known vector of graph statistics (configurations) on \( x \).

A well-fitting ERGM would then be able to adequately represent the network as being the result of a set of configurations and their associated coefficients. The coefficients capture if a certain configuration is suppressed or enhanced, and are in a way conceptually equivalent to the coefficients in a regression model where a coefficient represents the net effect of an independent variable on the dependent variable. The analogy with regression models should, however, be seen as purely conceptual since these different models are based on entirely different assumptions on data independencies (Bodin et al., 2016). Furthermore, an ERGM analysis typically consists of two steps. The first is to fit a model to the data. This step involves adding (or removing) different configurations in a theoretically informed way while simultaneously tracking model performance (with a specific focus on model convergence issues). The second step involves investigating the fit of the model from the first step. Here a goodness-of-fit approach is used, and the objective is to see how well the model manages to reproduce the structural characteristics of the empirical network. This test usually involves testing the fit to a larger number of configurations than what was included in the model itself. For each configuration, a \( t \)-ratio is obtained. The \( t \)-ratios capture how many standard errors different from the number of configurations are in the empirical network in relation to the mean values drawn from a large number of random networks generated using the model from step one. A \( t \)-ratio \(<2.0\) is usually interpreted as the model produces a reasonably good fit for that specific configuration, whereas a larger \( t \)-ratio implies the opposite (Lubell et al., 2014).

Furthermore, we also assessed the Mahalanobis distance measure in MPhnet (Wang, Robins, Pattison, & Koskinen, 2014), which is an indicative measure being conceptual similar to \( R \)-square in regression analysis (however, the smaller the Mahalanobis distance, the better fit of the model). This provided us with a measure that allowed us to compare the fit of the ERGM for the four different networks.

Given the aim of the paper, we are particularly interested in those configurations we can theoretically link to the assumed relationship between patterns of ties and perceptions of risk. We here follow the operationalization by Berardo and Scholz (2010). Bridging structures conducive for low-risk coordination problems are captured by some actor being sought by relatively many others (‘in-2-stars’) and by some actors indirectly linking two others (‘Two-path’; Table 2). Bonding structures are captured by reciprocity (actors reciprocate an incoming social tie) and transitive triads (two actors tied to a common third will also be socially tied; Table 2).
First, to assess whether engaged facilitators were present in a network, we looked for any alter effect stemming from a high level of engagement in the BR. An alter effect implies that some attributes of actors make them more/less popular for other (alters) to engage with (Berardo & Scholz, 2010). The logic here is that if level of engagement coincides with having many incoming ties, an actor brings many other actors together (many ties) through its high engagement in the collaborative endeavour, thereby providing facilitation enhancing the level of trust (Proposition 3).

To account for potential risk mediators, we also investigated configurations associated with some other alter effects. Due to the limited sizes of the networks, we did not investigate the alter effects for all attributes in Table 1 (to avoid overfitting in cases where none or just very few actors had a given attribute). Instead, we focus on the ones we deemed as most theoretically important. First, we focused on the organizations that are representing the state or an NGO. These two types are often explicitly discussed in theoretical frameworks related to multi-actor governance (for example, adaptive governance, see Folke et al., 2005; or co-management, see Carlsson & Berkes, 2005; or adaptive co-management, see Armitage et al., 2009). Secondly, we focused on organizations operating at regional or national scales. We choose these since we wanted to specifically investigate if actors operating in geographical scales larger than the BR were more or less active/sought after. These could be potential scale-crossing brokers, that is, actors that bridge across different geographical scales (Ernstson, Barthel, Andersson, & Borgström, 2010).

We also tested for homophily effects (i.e. actors with the same attributes tend to be tied to each other, see McPherson, Smith-Lovin, & Cook, 2001). Here we included the full range of all attributes (Table 1). Finally, we also included the out-2-star configuration (Table 2) and a series of ego effects to control for some actors’ possible tendencies to more actively establish, and/or report ties towards many others. An ego effect implies that some attributes make an actor (ego) more/less prone to seek connections with others.

### 3.4 Frequency of collaboration and network centralization

We complemented the ERGM by also assessing bonding and bridging structures on the level of the whole network. Bonding and bridging structures were assessed by measuring average degree centrality (how many in- and outgoing ties each actor has, on average, not to be confused with network density that captures how many potential ties are realized), and the level of degree centralizations (how much the network resembles a star-shaped network with a hub in the middle and all others being connected to the hub, and no-one else) for all networks respectively. The former is important since it captures a general tendency among the actors to be deeply entangled with many others in collaboration (representative of bonding, see e.g. Crowe, 2007), and the latter is important as it captures to the extent a network is steered by a central hub (bridging). A star network could be seen as the ideal...
bridging structure where the central hub is solely responsible for distributing tasks among the network members. Such a centralized network would, however, lack bonding structures.

4 | RESULTS

We first present the results from the qualitative analyses assessing the levels of conflict severity and social–ecological stability in each BR, followed by a presentation of the results from the subsequent quantitative analyses of the social networks. These results are then integrated in the discussion section and evaluated in light of our propositions.

4.1 | Cooperation or coordination—Assessing the nature of the collective problem

In both Swedish BRs, conflicts of interest between different actors had surfaced from time to time. In KVA, there was a tension between irrigated agriculture on sandy grasslands on the one hand and conservation of biodiversity and recreational values through maintaining traditional agricultural practices on these grasslands on the other. Other conflicts in the past had arisen between urban expansion and conservation of wetlands. The strategy of the BR was to resolve conflicts between conservation and development through face-to-face dialogues, focusing on identifying win-win solutions and emphasizing holistic approaches. A BR manager explained:

‘I really believe in individual meetings, because it makes people feel seen and their opinion is heard. It takes some time, of course. I have one example, a landowner who I managed to bring on board. At first, she was totally uninterested, but then I went home to her with reports showing the values and really rare species we had found on her land. Now she has even become a biosphere ambassador!’, and ‘I have tried to communicate that different interests can indeed find common ground, it can be hard in a small space to agree with a golf course, but if you see it as part of the board: There [was] tangible animosity and there are still elements of that…But in terms of the network, that animosity really I would say has – and I can’t say it’s because the BR got designated or because the network was created, but certainly that from the networking perspective, a lot of that is sort of eased, a lot of those tensions have eased’. (GB co-manager).

From Canada, the cases also represented varying levels of conflict. In FA, there had been little conflict among actors. However, some evidence of conflict between the FA board and the community in terms of actions was observed. For example, a FA manager stated that intermediary organizations representing business owners in the region blocked communications between the FA and business owners. The FA’s response was to be open to what the community wants to do, rather than push their own agenda:

we’ve been working as much as we can work with the businesses individually, but they, for decades have had kind of a reliance back to these intermediary organizations...instead of trying to drive a wedge or push down the [intermediary organizations]...that door is always open. We always invite them, you know, ‘Come on in!’ (FA manager).

GB overcame major conflicts of interests regarding resource use among four actor groups: the boating community, cottagers, First Nations and non-First Nations permanent residents. While these conflicts of interests led to extensive conflicts in the past, a coalition formed among all four groups around protecting natural resources and encouraging sustainable development, led by an individual who ‘saw the potential for collaboration among [them], and so his vision was to create or to use the biosphere reserve as a tent to bring those four groups together’ (GB co-manager).

‘When the biosphere were being struck...those challenges were real. There was a tangible feeling, especially – I mean there are court cases...there were legal challenges...so, there was animosity...This coalition has persisted with three of the four groups still on the board: There [was] tangible animosity and there are still elements of that...But in terms of the network, that animosity really I would say has – and I can’t say it’s because the BR got designated or because the network was created, but certainly that from the networking perspective, a lot of that is sort of eased, a lot of those tensions have eased’. (GB co-manager2). This co-manager went on to say that ‘Fortunately, we don’t have much conflict in the organization literally at any level’.

To summarize, KVA and FA represented cases where open conflicts had been less pronounced (which at least in KV was partly due to the results of a deliberate strategy to avoid bringing stakeholders together that have widely different options about the issue at hand). OV and GB were, on the contrary, better characterized as more deeply conflict-ridden, although both cases also demonstrated that such conflicts do not necessarily rule out possibilities for constructive collaboration.

4.2 | Social–ecological stability

Furthermore, in terms of stability we also saw distinctive variation. Although all cases have been operational for many years, the Swedish cases had experienced some fairly recent disturbances.
In contrast, no such recent disturbances were mentioned by any Canadian respondents. One of the most well-known and central individuals who had been deeply engaged in the establishment of the KVA BR abruptly withdrew from all formal engagements with short notice just 1 year before our study. Although the BR is larger than one individual, this still constituted a fairly big social disturbance. As one of the respondents expressed it:

Before, you would think, ‘How would we ever cope without (the previous manager)?’ But it is just as they say – it works, only in a different way.

Also, although OV as a collaborative initiative had been active for more than a decade, it had more recently been established as a BR (4 years prior to this study). The BR manager explained:

The project group, as we were called before we became a biosphere reserve, has been really tight, it has consisted of the same people during almost the whole journey of 10–15 years, and this has been an important factor for conflict resolution and for solving hard issues like balancing conservation and production.

The process of becoming a BR, however, meant that the long-lasting collaborative process was partly re-evaluated by the participants, and that previous collaborative processes needed to be reinvented (to some extent). A former coordinator expressed that as:

We formed a biosphere association as we became a biosphere reserve, and when we formed a board we had a window to broaden the project group. (---) we brought in a representative of the University. We also felt a great need to bring in more private business actors (---) The [previous] project group was quite old and male so it was a goal to get younger and female members. Another thing was also the geographical spread (our clarification in brackets).

Hence, this BR experienced a strong disturbance in the form of a rapid turnover and replacement of relatively many key actors. In conclusion, both Swedish cases were less stable than the Canadian ones.

4.3 \ Social network analyses

The networks are presented in Figure 2. The Swedish cases KVA and OV were characterized by virtually all actors having many ties (mean degree of 13.2 and 11.9 for KVA and OV), thus indicating the prevalence of bonding structures. GB and FA had taken a clearly different path. Here the networks were comparatively sparser and actors in general only had approximately half the number of ties in comparison to the Swedish cases (mean degree of 6.6 and 6.0 for GB and

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**FIGURE 2** Collaborative networks of (a) KVA, (b) OV, (c) GB and (d) FA. Colours represent organizational type: black = State/government (representative of organization), red = Non-governmental and non-profit NGO NFP (representative of organization), green = Private business/landowner (individual represents self), blue = Other. The number of actors included in the studied networks in KVA, OV, GB and FA were 25, 18, 20, 12, respectively (62%–67% of the identified key individuals)
FA respectively). Although the Canadian networks were found to be sparser, none of them were fragmented into separate subgroups nor were they remarkably sparse. The Canadian cases, however, had a higher level of centralization (in-degree centralization coefficient of 0.63 and 0.5 for GB and FA [on a scale from 0 to 1], whereas KVA and OV had 0.38 and 0.32 respectively). Our interviews with the respondents also revealed these highly central actors were held in high regard by the BRs board members. These fairly high levels of centralization for the Canadian cases reveal the strong presence of bridging structures.

The results from the ERGM are presented in Table 3. Not all configurations could be included in all models due to model convergence problems (cf. Lubell et al., 2014; McAllister et al., 2015). The t-ratios for these configurations, however, never exceeded 2.0 in the goodness-of-fit (this includes various transitivity configurations). Thus, we interpret those configurations as neither over- nor underrepresented. Hence, no apparent tendency for transitivity was observed for any of the networks. Difficulties in making the models to converge when including the two-path, that is, when two actors are indirectly connected through a mediating actor (Table 2), made us exclude that configuration from all models. However, the t-ratio for the two-path never exceeded 2.0, thus we interpret this as there is no apparent tendency for this configuration to be over- or under-represented in any of the networks.

Frontenac Arch presented an exception with a t-ratio of 3.3 for reciprocity, implying this configuration was significantly overrepresented (it was not possible to include this configuration due to convergence problem). Since we did not want to include other purely structural configurations (e.g. in-2-star) when reciprocity could not be included in the model, these were omitted for FA irrespective of whether the model would have converged or not with them included (this exclusion of configurations explains why the Mahalanobis distance was higher for this BR). The rationale for this decision was that if the model cannot accommodate (control for) such a basic structure as reciprocity, the results for other more complicated structural configurations are difficult to correctly interpret and could therefore be misleading. This limitation applies less to the simpler attribute-driven effects (these structures are topologically very different from the structure of reciprocity, and therefore the overlap and the possibility for confflation is reduced). Hence, we deemed these results as reliable.

Taking the convergence issues in the FA case into account, we nonetheless found strong (or fairly strong) tendencies for reciprocity across all BRs. Although no specific propensity to form closed-knit

| Effects \(^{ab}\) | KVA | OV | GB | FA |
|-----------------|-----|----|----|----|
| Arc | -3.088 | -6.549 | -5.185 | -1.887 |
| Reciprocity | 1.924* | 2.092* | 1.043* | -c |
| In-2-Star | -0.031 | 0.165* | 0.145 | -c |
| Out-2-Star | 0.185* | 0.072 | 0.253* | -c |
| Transitive-Triad | - | - | -0.046 | -c |
| State_Sender | 0.531 | -0.356 | 0.200 | 0.137 |
| State_Receiver | 1.972* (0.70) | 0.273 | -0.109 | -0.563 |
| NGO_Sender | -0.131 | 1.594 | 0.980* | -0.517 |
| NGO_Receiver | 0.778 | 2.743* (0.83) | -0.334 | -0.425 |
| Regional_Sender | -0.412 | - | -0.302 | 0.701 |
| Regional_Receiver | -1.864* | - | -0.864* | 0.109 |
| National_Sender | -0.410 | 3.820* | - | -0.090 |
| National_Receiver | -2.646* | 2.460* (0.80) | - | -1.184 |
| Activity_Sender | 0.055 | 0.093 | 0.106* | 0.211* |
| Activity_Receiver | -0.112 | 0.012 | 0.165* | 0.184* |
| Scale_Match | 0.492* | 2.675* | 0.328 | 0.120 |
| Stakeholder.type_Match | 0.066 | -0.294 | 0.596 | 0.575 |
| Mahalanobis distance | 433 | 323 | 453 | 2,323 |

<sup>a</sup>For all significantly overrepresented attribute-based receiver configurations in Table 1, the ratios of closed versus open triangles are presented within parenthesis (the higher ratio, the more this type of actor resembles a risk mediator).

<sup>b</sup>A '-' indicates that the specific configuration was not included in the ERGM model for that BR.

<sup>c</sup>Reciprocity was not included in the model due to convergence problem (hence, no other higher order configurations, such as in-2-star, were included). However, the goodness of fit test indicated that reciprocity was significant (t-ratio of 3.3 in comparison to a large set of random networks).

<sup>d</sup>‘Activity’ represents how many projects and tasks an actor has been engaged in, and thus captures the actor’s time and energy investments in the BR.

<sup>*</sup>Indicates a p-value < 0.05.
triangular structures in any of the BRs were observed, taking the reciprocity in consideration we argue that we found support from the ERGM for bonding structures to be present in all BRs, albeit less pronounced in the Canadian BRs (coinciding with the descriptive analyses above).

A striking difference between the Swedish and the Canadian BRs was the alter (and the ego) effects associated with level of activity. For the Swedish cases, no effects of engaging in many activities were observed. Contrary to this, in the Canadian BRs, both of these effects were significant (Table 3). Hence, the more you engage in activities, the more you link up with others, and the more sought after you are. That suggests the Canadian cases can be more clearly associated with some actors providing engaged facilitation.

We furthermore found support for some actor types to be associated with alter effects in both Swedish BRs. The specific attributes, however, differed between the cases. In KVA, state-level actors were often sought after, and in OV, NGOs and actors operating on national geographical scale had many incoming ties (the latter indicating scale-crossing brokerage). Caution is, however, warranted since the numbers of actors with certain attributes were low. Furthermore, OV showed a tendency to rely on intermediate brokers (in-2-star) and some brokering (in-2-star) were observed.

Finally, the Swedish cases experienced homophily in that actors operating on the same geographical scales tended to collaborate (OV in particular). This indicates that actors working on issues with similar geographical scope tended to work together and that actors addressing issues of different scales were not so prone to collaborate. No homophily effect based on actor types was, however, observed in any of the BRs. All our results are summarized in Table 4.

5 | DISCUSSION

5.1 | Conflicts of interests and network structures

Overall, our results show that all BRs experience actor preferences favouring both bridging and bonding structures. This observation largely resembles recent work on the risk hypothesis—both types of structures are present simultaneously (Berardo & Lubell, 2016; Mcallister et al., 2017). This is also corroborated by the interviews with the respondents indicating that all BRs had been addressing both cooperative and coordinative collective action problems. In other words, the relative abundance of bridging versus bonding structures in the BRs did not seem to coincide with the ratios of bridging structures found in other settings where the risk hypothesis is present simultaneously (Berardo & Lubell, 2016; Mcallister et al., 2017). The dominance of bonding structures is present in both the Swedish and the Canadian BRs, which is in line with the risk hypothesis. A striking result is that the level of conflicts (Table 4) in the BRs did not seem to coincide with the ratios of bridging structures found in other settings where the risk hypothesis is present simultaneously (Berardo & Lubell, 2016; Mcallister et al., 2017). The dominance of bonding structures is present in both the Swedish and the Canadian BRs, which is in line with the risk hypothesis.
of bonding versus bridging in relation to KVA and FA. Hence, we found no support for the simplistic assumption of Proposition 1.

5.2 Stability, trust and network structure

If we equate stability with how long ago there were any major disturbance (more about this further down), GB and FA are more stable than KVA and OV. And during these relative long periods of stability, they have potentially developed more trust in the collaborative endeavour (leading to a reduction of the perceived risk), and subsequently developed a fair amount of bridging structures, although the nature of the collective action problems largely remained the same.

Kristianstad vattenrike and OV, on the other hand, more recently experienced major disturbances. The disturbance in KVA was furthermore directly related to the bonding and bridging structures of the collaborative network, since it involved a previous highly engaged and renowned leader resigning. Although it has not been not empirically assessed in a quantitative manner, numerous previous studies demonstrate the leader used to hold a very central position in the network (e.g. Hahn et al., 2006; Olsson et al., 2004). Hence, the resignation, by itself, meant that some bridging structure disappeared (and the remaining network would therefore inevitably increase its relative share of bonding structures). Nonetheless, our interviews with actors in the BR suggest that the leader’s resignation instigated them to partly reinvent the collaborative processes (this we interpret as they needed to redevelop mutual trust in the collaborative processes although we saw no signs of the actors starting to question the trustworthiness of each other). Furthermore, as part of these developments, the actors also engaged in revitalizing the direct ties they held with others, which might already have been in place before the leader resigned. In other words, no clear signs were observed indicating that they, as a response to the disturbance, did develop entirely new ties to form bonding structures. Rather the data suggest they started to utilize their older ‘dormant’ ties more intensively. The fact that they managed to overcome this disturbance without failing their core objectives indicate that these (potentially dormant) bonding structures were well suited to deal with the collaborative challenges following the resignation of the previous leader.

In summary, these results are in overall agreement with our second proposition.

5.3 Facilitation, trust and network structures

In the Canadian BRs, highly active facilitators are seemingly present. And since the Canadian cases were associated with bridging structures, our third proposition is therefore supported. We, however, acknowledge we are not able to distinguish if stability and/or active facilitation (Propositions 2 and 3) led to bridging structures since these factors coincide on the same cases.

A key question emerging from this ambiguity is therefore whether the effectiveness of facilitation (Proposition 3) could solely explain the high levels of bridging structures for the Canadian cases instead of the proposed effect of contextual stability (Proposition 2), or vice versa? Even though the results from several studies demonstrate how active facilitation can positively affect trust and commitment (e.g. Österblom & Bodin, 2012; Provan & Kenis, 2007), we nonetheless suggest our proposed relationship between contextual stability and the prevalence of bridging structures should be favoured over (albeit not replacing) the proposed impact of active facilitation. As expressed by one of the GB managers:

I see the biosphere reserve in three phases, pre-nomination where you’re soliciting support for the nomination, just to get this thing to Paris, then there’s the formative years where you’re defining what and who you are and trying to retain original support or grow new dynamic support from other corners, and then there’s this development phase....

This statement captures how the BR has been going through several distinctive phases as the actor built commitment in the collaborative endeavour, and thus indirectly in each other. If, however, the social–ecological context experience disturbances (as KVA and OV experienced relatively recently), these processes are likely disturbed.

5.4 Limitations

Given the low number of BRs, our investigation should not be seen as a test for validity, but rather as a test for invalidity. Furthermore, we were not able to directly measure and analyse all parts of the assumed causal relationships underlying this study and our propositions (Figure 1a). Other explanations for our results are indeed possible. For example, the differences in structural characteristics of the network could be solely attributed to different cultures of collaboration in Sweden versus Canada. However, collaborative initiatives in Sweden do not inevitably lead to dense and cohesive bonding structures as observed here, but could also develop sparser and more centralized structures (e.g. Bodin et al., 2017; Sandström & Rova, 2010). Furthermore, since our results support both Propositions 2 and 3, a possible interpretation is that contextual stability favours both the emergence of highly active facilitators and trust, potentially in a co-evolving and mutually reinforcing fashion.

Finally, we wish to make clear that we have not assessed how effective the different collaborative initiatives have been in accomplishing various outcomes (e.g. Plummer, Baird, Dzyundzyak, et al., 2017). Instead, we have treated the observed networks as the dependent variable, in other words we have tried to explain why the networks are shaped as they are. Thus, factors such as resource availability, often associated with network effectiveness in delivering various
outcomes (Turrini, Cristofoli, Frosini, & Nasi, 2010), have not been analysed. Nonetheless, we acknowledge that effectiveness might influence the network formation processes by affecting actors’ further engagements in the collaborative endeavours. Still, all studied cases were chosen since they were assessed as performing reasonably well, hence although we would expect them to differ in effectiveness, we argue these differences are likely not big enough to solely explain our results.

6 | CONCLUSIONS

Collaborative approaches to environmental governance are increasingly being advocated across different literatures and fields of studies. Earlier work has demonstrated that many of the collective action problems of such collaborative undertakings are set to solve can be categorized as either being a coordination or cooperation problem. Furthermore, it has also been suggested that coordination and cooperation problems are more effectively addressed by networks of collaborating actors characterized by bridging and bonding structures respectively. However, results from recent studies demonstrate some ambiguities, therefore questioning the validity of the presumed relationships between coordination and cooperation problems, and bonding and bridging network structures.

Here the scope of earlier studies is extended by more precisely accounting for certain aspects of context and agency. In doing so, we develop a set of propositions that could explain observed ambiguities. Our reasoning partly builds from the assumption that bridging structures could also be adequate for addressing cooperation as well as coordination problems. This assumption, however, hinges upon actors’ experiencing trust in the collaborative process. Development of such trust, in turn, hinges upon a set of conditions that we summarize in two propositions stating that the development of more bridging structures relies on social–ecological stability, and/or some actors acting as engaged facilitators. These two propositions thus articulate aspects of context and agency respectively. We have evaluated these propositions using four collaborative undertakings designated by the UNESCO Man and Biosphere Programme as our empirical basis. The results are in line with our assumptions, although the limited number of cases implies that we are not able to say if only one of them or both of the propositions are supported. Furthermore, we do lack explicit case-by-case longitudinal data to more firmly evaluate the effect of social–ecological stability on the collaborative network structures. Nonetheless, we argue that our study has provided plausible explanations rectifying recent and seemingly ambiguous empirical findings. A better understanding of how collaborative environmental governance evolves over time, and how different factors affect perceived levels of trust and risk in engaging in collaborative endeavours, is paramount to better explain differences in collective abilities to address different kinds of environmental problems. Such knowledge can have significant implications on how to better formulate, design, support and maintain more effective governance arrangements.

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CONFLICT OF INTERESTS

The authors declare no conflict of interests.

AUTHORS’ CONTRIBUTIONS

Ö.B. conceived the ideas and designed the corresponding methodology; J.B. and L.S. collected the data; Ö.B., J.B. and L.S. analysed the data with support from R.P. and D.A.; Ö.B. led the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

DATA AVAILABILITY STATEMENT

The social network data are, albeit anonymized, publicly available at the Swedish National Data Service website https://doi.org/10.5878/y0q4-8w20 (Bodin, Baird, Schultz, Plummer, & Armitage, 2020). The qualitative data we used (i.e. quotes) are presented in the paper.

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REFERENCES

Alexander, S. M., Andrachuk, M., & Armitage, D. (2016). Navigating governance networks for community-based conservation. Frontiers in Ecology and the Environment, 14(3), 155–164. https://doi.org/10.1002/fee.1251
Angst, M., & Hirschi, C. (2017). Network dynamics in natural resource governance: A case study of Swiss landscape management. Policy Studies Journal, 45(2), 315–336. https://doi.org/10.1111/pjs.12145
Ansell, C., & Gash, A. (2007). Collaborative governance in theory and practice. Journal of Public Administration Research and Theory, 18(4), 543–571. https://doi.org/10.1093/jopart/mum032
Armitage, D. R., Plummer, R., Fikret Berkes, R. I., Arthur, A. T., Charles, I. J., Davidson-Hunt, A. P., … Wollenberg, E. K. (2009). Adaptive co-management for social-ecological complexity. Frontiers in Ecology and the Environment, 6(2), 95–102. https://doi.org/10.1890/07089
Baird, J., Plummer, R., Schultz, L., Armitage, D., & Bodin, Ö. (2019). How does socio-institutional diversity affect collaborative governance of social-ecological systems in practice? Environmental Management, 63(2), 200–214. https://doi.org/10.1007/s00267-018-1123-5
Barnes, M., Kalberg, K., Pan, M., & Leung, P. S. (2016). When is brokerage negatively associated with economic benefits? Ethnic diversity, competition, and common-pool resources. Social Networks, 45, 55–65. https://doi.org/10.1016/j.socnet.2015.11.004
Berardo, R. (2014). The evolution of self-organizing communication networks in high-risk social-ecological systems. *International Journal of the Commons, 8*(1), 236–258. https://doi.org/10.18352/ijc.463

Berardo, R., & Lubell, M. (2016). Understanding what shapes a polycentric governance system. *Public Administration Review, 76*(5), 738–751. https://doi.org/10.1111/puar.12532

Berardo, R., & Scholz, J. T. (2010). Self-organizing policy networks: Risk, partner selection, and cooperation in estuaries. *American Journal of Political Science, 54*(3), 632–649. https://doi.org/10.1111/j.1540-5907.2010.00451.x

Bodin, Ö. (2017). Collaborative environmental governance: Achieving collective action in social-ecological systems. *Science, 357*(6352), eaan1114. https://doi.org/10.1126/science.aan1114

Bodin, Ö., Alexander, S. M., Jacopo Baggio, M. L., Barnes, R. B., Cumming, G. S., Dee, L. E., ... Sayles, J. S. (2019). Improving network approaches to the study of complex social-ecological interdependencies. *Nature Sustainability, 2*(7), 551–559. https://doi.org/10.1038/s41893-019-0308-0

Bodin, Ö., Baird, J., Schultz, L., Plummer, R., & Armitage, D. (2020). Data from: The impacts of trust, cost and risk on collaboration in environmental governance. *Swedish National Data Service*, https://doi.org/10.5878/yOo4-8w20

Bodin, Ö., & Nohrstedt, D. (2016). Formation and performance of collaborative disaster management networks: Evidence from a Swedish wildfire response. *Global Environmental Change, 41*, 183–194. https://doi.org/10.1016/j.gloenvcha.2016.10.004

Bodin, Ö., & Prell, C. (2011). Social networks and natural resource management: Uncovering the social fabric of environmental governance. Cambridge, UK: Cambridge University Press.

Bodin, Ö., Robins, G., McAllister, R. R. J., Guerrero, A. M., Crona, B., Tengö, M., & Lubell, M. (2016). Theorizing benefits and constraints in collaborative environmental governance: A transdisciplinary social-ecological network approach for empirical investigations. *Ecology and Society, 21*(1), 40. https://doi.org/10.5751/ES-08368-210140

Bodin, Ö., Sandström, A., & Crona, B. (2017). Collaborative networks for effective ecosystem-based management: A set of working hypotheses. *Policy Studies Journal, 45*(2), 289–314. https://doi.org/10.1111/psj.12146

Buskens, V. (1998). The social structure of trust. *Social Networks, 20*(3), 265–289. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0378873398000057

Canadian Thousand Islands Heritage Conservancy. (2002). World network of biosphere reserves biosphere reserve nomination form: Canadian Thousand Islands — Frontenac Arch Biosphere Reserve.

Carlsson, L., & Berkes, F. (2005). Co-management: Concepts and methodological implications. *Journal of Environmental Management, 75*, 65–76. https://doi.org/10.1016/j.jenvman.2004.11.008

Castro, A. P., & Nielson, E. (2001). Indigenous people and co-management: Implications for conflict management. *Environmental Science and Policy, 4*, 229–239. https://doi.org/10.1016/S1462-9011(01)00022-3

Crowe, J. (2007). In search of a happy medium: How the structure of interorganizational networks influence community economic development strategies. *Social Networks, 29*(4), 469–488. https://doi.org/10.1016/j.socnet.2007.02.002

Dietz, T., Ostrom, E., & Stern, P. C. (2003). The struggle to govern the commons. *Science, 302*, 1907–1912. https://doi.org/10.1126/science.1091015

Edelenbos, J., & van Meerkerk, I. (2015). Connective capacity in water governance practices: The meaning of trust and boundary spanning for integrated performance. *Current Opinion in Environmental Sustainability, 12*, 25–29. https://doi.org/10.1016/j.cosust.2014.08.009

Emerson, K., Nabatchi, T., & Balogh, S. (2012). An integrative framework for collaborative governance. *Journal of Public Administration Research and Theory, 22*(1), 1–29. https://doi.org/10.1093/jopart/mur011

Ernstson, H., Barthel, S., Andersson, E., & Borgström, S. T. (2010). Scale-crossing brokers and network governance of urban ecosystem services: The case of Stockholm. *Ecology & Society, 15*(4), 28. https://doi.org/10.5751/ES-03692-150428

Fearon, J. D., & Laitin, D. D. (1996). Explaining interethnic cooperation. *American Political Science Review, 90*(4), 715–735. https://doi.org/10.2307/2945838

Fischer, M. (2015). Collaboration patterns, external shocks and uncertainty: Swiss nuclear energy politics before and after Fukushima. *Energy Policy, 86*(November), 520–528. https://doi.org/10.1016/j.enpol.2015.08.007

Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources, 30*, 441–473. https://doi.org/10.1146/annurev.energy.30.050504.144511

Georgian Bay Biosphere Reserve Inc. (2004). *Nomination submission from Canada for the Georgian Bay Littoral Biosphere reserve*. Retrieved from https://www.gbbcr.ca/our-organization/

Hahn, T., Olsson, P., Folke, C., & Johansson, K. (2006). Trust-building, knowledge generation and organizational innovations: The role of a bridging organization for adaptive co-management of a wetland landscape around Kristianstad, Sweden. *Human Ecology, 34*(4), 573–592. https://doi.org/10.1007/s10745-006-9035-z

Henry, A. D., & Volland, B. (2014). Networks and the challenge of sustainable development. *Annual Review of Environment and Resources, 39*(1), 583–610. https://doi.org/10.1146/annurev-environ-101813-013246

Ingold, K., & Fischer, M. (2014). Drivers of collaboration to mitigate climate change: An illustration of Swiss climate policy over 15 years. *Global Environmental Change, 24*(January), 88–98. https://doi.org/10.1016/j.gloenvcha.2013.11.021

Jonérgard, S. (2011). *East Vättern Scarp Landscape – Biosphere reserve nomination form*. Jönköping, Sweden: Municipality of Jönköping.

Klijn, E.-H., Steijn, B., & Edelenbos, J. (2010). The impact of network management on outcomes in governance networks. *Public Administration, 88*(4), 1063–1082. https://doi.org/10.1111/j.1467-9299.2010.01826.x

Koontz, T. M., & Thomas, C. W. (2006). What do we know and need to know about the environmental outcomes of collaborative management? *Public Administration Review, 66*(1), 111–121. https://doi.org/10.1111/j.1540-6210.2006.00671.x

Leach, W. D., & Sabatier, P. A. (2005). To trust an adversary: Integrating rational and psychological models of collaborative policymaking. *American Political Science Review, 99*(4), 491–503. https://doi.org/10.1017/S000305540505183X

Lubell, M. (2015). Collaborative partnerships in complex institutional systems. *Current Opinion in Environmental Sustainability, 12*(February), 41–47. https://doi.org/10.1016/j.cosust.2014.08.011

Lubell, M., Jaysy, L., & Hasting, A. (2017). Network governance for invasive species management. *Conservation Letters, 10*(6), 699–707. https://doi.org/10.1111/conl.12311

Lubell, M., Robins, G., & Wang, P. (2014). Network structure and institutional complexity in an ecology of water management games. *Ecology and Society, 19*(4), 23. https://doi.org/10.5751/ES-06880-190423

Lusher, D., Koskinen, J. H., & Robins, G. (2013). *Exponential random graph models for social networks: Theory, methods, and applications*. Cambridge, UK: Cambridge University Press.

Margerum, R. D. (2011). Beyond consensus: Improving collaborative planning and management. *The MIT Press*. https://doi.org/10.7551/mitpress/9780262015813.001.0001

Marin, A., Bodin, Ô., Gelich, S., & Crona, B. (2015). Social capital in post-disaster recovery trajectories: Insights from a longitudinal study of tsunami-impacted small-scale fisher organizations in Chile.
