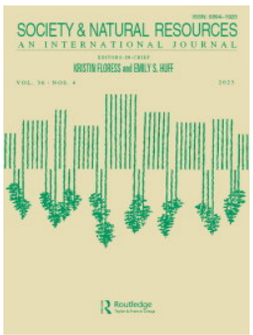

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REVIEW ARTICLE

A Systematic Review of Key Factors of Effective Collaborative Governance of Social-Ecological Systems

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ABSTRACT

Sustainable resource management requires governance systems that facilitate effective collaboration among a variety of stakeholder interests, across jurisdictional scales and resource sectors. Yet, there is not widespread scholarly agreement on the key ingredients that need to be present to facilitate the effective collaborative governance of natural resources. To address this scholarly gap, we conducted a systematic literature review which revealed 17 publications that compiled essential lists of key factors for effective collaboration. From these studies across multiple disciplines, we identified 22 common factors associated with effective collaborative natural resource management, including near unanimous acceptance of the importance of nested governance structures and conflict resolution mechanisms. These 22 factors, along with additional contextual and outcome-oriented factors, could begin to form a core set of factors to comparatively test large numbers of case studies on collaborative governance of social-ecological systems around the world.

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Collaborative governance; collaborative resource management; collective action; community-based natural resource management; co-management; institutional analysis; institutional design principles; RepOrting standards for systematic evidence synthesis (ROSES); review areas; social-ecological systems

Introduction

In theory and in practice, there has been increasing emphasis on collaborative natural resource management (Gash 2022; Sørensen and Torfing 2021). Collaboration is useful for mitigating numerous challenges, including limited finances, devolution of resource control, and the increasing complexity of intertwined issues facing resource managers. At local and global levels, interdependence and collaboration are contemporary realities of managing natural resources sustainably, contributing to the adaptive capacity of social-ecological systems (SES), i.e., their ability to cope with change (Schoon et al. 2021; Cheng et al. 2015; Folke et al. 2005).

Extant collaborative natural resource governance studies are hampered by the heterogeneity of researchers' approaches to answering similar questions around the effectiveness of collaborative governance (Cox et al. 2020, Cumming et al. 2020, Pacheco-Romero

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et al. 2020, Magliocca et al. 2018). Similar aspects of collaboration are highlighted differently in case studies across disciplines, including political science, public policy, geography, economics, sociology, environmental studies, sustainability, and more. The use of differing frameworks and variables to measure similar conditions and factors inhibits researchers' ability to make generalizations across numerous cases, or identify knowledge gaps (Cox et al. 2020). This paper pulls together key factors from studies across numerous disciplines that were deemed pivotal to the success of collaborative natural resource governance.

Due to our focus on applicability across disciplines, we apply broad and inclusive definitions of collaborative governance and other relevant terms. We see collaborative governance as "effectively solving societal problems with improved structures of nonhierarchical and decentralized institutions" (Kapucu, Yuldashev, and Bakiev 2009). Our goal has been to find agreement on concepts and terms across disciplines. We found that the public administration literature tends to specify government inclusion in collaborative governance more than the literature in other disciplines. We consider "management" to be more operationally focused than the overarching term "governance", but we deemed these semantic differences less important than the similarities.

The need to unify key factors in collaborative governance across disciplines has been identified by numerous scholars. Agrawal (2003) called for the examination of comparative case studies and meta-analyses to generate a more complete set of requisite conditions and factors of sustainable and effective commons management that can further inform empirically based commons theory. This was echoed by Poteete, Janssen, and Ostrom (2010) in their call for a shift away from single study findings to large-scale syntheses and generalizable results. Basurto and Ostrom (2009) recommended the development of an interdisciplinary diagnostic framework to provide a foundation for further empirical research from which to build theory. In response, multi-case studies and metastudies have increased.

While there are numerous frameworks, models (e.g. Sabatier and Mazmanian 1980, Ostrom 2005, Ostrom 2009a, Emerson, Nabatchi, and Balogh 2012, Koontz et al. 2015, Newig et al. 2018) and overlapping lists of key factors to aid in the assessment of collaborations – including conditions important to successful fisheries (Pomeroy, Katon, and Harkes 2001) and the effective co-management of protected areas (De Pourcq et al. 2015) – there is no single set of agreed-upon core factors of collaborative SES governance that transcend resource sectors and academic disciplines. Ostrom's design principles (DPs) (Ostrom 1990) provide the most empirically tested set of generalizable resource governance criteria. However, we are cognizant of criticism of DP emphasis on SES rules and lack of attention to the social processes, dynamics and contexts within which these rules are embedded. We address this criticism, and the transectoral and disciplinary gaps by distilling sets of process and contextual factors identified in publications from a variety of social science disciplines and adding them to Ostrom's DPs.

Beginning our analysis with Ostrom's eleven modified DPs for long-enduring institutional arrangements (Cox, Arnold, and Villamayor-Tomas 2010) established a well-studied and supported foundation that included the governance factors necessary to address collective action dilemmas. We then derived another 11 factors from the literature, and categorized all factors into three categories: (1) rules (conditions of the project that outline

required, desired, or prohibited behaviors, rights, and responsibilities of actors, e.g., monitoring obligations); (2) processes (aspects of the methods and procedures used to implement the project, meant to facilitate collaboration and improve the project context, e.g., building knowledge); and (3) context (system conditions, e.g., levels of trust and social capital).

Our study addressed the question: What core factors of effective collaborative resource governance/management have found agreement across various disciplines? We define an effective collaborative resource governance system as one that is able to reach the resource management objectives it has set for itself. Identifying and agreeing on such factors would support on-the-ground evaluation and planning for collaborative governance, and facilitate small- and large-N comparative SES case study analyses.

Enabling conditions for effective natural resource governance are crucial when governance is viewed as an emergent feature of coupled SES (Anderies and Janssen 2013, Anderies, Janssen, and Schlager 2016). Written policies are perceived, influenced, and operationalized by their social systems (i.e., attributes of the community; implementing actors) within a particular ecological system. More rigorous analyses of large numbers of case studies are needed to reveal the connection between institutional elements including rules, processes, and contexts (Cumming et al. 2020), and utilizing a common set of core factors linking these elements together is necessary to do so (Ostrom 2007).

Our study complements other research projects, including the Collaborative Governance Case Database (CGCD) (Douglas et al. 2021) and the SCAPE analytical framework for environmental governance systems (Newig et al. 2013). The CGCD offers a variable set for the assessment of any collaborative governance system. The SCAPE analytical framework advances variables associated with collaborative processes, contexts, and their outputs/outcomes. While some of the variables identified in CGCD and SCAPE align with factors we identified, both the CGCD and SCAPE developed their own coding tools/manuals for their meta-analyses.

Our systematic literature review identified key factors deemed important to effective collaborative resource governance, including the literature on collective action and common-pool resource management (which tends to focus on institutional DPs and rules governing use of a resource), the literature on collaborative governance and adaptive management (which tends to focus more on the social dynamics of the collaborative process), and the literature on resilience of SES (which tends to include a mix of these, with more of a focus on the environmental systems themselves). Table 1 details the consulted literature clusters.

Methods

Overview

We conducted a traditional literature review followed by a systematic literature review. To be included, the studies had to draw on a minimum of three cases and produce a list of core factors of effective collaborative governance systems. We then matched the core factors across studies to find those that had broad agreement.

The initial literature review and pile-sort was conducted in 2017, and the subsequent modified, systematic review using the RepOrting standards for Systematic Evidence

Table 1. Disciplinary categories of the literature reviewed, and factors emphasized.

Sub-disciplinary bodies of theory:	Publications with a list of core components of effective collaboration:	Factors emphasized
Common Pool Resource theory/Collective Action	Ostrom and Cox (2010); Cox et al. (2010); Dietz, Ostrom, and Stern (2003); Fleischman et al. (2014; Gari et al. (2017)	Institutional design / rules
Adaptive Collaborative Management	Plummer et al. (2012); Armitage et al. (2009); Plummer and Armitage (2007)	Flexibility in design; importance of process; social learning; knowledge building
Community-based natural resource management (CBNRM)	Gruber (2010); Fabricius and Collins (2007); Delgado-Serrano et al. (2018); Ruiz-Mallén and Corbera (2013)	Institutional design with increased emphasis on process
Public Administration: Collaborative Governance	Ansell and Gash (2007); Cheng and Sturtevant (2012)	Importance of process; key role of government / public sector; emergent properties of social dynamics
Resilience and Adaptive Governance	Olsson et al. (2006)	Social learning; adaptive institutions
Political Science: International Environmental Governance	Young (2002); Stern (2011)	Institutional fit

Syntheses (ROSES) procedure (Haddaway et al. 2018) was done in 2021. Conducting a systematic review following a preliminary literature review provides a rigorous approach to the identification of potentially relevant research (Mizrahi et al. 2019).

Step One: Literature Review and Pile-Sort

Starting with Ostrom's (1990) *Governing the Commons* and several publications which built on her work (e.g., Dietz, Ostrom, and Stern 2003, Armitage et al. 2009), we then searched for other resource governance studies that identified lists of key factors and conditions for effective collaboration (Olsson et al. 2006, Plummer and Armitage 2007, Plummer et al. 2012, Gruber 2010). We noticed significant overlap in the published lists of key factors which we tracked by sorting and matching all factors identified to build Table 2[1].

Sorting and matching: Each of the key factors identified in the selected publications were written onto index cards and sorted into categories (i.e. piles) using a two-step pile-sort process (Bernard, Wutich, and Ryan 2017). First, two of the paper's authors individually sorted the index cards into categories based on the common language and intent of the identified factors. Second, both authors jointly reviewed and cross-compared the results of their pile sorts, discussed and resolved any inconsistencies, before sorting the factors into three overarching governance categories (rules, process, and context), and creating a series of tables of quotes for further analysis (see supplementary materials).

Several studies included multiple sets of variables. In those instances, we selected the set of factors that aligned with our research question (see Table 2 footnotes). For example, in Ostrom and Cox (2010), we reviewed all 66 SES variables for matches, but only included variables relevant to collaborative governance; i.e., those in the *Actors and Action situations* categories.

The resulting list contained the eleven factors identified by Ostrom and colleagues as important to the design of *rules,* (Cox, Arnold, and Villamayor-Tomas 2010), plus six

Table 2. Key factors of effective collaborative natural resource governance systems identified in multi-case studies and meta-studies from multiple disciplines:Table 2 represents a synopsis of our findings. Each publication was assessed for each factor on a scale as follows: 0 (factor not listed in that literature), 1 (factor is listed), or .5 (factor is covered to some extent, but not fully – either not in the list, but elsewhere in that piece of writing, or covered only in a very general way). We used 1+ to indicate that this factor was mentioned more than once or included in various ways in the article indicated. (in supplemental materials, we provide a sheet with the quoted words from each article/book). Each column represents one piece of literature reviewed (see below for listing of literature). Column "#" provides a summary count for each factor across publications reviewed (e.g., the summary count of "user rights" is 10.5).

KEY FACTORS of EFFECTIVE COLLABORATIVE NATURAL RESOURCE GOVERNANCE SYSTEMS																		
RULES:	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	#
1 User rights	1	1	1 +	0	1	0	0.5	0	1+	1	1+	0	1	1	1	1	0	11.5
2 Resource boundaries	1	1	1	0	1	0	0	0	0	0	1	0	1	1	1	1	0	9
3 Fits ecology and culture	1	1	1+	1	0	0	1	0	1+	1+	1	0	1	1	0	1	0	11
4 Equity	1	0.5	0.5	0	0	0	1+	1+	0.5	1	1	0	1	1	1	1	0	10.5
5 Collective choice	1	1	1	1	1	0	1+	0.5	1+	1+	1+	1+	1	1	0	1	1	14.5
6 Monitoring resource	1	1	1	0	0	1	0	1+	0	1	1	0	1	1	1	1	1	12
7 Monitoring monitors	1	1	1	1	0	1	0.5	1	0	1	1	0	1	1	1	0	0	11.5
8 Graduated sanctions	1	1	1	1	0	0	0	1+	0	0	1	1+	1	1	0	0	0	9
9 Conflict resolution	1	1+	1	1	0	1	1+	1	1	1	1	0	1	1	1	1	1	15
10 Rights to organize	1	1	1	1	1	0	1+	0	1	1	1+	1	1	1	1	1	0	14
11 Nested enterprises	1	1	1	1	0.5	1	1	1	0.5	1+	1	1	1	1	1	1	1	16
PROCESS:	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	
12 Institutional Adaptability	0	1+	0	1	1	1	0	1	0.5	1+	1	1	0	0	0	0	0	8.5
13 Vision & Commitment	0	0	0	0	1	1+	1	0	0.5	1+	1	1	0	0	1	0	1	8.5
14 Leadership	0	0	1	0	1	1	1	0	1	1	1	1	1	0	0	1	1	11
15 Social learning	0	0	0	0	1	1	0	1	1	1	1+	1	0	0	0	0	1	8
16 Capacity	0	0	1+	1	1	1	1	1	0.5	1+	1	1	0	0	1	1	1	12.5
17 Building Knowledge	0	1	1	1+	0	1+	1	0	1+	1+	1+	1	0	0	1	1	1	12
CONTEXT:	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	
18 Prior Networks	0	0	0		0	1+	0.5	0	1	0.5	0.5	0	0	0	1	0	0	4.5
19 Trust & Social cap.	0.5	0.5	1	0.5	0.5	1	1	0	1	1	1+	1	1	0	0	1	1	12
20 Resource Dependence	0.5	0	1	0	0.5	0	1	0	0	0	1	0.5	1	1	0	1	0	7
21 Group size	0.5	0	1	1	1	0	0	0	0	0	0	0	1	1	0	1	0	6.5
22 Group homogeneity/ heterogeneity	0.5	1	0	1	1	0	1	1	0.5	0	1	0	1	1	0	0.5	0	9.5

A. Cox, Arnold, and Villamayor-Tomas (2010) (In reviewing this publication, we also considered the related publications Ostrom [1990, 2009b]).
B. Dietz, Ostrom, and Stern (2003).
C. Ostrom and Cox (2010, focus on last two categories: "Actors" and "Action Situations").
D. Stern (2011).
E. Armitage et al. (2009).
F. Olsson et al. (2006).
G. Ansell and Gash (2007).
H. Young (2002).
I. Plummer et al. (2012, Table 2).
J. Plummer and Armitage (2007, Table 1).
K. Gruber (2010, Table 1).
L. Ruiz-Mallén and Corbera (2013, Table 3).
M. Gari et al. (2017).
N. Fleischman et al. (2014).
O. Fabricius and Collins (2007).
P. Delgado-Serrano et al. (2018, especially Table 3).
Q. Cheng and Sturtevant (2012).

process and two *contextual* factors. We mapped these factors onto Ostrom's Institutional Analysis and Development (IAD) framework (Ostrom 2005) to theorize on their potential interactions.

Step Two: Systematic Review Process

To complement the traditional literature review, we conducted a systematic review to find peer-reviewed publications in other social science disciplines that identified factors important to collaborative governance. We utilized the Scopus database which includes over 87 million records from more than 7,000 publishers (Scopus 2022) and consistently provided more expansive search findings than other databases we tested. We developed a search string based on an adjusted version of the PICOS (population, intervention, comparison, outcomes, and study type) model (Methley et al. 2014) and included an expansive set of initial terms based on the following two categories:

1. Population of interest: Articles reporting on natural resource governance
2. Intervention of interest: Collaboration

Although terms for the other PICOS categories (comparison, outcomes and study type) were initially included, they yielded no additional returns. The final search string was the result of an iterative testing process in which various combinations of terms were tested for relevance and the number of results. Search terms that returned very few or unrelated articles were removed from the string. Figure 1 reflects the final two-part search string that included the population and intervention terms.

The Figure 1 search string returned 258 articles in February 2021, of which only one was a duplicate from the traditional literature review; an indication that we were finding relevant articles from a wider array of disciplines. Using Colandr, a systematic bibliometric analysis tool (Cheng et al. 2018), we participated in iterative rounds of evaluating the identified articles for inclusion in our review based on the following criteria:

1. Focus on collaborative natural resource governance/management.
2. Inclusion of a list of factors important to effective collaboration.
3. Inclusion of three or more case studies.
4. Reported research was *not* a retest of Ostrom's DPs.
5. Reported research was *not* focused on a specific sector (e.g., collaborative governance of small-scale fisheries) since the goal of our study was to identify factors that are broadly generalizable across resource sectors[2].

```
TITLE-ABS-KEY("natural resource governance" OR "collaborative conservation" OR
"community-based natural resource management" OR "community conservation" OR "common-
pool resource management") AND TITLE-ABS-KEY("collaboration" OR "co-management" OR
"design principles" OR "resilience" OR "adaptive co-management")
```

Figure 1. Finalized search string as applied to Scopus in February 2021.

We excluded 206 articles at the title and abstract level (see Figure 2 for the RoSES diagram). The remaining 51 articles were reviewed at the full text level. Two of the 51 articles were not accessible for review. Of the remaining 49 papers, 43 were excluded at the full text level because they did not meet one or more of the inclusion/exclusion criteria outlined above. The remaining six articles were then added to the original set of 11 works, resulting in 17 publications included in our analysis.

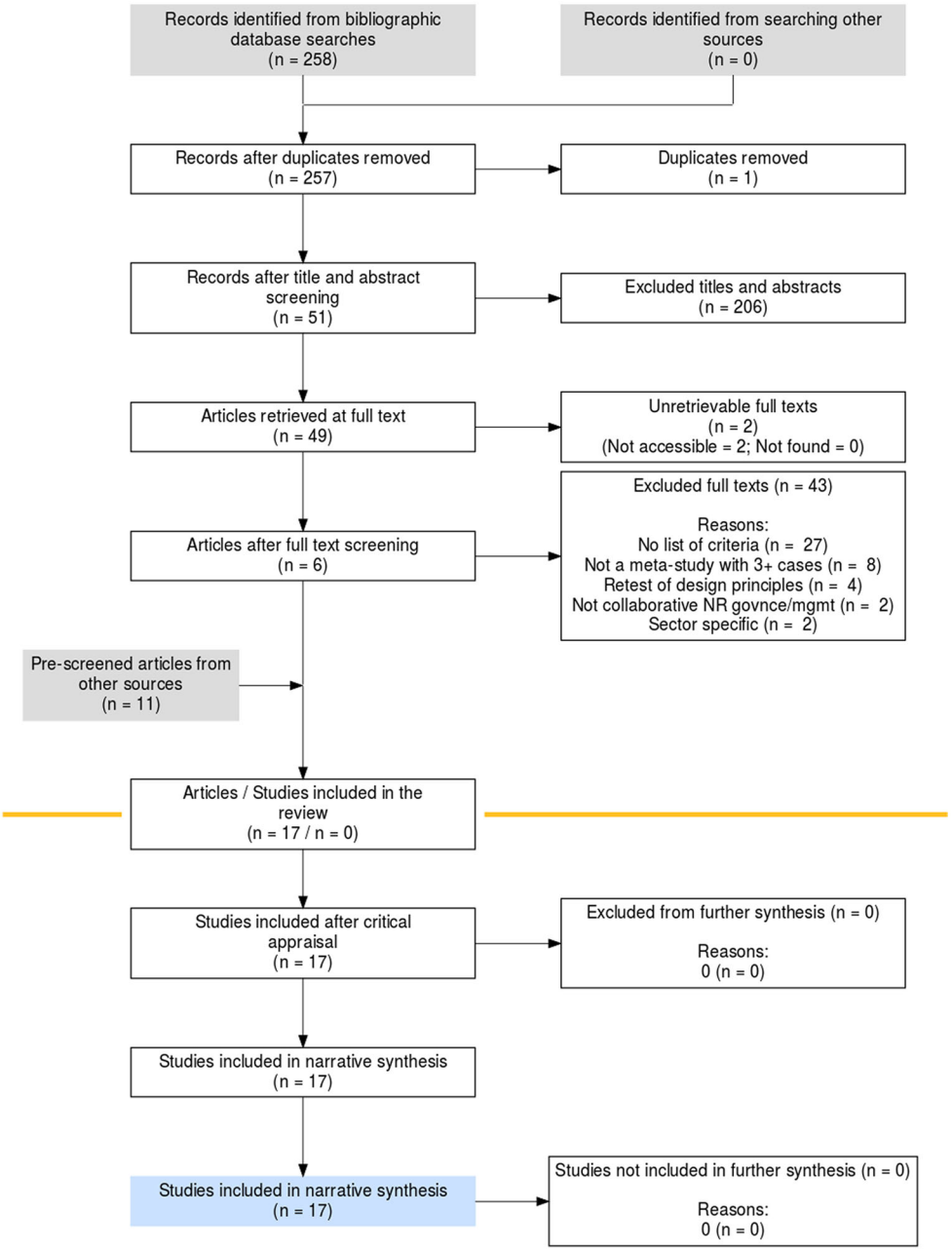

Figure 2. ROSES diagram for our systematic review outlining the process.

We then assessed the effective collaborative resource governance factors reported in each of the six new articles and compared them to the list of factors identified in Step One. This led to the identification of an additional three factors, all of which were contextual. We then re-reviewed the original eleven articles to determine whether they included the three new factors identified and adjusted our findings.

The next section describes the final list of factors. While the matching and distillation process was interpretive, the factor descriptions draw on the original definitions while being sensitive to subtle differences in descriptions, as needed (see number 22, for example) and as suggested for conceptual clarity by Ansell (2021).

Results

Our analysis shows that among collaborative SES governance publications, there is a large degree of agreement on common factors of effectiveness. We identified a set of 22 factors (11 *rules*, 6 *process*, and 5 *contextual*) across several disciplines. We offer these as a manageable set of foundational criteria useful to the analysis and design of resource governance systems across sectors and jurisdictional scales (see Table 2). Table 2 provides the raw count of inclusion of a particular factor in the included literature and is intended as a guide to what factors were discussed more frequently in the meta-studies. Further research is needed to ascertain the value of these factors as indicators of effective collaborative governance systems. We invite testing of this list.

Below are brief descriptions of the 22 key factors of effective collaborative resource governance systems that were deduced from our review. See the supplementary materials (Quotes tables A-E) for the original factor descriptions.

1. *User rights*: Users' rights to access and use resources are clearly defined.
2. *Clear resource boundaries*: Resources with clearly defined boundaries (e.g. fish in a pond) are easier to monitor than a resource without clearly defined boundaries, (e.g. marine fishery).
3. *Resource harvesting rules are congruent with ecology and culture*: The rules governing resource use are environmentally sustainable and fit within the social context.
4. *Equitable resource use* (cost/benefit proportionality): The benefits of collaboration must outweigh the costs of participating.
5. *Collective choice arrangements*: Most individuals affected by the operational rules (the rules governing daily decision-making and action, e.g., when and where can I fish?) can participate in modifying these rules (e.g. fishers can participate in a fishing cooperative and vote on establishing fishing quotas and access to the fishery).
6. *Monitoring resources & use*: Monitoring of resource conditions and usage are essential for assessing their status.
7. *Monitoring the monitors*: Monitors are accountable to resource appropriators, are seen as credible by all parties, and ideally have a vested interest in sustaining the resource.

8. *Graduated sanctions*: A continuum of consequences exists for rule violations, ensuring that the punishment is proportional to the severity and frequency of the misconduct.
9. *Conflict resolution mechanisms*: Conflict resolution arenas are available at low cost to quickly resolve conflicts.
10. *Recognition of rights to organize*: Rights of collaborators to devise their own institutions are not challenged by authorities.
11. *Nested enterprises*: Governance activities in large-scale systems are polycentrically organized in multiple coordinated jurisdictional layers.
12. *Institutional adaptability, flexibility, and/or variety*: Progress is regularly reviewed, and rules and management activities are subject to revision based upon feedback and results. This is a form of flexibility in planning and establishing rules. It may be advantageous to apply a variety of types of rule systems (e.g., a mix of hierarchical and decentralized governance).
13. *Long-term commitment & shared vision*: There is a shared vision of goals, and long-term commitment of stakeholders/collaborators.
14. *Leadership*: An individual or team able to foster collective action can lead a group toward a common vision.
15. *Social learning:* Learning together, collectively, through inquiry or experimentation, and then using the new knowledge gained.
16. *Capacity*: Institutions are created and maintained through the skills and abilities of the stakeholders involved.
17. *Building knowledge*: Activities and processes are in place to gather (e.g., scientific studies) and disseminate knowledge (information sharing) throughout and beyond the group (e.g., publications, speaking events, public meetings etc.).
18. *Prior Networks*: Early networks established before a collaborative governance arrangement is formalized bring together key stakeholders and facilitate development of a common vision.
19. *Trust & Social capital*: These are necessary ingredients of collaboration. Trust is needed to work together and establish rules for resource governance. Social capital is built and drawn upon in the process.
20. *Resource Dependence*: The dependence of a community on a particular resource may have differing effects in different cases. (directionality unclear)
21. *Group size*: The number of active stakeholders/collaborators may affect the success of collaborative governance. (directionality unclear)
22. *Group homogeneity/heterogeneity*: Similarities and differences between the collaborators may affect the outcomes of collaboration. (directionality unclear)

Discussion

Our research showed that a holistic institutional analysis of the collaborative governance process requires thoughtful attention to the rules, processes, and contextual dynamics. An effective governance system needs to include *rules* that govern actions. There needs to be a *process* facilitating the implementation of the collaborative governance system, and these rules and processes have to be crafted in a manner that is appropriate and

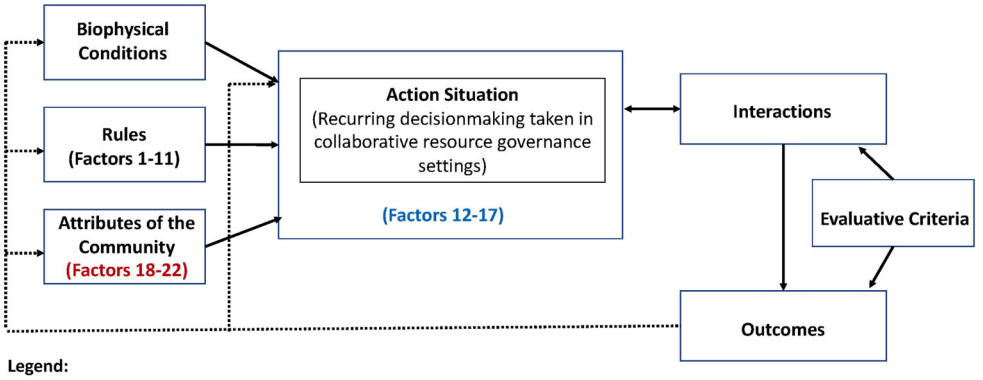

Figure 3. The 22 factors categorized according to the organization of the IAD framework (Ostrom 2005).

sensitive to a particular *context*. We use the IAD to visualize potential linkages among factors and their potential to affect collaborative decision-making (Figure 3).

As noted in Table 1, some publications (Ostrom 1990; Cox, Arnold, and Villamayor-Tomas 2010; Young 2002; Stern 2011; Dietz, Ostrom, and Stern 2003) emphasize institutional design (i.e., the rules, norms, and shared strategies that guide interactions) as key to effective outcomes, while others (Ansell and Gash 2007; Olsson et al. 2006; Plummer et al. 2012) prioritize collaborative governance *processes*, including the more elusive (or challenging to control) emergent properties of social dynamics (such as leadership, capacity building, social learning etc.). Yet the process-oriented literature still acknowledges the importance of institutional design, while focusing on the social aspects of collaboration as key process factors for successful outcomes. Context matters in all instances because contextual factors may affect whether actors choose to collaborate in the first place, and/or determine how formalized the collaborative process needs to be (Ostrom 1990).

The first eleven factors in Table 2 are the "rules" factors derived from Ostrom's DPs, which have undergone much academic scrutiny (e.g., Cox, Arnold, and Villamayor-Tomas 2010; Baggio et al. 2016; Anderies, Janssen, and Schlager 2016) and have been found to be reliable indicators for long-enduring and effective governance systems at various jurisdictional levels (e.g. Keohane and Ostrom 1995; Young 2002; Stern 2011). The last eleven process and context factors warrant more in-depth discussion, as they are less explored than the DPs.

Figure 3 illustrates how the 22 factors are organized within the IAD framework. The *process factors* (Factors 12–17) are generated by the interactions among collaborators in an action situation, which is any forum where collaborators "are faced with a set of potential actions that can jointly produce outcomes" (Ostrom 2005, 32) relevant to the resource and users. Ostrom's expanded DPs (Factors 1–11) motivate the IAD's *rules* component by providing the regulative constraints and permissions on decision-making actors.

The *contextual factors* (Factors 18–22) are part of the attributes of the broader community within which the collaboration is embedded and outline the social/environmental considerations that influence decision-making.

Process Factors

Institutional adaptability, flexibility and variety can help a collaboration avoid setbacks caused by rigid or inflexible rules (Wondolleck and Yaffee 2000). Adaptive management requires flexibility, or a variety of different institutional types (Dietz, Ostrom, and Stern 2003; Plummer and Armitage 2007; Olsson et al. 2006; Stern 2011) in a nested polycentric governance structure.

Long-term commitment and shared vision are built over time through interaction among collaborators. This includes sharing power and responsibility and mobilizing support (Plummer and Armitage 2007; Olsson et al. 2006; Ansell and Gash 2007; Armitage et al. 2009).

When effective *leadership* is able to foster collective action toward a common vision it affects all aspects of collaboration and fosters sustainable resource stewardship. It must be attuned to the group's needs and dynamics and respond accordingly. Leadership may be demonstrated by multiple individuals who coordinate efforts across scales (Ruiz-Mallén and Corbera 2013; Gari et al. 2017), build networks, reconcile problems and resolve conflict, build group trust, or foster novel thinking (Armitage et al. 2009; Plummer et al. 2012; Gruber 2010). Often, one person or group takes on key tasks (Armitage et al. 2009; Plummer et al. 2012; Gruber 2010). Such key individuals are variously referred to as policy or institutional entrepreneurs, champions, social innovators, or transformative agents (Westley et al. 2013). Effective leadership can lead to successful resource governance even in cases that are missing many other key factors (Barnett et al. 2016).

Social Learning can be purposely orchestrated and/or organically emerge from the collaborative process. What the group learns socially is different from what any individual would learn without the interactive process, as the group shapes the process collectively. A social process of shared decision-making may draw upon various knowledge systems and ways of knowing. Social learning is widely considered to be a core component of collaboration (Armitage et al. 2009; Olsson et al. 2006; Plummer et al. 2012; Young 2002; Gruber 2010).

Building knowledge often involves bringing in experts, presenting scientific findings, disseminating important information about policy processes, ecological conditions, or other relevant knowledge, whether scientific, traditional, local or other, that helps to shape the collective decision-making approach. Dietz, Ostrom, and Stern (2003) note the importance of "providing trustworthy information about environmental conditions and human-environment interactions."

Knowledge building helps expand the *capacity* of a group to plan and respond to concerns. Other important aspects of capacity building include the ability to secure and mobilize resources and develop and strengthen participants' skills. Building capacity may include training, securing grants and donations, enhancing the network, connecting

with decision-makers and other powerful allies, increasing visibility of the work, or peer-to-peer learning (Armitage et al. 2009; Plummer and Armitage 2007; Young 2002).

Contextual Factors

There have been calls for better understanding the interaction between mechanism-based theories of institutions and contextual factors (Ostrom 2009b; Baland and Platteau 1996; Agrawal 2003; Cockburn et al. 2020; Cumming et al. 2020; Ferraro and Agrawal 2021). While there are numerous contextual factors that can come into play, this review revealed five that surfaced repeatedly: trust and social capital, prior networks, resource dependence, group size, and group homogeneity. While the first two are always seen as positive, there is more debate surrounding the last three.

Literature on the adaptive capacity of collaborative governance highlights the importance of social capital (Cheng et al. 2015). Effective collaborative efforts often first must work to build *trust and social capital,* which can be done through carefully structured facilitation processes and informal socializing (Wondolleck and Yaffee 2000). Ansell and Gash (2007) emphasize the central importance of building and maintaining trust (the word "trust" appears 53 times in their paper), noting that doing so can be time consuming. Ostrom acknowledged that trust and mutual respect were *essential pre-requisites* to the existence of functional institutions (Ostrom 1990, 2009b). Although these conditions were not formally captured within the DPs themselves, they informed the development of early common-pool resource governance theory (Ostrom and Walker 2003). Social capital is also included in the SES variables (Ostrom and Cox 2010). Unfortunately, many natural resource collaborations are initiated in a context of deep distrust (Ansell and Gash 2007; Wondolleck and Yaffee 2000).

One way that trust and social capital are sometimes built over time is through *prior networks* that bring people together to talk through issues before collaboration is formalized. These fora are often the catalysts/progenitors of higher profile collaborative efforts which may serve to bridge divides and bring agreement on a common vision for resource governance. Olsson et al. (2006) call these "shadow networks", working behind the scenes to build common ground upon which the subsequent formal collaboration is built. Mattor and Cheng (2015) found that prior networks were a major success factor in U.S. collaborative forest management cases.

The *resource dependence* of a community on a particular resource(s) is often cited as a key explanatory contextual variable (Ostrom and Cox 2010; Ansell and Gash 2007; Gruber 2010; Gari et al. 2017; Fleischman et al. 2014; Delgado-Serrano et al. 2018). High resource dependence may encourage efforts to manage a resource. For example, Nagendra and Ostrom (2014) describe cases in India in which dependence on lakes led to stewardship. However, high resource dependence may also lead to unsustainable use (Fleischman et al. 2014; Chhatre and Agrawal 2008).

Group size refers to the number of active stakeholders or collaborators in a natural resource governance collaboration. The connection between group size and collective/collaborative action has been investigated since Olson's (1965) seminal writing on the topic. Smaller groups engaged with and impacted by resource management tend to be more successful than larger groups (Stern 2011, Armitage et al. 2009; Gari et al. 2017), but

there are notable exceptions where larger groups collaborate effectively (e.g., Fleischman et al. 2014). This also ties into the issue of scale, discussed in the next section.

The reviewed literature was most divergent on the effect of *group homogeneity/heterogeneity*. Some emphasized the importance of group homogeneity and shared social norms for the success of collaborative governance (Gari et al. 2017; Armitage et al. 2009), while others stress the importance of representing a diversity of different groups in collaborative governance (Ansell and Gash 2007; Gruber 2010). Underscoring the complexity of this factor (Vedeld 2000), Fleischman et al. (2014, 445) found that "groups are more likely to resolve a collective action problem when they are small, share common interests and identities, but are heterogeneous in terms of wealth and endowments." This finding also shows that the interplay between contextual factors matters, highlighting the need for greater understanding of these interactions.

Addressing Common Criticisms of Ostrom's Design Principles

Ostrom's DPs represent an effort to understand why the results of processes designed to foster collective action in resource governance systems are robust in some cases but fail in others (Ostrom 2009b). As such, the DPs should be viewed as core criteria of robust common pool resource governance systems which stand in contrast to variables that specifically test for factors that facilitate (or inhibit) resource users from organizing to solve collective action problems (e.g., group size, leadership, market integration, resource dependence) (Ostrom 2009b, 38).

Common criticisms include: (1) DP incompleteness, including their failure to investigate critical social and ecological factors and to consider external factors important to sustainable natural resource management, such as power dynamics and inequality within communities and between communities and other levels of governance; (2) their limited applicability to the assessment of common-pool resource (CPR) systems at higher governance scales (e.g. international level); and (3) their narrow focus on formal rules and strategies which ignores complexity that extends beyond the institutional framework (Cox, Arnold, and Villamayor-Tomas 2010). We address (1) and (3) through the inclusion of specific context and process factors taken from newer sub-disciplines such as adaptive and collaborative management, as well as a search of the global resource governance literature for variables and key criteria that match or supplement the DPs (Table 2). However, we note that power dynamics are not well represented in the literature on the commons, and because the factors emerged from a review of the literature, power does not feature prominently. This doesn't mean that it shouldn't be explicitly included as a factor, and we are open to the addition of such a variable, but it should also be noted that power dynamics are implicitly embedded throughout the rules, process, and context variables. For example, collective choice and rights to organize are about the balance of power among levels and players. Leadership, a dynamic part of the process of governing, has a strong power dimension. Additionally, trust and social capital, prior networks, and group homogeneity or heterogeneity may affect power dynamics.

Criticism (2) was addressed through the inclusion of meta-analyses that were written for local level governance scenarios (e.g. Ostrom 1990; Gruber 2010), global level resource management (Young 2002; Stern 2011), or a mix of both (Dietz, Ostrom, and

Stern 2003; Armitage et al. 2009). Scale and cross-scale linkages are increasingly important, and although some have questioned their scalability, empirical studies have repeatedly shown their applicability to resource governance systems at a variety of governance scales (Ostrom 2005).

Conclusion

Based on our review of 17 metastudies and multi-case studies from various disciplines, we identify a set of 22 key factors of effective collaborative resource governance systems that transcend resource sectors and academic disciplines. We invite scholars to empirically test these factors in a variety of contexts. We have included our coding manual as supplementary material for those who wish to assess the factors' usefulness in understanding what makes collaborations work. Further research is needed to determine which factor configurations are likely to lead to effective collaboration and/or are associated with particular outcomes.

Identification of a core set of factors allows us to develop an interdisciplinary diagnostic framework that provides a foundation to facilitate meta-analyses of resource governance systems, and to better understand how to structure governance systems that can withstand social and environmental change (Basurto and Ostrom 2009; Poteete, Janssen, and Ostrom 2010). The factors interlink with the IAD framework, thereby, contributing to traditional rule-focused institutional analysis and moving us closer to Ostrom's vision of a universal set of building blocks that govern a wide variety of human interactions (Ostrom 2005). It complements extant research efforts aimed at identifying core variables of collaborative governance systems in general (Douglas et al. 2021), and variables important to the linkage between collaborative decision-making and outcomes (Newig et al. 2013).

Our work contributes to theories of collaborative governance of SESs by distilling key conditions of effective collaborative resource management identified across various disciplines to a manageable number to analyze interactions between these key factors. It also helps develop consistency in defining variables and meta-data across case studies on the management and governance of natural resources (Cox et al. 2020). Future research programs should test large numbers of case studies that use these factors to better understand interactions and patterns of correlation and causality between the factors and various outcomes, including which factors act as mechanism variables in which contexts (Agrawal 2003; Cockburn et al. 2020; Cumming et al. 2020).

For practitioners, this set of factors could be utilized to assist with the initial design of a collaboration and assessment of the context within which it is embedded, or to evaluate the effectiveness of an ongoing or completed collaboration. While there are similar tools available, the robustness of this set of factors comes from the distillation of key factors from studies across multiple disciplines to assess the effectiveness of any collaborative resource governance system.

- We conducted a systematic literature review across multiple social science subdisciplines, identifying 22 core factors of effective collaborative natural resource governance.

- Based on the characteristics of the factors, we organized them into three categories: contextual, process, and rules.
- We provide a coding manual to aid in further review and testing of these collaborative governance key factors, and to facilitate future case study comparisons and metastudies.

Notes

1. The predecessor to Table 2 is a series of tables containing the language selected from each article, which we have provided as supplementary materials.
2. While the Cheng and Sturtevant (2012) article included in our analysis focused on community-based forest governance systems, the aim of the paper was to analyze particular areas of collective action, including learning and decision-making, factors that are relevant across all resource governance systems.

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(** indicates publications that were included in the systematic review)

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