International Journal of the Commons

The Promise of Collective Action for Large-Scale Commons Dilemmas: Reflections on Common-Pool-Resource Theory

REVIEW ARTICLE

LANDON YODER
COURTNEY HAMMOND WAGNER
KIRA SULLIVAN-WILEY
GEMMA SMITH
*Author affiliations can be found in the back matter of this article

ubiquity press

ABSTRACT

It has become axiomatic that collective action is core to overcoming commons dilemmas. However, the popularity of the commons dilemma framing has led to its decoupling from canonical common-pool-resource cases. This decoupling is especially problematic for theorizing under what conditions collective action would emerge to solve complex, large-scale environmental problems, such as climate change, biodiversity loss, or ocean hypoxia. We argue that there is an over-emphasis on using diagnostic tools (e.g., the design principles), which has come at the expense of theory building for non-canonical cases. Canonical cases, such as fisheries, forests, or irrigation networks, rely on situations where salience of social dilemmas arises from joint costs and benefits actors face from allocating and sustaining a shared pool of livelihood-dependent resources. By expanding the commons definition to more generally mean shared needs or benefits, such as ecosystem services, the consequences of uses in large-scale CPRs, such as pollution, become less obvious. In this paper, we argue that it is particularly urgent to generate a revised theory of collective action for these types of cases, where environmental bads are core to the social dilemma. We contend that Ostrom's design principles represent a particular set of solutions to several interconnected and foundational aspects of group problem-solving: generating salience, achieving widespread participation, and ensuring compliance over time. We argue that reconceptualizing how particular institutional arrangements address salience, participation, and compliance can expand CPR theory's applicability to these large-scale problems and help to clarify the role that collective action can play in solving these pressing challenges.

CORRESPONDING AUTHOR:
Landon Yoder
Indiana University, USA
yoderl@indiana.edu

KEYWORDS:
Cooperation; social dilemma; global environmental change; wicked problems; behavior change; social-ecological systems

TO CITE THIS ARTICLE:
Yoder, L., Wagner, C. H., Sullivan-Wiley, K., & Smith, G. (2022). The Promise of Collective Action for Large-Scale Commons Dilemmas: Reflections on Common-Pool-Resource Theory. *International Journal of the Commons*, 16(1), pp. 47–63. DOI: *https://doi.org/10.5334/ijc.1163*

INTRODUCTION: THE RELEVANCE OF COLLECTIVE ACTION

More than 50 years have passed since the seminal arguments on collective action focused on its limitations for solving problems of governance (Olson 1965; Hardin 1968). These contributions led to foundational theoretical advancements revealing that collective action had been a consequential feature of local environmental governance for generations and a positive force for sustaining environmental resources (McCay & Acheson 1987; Feeny et al. 1990; Ostrom 1990). Yet, environmental problems have become increasingly regional and global in nature since the Great Acceleration (Steffen et al. 2015) and often reflect the cumulative effects of negative externalities and public good dilemmas, such as climate change, biodiversity loss, and ocean hypoxia. Our theoretical understanding of how collective action can contribute to solving these large-scale problems remains limited (Ostrom 2009; Berge & van Laerhoven 2011; Stern 2011; Araral 2014; Anderies et al. 2016; York et al. 2021).

In this paper, we argue that we need to expand on current theory to explain why collective action will emerge, expand, and persist to address large-scale environmental problems. We contend that one of the major barriers to expanding theory on collective action is the popularity and use of Ostrom's design principles (***Table 1***), which we suggest has created an over-emphasis on problem diagnosis at the expense of theory-building. This is neither an entirely new critique (see Quintana & Campbell 2019 for an overview of critical commons scholarship) nor a critique of the design principles themselves. What we argue is that too often institutional analyses, including the social-ecological system (SES) framework (Ostrom 2007), apply the design principles as a diagnostic approach to identify symptoms with an assumed "known" path to a solution rather than build a broader theoretical understanding of diverse conditions under which collective action can emerge and support sustainable management. Here, the assumed "known" path is that if the design principles apply, then collective action through local community-based management can achieve sustainable management. If it is not possible to achieve the design principles within a given environmental problem (e.g. because the boundary conditions cannot be changed), the diagnostic approach hits a dead end and it is assumed collective action is not feasible to resolve the dilemma.

Many environmental problems have the features of common-pool resources (CPRs), where there are competitive, zero-sum uses (i.e., rivalry conditions) and it is difficult to prevent people engaging in those uses (i.e., excludability conditions). These dynamics create a social dilemma where short-term individual benefits are pitted against collective, long-term costs (Dietz et al. 2002). In practice, many scholars (ourselves included) have looked for the conditions of a CPR dilemma and then attempted to see if the design principles are applicable (***Table 1***). We think this approach often leads to a poor fit for the design

Design Principle 1	Clearly defined boundaries *The boundaries of the resource and individuals with rights to use the resource are clearly defined.*
Design Principle 2	Proportional equivalence between benefits and costs *Those who use the largest proportion of a resource are required to pay the highest proportion of the costs (monetary or otherwise) and that rules address local conditions.*
Design Principle 3	Collective-choice arrangements *Individuals who are impacted by rules relating to the resource are included in the group that can modify these rules*
Design Principle 4	Mutual Monitoring *The resource and resource users can be jointly monitored to ensure the accountability of resource users to agreed-upon rules or norms*
Design Principle 5	Graduated sanctions *Sanctions (typically applied by other resource users) will apply to resource users who violate operational rules, with these sanctions increasing for repeat or more severe offences*
Design Principle 6	Resolution mechanisms *Low-cost, local arenas to resolve conflicts among users (or between users and officials) are available*
Design Principle 7	Minimal recognition of rights to organize *The rights of users to design their own institutions and rules to manage resource use are not disputed by officials*
Design Principle 8	Nested enterprises *The aforementioned design principles are organized across multiple organizational layers appropriate to the scale of the resource system, whereby lower-level units are nested inside of higher-level units of governance.*

Table 1 Ostrom's Design Principles for self-governance of common pool resources (adapted from Ostrom 1990).

principles as a group, where some seem highly applicable while others may be impractical (e.g., Stern 2011; Graham et al. 2019; Niemiec et al. 2020). This results in ambiguity for when and why the design principles are relevant as indicators for effective collective action. We propose that CPR research needs to return to theory-building on the emergence and persistence of different forms of collective action to better understand how we can achieve sustainable governance arrangements for larger-scale environmental dilemmas.

We consider the design principles to be highly applicable to the specific circumstances that Ostrom (1990) identified in her case studies in *Governing the Commons*. In these types of "canonical" cases, there are a mostly static number of people in the group, where livelihoods are highly dependent on a shared resource, and the consequences of non-cooperation are evident and mutual. Scholars have noted the presence of the "big five" types of CPR studies where these conditions are often present: fisheries, pasture, forests, irrigation systems, and water resources, such as aquifers (van Laerhoven et al. 2020). For these types of cases, a diagnostic approach is feasible and useful for supporting sustainable management. However, in our own research on agri-environmental governance, which intersects with climate change, biodiversity loss, and ocean hypoxia, CPR theory struggles to explain how collective action will emerge, expand, and be sustained in these large-scale problems. Other studies have similarly noted the limitations of CPR theory (c.f., Kerr 2007; Stern 2011; Araral 2014; Fleischmann et al. 2014; Villamayor-Tomas et al. 2019). These problems differ markedly from both the ecological and the social connectivity that is present in the canonical commons cases that CPR theory emerged to address (Stern 2011). Given that these problems continue to worsen despite extensive scientific knowledge and public awareness (IPCC 2021; IPBES 2019; Breitberg et al. 2018), advancing our theoretical understanding of the role that collective action might play in mitigating or solving them offers potentially vital insights to society. We are revisiting the question of how CPR theory can speak to collective action as part of the solution to environmental changes operating at large or over long scales. A common approach to defining CPR theory is to refer to the presence of the design principles as enabling sustainable self-governance of natural resources. To provide more focus and space for theory-building around collective action, we argue that a small shift in describing the core tenet of CPR theory is important: successful, natural resource self-governance occurs when livelihood-dependent groups develop, monitor, and enforce commitment-enabling rules to sustain CPR uses.

From applying the design principles in non-canonical CPR contexts, we have observed that the theory of collective action, and the solution space for problem-solving, is constrained. For large-scale environmental challenges, we need a more robust theoretical understanding for predicting how cooperation can emerge and be sustained. This marks a shift in focus from applying diagnostic tools to building theoretical understanding. In this sense, our argument is similar to others that have been made already (Steins & Edwards 1999; Johnson 2004; Cleaver 2012), and in practice there are many ongoing theory-building efforts in the commons literature (c.f., Clement 2010; Poteete et al. 2010; Fleischmann et al. 2014; Andersson et al. 2014; Baggio et al. 2016; Orazgaliyev & Araral 2019; Niemiec et al. 2020; Olivier & Schlager 2021), including many studies using the SES framework (c.f., Epstein et al. 2014; Cox 2014; Hammond Wagner et al. 2020; Wang et al. 2020) and others building on critical institutionalism (Cleaver & de Koning 2015).

An outcome of the lack of theory building, we suggest, is that few environmental governance subfields have integrated CPR theory into their approaches. Local self-governance emphasized by CPR theory is highly relevant to collaborative governance, the Advocacy Coalition Framework, and knowledge co-production, among others, but the design principles are infrequently applied in these subfields. One of the most notable limitations is that CPR theory places little weight on government action (e.g., Wade 1988; Feeny et al. 1990; Ostrom 1990; Baland & Platteau 1996; Dietz et al. 2002) despite widespread recognition that government often plays an important role in enabling local participation and action (Koontz et al. 2004; Armitage 2008; Stern 2011; Anthony & Campbell 2011; Bonnell and Koontz, 2021). Evidence that theory needs a greater role in commons research can be drawn, paradoxically, from the large number of theories associated with SES research (Cox et al. 2016). The SES Meta-Analysis Database (SESMAD) lists 63 different theories used by SES scholars, one of which is the design principles, suggesting that CPR theory addresses just one of many potential pathways to sustainable governance. In our view, the presence of many mid-range theories presents an opportunity: By refocusing CPR research on theory-building, there is great potential for synergistic insights to expand our understanding of the wider range of circumstances and pathways that collective action can take, particularly in large-scale environmental dilemmas. This could add valuable insights on developing diagnostic tools, like the design principles, for a wider range of CPR dilemmas that go beyond the canonical conditions.

Our focus in this paper is to establish how CPR theory can inform our understanding of the role of collective action

in large-scale commons dilemmas. We are responding to the increasing number of studies rethinking and expanding on how CPR theory can apply to a wider range of environmental problems (Stern 2011; Fleischmann et al. 2014; Graham et al. 2019; Villamayor-Tomas et al. 2019; Niemiec et al. 2020). In the following sections, we offer and support four reflections: (1) collective action remains an essential pathway for environmental governance at the regional and global scales; (2) we need to consider different motivators and conditions for collective action in large-scale environmental commons than are traditionally considered for canonical commons; (3) a return to theory-building in CPR Theory should address how collective action shapes patterns of salience, participation, and compliance; and (4) resolving salience, participation, and compliance action situations are important for mitigating large-scale environmental commons. In Reflections 3 and 4, we propose that we can build on CPR theory to advance our understanding of collective action for large-scale environmental commons by focusing on foundational and interconnected aspects of problem solving that we observe across different literatures: generating salience; motivating participation; and ensuring compliance. We contend that the canonical CPR cases, and the design principles, represent one particular pathway where collective action is central to problem solving, while other pathways of collective action may exist for environmental governance at different temporal and spatial scales (e.g., Marshall 2008; Ostrom 2009; Stern 2011). It is our hope that rethinking collective action as needing to address the three interconnected challenges of salience, participation, and compliance can offer a valuable way to expand CPR theory's applicability to public good and negative externality problems.

REFLECTION 1: COLLECTIVE ACTION REMAINS AN ESSENTIAL PATHWAY FOR ENVIRONMENTAL GOVERNANCE AT REGIONAL AND GLOBAL SCALES

Just as the design principles pointed toward a third way between regulation and privatization (Ostrom 1990), local collective action remains crucial as a third path that is neither purely voluntary nor compulsory for large-scale environmental governance. The conditions for mitigating the challenges in large-scale commons dilemmas are distinct from small-scale CPRs (Stern 2011). Some of the most notable differences for problem solving include: substantial ambiguity in cause-and-effect in the system, which results in low problem salience; distributional tradeoffs among different stakeholder groups that affects the motivations and costs of cooperation; and high compliance costs given the difficulty in monitoring sources of pollution (or harm) to assign responsibility (Cash et al. 2006; Kerr 2007; Smith & Porter 2010; Armstrong et al. 2019). These dynamics have been called "wicked problems" (Rittel & Weber 1973) or "resource dilemmas" (Ison & Collins 2008) because while their resolution requires that individuals work together, they generate conflicts among stakeholders over problem salience, competing priorities, and challenge clear lines of accountability for compliance. Establishing clear cause and effect through scientific data can also be a complex undertaking for these problems (Ison & Collins 2008). Thus, implementing and scaling up pro-environmental interventions, as we have seen with both voluntary and compulsory approaches, is likely to be a slow and contested process as understandings of the problem and perceived levels of necessary changes can vary greatly among the many actors whose environmental behavior matters.

In this paper we illustrate the challenges of large-scale environmental dilemmas by looking at research on agricultural non-point source (NPS) pollution. NPS features multiple types of complexity that make collective action difficult but also necessary; and it has been the focus of a limited amount of CPR research where theorizing the role of collective action has proven difficult (Lubell 2004; Sarker et al. 2008; Smith & Porter 2010; Patterson et al. 2013; Patterson et al. 2017; Yoder 2019; Hammond-Wagner et al. 2020). NPS pollution results from spatially diffuse erosion, runoff, and leaching of phosphorus and nitrogen fertilizers into water bodies, making it difficult to monitor and to attribute relative responsibility to any particular farmers for downstream water quality degradation, such as harmful algal blooms or hypoxic zones (Robertson & Vitousek 2009; Shortle & Horan 2013). Compounding this challenge is that effects from changes in farm management to mitigate water quality may take as long as 25 years to detect (Melland et al. 2018). Intense disagreements (Hammond Wagner et al. 2020), disbelief (Yoder & Roy Chowdhury 2018), and partial or noncompliance (Barnes et al. 2013) are among farmers' responses to government interventions to compel farm management changes.

Pollution is often characterized as a negative externality or public good problem. While regulations represent the conventional wisdom for solving public good or negative externality problems (Anderson & Libecap 2014), how they are implemented is crucial to avoid unintended consequences or widespread noncompliance (Howlett 2017). Interventions that lead to widespread resistance can lead to prohibitively costly monitoring and enforcement (Shortle & Abler 2001). In the United States, there is ample evidence to point towards the complications of social and political opposition to regulatory fixes for NPS pollution:

the major water law in the United States, the Clean Water Act, exempts agricultural drainage from regulation (Houck 2003); in countries with regulations, compliance levels vary significantly (MacGregor & Warren 2006; Barnes et al. 2013); skepticism of the scientific basis for regulations runs deep (Duncan 2016; Yoder & Roy Chowdhury 2018); and farmers have been forced to dramatically change their production systems to meet strict compliance standards, leading to extensive frustration (Hammond Wagner et al. 2020) or legislative reversals of strict approaches (Drevno 2016). Finally, the scale and breadth of many of today's environmental challenges make it nearly impossible to monitor and penalize behavior in a way that *regulations alone* can sustain.

Current NPS pollution approaches have generally failed to achieve notable progress, despite taking many different forms. For example, watershed partnership approaches often are stymied by limited funding and authority because of political fights (Schlager & Blomquist 2008; Huitema & Meijerink 2017). Payment-for-ecosystem service approaches that provide pro-environmental subsidies typically offer little engagement for farmers in local rulemaking (Kerr et al. 2014) and fail to provide compelling incentives when compared to readily available and environmentally harmful subsidies for row-crop production (Jetoo 2018). Finally, knowledge-transfer approaches that encourage voluntary adoption of pro-environmental practices rely heavily on perceptions of those practices' "relative advantage" over current options (Pannel et al. 2006; Blackstock et al. 2010), which has tended to result in slow and limited uptake as farmers have a wide variety of experiences shaping these perceptions (Lal et al. 2007; Ribaudo et al. 2011; Reimer et al. 2012; Roesch-McNally et al. 2018). The limitations of these approaches have coincided with ongoing water quality degradation worldwide; dead zones in marine waters cover an area roughly the size of the European Union (Breitburg et al. 2018), where agriculture is a leading or major contributor. In practice, farmers individually benefit from the current production system where high amounts of fertilizer are both applied and lost, while downstream communities bear the cumulative costs (Drinkwater & Snapp 2007). The biogeochemistry aspects of the problem have been extensively studied and are well understood in the scientific community; what remains is how to transform farm management (Stuart et al. 2015).

Because neither voluntary nor compulsory approaches have delivered cleaner water, collective action offers an enticing third pathway. However, as we will address in the next section, the motivations of actors implied in CPR theory would predict that collective action will not emerge to solve negative externalities, such as NPS pollution (Villamayor-Tomas et al. 2019). Despite this existing theoretical expectation, NPS pollution remains a collective-action problem because even if political support for regulations was feasible, enforcement of those regulations would likely be cost-prohibitive and/or not yet functionally possible given current technology. Some level of farmer self-compliance (i.e., support for regulations), likely very high, would be necessary to make those costs manageable. What this indicates is that some degree of collective action, likely alongside government action, is needed. This is not a new argument; co-management, multilevel governance, and devolution research have explored how government can work alongside local communities (Acheson 2003; Adger et al. 2006; Plummer & FitzGibbon 2007; Marshall 2008; Berkes 2010). Yet, despite this substantial literature, and other relevant subfields studying institutional arrangements involving government and local community management, CPR theory has expanded very little to incorporate a wider range of expectations on the roles and forms collective action might take in a variety of institutional arrangements that address negative externalities or public good problems.

We observe that the definition of what constitutes collective action has also remained relatively broad. Generally, definitions invoke clauses around shared interests and similar actions (Meinzen-Dyck et al. 2004; Graham et al. 2019). An additional component that is sometimes included is the notion of interdependence, where "[a]ctors collaborate to achieve goals that they cannot achieve by acting alone" (Kim et al. 2020, p. 2). There is practical importance to generating more precise definitions of collective action if we want to understand what role it can play in large-scale commons dilemmas. For example, scaling up new land management practices, such as afforestation or planting cover crops, could entail parallel efforts of individuals responding to government or market-based incentives to adopt new practices. These actions are simultaneous and cumulative, but not intentional or collaborative. Within the CPR literature, forming agreements serves as the basis on which collective action is assumed or defined, since similar interests and actions lead to or emerge from intentional agreements on rules-in-use. Is collective action exclusively the domain of non-nongovernmental actors agreeing to self-imposed rules or can it occupy more specific niches within overall governance where it contributes to problem-solving and/or behavior change? While we err on the latter side of this proposition, we do not attempt to resolve this question in this paper. We consider it to be an important issue to raise that flows from our interest in expanding CPR theory. Without defining it any more precisely in this paper, we still consider collective action to be a core element of large-scale government especially because it has played, and can

play, a crucial role in shaping and responding to perceptions of the need for problem-solving and the means for doing so when neither voluntary incentives nor government regulations have been able to deliver effective solutions.

REFLECTION 2: WE NEED TO CONSIDER DIFFERENT MOTIVATORS AND CONDITIONS FOR COLLECTIVE ACTION IN LARGE-SCALE ENVIRONMENTAL COMMONS THAN ARE TRADITIONALLY CONSIDERED FOR CANONICAL COMMONS

Given the popularity of the commons framing, there are now many environmental problems called the commons that do not reflect the definition on which CPR theory is based. This may seem trivial, but the rhetorical decoupling of the "commons dilemma" from canonical CPR cases presents important challenges and constraints to applying CPR theory to a wider range of problems. To expand the insights from CPR theory, these limitations must first be addressed. At its most basic, CPR theory predicts that communities can successfully engage in collective action to establish and maintain rules to protect shared resources when certain commitment-enabling conditions are present (i.e., the design principles; ***Table 1***). Importantly, those shared resources are part of a limited supply (the "common pool") that makes the costs of joint-use, particularly overuse, highly salient to the user group, which in turn also makes the benefits of apportioning the available supply highly salient. Drawing on narrow rationality, the economic (e.g., livelihood) calculations in these situations motivate collective action to sustain a future supply.

In practice many scholars, ourselves included, have identified CPR problems based on the typology of goods framework where high rivalry and costly excludability are the *only definitional criteria* for classifying a commons dilemma (Schlager et al. 1994). Implicit in the typology of (economic) goods are the functions of supply and demand. Economic goods may have a limited supply and can be overused to the point of exhaustion (e.g., Hardin 1968). In situations where market pricing does not, or cannot, effectively balance supply and demand, then apportioning how much any one person can take from the overall supply (the "common pool") is an important challenge. In low-supply, high-demand systems, one way to manage limited supplies is to exclude all but a defined group of consumers from accessing the resource. Notably, the most prevalent CPRs studied involve resources that represent low-supply, high-demand systems that are extractable and rely on group rulemaking around how to set exclusion criteria, divide the shared resource pool between authorized users, and contribute to maintaining (i.e., provisioning) the resource pool over time, e.g., pastures, fisheries, forests, irrigation systems, and aquifers (van Laerhoven & Ostrom 2007; van Laerhoven et al. 2020). In these cases, biophysical dimensions shaping joint-use can result in high problem salience that can lead to cost-sharing agreements, where those sharing in the common pool participate in rulemaking and ongoing enforcement of the rules (Blomquist & Ostrom 1985).

Applying the typology of goods framing to large-scale commons dilemmas, particularly with negative externalities, can be much less intuitive (Kerr et al. 2007; Hammond Wagner 2019; Graham et al. 2019). For example, like canonical CPRs, water quality can be conceptualized as having excludability challenges: it is difficult to prevent nutrients from farms (or other sources) from entering a waterbody and it has features akin to rivalry of use; there is a finite amount of pollutants a waterbody can absorb without causing severe human health and aquatic ecosystem harms (Sarker et al. 2008; Smith & Porter 2010). Yet, pollution is a poor fit given that environmental bads, for all practical purposes, represent *high-supply and low-demand systems*, the inverse of canonical CPR problems and more akin to a public good provisioning problem. Framing water quality as a CPR does not clearly offer meaningful analytical advantages for enabling collective action, because there is (a) no common pool of economic goods facing demand pressure and (b) salience is low because those generating pollution do not bear the consequences. Facing shared consequences can be crucial to making social dilemmas highly salient (Cash et al. 2006; Kerr 2007; Stern 2011).

With the increased popularity of the commons framing, based largely on the definitional criteria of rivalry and excludability, the commons has come to more generally refer to *shared needs or benefits* where there are interconnected ecological effects across spatio-temporal scales. For example, the atmosphere can be conceptualized as a commons, where there is a limited carbon budget with excludability and rivalry problems. Understanding the atmosphere as a large-scale commons is enabled by greater understanding of global biogeochemical processes. While framing the atmosphere as a commons maintains the rhetorical use of a social dilemma, the relevance of CPR theory, based on salience to motivate collective action stemming from joint use, is greatly diminished. Many people using up the carbon budget do not perceive it entailing shared consequences, leading to de facto asymmetrical distribution of costs and benefits. This is similar to challenges with conceptualizing water quality within nested watersheds as a commons dilemma (Kerr 2007).

A core theoretical challenge, which has been repeatedly noted in the literature, is the need to understand different motivations for cooperation that go beyond narrow rationality (Steins & Edwards 1999). Generating problem salience of future joint uses and consequences from large-scale environmental problems requires different theoretical explanations.

One reason for the increasing use of commons framing for a wider range of ecosystem dynamics is that far more is understood now about ecological interconnectedness than when CPR theory emerged, which has informed an explosion in the literature of how actions in one area cause changes in another across local to global scales. This is evident in the emergence of SES, coupled human-natural systems, and sustainability science fields (c.f., Turner et al. 1990; Vitousek et al. 1997; Gunderson & Holling 2002; Steffen et al. 2004; Folke et al. 2005; Liu et al. 2007; Rockström et al. 2009; York et al. 2021). For example: Armitage (2008) refers to the commons as a complex systems problem; Sarker et al. (2008) refers to multiple types of CPRs for water quality and quantity; and Stern (2011) argues for new design principles for global commons. This conceptual transition is demonstrated in the evolution and emergence of Ostrom's (2007) SES framework, which Ostrom suggested could serve as a meta-theoretical foundation to analyze environmental problems writ large. However, the SES framework has struggled to serve as an analytical tool to test new collective action theory and remains primarily a descriptive one (Partelow 2018; Hammond Wagner 2019). We would argue that a major reason for this is the focus on diagnosis rather than theory-building to explain collective (in)action.

In practice, there are three types of commons that contribute to theoretical confusion: common property, common pool resources, and novel commons. Historically, the commons referred to areas under common-property management, especially customary land tenure systems, based on research pioneered largely by Anthropologists and Geographers in the subfields of Cultural and Political Ecology (c.f., e.g., Netting 1982; McCay & Acheson 1987; Lansing 1991; Carney 1993; Rochelaeu 2001; Mosse 2003; Cleaver 2012). CPR theory draws on this literature, which played an important role in some of the case studies on which the design principles are based. In areas under common-property institutions, there are often multiple, low-intensity types of resource uses and a variety of rules and customs (i.e., descriptive and social norms) governing environmental behavior. One reason why the term "commons" has stuck is due to its reference to European land tenure where the commons were increasingly enclosed by private property regimes (Anderies & Janssen 2013). Ironically, colloquial use of the word "commons" is often invoked to refer to natural resources that are *held in common and available to all* (see the Wikipedia entry for "commons"); this conceptualizes the commons as functionally open access, rather than limiting access to just some people.

Canonical CPR cases emerge where there are resource users focusing on jointly managing and sustaining a single type of common pool (e.g., fish stock). The shift to a CPR framing, from common property, moves much of the custom-based behavior to the background, foregrounding instead the narrow rationality motivating cooperation. This has been the source of substantial criticism, particularly that it greatly oversimplifies people's motivations for cooperation by ignoring local historical context and power dynamics (c.f., Steins & Edwards 1999; Johnson 2004; Forsythe & Johnson 2014). The literature is now large enough it has received its own subfield label of "critical commons scholarship" (see Quintana and Campbell 2019 for a detailed synthesis). A third type, which might be labeled novel commons (Berge & van Laerhoven 2011), extends the CPR framing by using a coupled social and biophysical systems approach, where shared needs arising from the environment and/or environmental change are recognized by some, especially in the scientific community (e.g., ecosystem services), but generally lack the tight coupling of environmental change to social dynamics where joint use of a CPR can heighten people's salience of a problem sufficiently to animate collective action.

We argue that it is essential to distinguish between these multiple conceptualizations of the commons because they imply different theoretical expectations for motivating collective action. Analysis of canonical commons has relied primarily on narrow or bounded rationality to explain the emergence and maintenance of collective action. Given highsalience arising from the costs of joint use in canonical cases, this is logical: shared costs create a higher benefit-to-cost ratio for cooperation. However, this logic often falls flat when applied to more novel applications of the CPR framing, such as large-scale environmental problems, with lower salience, asymmetrical benefits and costs, and high compliance costs. We are, however, careful to note that while the design principles emerge from case studies of common-property regimes, the social dilemmas arising in those situations do remain an important basis for studying collective action in regional and global environmental problems. For example, Young (2011) noted that all property regimes suffer from various problems, such as externalities resulting from private property rights. To expand CPR theory, we need to move beyond a focus on the narrow case of collective action as the rationally-driven

emergence of rules to govern shared use of a resource (Steins & Edwards 1999). Instead, we need to ask, ***what motivates collective action in large-scale commons dilemmas and what role can collective action play (in conjunction with different institutional arrangements) in resolving these dilemmas?***

REFLECTION 3: A RETURN TO THEORY-BUILDING IN CPR THEORY SHOULD ADDRESS HOW COLLECTIVE ACTION SHAPES PATTERNS OF SALIENCE, PARTICIPATION, AND COMPLIANCE

Expanding a theory of collective action to large-scale commons dilemmas requires a better conceptualization of not only why people are motivated to cooperate but how cooperation is carried out and maintained. When we consider parallel research in other fields, we see an opportunity to integrate multiple theoretical insights into a more robust understanding of collective action. We do not anticipate that there will be a grand theory that explains collection action across most contexts, but the potential for a better and more consistent set of mid-range theories that identify key contextual factors would be a worthwhile direction for commons research (see Meyfroidt and colleague's (2018) review of mid-range theories for land system science as an example). If collective action matters to large-scale commons dilemmas, particularly among non-governmental actors operating at local scales, we expect that it would operate across three core challenges of problem solving that are prevalent across multiple relevant environmental governance subfields: generating salience, achieving participation, and ensuring compliance (e.g., Newig et al. 2018). Drawing on terminology from the Institutional Analysis and Development (IAD) framework, we propose that each of these core challenges represents a set of interconnected action situations in the process of solving environmental problems (e.g., McGinnis 2011), as we represent via arrows in the diagram (***Figure 1***).

The purpose of this illustration is to offer one way forward on integrating existing theory in environmental governance subfields with CPR theory. We recognize that there are many meta-theoretical frameworks in existence already (Binder et al. 2013); the value of identifying salience, participation, and compliance is not to propose a new framework but to foreground key issues as part of a research agenda that can help us theorize collective action. In selecting these three action situations, we draw on the systematic literature review conducted by Newig et al. (2018), who identified multiple clusters of causal mechanisms in public decision-making processes that involve stakeholders in environmental governance. In our view, their framework also effectively captures key aspects of informal decision-making contexts outside of public management. Their causal mechanism approach provides crucial attention to explaining why decision-making

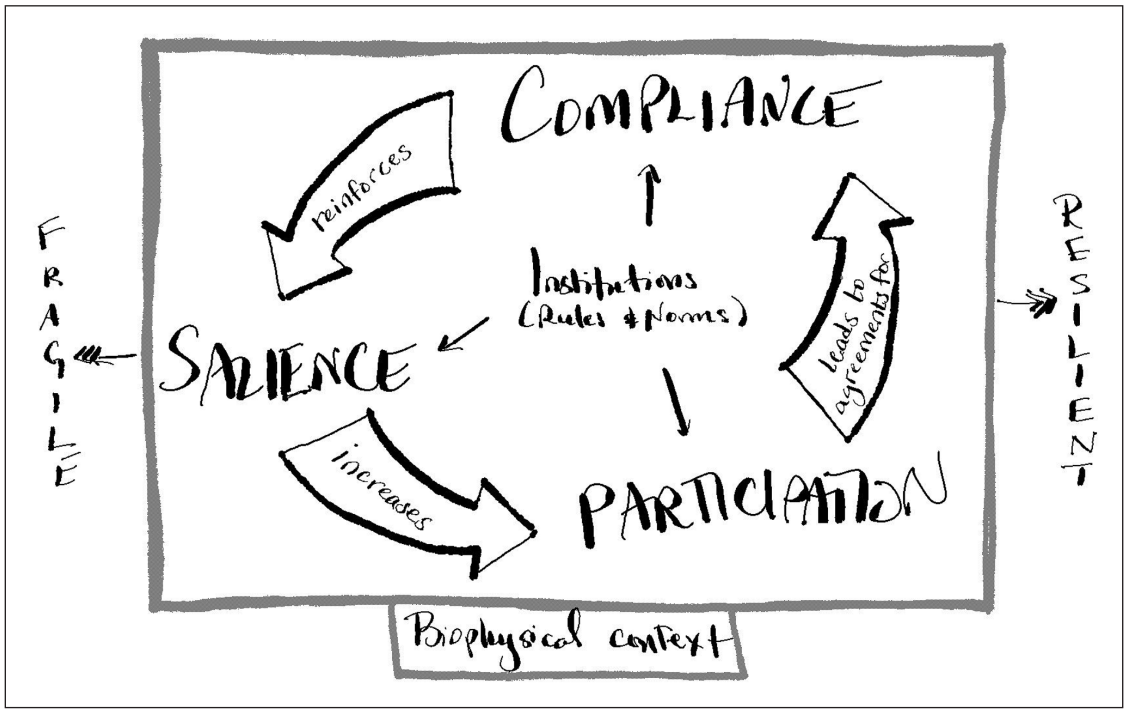

Figure 1 The diagram of salience, participation, and compliance represents interconnected action situations that are present across many types of environmental challenges where collective action can contribute to problem solving.

processes may fail, which is essential for a more robust theory of collective action (or inaction).

We highlight salience, participation, and compliance (SPC) action situations because they represent fundamental and ongoing problem-solving situations through which relevant actors could interact to resolve an environmental challenge regardless of the property regime(s) (***Table 2***). If scholars can better identify and explain pathways where collective action contributes to overall governance, then we may also be better able to identify and apply diagnostic tools, such as the design principles. We would anticipate that an actor's or group's progression through these interconnected action situations does not predict an ecologically resilient outcome, but could result in a wide spectrum of outcomes, including entrenching opposition and environmental harms. These responses will lead to different levels of participation in problem-solving and have important implications for compliance outcomes. For example, in NPS pollution situations, an action situation focused around achieving salience as an "outcome" in the IAD framework could include on-farm demonstration projects leading to new management techniques or the promulgation of regulations that lead to collective opposition from farmer organizations. We hypothesize that achieving an ecologically resilient outcome in large-scale commons dilemmas requires reaching some critical threshold for salience, participation, and compliance among the relevant actors. Importantly, we contend that the design principles represent a particular set of circumstances where people resolve the challenges foregrounded in these three interconnected action situations. Expanding CPR theory requires us to rethink what these problem-solving stages look like across a wide range of circumstances beyond the canonical cases.

3.1. THE DESIGN PRINCIPLES AS ONE PATHWAY TO RESILIENCE IN COMMON-PROPERTY REGIMES

In our view, canonical CPR dilemmas represent a special case of SPC action situations. In these cases, high salience of the problem already exists because of the biophysical conditions in which actors are operating and their relevance to livelihoods. In practice, this local context resolves a key situation for problem-solving where actors can visibly see, through their day-to-day experience, changes in biophysical conditions and the resulting effects on economic well-being. This contrasts with the ambiguity and ignorance that slow and undermine agreements on more complex problems (Cash et al. 2006; Brugnach & Ingram 2012). The neighboring challenge is achieving participation. In canonical CPR cases, the core consideration is to establish assurances that minimize opportunism (e.g. free riders or defectors) to generate active participation to create an agreement on what to do, as emphasized by Ostrom (1990, 2009) in both canonical and large-scale commons dilemmas. Trust, developed through repeated face-to-face interactions, has been demonstrated to matter in providing assurances that other actors will meet their agreed-upon obligations (Ansell & Gash, 2008; Bryson et al. 2006). Lastly, in canonical cases, compliance is achieved because of the boundary conditions that create an in-group, where there are shared needs for compliance. If everyone is dependent on the rules being enforced there is both a high degree of self-compliance and subsequently a manageable amount of mutual monitoring, graduated sanctioning, and conflict resolution options to complement and maintain self-compliance (Ostrom 1990). CPR research has pointed to the importance of compliance more broadly, showing the a lack of compliance can reflect an unwillingness to enforce existing rules (Bodin & Crona 2009) and is a stronger predictor of environmental protection than monitoring or participatory rulemaking (Varughese & Ostrom 1998; Andersson et al. 2014).

We argue that when considering CPR theory, the design principles reflect how collective action has addressed these three core challenges of problem solving in canonical cases, where protecting livelihoods is a central motivator. Boundary conditions provide for all three problems to be addressed by the same group of people (the resource users),

CONCEPT	DEFINITION	THEORETICAL EXPECTATION
Salience	Belief in the need for action in response to a perceived problem or proposed solution.	Higher salience leads to knowledge exchanges and greater agreement on perceived problems to foster participation and/or legitimize government actions
Participation	Engaging with new rule or social norm formation to provide assurances and commitments that behavior changes will be undertaken and lead to desired outcomes.	Participation matters by generating new patterns of behavior that directly benefit the environment or indirectly influence other people's behavior through examples or new norms.
Compliance	Act of engaging in or legitimizing enduring, long-term pro-environmental behavior and upholding this behavior in others.	Compliance costs are influenced by the level of individual self-compliance and perceived legitimacy in the government's role to constrain behavior.

Table 2 Definitions of Key Concepts for Collective Action in Large-Scale Commons Dilemmas.

but it especially matters to generate salience among an in-group. Local rules, collective-choice arrangements, and rights to organize address participation, by providing a basis for devising agreed-upon rules-in-use (keeping in mind that such rules may be unfair and advantage those higher up in social hierarchies). Finally, monitoring, graduated sanctions, conflict resolution, and nested governance offer compliance mechanisms to maintain rule-adherence over time.

Commons scholars have pursued several directions to tackle large-scale commons dilemmas, though none have directly integrated the design principles into their approach. However, these different directions, most prominently multilevel governance and co-management (Young 2002; Armitage 2008), devolution and nesting (Marshall 2008; Berkes 2010), and polycentricity (McGinnis 1999; Ostrom 2009; Lubell 2013), integrate some aspects of the underlying theory implied by the design principles. It should be noted that Stern (2011) does propose a series of revised design principles for global natural resource and technology commons, but aims to support a revised diagnostic approach rather than support new theory-building on collective action in global commons. One of the shared elements in these approaches is the role of trust in facilitating agreements between groups, often conceptualized in terms of social capital (Brondizio et al. 2009; Anthony & Campbell 2011). Government is included as a factor in these analyses, where government agencies or officials can provide a constructive role in helping to catalyze action and offer complementary functions alongside local management (Dietz et al. 2004). We do not intend to provide a detailed review of these directions in this paper; we mention these directions primarily to note that there are ample insights on which to build a more integrated theory, or set of mid-range theories, of how collective action contributes to problem-solving beyond canonical CPR cases.

REFLECTION 4. RESOLVING SALIENCE, PARTICIPATION AND COMPLIANCE ACTION SITUATIONS ARE IMPORTANT FOR MITIGATING LARGE-SCALE ENVIRONMENTAL COMMONS

We propose studying SPC action situations as one way to better theorize collective action. Drawing again on the example of NPS pollution, we see the challenge of collective action remaining a primarily local concern because of the importance of creating an in-group for problem solving. Scholars have repeatedly noted the challenges inherent in mismatches between the spatial or temporal scale of a problem and socially relevant boundaries (Young 2002; Cash et al. 2006; Mollinga et al. 2008; Lebel et al. 2013). Because the boundary conditions and, in particular, shared consequences arising from joint use are not present among a shared set of actors in non-canonical CPR cases such as NPS pollution, we posit that the salience problem must achieve some threshold of support among the relevant actors for participation and compliance aspects to be scaled up and sustained. The biophysical conditions that matter to NPS pollution make it difficult to directly observe, monitor, or interpret changes in the environment. Instead, these require novel ways of representing that a problem exists, such as statistical modeling, fine-grain monitoring, or using analogies for understanding to generate the levels of salience needed to subsequently foster widespread participation in the problem-solving process. While disbelief and ambiguity of agriculture's contribution to water pollution among farmers is not uncommon (e.g., Barnes et al. 2009), these perceptions are also not universal. Many farmers become convinced that water quality is a problem and choose to act (Lubell 2004; Marshall 2004; McGuire et al. 2013). Awareness of changing biophysical conditions is not the sole pathway to achieving salience, and government can play an instrumental role by helping to create salience through a variety of mechanisms. The threat of regulations might be an entry point that will shape the process of collective action (Prokopy et al. 2014). Greater monitoring offers another, non-compulsory measure to generate salience. In Australia's Murray-Darling basin, a collaborative report card provided a valuable means to address the large spatio-temporal scale between the source of pollution and its downstream impact (Patterson 2017).

Participation in problem-solving also appears to be a critical action situation of collection action, especially through new behaviors or management actions, and is likely affected by the ways in which salience is generated. For NPS pollution, this process has proven especially contentious. However, devolution represents one promising approach to achieving effective participation, potentially due to the importance of local conditions and recognizing the value that farmers place on positive recognition (Burton & Paragahawewa 2011; Pickering et al. 2018), as well as sticking with the herd on popular opinions (Kuhfuss et al. 2016). As one example, the French government devolved implementation of a pesticide-reduction program to a farm cooperative, which itself generated revenue from pesticide sales. Despite this seemingly problematic conflict, the cooperative succeeded in enrolling more than two-thirds of 180 eligible farmers within a year, with 90% of those enrolled meeting their pesticide reduction targets (Del Corso et al. 2017). Del Corso and his colleagues argue

that the critical element in this outcome was not just that the cooperative represented a trusted intermediary, but the goal of water quality protection and participation in meeting that goal were legitimized by its role in training and administration. It is also plausible that for actors starting with participation, responding to their peers' concern of the problem will increase their own salience of the need for collective action, indicating a bidirectional relationship between salience and participation.

Finally, compliance is itself an action situation critical to collection action, with bidirectional relationships with both salience and participation. The legitimacy of traditional compliance mechanisms, such as permits and penalties, is low when salience and participation are low (Howlett 2017). One logical explanation for this is that regulations, such as traditional command-and-control, reduce people's autonomy and thus their agency in contributing to solutions. Burton and Paragahawewa (2011) have argued that, in promoting solutions, policies need to recognize and tap into what land managers value, such as the positive reputational benefits from demonstrating their skills in pro-environmental management. For example, rule specifications, while aiming to achieve the same outcome, may grant actors more or less agency in manner of compliance, as is the case of prescriptive, practice-based rules for NPS pollution as compared to more flexible, performance-based rules that allow actors to choose their actions to achieve compliance (Hammond Wagner et al., 2020). Social expectations can also factor into sustaining compliance through time. In the Florida Everglades, for example, farmers faced mandatory requirements to collectively reduce phosphorus pollution. Farm-level monitoring provided annual information on each farm's performance, which tapped into locally relevant peer pressures to improve performance. Peer pressure functioned similarly to mutual monitoring, helping to reduce compliance costs for state regulators (Yoder & Roy Chowdhury 2018). We hypothesize that to achieve sustained and widespread pro-environmental behavior each of the action situations must first surpass some minimum threshold of legitimacy among relevant actors to permit regulations (or norms) to be politically (or socially) viable.

Multiple environmental governance subfields have theorized extensively on many of the key aspects needed to understand how and why collective action emerges to address complex environmental problems. Social learning, knowledge co-production, and co-management research emphasize the importance of working across different knowledge and value systems, including perceptions and problem framing, to generate salience (Pahl-Wostl et al. 2009; Clark et al. 2016 Jackson 2019; Arnott & Lemos 2021). Collaborative governance (Wondelleck & Yaffee 2000; Ansell & Gash 2007; Margerum 2011), Ecology of Games (Lubell 2013), Institutional Grammar (Olivier & Schlager 2021), Advocacy Coalition Framework (Sabatier 1988; Sabatier & Weible 2019), and Institutional Collective Action (Kim et al. 2020) approaches capture elements of participation, including decision-making and bargaining processes, that are used to overcome stalemates or promote mutual gains across different stakeholder groups. Compliance is less studied generally (Howlett 2017), but partly this is tied to the ways in which CPR and related scholars have focused on local participation and problem-solving phases, rather than on situations where government regulation plays a major role. Amongst legal and policy studies, there is a diffuse, yet large study of law, rule, or institutional impact (Friedman 2016) that is rarely linked to CPR theory and questions of salience and participation. It is clear that governments can play the role of backing up agreements to keep parties accountable (Ostrom 1990; Mansbridge 2014), provide resources to make compliance more technologically feasible, or reduce transaction costs associated with compliance (Koontz et al. 2004; Durant et al. 2017). What remains missing from current research is greater attention to integrating how factors drive problem-solving across all three action situations to achieve resilient outcomes.

We want to emphasize that the connections between the different action situations of salience, participation and compliance matter. Various patterns may emerge and become more identifiable as problem solving in one arena influences solutions and new perceptions in the other action situations. Our diagram (***Figure 1***) illustrating these potential pathways emphasizes that there is no clear entry or exit point and that stakeholders enter problem solving at different times, influencing these patterns of collective action towards greater or lesser success. Here, we draw inspiration from Young's (2010) endogenous-exogenous alignment theory for institutional change that posits that institutional change is a combination of regime-specific (endogenous) and biophysical or socioeconomic (exogenous) factors that leads to regime patterns that support ecological resilience or lead to increased ecological vulnerability. Through identifying patterns, we can better understand the causal drivers of regime change. Young (2010) identifies five emergent patterns in global environmental governance regimes, including progressive development, punctuated equilibrium, arrested development, diversion, and collapse, and proposes a number of factors that, drawn from case studies, have shaped these patterns. Whether pathways through the SPC action situations follow similar patterns to the

global environmental governance regime patterns Young proposes, and how actors work through the challenges of salience, participation, and compliance to support these patterns is a research question we suggest should be pursued.

CONCLUSION: WE NEED A REVISED THEORY OF COLLECTIVE ACTION TO SOLVE LARGE-SCALE COMMONS DILEMMAS

We propose that a focus on collective action is both relevant and crucial for tackling large-scale commons dilemmas. The practical concern remains that we continue to have greater scientific knowledge and awareness of the severity of shared problems, such as climate change, biodiversity loss, or ocean hypoxia, but remain limited in our capacity to change problematic short-term behaviors for long-term sustainable outcomes. CPR theory has relied heavily on narrow rationality based on high in-group salience to explain motivations, which we have argued is insufficient to deal with these kinds of dilemmas. Further, compliance with pro-environmental regulations is not self-executing because of the challenges of ambiguity in cause-and-effect, conflicting priorities among people, and high monitoring and enforcement costs. The critical role of collective action in these problems is as a catalyst for generating salience, achieving participation, and ensuring compliance by legitimizing the need for new and sustained pro-environmental actions.

Our proposition that salience, participation, and compliance represent a set of interconnected action situations is intended to integrate insights across environmental governance subfields to expand our theoretical understanding of the role that collective action can play in large-scale commons dilemmas. Potential theoretical advances require hypothesizing around the mechanisms linking each of the SPC action situations and whether these processes, particularly collective action emerging among in-groups (given the absence of meaningful geographic boundaries), lead to sustained and widespread pro-environmental behavior and outcomes. We diagram the SPC action situations as interconnected because it emphasizes the linkages and feedbacks between these three core stages of problem solving. This is crucial when considering how to advance and sustain pro-environmental behavior because people will engage with problem-solving at different times and within different action situations. Future research will need to examine whether and how collective action can reveal consistent patterns that will help scholars, practitioners, and policymakers better understand how to resolve conflicts and strengthen problem-solving capacities in situations involving negative externalities and public goods dilemmas.

ACKNOWLEDGEMENT

The authors would like to thank Amanda Christophe for her help as a research assistant on this project and Indiana University's Sustainability Scholars program for funding to support her time. Author Gemma Smith is supported by the William C. and Jeanne M. Landreth Fellowship in the Emmett Interdisciplinary Program in Environment and Resources. The authors also extend their appreciation to the two anonymous reviewers for their detailed insights and constructive comments that strengthened the quality of the manuscript.

COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR AFFILIATIONS

Landon Yoder *orcid.org/0000-0002-0839-9920*
Indiana University, USA

Courtney Hammond Wagner *orcid.org/0000-0001-5295-789X*
Stanford University, USA

Kira Sullivan-Wiley *orcid.org/0000-0003-4704-3625*
University of Notre Dame, USA

Gemma Smith *orcid.org/0000-0003-1388-2375*
Stanford University, USA

REFERENCES

Anderies, J., & **Janssen, M.** (2013). *Sustaining the commons*. Tempe, AZ: Center for Behavior, Institutions, and the Environment, Arizona State University.

Anderies, J., Janssen, M., & **Schlager, E.** (2016). Institutions and the performance of coupled infrastructure systems. *International Journal of the Commons, 10*(2), 495. DOI: *https://doi.org/10.18352/ijc.651*

Anderson, T. L., & **Libecap, G. D.** (2014). *Environmental markets: A property rights approach*. New York: Cambridge University Press. DOI: *https://doi.org/10.1017/CBO9780511845734*

Andersson, K., Benavides, J. P., & **Leon, R.** (2014). Institutional diversity and local forest governance. *Environmental Science and Policy*, *36*, 61–72. DOI: *https://doi.org/10.1016/j.envsci.2013.07.009*

Ansell, C., & **Gash, A.** (2008). Collaborative governance in theory and practice. *Journal of Public Administration and Theory, 18*(4), 543–571. DOI: *https://doi.org/10.1093/jopart/mum032*

Anthony, D. L., & **Campbell, J. L.** (2011). States, social capital and cooperation: Looking back on governing the commons. *International Journal of the Commons*, *5*(2), 284–302. DOI: *https://doi.org/10.18352/ijc.250*

Araral, E. (2014). Ostrom, Hardin and the commons: A critical appreciation and a revisionist view. *Environmental Science and Policy, 36*, 11–23. DOI: *https://doi.org/10.1016/j.envsci.2013.07.011*

Armitage, D. (2008). Governance and the commons in a multi-level world. *International Journal of the Commons, 2*(1), 7–32. DOI: *https://doi.org/10.18352/ijc.28*

Armstrong, A., Stedman, R., & **Tucker, G.** (2019). Beyond 'us and them': Why do landowners disagree about local water pollution? *Society & Natural Resources, 32*(11), 1200–1221. DOI: *https://doi.org/10.1080/08941920.2019.1620390*

Arnott, J. C., & **Lemos, M. C.** (2021). Understanding knowledge use for sustainability. *Environmental Science & Policy*, *120*, 222–30. DOI: *https://doi.org/10.1016/j.envsci.2021.02.016*

Baggio, J., et al. (2016). Explaining success and failure in the commons: the configural nature of Ostrom's institutional design principles. *International Journal of the Commons, 10*(2), 417-439. DOI: *https://doi.org/10.18352/ijc.634*

Baland, J., & **Platteau, J.** (1996). *Halting degradation of natural resources: is there a role for rural communities?* Rome: Food & Agriculture Organization.

Barnes, A. P., Toma, L., Willock, J., & **Hall, C.** (2013). Comparing a 'budge' to a 'nudge': Farmer responses to voluntary and compulsory compliance in a water quality management regime. *Journal of Rural Studies, 32*, 448–59. DOI: *https://doi.org/10.1016/j.jrurstud.2012.09.006*

Barnes, A. P., Willock, J., & **Toma, L.** (2009). Farmer perspectives and practices regarding water pollution control programmes in Scotland. *Agricultural Water Management*, *96*, 1715–22. DOI: *https://doi.org/10.1016/j.agwat.2009.07.002*

Berge, E., & **van Laerhoven, F.** (2011). Governing the commons for two decades: A complex story. *International Journal of the Commons*, *5*(2), 160. DOI: *https://doi.org/10.18352/ijc.325*

Blackstock, K. L., et al. (2010). Understanding and influencing behaviour change by farmers to improve water quality. *Science of the Total Environment*, *408*, 5631–38. DOI: *https://doi.org/10.1016/j.scitotenv.2009.04.029*

Blomquist, W., & **Ostrom, E.** (1985). Institutional capacity and the resolution of a commons dilemma. *Review of Policy Research*, *5*(2), 383–394. DOI: *https://doi.org/10.1111/j.1541-1338.1985.tb00364.x*

Bodin, O., & **Crona, B. I.** (2009). The role of social networks in natural resource governance: what relational patterns make a difference? *Global Environmental Change*, *19*(3): 366–374. DOI: *https://doi.org/10.1016/j.gloenvcha.2009.05.002*

Bonnell, J. E., & **Koontz, T. M.** (2021). A cross-cultural comparison of government influence on collaborative watershed institutions in Ohio (USA) and the Dominican Republic and implications for decentralization of resource management. *Society & Natural Resources*, *34*(10), 1412–1422. DOI: *https://doi.org/10.1080/08941920.2021.1951410*

Breitburg, D., et al. (2018). Declining oxygen in the global ocean and coastal waters. *Science*, *359*(6371), eaam7240. DOI: *https://doi.org/10.1126/science.aam7240*

Brugnach, M., & **Ingram, H.** (2012). Ambiguity: The challenge of knowing and deciding together. *Environmental Science & Policy*, *15*(1), 60–71. DOI: *https://doi.org/10.1016/j.envsci.2011.10.005*

Bryson, J. M., Crosby, B. C., & **Stone, M. M.** (2006). The design and implementation of Cross-Sector collaborations: Propositions from the literature. *Public Administration Review*, *66*, 44–55. DOI: *https://doi.org/10.1111/j.1540-6210.2006.00665.x*

Burton, R. J. F., & **Paragahawewa, U. H.** (2011). Creating culturally sustainable agri-environmental schemes. *Journal of Rural Studies*, *27*, 95–104. DOI: *https://doi.org/10.1016/j.jrurstud.2010.11.001*

Carney, J. (1993). Converting the wetlands, engendering the environment: The intersection of gender with agrarian change in the Gambia. *Economic Geography*, *69*(4), 329–48. DOI: *https://doi.org/10.2307/143593*

Cash, D. W., et al. (2006). Scale and cross-scale dynamics: Governance and information in a multilevel world. *Ecology and Society*, *11*(2). DOI: *https://doi.org/10.5751/ES-01759-110208*

Clark, W. C., et al. (2016). Boundary work for sustainable development: Natural resource management at the Consultative Group on International Agricultural Research (CGIAR). *Proceedings of the National Academy of Sciences*, *113*(17), 4615–22. DOI: *https://doi.org/10.1073/pnas.0900231108*

Cleaver, F. (2012). *Development through bricolage: Rethinking institutions for natural resource management*. New York: Routledge.

Cleaver, F., & **de Koning, J.** (2015). Furthering Critical Institutionalism. *International Journal of the Commons*, *9*(1): 1–18. DOI: *https://doi.org/10.18352/ijc.605*

Cox, M., et al. (2016). Synthesizing theories of natural resource management and governance. *Global Environmental Change*, *39*, 45–56. DOI: *https://doi.org/10.1016/j.gloenvcha.2016.04.011*

Del Corso, J., Nguyen, T. D. P. G., & **Kephaliacos, C.** (2017). Acceptance of a payment of ecosystem services scheme: The decisive influence of collective action. *Environmental Values*, *26*, 177–202. DOI: *https://doi.org/10.3197/096327117X14847335385517*

Dietz, T., Dolšak, N., Ostrom, E., & **Stern, P. C.** (2002). The drama of the commons. In *The Drama of the Commons*, 3–36. Washington, DC: National Academy Press.

Drevno, A. (2016). Policy tools for agricultural nonpoint source water pollution control in the U.S. & E.U. *Management of Environmental Quality: An International Journal*, *27*(2), 106–23. DOI: *https://doi.org/10.1108/MEQ-12-2014-0177*

Duncan, R. (2016). Ways of knowing – out-of-sync or incompatible? Framing water quality and farmers' encounters with science in the regulation of non-point source pollution in the Canterbury Region of New Zealand. *Environmental Science & Policy*, *55*, 151–57. DOI: *https://doi.org/10.1016/j.envsci.2015.10.004*

Durant, R. F., Fiorino, D. J., & **O'Leary, R** (eds.) (2017). *Environmental Governance Reconsidered: Challenges, Choices, and Opportunities*. Second edition. Cambridge, MA: MIT Press.

Feeny, D., Berkes, F., McCay, B. J., & **Acheson, J. M.** (1990). The tragedy of the commons: Twenty-two years later. *Human Ecology*, *18*(1), 1–19. DOI: *https://doi.org/10.1007/BF00889070*

Fleischman, F. D., Loken, B., Garcia-Lopez, G. A., & **Villamayor-Tomas, S.** (2014). Evaluating the utility of common-pool resource theory for understanding forest governance and outcomes in Indonesia between 1965 and 2012. *International Journal of the Commons, 8*(2), 304–36. DOI: *https://doi.org/10.18352/ijc.409*

Folke, C., Hahn, T., Olsson, P., & **Norberg, J.** (2005). Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources*, *30*, 441–73. DOI: *https://doi.org/10.1146/annurev.energy.30.050504.144511*

Forsyth, T., & **Johnson, C.** (2014). Elinor Ostrom's legacy: Governing the commons and the rational choice controversy. *Development and Change, 45*(5), 1093–1110. DOI: *https://doi.org/10.1111/dech.12110*

Friedman, L. M. (2016). Impact: how law affects behavior. Cambridge, Massachusetts: Harvard University Press.

Hammond Wagner, C. R. (2019). Governing water quality limits in agricultural watersheds. University of Vermont.

Hammond Wagner, C. R., et al. (2020). Evaluating water quality regulation as a driver of farmer behavior: A social-ecological systems approach. *Ecology and Society, 25*(4), art35. DOI: *https://doi.org/10.5751/ES-12034-250435*

Hardin, G. (1968). The tragedy of the commons. *Science*, *162*, 1243–48. DOI: *https://doi.org/10.1126/science.162.3859.1243*

Houck, O. A. (2003). *The Clean Water Act TMDL Program: Law, Policy, and Implementation*. 2nd Edition. Washington, DC: Environmental Law Institute.

Howlett, M. (2017). Matching policy tools and their targets: Beyond nudges and utility maximisation in policy design. *Policy & Politics*. DOI: *https://doi.org/10.1332/030557317X15053060139376*

Huitema, D., & **Meijerink, S.** (2017). The politics of river basin organizations: Institutional design choices, coalitions, and consequences. *Ecology and Society*, *22*(2), 42. DOI: *https://doi.org/10.5751/ES-09409-220242*

IPBES. (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, & H. T. Ngo (eds.), IPBES secretariat, Bonn, Germany. pp. 1148.

IPCC. (2021). Climate change 2021: The physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Masson-Delmotte, V., et al. (eds.). Cambridge University Press.

Ison, R., & **Collins, K.** (2008). Public policy that does the right thing rather than the wrong thing righter. In: *Analysing Collaborative and Deliberative Forms of Governance*, 14 Nov 2008, The Australia National University, Canberra, Australia.

Jackson, S. (2019). Building trust and establishing legitimacy across scientific, water management and Indigenous cultures. *Australasian Journal of Water Resources*, *23*(1), 14–23. DOI: *https://doi.org/10.1080/13241583.2018.1505994*

Jetoo, S. (2018). Multi-level governance innovations of the Baltic Sea and the North American Great Lakes: new actors and their roles in building adaptive capacity for eutrophication governance. *Marine Policy*, *98*, 237–245. DOI: *https://doi.org/10.1016/j.marpol.2018.09.020*

Johnson, C. (2004). Uncommon ground: The 'poverty of history' in common property discourse. *Development and Change*, *35*(3), 407–33. DOI: *https://doi.org/10.1111/j.1467-7660.2004.00359.x*

Kerr, J. (2007). Watershed management: Lessons from common property theory. *International Journal of the Commons*, *1*(1), 89–109. DOI: *https://doi.org/10.18352/ijc.8*

Kerr, J. M., Mardhan, M., & **Jindal, R.** (2014). Incentives, conditionality and collective action in payment for environmental services. *International Journal of the Commons*, *8*(2), 595–616. DOI: *https://doi.org/10.18352/ijc.438*

Kim, S. Y., et al. (2020). Updating the Institutional Collective Action Framework. *Policy Studies Journal*. DOI: *https://doi.org/10.1111/psj.12392*

Koontz, T. M., et al. (2004). *Collaborative Environmental Management: What Roles for Government?* Washington, DC: Resources for the Future Press.

Kuhfuss, L., et al. (2016). Nudges, social norms, and permanence in agri-environmental schemes. *Land Economics*, *92*(4), 641–55. DOI: *https://doi.org/10.3368/le.92.4.641*

Lal, R., Reicosky, D. C., & **Hanson, J. D.** (2007). Evolution of the plow over 10,000 years and the rationale for no-till farming. *Soil and Tillage Research*, *93*(1), 1–12. DOI: *https://doi.org/10.1016/j.still.2006.11.004*

Lebel, L., Nikitina, E., Pahl-Wostl, C., & **Knieper, C.** (2013). Institutional fit and river basin governance: A new approach using multiple composite measures. *Ecology and Society*, *18*(1), 1–20. DOI: *https://doi.org/10.5751/ES-05097-180101*

Liu, J., et al. (2007). Complexity of coupled human and natural systems. *Science*, *317*, 1513–16. DOI: *https://doi.org/10.1126/science.1144004*

Lubell, M. (2004). *Collaborative Watershed Management: A View from the Grassroots*. Russell Sage Foundation. DOI: *https://doi.org/10.1111/j.1541-0072.2004.00069.x*

Lubell, M. (2013). Governing institutional complexity: The ecology of games framework. *The Policy Studies Journal*, *41*(3), 537–59. DOI: *https://doi.org/10.1111/psj.12028*

Macgregor, C. J., & **Warren, C. R.** (2006). Adopting sustainable farm management practices within a nitrate vulnerable zone in Scotland: The view from the farm. *Agriculture, Ecosystems and Environment*, *113*, 108–19. DOI: *https://doi.org/10.1016/j.agee.2005.09.003*

Mansbridge, J. (2014). The role of the state in governing the commons. *Environmental Science and Policy, 36*, 8–10. DOI: *https://doi.org/10.1016/j.envsci.2013.07.006*

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

Marshall, G. R. (2004). Farmers cooperating in the commons? A study of collective action in salinity management. *Ecological Economics*, *51*, 271–86. DOI: *https://doi.org/10.1016/j.ecolecon.2004.06.016*

Marshall, G. R. (2008). Nesting, subsidiarity, and community-based environmental governance beyond the local level. *International Journal of the Commons, 2*(1), 75–97. DOI: *https://doi.org/10.18352/ijc.50*

McCay, B. J., & **Acheson, J. M.** (1987). Human ecology and the commons. In *The question of the commons: The culture and ecology of communal resources*. Tucson, Arizona: The University of Arizona Press, 1–34.

McGuire, J., Morton, L. W., & **Cast, A. D.** (2013). Reconstructing the good farmer identity: Shifts in farmer identities and farm management practices to improve water quality. *Agriculture and Human Values*, *30*, 57–69. DOI: *https://doi.org/10.1007/s10460-012-9381-y*

Meinzen-Dick, R., Digregorio, M., & **McCarthy, N.** (2004). Methods for studying collective action in rural development. *Agricultural Systems*, *82*(3), 197–214. DOI: *https://doi.org/10.1016/j.agsy.2004.07.006*

Melland, A. R., Fenton, O., & **Jordan, P.** (2018). Effects of agricultural land management changes on surface water quality: A review of meso-scale catchment research. *Environmental Science and Policy*, *84*, 19–25. DOI: *https://doi.org/10.1016/j.envsci.2018.02.011*

Mosse, D. (2003). *The rule of water: Statecraft, ecology, and collective action in South India*. New Delhi, India: Oxford University Press.

Newig, J., et al. (2018). The environmental performance of participatory and collaborative governance: A framework of causal mechanisms. *Policy Studies Journal*, *46*(2). DOI: *https://doi.org/10.1111/psj.12209*

Niemiec, R. M., McCaffrey, S., & **Jones, M. S.** (2020). Clarifying the degree and type of public good collective action problem posed by natural resource management challenges. *Ecology and Society*, *25*(1), art30. DOI: *https://doi.org/10.5751/ES-11483-250130*

Olivier, T., & **Schlager, E.** (2021). Rules and the ruled: Understanding joint patterns of institutional design and behavior in complex governing arrangements. *Policy Studies Journal*. psj.12429. DOI: *https://doi.org/10.1111/psj.12429*

Olson, M. (1965). *The logic of collective action: Public goods and the theory of groups*. Cambridge, Massachusetts: Harvard University Press.

Orazgaliyev, S., & **Araral, E.** (2019). Conflict and cooperation in Global Commons: Theory and evidence from the Caspian Sea. *International Journal of the Commons*, *13*(2), 962–76. DOI: *https://doi.org/10.5334/ijc.914*

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. New York: Cambridge University Press. DOI: *https://doi.org/10.1017/CBO9780511807763*

Ostrom, E. (2007). A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences of the USA*, *104*(39), 15181–87. DOI: *https://doi.org/10.1073/pnas.0702288104*

Ostrom, E. (2009). *A polycentric approach for coping with climate change*. Washington, DC: The World Bank. Background Paper to the 2010 World Development Report. DOI: *https://doi.org/10.1596/1813-9450-5095*

Partelow, S. (2018). A review of the social-ecological systems framework: applications, methods, modifications, and challenges. *Ecology and Society*, *23*(4), 36. DOI: *https://doi.org/10.5751/ES-10594-230436*

Patterson, J. (2017). Purposeful collective action in ambiguous and contested situations: Exploring 'enabling capacities' and cross-level interplay. *International Journal of the Commons*, *11*(1), 248–74. DOI: *https://doi.org/10.18352/ijc.696*

Patterson, J. J., Smith, C., & **Bellamy, J.** (2013). Understanding enabling capacities for managing the 'wicked problem' of nonpoint source water pollution in catchments: A conceptual framework. *Journal of Environmental Management*, *128*, 441–52. DOI: *https://doi.org/10.1016/j.jenvman.2013.05.033*

Pickering, J., Hong, J., Stower, R., Hong, D., & **Kealley, M.** (2018). Using psychology to understand practice change among sugar cane growers. *Rural Extension and Innovation Systems Journal*, *14*(1), 62–72.

Poteete, A. R., Janssen, M., & **Ostrom, E.** (2010). *Working together: Collective action, the commons, and multiple methods in practice*. Princeton, New Jersey: Princeton University Press. DOI: *https://doi.org/10.1515/9781400835157*

Prokopy, L. S., Mullendore, N., Basier, K., & **Floress, K.** (2014). A typology of catalyst events for collaborative watershed management in the United States. *Society and Natural Resources*, *27*, 1177–91. DOI: *https://doi.org/10.1080/08941920.2014.918230*

Quintana, A., & **Campbell, L. M.** (2019). Critical commons scholarship: A typology. *International Journal of the Commons*, *13*(2), 1112–27. DOI: *https://doi.org/10.5334/ijc.925*

Ribaudo, M., et al. (2011). *Nitrogen in agricultural systems: Implications for conservation policy*. Washington, DC: U.S. Department of Agriculture Economic Research Service. DOI: *https://doi.org/10.2139/ssrn.2115532*

Rittel, H. W. J., & **Webber, M. M.** (1973). Dilemmas in a general theory of planning. *Policy Sciences*, *4*, 155–169. DOI: *https://doi.org/10.1007/BF01405730*

Robertson, G. P., & **Vitousek, P. M.** (2009). Nitrogen in agriculture: Balancing the cost of an essential resource. *Annual Review of Environment and Resources, 34*(1), 97–125. DOI: *https://doi.org/10.1146/annurev.environ.032108.105046*

Rockström, J., et al. (2009). A safe operating space for humanity. *Nature*, *461*, 472–75. DOI: *https://doi.org/10.1038/461472a*

Sabatier, P. A. (1988). An advocacy coalition framework of policy change and the role of policy-oriented learning therein. *Policy Sciences*, *21*, 129–68. DOI: *https://doi.org/10.1007/BF00136406*

Sabatier, P. A., & **Weible, C. M.** (2019). The advocacy coalition framework: Innovations and clarifications, 189–220. In *Theories of the policy process*. Routledge. DOI: *https://doi.org/10.4324/9780367274689-7*

Sarker, A., Ross, H., & **Shrestha, K. K.** (2008). A common-pool resource approach for water quality management: An Australian case study. *Ecological Economics*, 461–71. DOI: *https://doi.org/10.1016/j.ecolecon.2008.05.001*

Schlager, E., & **Blomquist, W.** (2008). *Embracing watershed politics*. Boulder, Colorado: University Press of Colorado. DOI: *https://doi.org/10.2307/j.ctt46nvqs*

Schlager, E., Blomquist, W., & **Tang, S. Y.** (1994). Mobile flows, storage, and self-organized institutions for governing common-pool resources. *Land Economics*, *70*(3), 294–317. DOI: *https://doi.org/10.2307/3146531*

Shortle, J. S., & **Abler, D. G.** (2001). *Environmental policies for agricultural pollution control*. Wallingford: CABI Publishing. DOI: *https://doi.org/10.1079/9780851993997.0000*

Shortle, J. S., & **Horan, R. D.** (2013). Policy instruments for water quality protection. *Annual Review of Resource Economics*, *5*(1), 111–38. DOI: *https://doi.org/10.1146/annurev-resource-091912-151903*

Smith, L. E. D., & **Porter, K. S.** (2010). Management of catchments for the protection of water resources: Drawing on the New York City watershed experience. *Regional Environmental Change*, *10*, 311–26. DOI: *https://doi.org/10.1007/s10113-009-0102-z*

Steffen, W., et al. (2004). *Global change and the earth system: A planet under pressure*. New York: Springer. DOI: *https://doi.org/10.1007/b137870*

Steffen, W., et al. (2015). The trajectory of the Anthropocene: The Great Acceleration. *The Anthropocene Review*, *2*(1), 81–98. DOI: *https://doi.org/10.1177/2053019614564785*

Steins, N. A., & **Edwards, V. M.** (1999). Collective action in common-pool resource management: The contribution of a social constructivist perspective to existing theory. *Society and Natural Resources, 12*, 539–57. DOI: *https://doi.org/10.1080/089419299279434*

Stern, P. C. (2011). Design principles for global commons: Natural resources and emerging technologies. *International Journal of the Commons*, *5*(2), 213–32. DOI: *https://doi.org/10.18352/ijc.305*

Stuart, D., et al. (2015). The need for a coupled human and natural systems understanding of agricultural nitrogen loss. *BioScience*, *65*, 571–78. DOI: *https://doi.org/10.1093/biosci/biv049*

Turner, B. L., II, et al. (1990). Two types of global environmental change: Definitional and spatial scale issues in their human dimensions. *Global Environmental Change*, *1*, 14–22. DOI: *https://doi.org/10.1016/0959-3780(90)90004-S*

van Laerhoven, F., & **Ostrom, E.** (2007). Traditions and trends in the study of the commons. *International Journal of the Commons*, *1*(1), 3. DOI: *https://doi.org/10.18352/ijc.76*

van Laerhoven, F., Schoon, M., & **Villamayor-Tomas, S.** (2020). Celebrating the 30th anniversary of Ostrom's Governing the commons: Traditions and trends in the study of the commons, revisited. *International Journal of the Commons*, *14*(1), 208–24. DOI: *https://doi.org/10.5334/ijc.1030*

Varughese, G., & **Ostrom, E.** (1998). The contested role of heterogeneity. *Working paper no. 32*. Bloomington, IN: Workshop in Political Theory and Policy Analysis, Indiana University.

Villamayor-Tomas, S., et al. (2019). Diagnosing the role of the state for local collective action: Types of action situations and policy instruments. *Environmental Science & Policy*, *97*, 44–57. DOI: *https://doi.org/10.1016/j.envsci.2019.03.009*

Vitousek, P. M., Mooney, H. A., Lubchenco, J., & **Melillo, J. M.** (1997). Human domination of Earth's ecosystems. *Science*, 277, 494–99. DOI: *https://doi.org/10.1126/science.277.5325.494*

Wade, R. (1988). *Village republics: Economic conditions for collective action in South India*. Cambridge, UK: Cambridge University Press. pp. 213.

Wang, Y., Zang, L., & **Araral, E.** (2020). The impacts of land fragmentation on irrigation collective action: Empirical test of the social-ecological system framework in China. *Journal of Rural Studies*, *78*, 234–44. DOI: *https://doi.org/10.1016/j.jrurstud.2020.06.005*

Yoder, L., & **Roy Chowdhury, R.** (2018). Tracing social capital: How stakeholder group interactions shape agricultural water quality restoration in the Florida Everglades. *Land Use Policy*, *77*(September), 354–61. DOI: *https://doi.org/10.1016/j.landusepol.2018.05.038*

York, A. M., et al. (2021). Integrating institutional approaches and decision science to address climate change: A multi-level collective action research agenda. *Current Opinion in Environmental Sustainability*, *52*, 19–26. DOI: *https://doi.org/10.1016/j.cosust.2021.06.001*

Young, O. R. (2002). *The institutional dimensions of environmental change: Fit, interplay, and scale*. Cambridge, Massachusetts: MIT Press. DOI: *https://doi.org/10.7551/mitpress/3807.001.0001*

Young, O. R. (2010). *Institutional dynamics: emergent patterns in international environmental governance*. Cambridge, Massachusetts: MIT Press. DOI: *https://doi.org/10.7551/mitpress/8457.001.0001*

Young, O. R. (2011). Land use, environmental change, and sustainable development: The role of institutional diagnostics. *International Journal of the Commons*, *5*, 66–85. DOI: *https://doi.org/10.18352/ijc.244*

TO CITE THIS ARTICLE:
Yoder, L., Wagner, C. H., Sullivan-Wiley, K., & Smith, G. (2022). The Promise of Collective Action for Large-Scale Commons Dilemmas: Reflections on Common-Pool-Resource Theory. *International Journal of the Commons*, 16(1), pp. 47–63. DOI: *https://doi.org/10.5334/ijc.1163*

Submitted: 08 November 2021 Accepted: 09 April 2022 Published: 27 April 2022