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Co-productive governance: A relational framework for adaptive governance

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ABSTRACT

Adaptive governance focuses our attention on the relationships between science and management, whereby the so-called 'gaps' between these groups are seen to hinder effective adaptive responses to biophysical change. Yet the relationships between science and governance, knowledge and action, remain under theorized in discussions of adaptive governance, which largely focuses on abstract design principles or preferred institutional arrangements. In contrast, the metaphor of co-production highlights the social and political processes through which science, policy, and practice co-evolve. Co-production is invoked as a normative goal (Mitchell et al., 2004) and analytical lens (Jasanoff, 2004a,b), both of which provide useful insight into the processes underpinning adaptive governance. This paper builds on and integrates these disparate views to reconceptualize adaptive governance as a process of co-production. I outline an alternative conceptual framing, 'co-productive governance', that articulates the context, knowledge, process, and vision of governance. I explore these ideas through two cases of connectivity conservation, which draws on conservation science to promote collaborative cross-scale governance. This analysis highlights the ways in which the different contexts of these cases produced very different framings and responses to the same propositions of science and governance. Drawing on theoretical and empirical material, co-productive governance moves beyond long standing debates that institutions can be rationally crafted or must emerge from context resituate adaptive governance in a more critical and contextualized space. This reframing focuses on the process of governance through an explicit consideration of how normative considerations shape the interactions between knowledge and power, science and governance.

1. Introduction

Building effective relationships between science, policy, and practice, knowledge and action requires attention to governance. Governance concerns the various processes and structures shaping individual or collective action (Young, 1992), solidified through formal or informal norms or rules (Lebel et al., 2006). More specifically, environmental governance concerns environmental-related incentives, knowledge, institutions, and decision-making behaviors (Lemos and Agrawal, 2006). Environmental sciences are central to environmental governance, as new understandings of environmental systems often inspire new rules, regulations, or institutions (Miller, 2004; Forsyth, 2003). However, increasingly the knowledge base for environmental governance extends beyond science to include local, traditional, holistic, and experiential knowledge (Folke et al., 2005; Brown, 2010). Thus the relationship between different types of knowledge is central to environmental governance (Rist et al., 2007). Environmental governance also brings questions of morals, values and societal commitment to the fore (Hajer, 1995; Pielke, 2004; Bocking, 2006), as normative dimensions of governance convey assumptions about how society should be organized, how problems should be addressed and by whom (Glasbergson, 1998). In this way, environmental governance can be viewed as a constant negotiation of what we know about the world, how we choose to act, and how collective action is mobilized.

In a world of constant change and incomplete knowledge, environmental governance must respond to changes in social, institutional, and ecological systems (Folke, et al. 2005; Lemos and Agrawal, 2006). 'Adaptive governance' provides a conceptual umbrella for approaches seeking to integrate knowledge of social

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and ecological systems into inclusive decision-making that anticipates, learns from, and responds to change (Wyborn and Dovers, 2014). Adaptive and ecosystem-based management, precursors to adaptive governance, directed significant attention to the role of science in addressing uncertainty and non-linearity in ecological systems (Armitage et al., 2009). Adaptive governance expanded the focus of adaptive management to consider the broader contextual social and institutional processes influencing environmental management, with a particular emphasis on social learning, collaboration and co-management (Armitage et al., 2007; Folke et al., 2005). However, in the shift from 'adaptive management' to 'adaptive governance' the interplay between science and governance remains largely unexamined.

Co-production focuses attention on this interplay to conceptualize the complex interconnections between knowledge and decision-making (Jasanoff, 2004a,b; Vogel et al., 2007). Co-production has a long lineage as an analytical lens in science and technology studies (STS) and more recently has become an instrumental goal of science and policy (van Kerkhoff and Lebel, 2014). As an analytical lens, co-production highlights the myriad social, cultural, and political influences shaping relationships between science, policy, and practice (Jasanoff, 2004a,b). As an instrumental goal, co-production refers to innovative approaches where the producers and users of research collectively identify problems and produce knowledge intended for a specific context (Mitchell et al., 2004). This second invocation of knowledge co-production is now emerging in discussions of adaptive co-management as an effort to draw on diverse knowledge in environmental governance (Berkes, 2009; Armitage et al., 2011; Robinson and Berkes, 2011; Watson, 2013).

This paper unites these different theoretical approaches to present a new conceptual framing 'co-productive governance' that focuses attention on the dynamic interplay between the context, knowledge, process, and vision of governance (after Jasanoff, 2004a,b). This framework was developed to support empirical research that examined the potential for Jasanoff's "idiom of co-production" (2004) to provide an alternative theoretical basis to adaptive governance from the dominant neoinstitutional approaches. The research focused on two case studies of connectivity conservation as examples of both adaptive governance and co-production. The paper uses the co-productive governance framework to highlight the contextual influences shaping the co-production of science and governance in these to cases. These cases highlight the inability to separate considerations of science from governance, while also demonstrating the varied ways that co-productive processes shape how governance unfolds. These insights highlight the value of a framework that focuses attention on the co-evolutionary relationships between science and governance. Unlike the design principles and diagnostics central to adaptive governance scholarship, the co-productive governance framework focuses analytical attention on how existing knowledge, aspirations, and institutions can be harnessed to support governance that is adaptive to change.

2. Literature review

2.1. Adaptive governance

Adaptive governance links social, political, economic, and ecological domains, framing flexible, collaborative decision-making as an alternative to top–down, bureaucratic governance (Gunderson and Light, 2006; Armitage et al., 2007; Folke et al., 2005; Lebel et al., 2006). Adopting the iterative learning of adaptive management, adaptive governance grew from the realization that challenges to co-management and adaptive management predominantly emerge from the arenas of governance (Armitage et al., 2007). Centralized or overly bureaucratic governance structures struggle with management practices that plan for failure, learn from experimentation, and adapt to change (Allen and Curtis, 2005). Collaborative institutional mechanisms, networks, and cross-scale linkages are a principal focus of adaptive governance scholarship.

Social learning and collaborative co-management are foundational to adaptive governance (Folke et al., 2005). Social learning entails collective learning, reflexive practice, and action (Keen et al., 2005; Rist et al., 2007; Pahl-wostl et al., 2007). Collaborative co-management involves power-sharing between local communities and government to provide community benefits through decentralized decision-making (Armitage et al., 2007; Carlsson and Berkes, 2005; Olsson et al., 2004). Adaptive governance focuses on networks connecting people, ideas, and knowledge (Innes and Booher, 2010), to address environmental challenges that cross localto regional to global scales (Berkes, 2002; Ostrom, 2010; Biermann et al., 2009).

Collaborative planning and deliberative public policy scholarship parallels these intellectual developments, drawing on the intellectual lineage of critical social and political theory (Innes and Booher, 2010; Fischer, 2000; Hajer and Wagennar, 2003). Another response to the perceived failings of bureaucratic, expert led decision-making, collaborative planning emphases the importance of bringing non-traditional voices and more diverse knowledge into planning. Innes and Booher (2010) outline three key features of adaptive governance: diversity in agents and components; ample opportunity for interaction among agents; and effective modes for selecting appropriate methods. Collaborative dialogs have profoundly changed decision-making structures on the ground (Connick and Innes, 2003), providing fruitful insight into the challenges of balancing diverse interests in adaptive governance. However, these critical insights play less attention to the normative influences shaping the interplay between science and governance.

Developing and refining design principles and diagnostics is a central focus of adaptive governance scholarship. Design principles are conditions attributed to successful institutions that facilitate compliance with the rules in use (Ostrom, 1990). This approach identifies and examines the underlying principles or broad structural similarities common to robust governance systems (see Table 1). Design principles provide a heuristic, not a blue print, to examine governance (Ostrom, 2005). However, these insights were largely derived in small scale, well-defined resource systems within relatively homogeneous communities with a direct stake in resource management; characteristics not commonly found across the world (Dietz et al., 2003). Unlike design principles, Young's diagnostic approach disaggregates environmental conditions on a case-by-case basis to analyze and identify the implications of these conditions for institutional design (2002). The approaches are complementary: both identify generic rules or principles for institutional design, the principal distinction being the ability for diagnostics to be used across a larger diversity of cases (Cox et al., 2010). While acknowledging the substantial contribution of this work, lists of idealized conditions divorced from their context only presents half of the picture. Theory and practice must also attend to the ways in which actors can work within or transform existing structures and processes to facilitate effective environmental governance.

The view that institutions can be rationally crafted conflicts with contextual understandings of institutional change. Focusing on formal and informal rules typically neglects the relationships and processes central to practice of governance (Steins and Edwards, 1999; Cleaver, 2000; Nightingale, 2011), while imparting the notion that governance can be developed by recipe (Armitage et al., 2007). Moreover, institutions exist in a constant state of flux,

Table 1
Principles and Guidelines from adaptive governance scholarship.

Focus	Principles	Authors
Common property resource governance – collective action and sustainable resource use	• Clearly defined boundaries; • Rules regarding appropriation and provision adapted to local context; • Collective-choice arrangements that allow most resource appropriators to participate in decision-making; • Monitoring by monitors who are part of or accountable to the appropriators; • Graduated sanctions for appropriators who violate the rules; • Accessible conflict-resolution mechanisms; • Self-determination recognized by higher-level authorities; • Nested enterprises to accommodate larger common-pool resources.	Ostrom (1990)
Adaptive governance – conditions where effective governance is easier	• Tangible and measurable resource systems; • Systems under moderate rates of social and ecological change; • Places where people are able to maintain face-to-face contact to foster trust and social capital; • Where outsiders can be excluded at relatively low cost; • Where resource users are engaged in monitoring and enforcing resource extraction.	Dietz et al. (2003)
Conditions where adaptive co-management is likely to succeed	• Well defined resource system; • Small scale resource use contexts; • Clear and identifiable set of social entities with shared interests; • Reasonably clear property rights to resources of concern; • Access to adaptable portfolio of management measures; • Commitment to support a long-term institutional building process; • Provision of training, capacity building and resources for local, regional and national level stakeholders; • Key leadership of individuals prepared to champion the process; • Openness of participants to share and draw upon a plurality of knowledge systems and sources; • National and regional policy environment explicitly supportive of collaborative management efforts.	Armitage et al. (2009)
Features of adaptive governance	• Diversity in its agents and components; • Amply opportunity for interaction among the agents; • Effective methods for selecting appropriate actions.	Innes and Booher (2010)
Principles for enhancing ecosystem services	• Maintain diversity and redundancy; Manage connectivity; Manage slow variables and feedbacks; • Forster an understanding of social-ecological systems as complex adaptive systems; • Encourage learning and experimentation; • Broaden participation; • Promote polycentric governance systems.	Biggs et al. (2012)

shaped by power relations and conflicting interests (Mehta et al., 2001; Jasanoff, 2004a,b; Ansell, 2011). In this way, institutions embody social processes, they are not constructed from a vacuum when actors select mechanisms to fit collective action tasks (Cleaver, 2000; Nightingale, 2011).

Critiques call for more situated understandings of adaptive governance, taking into account the dynamic interplay of history, context, process, practice, and agency, while placing greater emphasis on power, negotiation, and contestation across scales (Mehta et al., 2001). While historical, contextual, and political factors are foundational to environmental governance (Armitage, 2008), the idea that institutions must emerge from context is limiting: it provides inadequate conceptual tools to share insights across contexts or help to those wishing to establish or improve environmental governance.

2.2. Co-production

Co-production provides analytical focus on the interactions between knowledge-making and decision-making in adaptive governance. This scholarship rejects the separation of science, policy, and practice, drawing attention to the socio-political, normative, and contextual influences shaping the use and uptake of knowledge (Jasanoff, 2004a,b; Dilling and Lemos, 2011; Muñoz-Erickson, 2014). Co-production builds on earlier ideas of 'boundary work' focused on negotiation and communication at the interface of science and practice (Gieryn, 1999; van Kerkhoff and Lebel, 2006). Boundary work can be harnessed to connect knowledge with action (Cash et al., 2003), and overcome conflicting interpretations of reliable or useable knowledge (Clark et al., 2011).

Critical analysis of co-production demonstrates the inseparability of what we know from how we choose to act in the world (Jasanoff, 2004a,b). At the interface of science and governance, facts and values are blurred when judgments and trade-offs between societal goals are negotiated (Pielke, 2004). When questions of what is and what should be are conflated, input and expertise beyond scientific domain of the problem space is required (Carolan, 2006). In such arenas, science and governance are co-produced through converging material, cognitive, social, and normative domains (Jasanoff, 2004a,b). In other words, our understanding of reality (the material) is shaped by what we know (the cognitive) and the context of knowledge production (the social), which cannot be divorced from how we choose to act in the world (the normative) (see Fig. 1). These accounts question relations between knowledge and power, highlighting how the cognitive authority of science elevates particular perspectives on policy and governance (Bocking, 2006).

The second invocation of co-production focuses on collaborative knowledge production among diverse actors situated across the boundaries of science, policy, and practice (Lemos and Morehouse, 2005; Dilling and Lemos, 2011; Armitage et al., 2011). Here, co-production emerges from meaningful interactions that generate knowledge relevant to policy and practice (Armitage et al., 2011; Cash et al., 2006; Lemos and Morehouse, 2005). Knowledge co-production requires a substantial commitment to interdisciplinary or transdisciplinary research that engages stakeholders in iterative collaboration (Lemos and Morehouse, 2005),

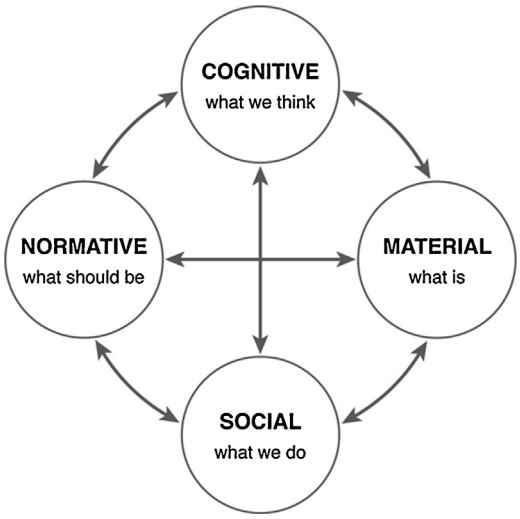

Fig. 1. A model of co-production depicting the interplay between the material, normative, social and cognitive domains.
Derived from Jasanoff (2004a,b).

and processes to enhance the capacities (institutional, human, organizational support and political opportunities) to apply knowledge in a particular context (Dilling and Lemos, 2011; Wyborn, 2014b). These approaches assume that knowledge co-produced for a particular context is more likely to lead to action (Cash et al., 2006).

With a shared focus on the interplay between science and society, these conceptualizations of co-production are clearly related (van Kerkhoff and Lebel, 2014). Both invocations of co-productioncharacterize the relationships between science, policy, and practice as a negotiation among actors highlighting the contextual – be they individual, cultural, political, or scientific – influences shaping environmental governance. In contrast, design principles neglect the power disparities and competing knowledge claims that pervade the complex arenas of environmental governance. Co-production views institutions as emerging from interactions between existing formal and informal rules, actors, aspirations, and discourses situated in context. This provides a lens to view governance in action, to understand the role of the public and non-disciplinary actors addressing questions of what is and what should be done (Jasanoff, 2004a,b). Collaboration is commonly proposed to improve the use of knowledge in practice, however it is naive to assume this leads to effective communication across science policy boundaries (Cash et al., 2006). This leads van Kerkhoff and Lebel (2014) to caution that the contextually-embedded, critical analysis may be lost when searching for the silver bullet of knowledge co-production. Thus, co-production requires a fundamental transformation of both science and governance toward more critical, inclusive, and reflexive practice (Buizer et al., 2011; Muñoz-Erickson, 2014).

3. Co-productive governance?

Political and social theorists have long identified the connections between knowledge and power, a tension that persists within contemporary efforts to connect science with policy and practice (van Kerkhoff and Lebel, 2006). Despite growing efforts to include diverse knowledge from local to global scales, western science undeniably plays a dominant role within environmental governance (Jasanoff, 2010; Forsyth, 2003; Bocking, 2006). Science, while fundamental to addressing environmental challenges, represents rather than mirrors reality, making scientific knowledge a space for contested claims of truth and power (Forsyth, 2003). Approaches to environmental management constrain options for policy and governance: command and control approaches yield very different governance to those accepting a plurality of legitimate perspectives (Brunner and Steelman, 2005). Where science is used to determine conservation priorities, adaptive governance must question how power is constituted within science itself (Watson, 2013).

Co-production provides analytical insight into these questions in ways that can usefully inform adaptive governance. Governance that is adaptive to change requires tight relationships between what we know and how we act: as knowledge changes, so too should governance and management. Thus co-production can be viewed as a normative goal of adaptive governance, although it is rarely expressed as such. What then, does it mean, to reconceptualize adaptive governance as a process of co-production?

Stripped to their core elements, Jasanoff's idiom of co-production and Ostrom's design principles have different ontological foundations. Neoinstitutional analysis views social reality as governed by rules and actions of individuals and institutions seeking to maximize individual or collective gain (Innes and Booher, 2010; Aligica and Boettke, 2011), while co-production is underpinned by a relational ontology that sees social transactions and processes as the foundations of social reality (Forsyth, 2003; Jasanoff, 2004a,b). Different ontological assumptions about the nature of social reality lead to different foci and recommendations for adaptive governance (after Emirbayer, 1997).

Relational approaches focus on the processes and interactions that connect entities rather than examining entities in isolation. From this view, design principles cannot be understood independently of their context, as knowledge and practice co-evolve through time. This perspective enables a richer understanding of political processes (Hobson, 2007) to yield deeply contextualized analysis of how actors and institutions co-evolve (Ojha et al., 2013). Relational approaches emphasize what can be pragmatically achieved at present rather than focusing on ideal types (Eyben, 2008). This perspective is compatible with the approach championed by Innes and Booher (2010), which focuses on the 'fluid linkages' of adaptive governance that connect nodes of interaction, dialog, and collaboration.

Co-production also highlights the normative and contextual influences shaping environmental governance. While these are increasingly recognized as important within adaptive governance scholarship (Olsson et al., 2007), neoinstitutional analysis lacks the analytical framing to understand how these influences enable or constrain adaptive governance (Nightingale, 2011). While formal rules and operating procedures are important, norms, values, and ideas provide the cognitive foundation for cooperative behavior (Thomas, 2003; Rist et al., 2007). Jasanoff's idiom of co-production provides an explicit framework to understand how normative and cognitive dimensions interact in a particular social and material context to produce particular outcomes and ways of governing.

Beyond stating that co-production emerges from the "constant interplay of the cognitive, the material, the social, and the normative" (2004, p38), Jasanoff provided very little indication of what she meant by these categories. Moreover, while the ideas and critical analysis of STS are central to the theory and practice of adaptive governance, the language is often inaccessible to those beyond the field. The co-productive governance framework builds on and simplifies these categories to conceptualize them as interacting arenas of adaptive governance. Viewed through this prism, I have interpreted Jasanoff's categories as follows:

- Context (material): the broader social, ecological, and institutional context in which each initiative is situated;

Table 2
Basic Comparison of Habitat 141° and Y2Y.

	Habitat 141°	Y2Y
Year established	2005	1993
Size	18,000 km^2; 700 km long, 200 km wide	1.2 million km^2; 3200 km long, 200–800 km wide
Jurisdictions	Victoria, South Australia, New South Wales	USA: Montana, Idaho, Wyoming Canada: British Columbia, Alberta, the Yukon Territories Tribal Lands of 31 Canadian First Nation and US Native American Tribes
Major Players	Government agencies, conservation NGOs, community stewardship groups	Conservation activists, scientists, conservation NGOs
Vision	To work with communities to conserve, restore and connect habitats for plants and wildlife on a landscape scale from the outback to the ocean.	Combining science with stewardship, we seek to ensure that the world-renowned wilderness, wildlife, native plants, and natural processes of the Yellowstone to Yukon region continue to function as an interconnected web of life, capable of supporting all of its natural and human communities, for now and for future generations
Governance structure	Alliance operating under a memorandum of understanding	Registered non-profit with a split Board on either side of the US/Canadian border
Focus	Natural resource management, ecological restoration, collaborative conservation, economic development	Large carnivore conservation, advocacy, wilderness and protected area conservation, collaborative conservation

- Knowledge (cognitive): knowledge related to the science, practice, and governance of connectivity conservation;
- Process (social): the formal and informal rules shaping collective action within each initiative;
- Vision (normative): the motivations guiding collective action and aspirations of what 'should be done'.

The empirical analysis presented below uses this framework to highlight how differences within, and interactions between, these arenas shaped the trajectories of governance in the case studies examined.

4. Methodology and methods

This paper presents an interdisciplinary analysis of two cases of connectivity conservation, one in Australia (Habitat 141°) and one in North America (Y2Y) (see Table 2 and Fig. 2). Case study research explores complex and poorly understood phenomenon through flexible research methods and in-depth analysis (Ritchie, 2003), to corroborate or falsify existing concepts or theory, or develop new concepts or theory (Baxter, 2010). Empirical cases of connectivity conservation provided a vehicle to explore the potential for co-production to provide an alternative theoretical basis for adaptive governance.

Connectivity conservation aspires to realign governance with current understandings of ecosystem dynamics, advocating for multi-stakeholder, cross-scale collaboration (Wyborn, 2011). These endeavors are an empirical example of co-production: advances in conservation science highlighting the connections between ecological and institutional fragmentation inspired new frameworks for biodiversity governance that transcend existing institutional boundaries. Connectivity conservation also draws heavily on adaptive governance scholarship to promote governance that distributes decision-making across local to regional scales (see Lockwood, 2010).

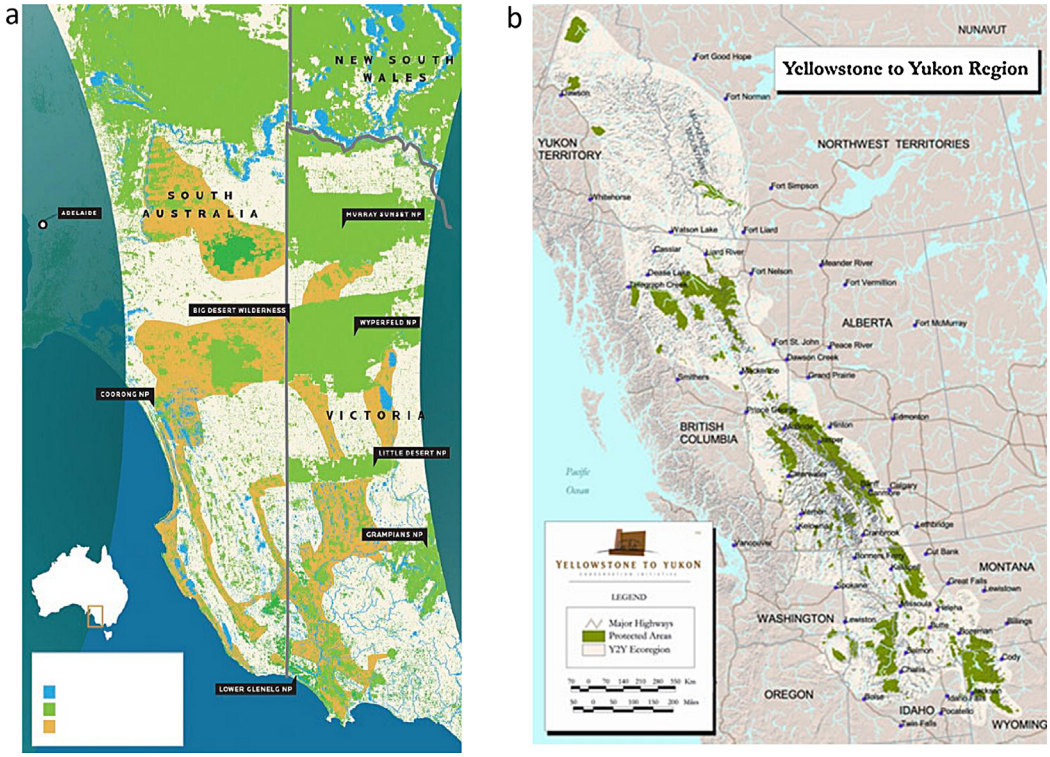

Fig. 2. (a) Map of Habitat 141° depicting approximate targets areas for improving connectivity. (b) Map of Y2Y depicting priority areas for conservation.

I conducted three rounds of semi-structured interviews between 2009 and 2011. First, with 14 Australian conservation 'experts' (scientists, policy makers, and NGO staff) to gain their perspective on the emergence, perceived validity, and efficacy of connectivity conservation in Australia. Second, with 26 past and present staff, partners, and board members of Y2Y, focused on Y2Y's vision, history, and governance; successes and challenges; and the role of science in decision-making. Finally, with 13 members of the Habitat 141° Governance Working Group (GWG) about the science, governance, and practice of connectivity conservation. All interviews were recorded, transcribed verbatim, and coded in NVIVO 9.2. Public (annual reports, brochures, websites, e-newsletters, and promotional material) and internal (meeting minutes, strategic planning documents, scoping studies, and workshop reports) material from both case studies were imported into NVIVO, coded and analyzed alongside interview data.

This research involved a ten-month period of "embedded research" (Wickson et al., 2006) with the GWG charged with developing governance arrangements for Habitat 141°. The 16 self-nominated members represented a spectrum of interests: public, private, civil society, and research. This effort is an empirical attempt to operationalize both co-production and adaptive governance as diverse actors combined experiential knowledge and theoretical insights to develop cross-scale collaborative governance arrangements tailored to the specific needs and context of Habitat 141°. I actively participated in the negotiations, contributing a theoretical perspective and empirical insights from my research in Y2Y. At the outset I abstained from voting on key issues, however, over time was invited to participate on the same terms as the rest of the group. This experience fostered a stronger, more empirically grounded analysis of co-production and adaptive governance.

Co-production is a process, not an outcome, requiring a methodology to examine how these processes unfold (Goldstein, 2010). To do this, I adopted a reflexive research approach to integrate theoretical insights with emerging contextual understanding (after Layder, 1998). Using both inductive and deductive reasoning, adaptive theory examines what is happening (deductive) while also asking why (inductive) it is happening (Layder, 1998). In a multi-staged analysis, I used NVIVO's matrix coding queries to support a constant comparative analysis, comparing and contrasting situations where variation manifests in the data (Boeiji, 2010). The co-productive governance framework was used as an analytical lens to explore ways in which the arenas (context, knowledge, process, vision) and their interactions interact and shape the trajectory of science and governance in the two case studies. A second iteration of analysis utilized a bi-focal lens of adaptive governance and co-production to contrast what the different theoretical perspectives highlighted in the data.

5. Findings

The findings below focus on how the aspirations of connectivity conservation to support collaborative cross-scale governance led to very different outcomes in the two cases. Before highlighting the ways in which these arenas interact to produce particular ways of governing, I first explore the different arenas (context, knowledge, process, vision) of each case study. Given the analytical focus on how these arenas change as a consequence of their interactions, drawing clear distinctions was at times elusive.

5.1. Habitat 141°

5.1.1. Context

Land clearing, habitat fragmentation, and European farming practices significantly degraded the Australian landscape (Saunders et al., 1990). In response, Federal environmental policy has supported landholder based collaborative conservation and restoration since the beginning of the 20th century (Dovers, 2000). While the ecological impacts of these efforts are questioned (Curtis, 2003), socially and symbolically, they are viewed as inherently good (Lockie, 1997). Habitat 141° builds on this history, promising to address pressures shared by farmers and conservationists.

The Habitat 141° alliance operates across 18 million hectares straddling the Victorian/South Australian border (see Fig. 2). The initiative spans the geographic area of six natural resource management (NRM) bodies, three State environment departments, and one national park agency. With the exception of NSW environment department, all these organizations were represented within the alliance. Federal and local governments have jurisdiction within the region, however they were not represented within the Habitat 141° alliance. The region is ecologically diverse containing heathland, mallee, river red gum forests, flood plains, grassy woodlands, and coastal ecosystems. Land-use varies greatly, encompassing large areas of conservation, intensive forestry, cropping, and extensive grazing.

Agriculture is the major employer and economic driver, followed by retail and construction, however employment in agriculture has declined over the last decade (URS, 2010). The region is slowly depopulating, with many small towns suffering as a consequence of migration to larger cities (URS, 2010). In the context of this decline, Habitat 141°'s vision to provide social and biodiversity outcomes through ecological restoration and conservation (Habitat 141°, 2010) received widespread support.

The external policy context both inspired and undermined Habitat 141°. Despite promoting collaboration, Australian environmental policy has also been attributed with creating competition between potential partners (Robins and Kanowski, 2011). The government was to provide up to AUS$20 million to large-scale collaborative projects (Australian Government, 2008), and rhetorically supported connectivity conservation through the National Wildlife Corridor Plan. However, this supportive policy environment did not translate into funding for Habitat 141°, as their bid for AUS$20 million failed, largely due to inadequate institutional structures to receive the requested funds. After the unsuccessful bid, fractures in the alliance emerged, with many GWG participants suggesting that the competitive funding environment directly undermined emerging collaborative relationships.

5.1.2. Knowledge

> I think you need ecological science, you need local knowledge, you need knowledge around governance and collaboration and facilitating an alliance towards outcomes ... and that is a significant and important piece of knowledge... I don't know if knowledge is really the barrier to Habitat 141° succeeding at this point, although maybe some of this governance stuff is part of that (National NGO).

Beyond the individual knowledge of participants in the alliance, Habitat 141° had limited resources to fund additional research to support its endeavors. While many believed that more refined knowledge (in governance, ecological, and social sciences) would be beneficial, they also recognized that the barriers to success emerged from power struggles and insufficient funding rather than a lack of knowledge.

Connectivity conservation in Australia is the subject of ongoing academic debate (see Hodgson et al., 2009; Possingham, 2009; Doerr et al., 2011; Hodgson et al., 2011). Principal critiques concern whether the approach will actually improve ecological

connectivity, the transfer of invasive species and diseases, the relative importance placed on connectivity over habitat quality and quantity, and whether it is a cost effective conservation strategy (Wyborn, submitted for publication). Despite these debates, connectivity science was regularly invoked to justify Habitat 141°. Those critical academic voices had few direct interactions with Habitat 141°, and many GWG participants believed the critiques were a misinterpretation of their goals and approach.

Habitat 141° had a Science Working Group (SWG), however it remained disconnected from decision-making. The insignificance of the SWG is underscored by how infrequently it was discussed in interviews and GWG negotiations. Participants questioned the salience of the SWG research to implementation needs, pointing to an inability in the current governance structure to support co-design and co-production of research.

A lack of governance expertise severely constrained Habitat 141°. Many GWG participants viewed their knowledge of governance as adequate to navigate the complex negotiations. Challenges faced by the GWG emerged from miscommunication around key terminology and disagreement around core issues (namely the distribution of power) that plagued the alliance since its outset. These debates undermined Habitat 141°'s credibility in many of the local communities in the region and detracted from regional conservation planning efforts. Habitat 141°'s challenges in this arena are as much about how knowledge is communicated and shared, highlighting the inability to separate questions of what we know from the processes shaping action.

5.1.3. Process

> I think we got sidetracked by talking about different governance models when really we should have talked about how you communicate in the relationships between people that is important in progressing a project like Habitat 141°. Having a perfect governance structure... won't do it for you. That was pretty evident (South Australian Gov't).

Habitat 141° is framed as a community driven initiative with a commitment to support local landholders and communities. Beyond the rhetoric, Habitat 141° was driven by government agencies and large NGOs, and the governance negotiations alienated smaller regional groups.

The GWG proposed a nested governance structure with a Council operating at the whole of landscape-scale, regional conservation planning in nine landscape 'Zones', with implementation the remit of landholders and partners working in collaboration. Insufficient funding and capacity precluded building linkages between these scales of decision-making (Wyborn, 2014a). The principle of susbsidiarity formed a cornerstone of the proposed governance: decision-making was to be devolved to those operating at the scale of a problem with the capacity to deliver desired outcomes. After eight months, the GWG could not resolve fundamental disagreements about rules of operation and the distribution of power across the nested governance structure. Despite insufficient legal expertise, the group spent significant time debating the formal legal structures underpinning the governance model, which many now believe was the wrong conversation. On reflection, GWG participants suggested they should have focused on how partners would work together to connect their vision with on-ground action.

GWG participants shared concerns that Habitat 141° lacked effective leadership. The co-chairs – one from government, the other a large NGO – held fundamentally different perspectives on the GWG process and the proposed governance structures. The two coordinators engaged over the duration of research believed that the powerful agencies and NGOs in the alliance constrained their leadership capacity. Attempts to exercise leadership were interpreted as an illegitimate exercise of power, while two partners within the alliance were accused of misusing financial power to achieve desired outcomes.

5.1.4. Vision

> Agreeing to the vision in a collaborative way has kept us there to persist until we get there... we know it is rock solid because if we don't have it, we're stuffed... [the vision] is an enormous motivation to keep going (state NGO).

Participants in Habitat 141° shared a commitment to community-based conservation and restoration, and the importance of landscape-scale conservation. All large gatherings began with an impassioned speech about the importance of the region, the people, and the collaborative effort. Landscape ecology, in particular, fragmentation and connectivity studies were communicated through compelling narratives about birds needing migratory habitat from the 'outback to the ocean'.

A number of local-scale community-based conservation initiatives lay the foundation for Habitat 141°. The most famous, Project Hindmarsh, involved the collaborative restoration of a 100 km vegetation corridor supported by Federal Government funding. A creation narrative frames Habitat 141° as "scaling-up" Project Hindmarsh's success. Building on their approach, the Habitat 141° alliance developed the following vision:

> To work with communities to conserve, restore, and connect habitats for plants and wildlife on a landscape-scale from the outback to the ocean (Habitat 141°, 2010).

While this provided a foundational "glue" through difficult negotiations, a shared belief in this vision both united and divided the GWG. All agreed that the support of local communities and existing initiatives are critical to Habitat 141°'s success, however, they were divided on how best to gain such support. Four models of legitimate governance emerged: top–down, bottom–up, action-oriented, and science-based, all based in normative judgments on the best way to motivate and organize collective action. The inability to resolve these differences caused the iteration of governance negotiations studied in this research to disband.

The Habitat 141° vision concealed the fundamentally different perspectives at the heart of the GWG's conflict, yet the vision remains beyond their struggles. Many leading figures during this research have moved on, while others remain involved in the growing number of activities inspired by the Habitat 141° vision.

5.2. Y2Y

5.2.1. Context

The natural resources and frontier communities founded around mining, forestry and agriculture define the contemporary history of the Rocky Mountains. Resource extraction began in the mid 1800s and by the 1890s degradation drove the genesis of the now significant public land estate in both the US and Canada (Travis et al., 2002). Since the 1970s, land-use conflict has divided the region, as new settlers and visitors critique the extractive industries that founded the regions' economies (Travis et al., 2002). These economies have slowly transitioned toward service-based tourism and mobile capital, with the natural resources remaining a draw card for newcomers (Rasker, 2005). The economies of the 'old' and 'new' West now co-exist, with the heated conflict of the past having largely dissipated.

Y2Y emerged in the early 1990s in the midst of this resource conflict to promote large carnivore conservation – grizzly bears

(*Ursus arctos horribilis*), gray wolf (*Canis lupus*), lynx (*Felis lynx canadensis*) and wolverine (*Gulo gulo*), however the initiative includes avian and aquatic conservation strategies. Y2Y covers approximately 120 million hectares encompassing three US states and four Canadian provinces, the jurisdiction of 13 Canadian and US land management agencies, and the territories of 31 Canadian First Nation and US Native American tribal lands. As a largely advocacy based initiative, government actors have had little involvement in Y2Y.

Carnivore conservation in the Northern Rockies has become a symbol of divisive conflicts between recreation-based versus extraction-dependent economies, and state's rights versus federalism (Primm and Clark, 1996). For environmentalists, carnivores symbolize the need to protect wild spaces, whereas for agricultural communities they symbolize excessive federal government control and infringements on private property rights (Chester, 2006). In this context, Y2Y's vision for land-use change became a tangible target for those involved with the extractive industries in decline. While Y2Y has made some progress in regaining credibility after the significant backlash surrounding its genesis, lingering perceptions of a hardline environmental organization undermine their capacity to connect with some communities across the region (Wyborn and Bixler, 2013).

In an institutionally fragmented landscape, carnivore conservation is governed by a diverse and inconstant array of laws (Keiter and Locke, 1996). However, carnivore conservation is inextricably linked to contentious issues concerning the US Endangered Species Act (ESA). Two characteristics of the ESA are critical to Y2Y's story. First, provisions within US environmental laws have culminated in a litigious culture of environmental advocacy (Nie, 2008), and second, the ESA mandates the use of best available science (Doremus, 2004). This context provided strong incentives for Y2Y to rely on science-based litigation and advocacy to achieve their vision.

5.2.2. Knowledge

> We all thought that by getting the science right things would follow but the facts don't change peoples' behavior and it took quite a few years to realize that (Y2Y board member).

Y2Y's early drivers strongly believed the initiative must be underpinned by credible science. According to this view, science provided the nonnegotiable "biological bottom line" to guide conservation actions, shift public debate, and redirect policy. In their first decade, Y2Y promoted a major research endeavor to produce a scientifically rigorous conservation plan. In 1999, Y2Y established a Science Grants Program, distributing over US$1.5 million to grow the scientific knowledge base for advocacy, create bridges between research and NGO communities, and build capacity for young scientists. The program was designed to provide scientific credibility to the advocacy efforts within the region, based on an assumption that scientific credibility would increase the effectiveness of their advocacy efforts (Mahr and Mauro, 2003).

While Y2Y has had some success, the science-based approach did not have the expected impact on policy or behavior change. Science may have provided legitimacy for the their vision in some arenas, however it failed to win the support of many local communities. One of Y2Y's partners explained how his organization used science to lobby the judiciary to enforce behavior change. Conversely, a founding member reported being frustrated with the use of science as an "arsenal of facts" to defeat the enemy, which he saw as fundamentally undermining Y2Y's public relations. According to this perspective, the backlash was not about science, it was about the normative legitimacy of Y2Y's vision of land-use change. This highlights the way in which normative positions influenced how people related to the scientific knowledge underpinning Y2Y's efforts.

Internal documents indicate a distinct conceptual separation between Y2Y science and the communication of their message. While early internal discussions focused on maintaining 50% of the region in protected areas this figure was not widely publicized. Beyond undermining their legitimacy through lack of transparency, this target is unlikely to materialize if it cannot be discussed in the public sphere. Y2Y has supported a significant and innovative research agenda, however many interviewees believed that their inability to connect this research with decision-makers undermined their capacity to turn their vision into action. Like Habitat 141°, these challenges stem from issues related to how knowledge is mobilized within the processes of governance.

5.2.3. Process

> It was very innovative work in the science field but it unfortunately just didn't get links with the work of working with the people out there not just the conservation groups, everybody else (Former Y2Y staff).

Y2Y began under the charismatic leadership of an American conservation biologist and a Canadian lawyer. As the "marriage of scientists and activists", Y2Y started as a loose network of approximately 40 conservation organizations and individuals, with a smaller Coordinating Committee to oversee implementation. Y2Y targeted like-minded groups who supported their mission with extractive industries, government, and local landholders notably absent. As a consensus-based collaboration, their exclusion was justified on the perceived potential to coopt Y2Y's goals and ambitions.

In 1999, the independent non-profit Yellowstone to Yukon Conservation Initiative (Y2YCI) was created. Three factors drove this transformation: the need for financial independence, the perception that the collaborative governance structure was vulnerable to capture by external threats, while also being too slow to support progress toward the vision. This formalization shifted oversight from the partners in the collaboration to a more hierarchical governance structure with a Board and Executive Director (Francis, 2005).

Y2YCI now works to promote the vision, provide scientific and other resources, and support regional collaboration. Structurally it now bares less resemblance to the types of organizations in the network, and without a Council there are no mechanisms for Y2Y's partners to directly interact with the Board. Some partners reported healthy relationships with the initiative, while others complained of power imbalances and challenges with the initiative's reputation as a hardline conservation organization.

5.2.4. Vision

> The courage that it took for people who loved nature to speak up... not only did we love nature, but we wanted to change land use in the region (founding Y2Y member).

The prominence of their vision is the most frequently cited measure of Y2Y's success. However, all interviewees recognized the power of the vision to both unite and divide, with some reporting a need to actively distance themselves from the initiative to work in certain communities. Y2Y's original vision was firmly situated in wilderness discourses advocating for radical land-use change. After the backlash the vision was reframed:

> Combining science and stewardship, we seek to ensure that the world-renowned wilderness, wildlife, native plants, and natural processes of the Yellowstone to Yukon region continue to function as an interconnected web of life, capable of supporting all of the natural and human communities that reside within it, for now and for future generations (Y2Y undated).

Y2Y's proponents claim that science provides the insight, "love of wild place" the impetus. Believing that the unification of science and values adds power to their mission, Y2Y's vision extends beyond carnivore conservation to promote an alternative future. Y2Y's communication material urges conservation groups to craft messages around emotions rather than facts and figures, to promote a shared image of the good life (Y2Y, 2003). However, where the vision is not shared, proponents believed that scientific credibility would legitimize their vision in policy debates.

Opposition to Y2Y manifest in diverse fora: media, industry reports, local municipalities and chambers of commerce (Chester, 2006). Negative press framed Y2Y as urban environmental elites seeking to threaten existing distributions of power and wealth, weaken property rights, and destroy regional economies. Leading proponents of Y2Y see the backlash as a misunderstanding of their vision and values, who believe Y2Y shares with rural communities a desire to support healthy landscapes and livelihoods. However, given their lack of credibility, these shared values are often not recognized. The backlash against Y2Y's vision cannot be separated from concerns about regional economic transition, property rights, and the governance implications of their vision of a network of protected areas across the Northern Rockies.

6. Discussion

In their attempts to support cross-scale governance to implement a science-based conservation vision, Habitat 141° and Y2Y's efforts are illustrative of both co-production and adaptive governance. Both were inspired by conservation biology, a normative attachment to large intact landscapes, and a perceived need to increase the pace and scale of conservation action. To realize these visions requires coordinated decision-making across land tenures and jurisdictions, resulting in focus on collaboration in both cases. Understanding how these two initiatives were co-produced provides insight into how particular approaches to governance evolved and the implications of those decisions for progressing their visions.

These cases clearly demonstrate a co-productive interplay between the context, knowledge, process, and vision of governance. Most evident is the blending of knowledge and vision in Y2Y as it overtly promotes scientific justifications to manage landscapes in line with their vision of appropriate land-use. Yet the socio-political consequences of the vision justified on narrowly framed scientific grounds significantly undermined Y2Y's work in many communities. Y2Y provides yet another example of where scientific descriptions of the material world are contested when they do not line up with normative visions of how landscapes should be governed. In Habitat 141°'s case, divergent perspectives on how to organize the processes of governance emerged from fundamentally different visions on the primary motivator for collective action; be that an institutional mandate from above, local decision-making autonomy, tangible on-the-ground action or a sound scientific rational.

A critical difference between Y2Y and Habitat 141° is the degree to which their visions directly conflicted with regional land-use. For Y2Y, the ultimate goal is a network of protected areas to preserve habitat connectivity for large carnivores requires widespread land-use change. The livelihoods provided by extractive industries in the Y2Y region hold a social and cultural significance that extends well beyond their economic value (Rasker, 1993). Consequently, Y2Y's vision was perceived as a direct threat to the existing social fabric of the region. Where as landscape-scale conservation in Habitat 141° was not only framed as compatible with existing land-use, proponents claimed it would benefit local agricultural communities. The emphasis of their visions lends to different approaches to governance: creating protected areas requires changes in government policy at a large scale, whereas Habitat 141° directed attention to working within existing policy frameworks to support landscape-scale collaboration. Moreover, the cultural symbolism of carnivores in Y2Y and collaborative stewardship in Australia produced vastly different outcomes for the public reception of these initiatives. These framings co-evolved from the context of the initiatives and have significant implications for how they approached questions of governance.

The formal institutional environment of the two case studies also produced different approaches to governance. Australia's policy settings made cross-sector collaboration a seemingly logical approach for Habitat 141°, whereas in the North American policy framework and historical reliance on regulation and litigation provided a strong incentive to emphasize scientific credibility. These differences reinforced the visions underpinning the initiatives to promote science led conservation or collaborative conservation. While Y2Y funded scientific research through projects that connect advocates with scientists, Habitat 141° funded collaborative planning with the agencies and community groups who would be responsible for implementing conservation actions. One emphasized collaboration to support science, the other collaboration to support on-ground action, yet neither of them actively connected science with governance.

While design principles and diagnostics provide ideals to work toward, the relational perspective of co-production highlights how the present is shaped by the past. For those innumerable contexts that do not correlate with the conditions articulated in the design principles, understanding how to work within or transform existing structures could provide a more useful starting point. Relational perspectives focus attention on what can be pragmatically achieved within the present, providing a more useful platform from which to strengthen the processes that will deliver beneficial change (Eyben, 2008). Analyzing Habitat 141° and Y2Y through the co-productive governance framework yields insight into the why the cases evolved on such different trajectories. This comes from analytical attention to the interactions between the context, knowledge, process, and vision of governance. Can this framing help inform deliberate efforts to create adaptive governance?

Considering how Habitat 141° and Y2Y attempted to establish interactions between science and governance highlights a paradox in both cases. While their motivations for collaborative governance emerged from advances in science, neither initiative built direct connections between the production of knowledge and the decision-making of governance. Y2Y's extensive science and advocacy does not have strong connections with regional landholders, extractive industries, and the public agencies. The potential avenues for co-production through existing institutional frameworks were not established. In Habitat 141°, the proposed governance structure failed to connect different scales of decision-making and conservation planning. Moreover, attempts to bring the Science Working Group and practitioners together to co-set research agendas and co-produce knowledge were limited and not considered within the governance of Habitat 141°.

Recommendations that both of these cases build more active connections between science and governance must address questions of power. Y2Y's science-based conservation agenda was widely rejected because it failed to respect and accommodate diverse perspectives and livelihoods. In Habitat 141°, fundamental

disagreements about governance were related to the locus of decision-making power. Advancing connectivity conservation is not a neutral scientific agenda, it also concerns who gets to determine the vision for the future of a region and how (Wandesforde-Smith et al., 2010). By focusing on how power manifests in networks of science and governance (Jasanoff, 2004a,b; Wynne, 2003), co-production provides much needed critical analysis to the adaptive governance and adaptive co-management literature (Watson, 2013).

The issues of power that manifest when these cases attempted to bring the co-production of connectivity conservation to local-scale action highlights an inherent tension within the analytical and instrumental framings of co-production. While one critiques relationships between knowledge and power, the other actively seeks to build them (Lövbrand, 2011). Building accountability and legitimacy within science-society collaborations has long been the remit of collaborative planning and adaptive governance (Innes and Booher, 2010; Fischer, 2000; Hahn, 2011), providing useful insight for the current efforts to co-produce knowledge within the global environmental change community. The powerful role of the vision in shaping both these cases highlights the importance of extending efforts to co-produce knowledge to also provide the space to reflect of normative questions critical to adaptive governance (see also Muñoz-Erickson, 2014).

7. Conclusion: toward co-productive governance

The aspirations of adaptive governance to respond to social, ecological, institutional change requires strong connections between knowledge with action, science with policy and practice. Co-production provides theoretical insight into the processes and relationships underpinning these connections, while providing critical insight into the ways that power manifests at the intersection between science and governance. In this paper, I introduced a new conceptual framing 'co-productive governance' that builds on Jasanoff's proposition that science and society are co-produced through interacting material, cognitive, social, and normative arenas. Bringing Jasanoff's conceptualization of co-production into an adaptive governance space, this framework focuses attention on the context (material), knowledge (cognitive), process (social), and vision (normative) of governance. The co-productive governance framework provides a tangible entry into the ontological approach and critical analysis underpinning Jansanoff's broad conceptualization of co-production. The relational ontology draws attention to how the interactions between these arenas shape the trajectories of governance in a particular context.

Applied to the cases of Habitat 141° and Y2Y, the co-productive governance framework helped to articulate how and why the same propositions of science and governance were led to very different outcomes in the two cases. In many senses, the case studies represent familiar stories about adaptive governance and the relationship between science and practice. It is no longer particular novel or useful to claim that (a) context matters, and (b) that the interactions between science and decision-making are complex. The contribution is to highlight the co-productive processes through which context, knowledge, process, and vision shape the relationship between science and governance.

Understanding how these cases were co-produced through the interactions of the social-ecological **context** of collective action (the material); the **knowledge** of connectivity science, governance, and practice (the cognitive); the formal and informal rules and **process** shaping collective action (the social); and a collective **vision** of what 'should be done' (the normative) points to the following critical interactions in these case studies:

- The emergence of their normative visions from the historical social-ecological landscape (vision and context);
- The role of connectivity science in motivating institutional change (knowledge and process)
- How the historical trajectory of conflict or collaboration shaped the framing of their normative visions and the public reception to them (vision, context, and process);
- The role of the broader policy environment in shaping how they approached questions of science and collaboration (process and context);
- The implications of a narrow framing of what 'useful' knowledge would be (knowledge and process);
- The way their vision shaped their goals and how they organized governance (vision and process).

Further research is required to consider whether the categorization of these arenas, and the focus on their interactions, can be used to explain how other cases of adaptive governance unfold. However, the co-production mechanisms characterized by Jasanoff are often indirect and hard to discern (Hegger et al., 2012). Providing firm categorizations of what is considered material, cognitive, social, or normative was a challenge for this analysis as the intention of the co-productive lens is to suggest that these cannot be separated, that they are mutually constituted. Yet despite these challenges, the co-productive governance framework offers a unique perspective on how the interactions between these arenas lead to particular outcomes for environmental governance.

Co-productive governance focuses attention on how actors and institutions are embedded within and reproduce relationships that affect the desired outcomes of connecting knowledge with action. This ontological reframing focuses on the relationships between entities, driving the frame of reference to the process of governance rather than idealized objectives. Moreover, this provides an explicit framework to examine how normative considerations shape the interactions between knowledge and power, science and governance. Despite growing attention to the normative elements of adaptive governance, these elements are yet to be adequately addressed within the design principles and diagnostics approaches currently dominant within the adaptive governance literature.

Co-productive governance provides a bridge between long standing debates over whether institutions are context-independent (design) or context-dependent (emergence) to view science-governance relationships as a product of both design and emergence. By articulating what is taking place within arenas of governance (context, knowledge, process and vision), actors or analysts can unpack the complex, and often opaque aspects shaping how governance practice emerges. Moving beyond the unsatisfying adage that 'context matters' the co-productive governance framework can be used to identify how and why context matters, and how existing institutions, knowledge, and aspirations can be transformed to support adaptive governance.

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