**Improving the Use of Science in Collaborative Environmental Governance**

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**Abstract:** To address complex socio-ecological system challenges, policy makers increasingly seek collaborative approaches across multiple levels of governance. At the same time, the climate emergency and other environmental threats have drawn greater attention to science and its role in responding to these threats. Scientists are working to not only expand knowledge, but to put it into practice. What are the barriers and opportunities for bridging science and collaboration? In this comparative case study we examine how scientific research is valued, acquired, evaluated, and applied in collaborative environmental governance. We gather data from three different types of collaborative watershed partnerships in the Puget Sound, Washington (USA): government-based (federal/local), government-based (state), and citizen-based. Analysis of group interviews, meeting observations, and documents will shed light on how collaborative organizations use science for watershed planning and management. This paper describes our research plan and progress to date on the research, focusing on operationalization and classification of partnership types in the Puget Sound region.

**Introduction**

Studies of how science is used in policymaking typically focus on policy made by professionals, especially civil servants in government agencies (Powell 1999; Amara et al. 2004; Head et al. 2014; Cherney et al. 2015). Yet much environmental policy today is shaped through collaborative governance, in which multiple stakeholders representing government agencies, industries, interest groups, landowners, citizens, and others work together in partnerships to recommend, and sometimes carry out, environmental management at local and regional levels (Emerson and Nabatchi 2015; Ansell and Gash 2008; Margerum and Robinson 2016; Ulibarri 2019). Common examples of collaborative environmental governance are watershed partnerships and marine partnerships, where stakeholders work together across boundaries to create and implement watershed and marine management plans. These partnerships frequently draw on scientific information to inform their management plans and actions, but the inclusion of many non-scientists in partnerships complicates the uptake of scientific findings (Massaua et al. 2016). Moreover, non-scientists bring additional forms of knowledge to the table, raising the question of which kinds of knowledge – scientific or otherwise – lead to more effective environmental management in different situations (Heikkila and Gerlak 2013; Ascher and Steelman 2012).

The knowledge gap in understanding how and to what effect science is used in collaborative settings hinders the ability of policy makers, managers, and scientists to assess the effectiveness of their efforts to instill science into collaborative policy-making, implementation, and adaptive management to achieve desired outcomes. In order to make better use of science in collaborative environmental partnerships, we must understand how partnership members interpret the relevance of scientific findings and the extent to which scientific findings shape their plans, projects, and policy recommendations at the local, state, and federal levels. In other words, we need to know where society can get the most return on our investment in science by understanding what science can and cannot do, and by enabling better use of science in different contexts.

 This project examines the causal processes shaping the use of science in collaborative partnerships. We will do so through a variety of methods, including case study comparisons, interviews, field observations, document analysis, and surveys. For the case studies, we will use purposeful sampling to select partnerships that vary on key dimensions of institutional design and stakeholder participation, based on findings from our pilot study of a smaller set of such partnerships (Koontz and Thomas 2018). We will build on our prior findings, and findings in the larger literature on collaborative governance, by investigating how the barriers, opportunities, successes, and failures vary depending on collaborative group institutional designs and participants. Partnerships composed primarily of local citizens, for example, are much different than those composed entirely of public agency staff (Moore and Koontz 2003). Partnerships linked closely to government institutions pursue different activities than do those operating independently (Bidwell and Ryan 2006; Margerum 2011). By systematically addressing variation in such things as institutions and participants, we will build theory about the role of science in addressing complex environmental challenges and how governments and partnerships might fruitfully work together to use science in contextually appropriate ways.

 Of course, the definition of science is not universally agreed upon. Among scientists, disagreements arise over whether, for example, hypothesis testing and randomized controlled research designs are necessary features of scientific inquiry. Social sciences are sometimes referred to as “soft sciences” or lumped together with humanities rather than natural sciences, but many social science disciplines are grounded in hypothesis testing and increasingly use randomized controlled trials. Peer review is a standard process in academic science, while government agencies often produce scientific reports that have not undergone similar peer review (sometimes called “grey literature”). We view science as one of many ways of knowing, and scientific findings as one of many kinds of information that may be used in addressing societal challenges such as ecological restoration. Specifically, we focus on science as a process of empirical inquiry, marshaling evidence to build and test theories about phenomena of interest and make inferences beyond the data in hand (King et al. 1994; Donovan and Hoover 2013; Kuhn 1962).

 This project focuses on the nation’s second-largest estuary, the Puget Sound basin in Washington State. The Puget Sound is a complex social-environmental system, home to over 4 million people and growing rapidly. The system includes abundant shellfish, endangered salmon, and a dwindling population of the iconic orca, along with 20 Native American tribes who have inhabited the region for thousands of years, and a leading technology hub that attracts workers with increasing demand for outdoor recreation. Much public policy attention in the region has been paid to ecosystem restoration over the past two decades, spurred by listing of several salmon species under the Endangered Species Act (Koontz 2019b). In 2007 the State of Washington created a public agency, the Puget Sound Partnership, to facilitate cooperation across federal, state, local, tribal, and nongovernmental groups towards a goal of ecosystem recovery. Our prior research found 57 collaborative partnerships working on environmental restoration in Puget Sound (Scott and Thomas 2017). Since then, even more partnerships have sprung up.

The Puget Sound basin is also well-resourced for scientific research, which means that these numerous collaborative partnerships have many scientific findings at their disposal to inform how they define problems and choose among alternatives. These scientific studies cover a wide range of topics, including species populations, water quality, habitat conditions, human well-being, and ecosystem service benefits (Koontz and Thomas 2018; Puget Sound Partnership 2016; Biedenweg et al. 2017). The region is also institutionally thick with multiple overlapping federal, state, local, and tribal government jurisdictions, as well as collaborative partnerships and programs, coinciding with different political and ecological boundaries. But very little is known about the extent to which any of these collaborative decision-making processes actually incorporate science. Our research questions will thus focus on key knowledge gaps for both theory and practice, while capitalizing on the great variation in types of collaborative partnerships and institutions in the region. Our research questions are:

1. How is scientific research valued, acquired, evaluated, and applied in collaborative environmental governance?

 a. What are barriers and bridges to these actions, and how do they vary across context?

 b. How is scientific research used instrumentally, conceptually, and symbolically?

2. What are the impacts of using science in collaborative environmental governance?

a. How is science filtered and translated as it moves through collaborative decision-making stages?

b. How does variation in the use of science affect collaborative inputs, processes, and

 outputs?

**Use of Science in Governance Processes**

The United Nations Scientific Advisory Board (2016) states, “It is critical for science to be engaged in the decision-making process more systematically, synthesized in ways that are relevant to current societal problems and challenges, and communicated to political leaders and societal groups in ways that are accessible and comprehensible” (p. 19). Other international and national organizations such as the Organization for Economic Cooperation and Development (OECD) (2013), European Commission (2010), and National Research Council (1999), as well as scholars (e.g., Banks 2009, Layzer 2008, Sallis et al. 2016; Hicks et al. 2016), have called for greater use of scientific research in policy making for better legitimacy and sustainability.

 Of course, more science use is not necessarily better. The politicization of science has long been identified as an impediment to good policy making. From the Republican “war on science” (Mooney 2007) to the “crisis of politicization within and beyond science” (Druckman 2017) and the Trumpian “post-truth” attacks on science (Fujimura and Holmes 2019), political actions to misrepresent or override scientific findings have garnered popular attention. But the use of science can also be diminished in more subtle ways. Policy makers and managers may not incorporate scientific findings in their decisions for myriad reasons related to organizational capacity, institutional fragmentation, communication, fit with local problem context, political filters, and unequal power distribution (Armitage et al. 2015; Cash 2001; Jasanoff 1990; Innes and Booher 2010; Koontz et al. 2004; Redman et al. 2015; Ouimet et al. 2009). In addition, science may be avoided because it can increase conflict and reduce agreement (Sarewitz 2004; Pielke 2004). In the sections that follow, we first review what is known about the extent to which civil servants use science in public agencies as a prelude for understanding how science might be used in collaborative partnerships among public agencies, nonprofit organizations, industry, and local citizens. We then develop several hypotheses to test in our study, based on this literature review.

**Civil Servants’ Use of Science**

Given that collaborative governance has emerged as an alternative to centralized decision-making and implementation by public agencies (Koontz et al. 2004), and given that civil servants are often key enablers and participants in collaborative partnerships (Genskow 2009; Thomas 2003), we start by examining what is known about how civil servants use science.

Scholarship on civil servants’ use of science began with organization and management research, and subsequently addressed characteristics of individuals within those organizations, as well as characteristics of research products. For example, Herbert Simon’s foundational work in management argued that individuals in organizations do not make decisions on the basis of a fully “rational” model, where all alternatives and their links to outcomes are considered (Bernard and Simon 1947). Rather, cognitive and information limits lead policy makers and managers to “satisfice” based on organizational incentives and power structures. Scholars have subsequently applied these ideas to the use of science by civil servants in government agencies, describing the information challenges and large gulf between science communities and policy making communities (Caplan 1979). While scientists have incentives to increase generalizable knowledge, policy makers are encouraged to find specific operational solutions (Hemsley-Brown 2004). Communication between these two communities is hindered by different styles, as scientists communicate with specialized jargon to their peers, while policy makers communicate in language that is more easily digested and shared with non-experts (Frenk 1992). Moreover, organizations can actively filter out information deemed threatening or irrelevant, which prevents policy makers in those organizations from receiving certain information from outside scientists (Ouimet et al. 2009; Rich and Oh 2000). To overcome such communication barriers, scholars have identified the importance of interactions between scientists and decision makers to build relationships and foster communication, including the role of boundary organizations and conferences to bridge the two communities (Guston 2001; Cash 2001; Jasanoff 1990; Swedlow 2017; Koontz et al. 2018). While increased interaction among scientists and decision makers does not necessarily mean that decisions are more informed by science, we hypothesize that interactions will indeed lead to more use of science by collaborative groups.

**H1: Increased interaction between scientists and collaborative group members leads to higher use of science by collaborative groups.**

In addition to organizational setting, individual knowledge and training affect how science is used by policy makers and agency managers. Lack of relevant skills and expertise reduce the prospects for these individuals applying scientific findings in decisions (Lavis et al. 2005). For example, Ouimet et al. (2009) and Amara et al. (2004) found that civil servants’ efforts to acquire scientific information are correlated with their level of education. Therefore, we similarly expect use of science within collaborative groups to be affected by the level – and perhaps type – of education of group members.

**H2: The use of science by collaborative groups is greater in groups that have a larger number of members with scientific training.**

Characteristics of scientific research products also matter. Scholars have identified features of research products (articles, reports, papers, etc.) that foster use of science by civil servants. These include credibility of the source and the salience of the findings – i.e., the degree to which the information applies to the local context and speaks to variables for which management intervention is possible (Landry et al. 2003; Jacobs 2002; Maynard 2006; Cash et al 2003). These characteristics are sometimes in tension, as when a peer-reviewed journal article is perceived to be highly credible, yet based on data that are unrelated to a local context, while agency reports are perceived to be less rigorous but more applicable to the local context (Koontz 2019a; Hegger et al. 2012). Moreover, one study found natural science was used less often than social science in watershed management (Safford and Norman 2011), though it is not clear if that was due to differences in perceived credibility, salience, or something else. Given these findings about use of science by civil servants, we expect similar findings in collaborative groups that include both civil servants and individuals from the private and nonprofit sectors.

**H3a: Higher perceived credibility of a scientific research product leads to its greater use by collaborative groups.**

**H3b. Collaborative group members perceive peer-reviewed journal articles to be more credible than government agency reports.**

**H3c. Collaborative group members perceive natural science to be more credible than social science.**

**H4a: Higher perceived salience of a scientific research product leads to its greater use by collaborative groups.**

**H4b. Collaborative group members perceive government agency scientific reports to be more salient than peer-reviewed journal articles.**

Finally, an important factor affecting use of science is what Cash et al. (2003) call legitimacy. By this they mean the degree to which stakeholder values and perspectives are equally represented in the process of knowledge creation. Stakeholder engagement in jointly producing knowledge allows for exchanges and co-evolution of knowledge, making it more usable (van den Hove 2007; Hegger et al 2012; Pristupa et al. 2019). Sometimes referred to as coproduction or transdisciplinary science, engaging stakeholders along with scientists in policy making (e.g., in climate adaption plans) can increase usability of scientific findings (Warmsler 2017; Lemos et al. 2012).

**H5: Engagement between scientists and collaborative group members in knowledge coproduction leads to greater use of science in collaborative groups.**

To better understand how science is used by policy makers and program managers, we must specify what we mean by the term “use.” Broadly, the use of science for policy and management refers to the degree to which scientific findings are discussed (e.g., at meetings) and subsequently incorporated into decisions (e.g., the design of restoration projects). Incorporating science involves several steps, as described by Ouimet et al. (2009) and Knott and Wildavsky (1980): recognizing the value of information, acquiring the information, evaluating the information, and applying the information to the decision. As shown in Figure 1, Ouimet et al. (2009) identify several factors thought to affect the use of science, namely the organizational setting, social interactions, and individual characteristics. However, they do not include characteristics of scientific research products, nor do they include the degree to which end users are involved in the process of doing science. Our project will add these factors (see Figure 2).

Figure 1: Conceptual Framework for Civil Servants’ Use of Science

Agency recruitment and skill development

Power relationships

Recognize the value

Acquire

 Utilize

Apply

**Use of Science**

Civil servants’ prior knowledge

Agency information services

Social interactions between civil servants and scientists

Agency

research infrastructure

Source: Adapted from Ouimet et al. (2009)

Figure 2: Conceptual Framework for Collaborative Governance Use of Science

Power relationships

Partnership recruitment

and skill development

Recognize the value

Acquire

 Utilize

Apply

**Use of science**

Partnership members’ prior knowledge

Science product characteristics:

 -Credibility

 -Salience

Legitimacy of scientific process

Social interactions among stakeholders

Institutional design of partnerships

Source: authors, based on literature review and synthesis

**Collaborative Governance Use of Science**

The research described above helps explain how civil servants make decisions involving science within public agencies. Much less known is how science is used in collaborative governance. A key aim of collaborative governance is to create and share knowledge among public, private, and nonprofit organizations to enable coordinated action to address problems that transcend public and private jurisdictions (Ison et al. 2013; Muro and Jeffrey 2012; Koontz 2014; Thomas 2003). Participants in collaborative partnerships work together to develop management plans, implement projects, and make policy recommendations, drawing on diverse types of knowledge (such as peer-reviewed science, technical reports, stakeholder experiences, and political expectations).

Numerous studies have concluded that use of science is a key factor for success in collaborative governance (Steelman and Carmin 2002; Leach and Pelkey 2001; Heikkila and Gerlak 2005; Koontz et al. 2004). But little is known about why science is used in some instances but not in others, how science is actually incorporated into collaborative decisions, and whether the influence of scientific findings is diminished in the process given the diverse forms of knowledge stakeholders bring to collaborative partnerships. Scholars have identified the importance of collaborative participants’ capacity to make sense of the science, as expressed in H2 above, along with access to science translators to make scientific findings applicable to the local context (Innes and Booher 2010; Kocher et al. 2012; Floress et al. 2015; Ross et al. 2016; Koontz and Thomas 2017). Yet, these results come largely from case studies and do not differentiate across actions of valuing, acquiring, evaluating, and applying science in collaborative governance; nor do they differentiate among variation in the institutional designs of collaborative partnerships. We know that different institutional designs of collaborative groups, including whether they are citizen-based or government-based, are associated with different decision-making processes and activities (Moore and Koontz 2003; Bidwell and Ryan 2006; Margerum 2011). In particular, collaborative groups closely affiliated with a government agency have been found to draw more heavily on information from that agency than from other sources (Koontz 2019a; Bidwell and Ryan 2006).

**H6a: Government-based collaborative groups use more scientific findings from their affiliated government agency than from other sources.**

**H6b: Citizen-based collaborative groups use scientific findings from a more diverse range of sources than do government-based collaborative groups.**

A handful of studies have concluded that the degree to which science is used in collaborative governance depends, in part, on two-way communication and relationships across stakeholders, as expressed in H1 above (Lauber et al. 2011; Massaua et al. 2016; Innes and Booher 2010; Curtin 2002; Koontz et al. 2018). In collaborative governance, actors cooperate by sharing information vertically, with higher or lower levels of aggregation, and horizontally, with actors in the same unit or in parallel units. Our prior research found that scientific information was diffused vertically from regional or state scales down to the local watershed scale, while time and place information about local circumstances was aggregated up to the basin level (Koontz and Newig 2014a; Koontz 2019b). These results suggest asymmetrical vertical diffusion of scientific information that is top-down rather than bottom-up.

**H7a: Vertical sharing of scientific findings is more top-down (e.g., federal or state to local level) than bottom-up (e.g., local level to regional or state level).**

 Horizontal diffusion in collaborative partnerships occurs as participants share information that helps them develop a common understanding of environmental issues and to generate management solutions (Muro and Jeffrey 2012). Participants can learn about not only scientific findings, but also what other participants want, which solutions are politically feasible, and how planning processes work (Muro and Jeffrey 2012; Schusler et al. 2003; Korfmacher and Koontz 2003). Prior research on horizontal diffusion has found it is affected by characteristics of the collaborative process, including extended engagement, process equity, and inclusiveness (Muro and Jeffrey 2012; Koontz 2014; Schusler et al. 2003; Webler et al 1995). But these results do not disaggregate scientific from other kinds of information. As a result, we do not know if the most important factors for horizontal diffusion of scientific information are the same as for information more generally.

**H8: Horizontal sharing of scientific findings is greater in collaborative groups that have more inclusive, extended, and equitable processes of deliberation.**

**Instrumental, Conceptual, and Symbolic Use of Science**

In addition to factors affecting *how much* science is used by civil servants, scholars have examined *how* science is used. Uses are generally grouped into three types: instrumental, conceptual, and symbolic (Weiss 1979; Beyer 1997; Weiss et al. 2005; Nutley et al. 2007). Instrumental use is the direct application of science to solve a particular problem or understand a specific cause-effect relationship. Conceptual use is the intake of scientific findings to more generally understand a phenomenon, so that decisions can be informed by this general understanding. Symbolic use is justifying predetermined actions with scientific knowledge in an attempt to legitimate them (sometimes called “cherry picking”). An empirical study of these use types across Canadian government agencies found that environmental management civil servants most frequently used scientific research for conceptual purposes, followed by symbolic use and, lastly, instrumental use (Amara et al. 2004). In our prior research, we examined types of science use in collaborative governance in the Puget Sound (Koontz 2019a). In that exploratory study, the most frequent use was conceptual, followed by instrumental use and then symbolic use.

 **H9: Conceptual use of science is more frequent than instrumental or symbolic use in collaborative groups.**

The relatively low incidence of symbolic use found by Koontz (2019a) comports with studies showing that deliberation among multiple stakeholders brings assumptions, claims, and contested knowledge into the open for consideration and re-evaluation (Innes and Booher 2010). Similarly, Sabatier and Jenkins-Smith (1993) and Weible (2008) argue that working together to build a collaborative coalition decreases symbolic use of science. In contrast, in a study of watershed management, Weible and Sabatier (2009) found collaboration did not reduce symbolic use of science. We will test these competing claims.

 **H10: Greater deliberation among diverse stakeholders reduces the symbolic use of science in collaborative groups.**

**Impacts of Science Use on Inputs, Processes and Outputs**

In the preceding sections, we described factors affecting how much and what kind of science is used in policy making and management (interactions, individual characteristics, research product characteristics, and the process of doing science) and how science is used (instrumentally, conceptually, or symbolically). Interest in these questions has been fueled by a common assumption that more use of science is better. But using science is not costless, and it may not yield better results. Science alone cannot solve problems when values are in conflict, as is often the case in collaborative environmental governance (Jasanoff and Wynne 1998; Ascher and Steelman 2012). Sarewitz (2004) and Pielke (2004) criticize the “linear model” of the science-policy link, where science is purported to directly drive a policy outcome. Instead, they argue, more scientific research generates greater uncertainty as more disciplines with diverse perspectives provide divergent conclusions, increasing the range of policy alternatives. In addition, scientific studies can deepen rather than resolve conflict, as different stakeholders draw on different studies to support their values and interests (Jasanoff and Wynne 1998; Wynne 1989; Sarewitz 2004; Healy and Ascher 1995). Use of science is diminished in policy environments marked by high political conflict (Jennings and Hall 2011). Moreover, the production of knowledge by scientists does not generate an objective truth, but rather it is affected by the scientists’ normative framework and competes with other sources of truth (Ascher and Steelman 2012; Jasanoff and Wynne 1998; Sarewitz 2004; Thomas 2003). Braun and Kropp (2010, p.776) argue that “…the expectation that scientific expertise will provide reliable, objective, true knowledge and thereby close down policy controversies is gone… Institutions of scientific governance have accepted the existence of dissent and a plurality of viewpoints as a fact of life and have adopted mechanisms to deal with it.” Within public agencies, these mechanisms include rules that require use of the “best available science,” but little is known about mechanisms adjudicating use of science in collaborative governance (Jennings and Hall 2011; Francis et al. 2005). Our project seeks to identify not only how much and how collaborative partnerships use science, but also the *impacts* of science use on collaborative governance inputs, processes, and outputs.

Inputs such as participant expertise, project funding, and institutional support affect the processes by which science is used to identify problems and weigh alternative solutions. The decisions that come from these processes lead to outputs such as management plans, policy recommendations, and on-the-ground projects. In the long run, these outputs shape social and environmental outcomes. Science can be brought in at various points to affect inputs, processes, and outputs. As of yet, however, studies examining how particular collaborative inputs and processes affect outputs and outcomes (e.g., Ulibarri 2015; Scott 2015) have not focused on the use of science.

More generally, scholars have called for greater attention to causal mechanisms in collaborative governance that link inputs, processes, and outputs (Newig et al. 2018; Thomas and Koontz 2011). Our prior research has argued for logic models as one means to do so, with multiple components to ultimately link inputs to ecological and social conditions (see Figure 3) (Thomas and Koontz 2011). Our project will thus focus on links in causal chains to explain how science as one component (input) is filtered and translated as it moves from meetings (processes) to plans (intermediate outputs) to project completion (end outputs). Although establishing causal connections between end outputs and outcomes is beyond the scope of this project, our study does include asking participants their views about the degree to which collaborative outputs, including plans and projects, were based on scientific findings about the most effective means to improve environmental conditions (end outcomes) in that context.

Figure 3: Logic Model for Collaborative Governance

Inputs (e.g., human, financial, and technical resources)

Intermediate outcomes

(e.g., resource consumption)

Processes (e.g., meetings)

Intermediate outputs

(e.g., plans completed)

All other variables

(e.g., climate and political conflict)

End outputs

(e.g., projects implemented, monitored and enforced)

End outcomes

(e.g., the condition of natural resources and the local community)

Source: Thomas and Koontz (2011).

Note: grayed boxes are the focus of this project.

**Methods**

The Puget Sound region is awash with scientific information and organizations that supply, guide, and use that information. The data richness in this setting provides an excellent opportunity to investigate our research questions and test hypotheses through multiple methods, including comparative case study, survey, and causal chain analysis. We have already identified thousands of individuals working across hundreds of organizations in the region, within at least 57 collaborative partnerships (Scott and Thomas 2017). These partnerships have held numerous meetings and conferences over the years, while generating many documents that we have already begun to gather. We have established numerous contacts in a large number of these partnerships. One of the PIs previously surveyed members of 57 partnerships about their networks and resources (Scott and Thomas 2015), and both PIs interviewed members of six collaborative partnerships about their use of science and analyzed documentary evidence of science use in meeting minutes and ecosystem recovery plans for several partnerships in a pilot study (Koontz et al. 2018; Koontz and Thomas 2018; Koontz and Thomas 2017) that will guide the larger study we are proposing here. We thus have an extensive empirical network to build upon for our proposed research on the use of science in collaborative governance. Below we describe the methods we will use to answer each of our research questions and test hypotheses, which build on our prior studies that were more limited in scope.

**Research Question 1: Comparative Case Study and Survey**

Research Question 1 asks: How is scientific research valued, acquired, evaluated, and applied in collaborative environmental governance? To answer this question, and to test Hypotheses 1-10, we will first conduct a comparative study of nine partnerships (using document analysis, group interviews, and meeting observations). We will then use the findings from these case studies to conduct a survey of members of over 50 additional partnerships to test generalizability of the case study findings. Comparative case studies are appropriate for understanding how and why processes unfold in complex, real-world contexts (Yin 2009; Gerring 2007; Marshall and Rossman 1989; Strauss and Corbin 2008).

We have identified nine partnerships that represent two broad types of collaborative partnerships: citizen-based (3 partnerships) and government-based (6 partnerships). Citizen-based partnerships are comprised mainly of citizens, and they usually operate on a smaller, more local scale. They align with Margerum’s (2011) “action level” collaboratives that focus on local activities such as stream cleanups and environmental education. In contrast, government-based partnerships bear the imprint of federal, state, and local government actors and institutions that are influential in guiding the partnership’s actions (Moore and Koontz 2003; Bidwell and Ryan 2006; Koontz et al. 2004). These partnerships typically work across governmental and organizational jurisdictions at larger scales than do citizen-based partnerships, and their members typically are representatives from public, nonprofit, and industry organizations (Margerum 2011). Within the set of government-based partnerships, we differentiate by their institutional design. In the Puget Sound region, two key types of government-based partnerships are Marine Resources Committees and Local Integrating Organizations. Marine Resources Committees (MRCs) are appointed by county commissioners to provide advice regarding marine resource management, under the auspices of the federal Northwest Straits Commission. Local Integrating Organizations (LIOs) are funded and closely guided by a Washington state agency, the Puget Sound Partnership (which, despite its name, is a public agency, not a collaborative partnership) to generate ecosystem recovery plans and actions. Including three MRCs, three LIOs, and three citizen-based partnerships will provide variation on level of government, institutional design, and collaboration type (citizen-based and government-based) across our nine cases.

Data collection for the case study will include group interviews, meeting observations, and documents. For the group interviews we will invite all active participants in each partnership, with the help of the partnership leader to identify participants who are actively engaged in group meetings and activities. Group interviews will follow a semi-structured format, allowing similar questions across groups with space for related topics as arise, and they will be recorded and transcribed for subsequent data analysis (Bernard et al. 2017). Our pilot study with group interviews in the region suggests the importance of having two interviewers from the research team, one to facilitate the group interview and one to take observational notes and identify which group members made which remarks (Koontz et al. 2018). We will revise interview questions from our prior pilot study to gather information to test our hypotheses. This will include asking questions such as, “Please describe examples of instances where scientific findings were and were not used. What made them more or less useful?” and “What are the barriers to incorporating science into your plan recommendations?” In our pilot study, we learned that sometimes science that informs a plan is not mentioned in a final plan due to political considerations, including avoidance of the term “climate change.” Asking about politics and power would be a follow-up probe to the question about barriers to incorporating science.

We will schedule group interviews immediately before or after a regularly scheduled partnership meeting, so we can attend the meeting for further data collection. Following Kawulich (2005), we will observe and take notes about how meeting discussions proceed, who shares information about what, and how scientific knowledge is treated. Given our prior research suggesting science is discussed differently in partnership executive meetings than in partnership technical committee meetings (Koontz and Thomas 2018), we will visit each partnership twice to observe both kinds of meetings. Finally, we will identify and collect relevant documents through the group interviews, communication with group leaders, and partnership web pages. We will seek meeting minutes, management plans, agency guidelines, and project reports to round out our understanding of the barriers and bridges involved in valuing, acquiring, evaluating, and applying scientific research in partnership work.

Data analysis for the case studies will follow qualitative analytical methods including summarizing, thematic analysis, coding, and pattern searching (Bernard et al. 2017; Miles and Huberman 1994). Analysis will be iterative, moving from specific details to general categories and then back to specific details, moving between data and theory (Corbin and Strauss 2008). Group interview transcripts and related documents such as meeting minutes, plans, guidelines, and reports will be analyzed by chunking texts into meaningful units, developing a data dictionary, and applying codes by multiple members of the research team that will be checked for inter-coder reliability (Mogalakwe 2006; Krippendorf 2004). Meeting observations will be recorded via field notes, which will subsequently be turned into memos focusing on themes (Miles and Huberman 1994).

 Results from the comparative case study will inform our subsequent survey of other partnerships to test for generalizability. Surveys are useful for obtaining information from a large number of participants in a standardized format for quantitative comparisons. Our survey instrument will build on the SEER framework (Ouimet et al. 2009), as shown in Figure 1 above, and follow Brennan’s (2017) operationalization of organizational factors affecting the use of science. We will add individual and research product and process factors to the survey from the literature and our prior research (Koontz 2019a; Koontz et al. 2018; Innes and Booher 2010; Floress et al. 2015), as shown in Figure 2 above. The survey will include questions about instrumental, conceptual, and symbolic uses of science. We will follow the sampling protocol one of the PIs used in a prior study of 57 partnerships in the Puget Sound region that achieved a high response rate by relying on partnership leaders to prompt participants to complete the online survey (Scott and Thomas 2015; Scott and Thomas 2017).

 Sampling for our survey will allow us to make inferences across partnership types, beyond those included in the comparative case study. Our sampling universe will be all Marine Resources Committees, Local Integrating Organizations, and citizen-based partnerships, as well as other partnerships and collaborative groups in the region, for a total of over 50 partnerships. We will build our sampling list starting with partnerships in the region identified by Scott and Thomas (2015) and our pilot work for our previous group interviews (Koontz et al. 2018). The research team will compile contact information for individuals in these partnerships, which we estimate to be roughly 1000 individuals. The survey will be web-based using the Qualtrics software platform. Invitations and reminders will be made by both email and phone calls, as well as announcements at partnership meetings and in partnership newsletters (Dillman 2007).

**Research Question 2: Causal Chain Analysis**

Research Question 2 asks: What are the impacts of using science in collaborative environmental governance? To answer this question, we will collect data to build causal chains for the logic model framework developed by Thomas and Koontz (2011) (see Figure 3 above). This will allow us to explain how science use affects inputs, processes, and outputs. Connecting the chain of events and influence from inputs, at one end of a collaborative effort, to outputs allows the researcher to estimate the effects of variables and identify causal mechanisms operating between them (Gerring 2007; George and Bennett 2005). Of particular interest for this project are the steps at which scientific research enters the causal chain, how it is filtered and translated in moving to the next step, and what effect it has on collaborative partnership outputs.

Our focus for this analysis is on outputs for salmon restoration in a particular geographic location within Puget Sound -- the Hood Canal – because of a unique opportunity there to explore causal chains with a natural experiment. Chinook (*Oncorhynchus tshawytscha*) and Chum (*Oncorhynchus keta*) salmon populations within Puget Sound were listed as threatened under the Endangered Species Act (ESA) in 1999 and have been closely monitored over time. Hood Canal Chum salmon populations have largely rebounded and are on the brink of removal from the ESA’s threatened list (Johnson et al. 2011; Brewer 2019). However, Chinook salmon numbers continue to decline (National Marine Fisheries Service 2018). We will examine how science has been used in both Chinook and Chum salmon management efforts and how that use of science may have led to differing outputs that contributed to their disparate recovery results.

In examining Hood Canal salmon recovery causal chains, we will compare and contrast how science is used by two different partnerships, a government-based and a citizen-based partnership, to recover Chinook and Chum salmon populations. Both the Hood Canal Coordinating Committee, a government-based partnership, and Long Live the Kings, a citizen-based partnership, have been operating for well over a decade with a mission to recover salmon species in Puget Sound. Both use science to develop plans and recommendations for salmon recovery projects, but under different institutional contexts and sources of funding and guidance. Since these partnerships are not part of our Research Question 1 comparative case study, they will provide an initial test of the generalizability of our findings from the comparative case study. But in this phase of the project we will drill deeper into specifics of the two partnerships’ causal chains, controlling for issue type (salmon restoration) and geographic location (Hood Canal).

For this causal-chain analysis we will conduct process tracing tests. These tests involve making causal process observations and identifying mechanisms by which one event or factor caused a particular outcome, step by step in a sequence from initial cause to final outcome (Collier et al. 2010; George and Bennett 2005; Mahoney 2012). We will analyze each partnership’s documents (plans, meeting minutes, technical committee reports, funding requests, and project reports) to determine how they use scientific findings in defining problems, weighing solutions, and deciding on plans and projects. Starting with the Reference section and in-text citations, we will trace references to scientific studies appearing in final plans back to draft plans, technical committee reports, and meeting minutes. We will compare characterizations of scientific findings across these documents and to the original source, to see how the findings are translated and presented at each step. For example, are estimates of uncertainty from the original source turned into point values without uncertainty estimates along the way? Are contingent relationships portrayed as bivariate to suggest simpler relationships? We will also conduct semi-structured interviews with members in each partnership to assemble their understandings of the connections between steps in the causal chain. This will include asking about scientific findings that were used at one or more steps, to identify bridges, as well as scientific findings that were not used, to identify barriers. We will ask about the mechanisms by which science moves from one step to the next, and what factors affect use at each step. We will identify interviewees through the document analysis as well as a snowball sampling method, asking each interviewee to suggest additional interviewees knowledgeable about the use of science in partnership processes over time.

**Findings from Initial Stages of Project**

This research project began in October 2021. Our first task was to develop a catalog of collaborative partnerships in our study area, the Puget Sound basin. Subsequently we selected 9 partnerships for in-depth case study via document analysis and interviews. Findings from these initial stages are described below, with respect to the challenges of identifying and classifying collaborative partnerships, the realities of different conceptions of the Puget Sound as a place, and the high density of collaborative partnerships in the region.

Identifying collaborative partnerships is not straightforward

In case study research, classification and typologies are crucial for theory building. Studying examples of a particular type of case allows identification of patterns across complexities of real-world phenomena (Yin 2009). As George and Bennett (2005) describe, thinking of a case as a member of a class of cases allows inferences beyond the data in hand. They argue that “middle range theory” is developed when researchers test the applicability of theory in new classes of cases.

But such classification of cases is not always straightforward. In studying collaborative environmental partnerships, prior research has identified theoretical reasons for differentiating among different types of partnerships, namely those comprised primarily of governmental members (government-based), and those primarily of non-governmental members (citizen-based). For this study we further differentiate between government-based partnerships that are in the state agency program (Local Integrating Organizations) and government-based partnerships that are in the federal-county program (Marine Resource Committees). As we developed our catalog of collaborative partnerships in the Puget Sound region we came across partnerships whose type changed over time, or whose type included several distinct classifications at the same time. For example, one new Local Integrating Organization began its existence as a citizen-based partnership, while other Local Integrating Organizations began their existence as government-based partnerships. Some Local Integrating Organizations are also salmon Lead Entities and Water Resource Inventory Areas, which are organized around two different state government programs.

More broadly, defining what is and what is not a collaborative partnership is unclear. Consider the different terms and definitions used in prior research. Margerum (2008, p. 488) defines collaborative efforts as involving “a cross section of stakeholders and the public. They have worked to build consensus through intensive deliberation and creative problem solving. They have also developed plans and structures for implementing their objectives.” Left undefined is what constitutes a “cross section” of stakeholders - must we know their values/preferences to judge whether a cross section has been engaged?

In describing collaborative environmental management, Koontz et al (2004, p. 20) write, “In collaborative efforts, stakeholders come together to gain a more comprehensive understanding of problems and implement strategies to address important issues… collaboration strives for more integrated involvement of diverse groups of stakeholders in the initiation, creation, implementation, and evaluation of alternatives that they have identified.” This definition doesn’t clearly exclude advocacy groups (e.g., Sierra Club). An important part of this definition is involvement in multiple stages of policy and planning, which suggests the importance of information to these efforts.

Wondolleck and Yaffee (2000, p. 4) describe collaborative efforts as “place-based, cooperative, multiparty, and grounded in high quality information. Of necessity, they involve building relationships between individuals and groups who have been isolated or alienated from each other.” This distinguishes collaborative partnerships from advocacy groups, but as a practical matter it is not clear from websites how to determine if the partnership has built relationships between groups who have been isolated from each other.

For collaborative watershed partnerships, Sabatier, Weible, and Ficker (2004 p. 49) write, “Collaborative watershed institutions are marked by (1) the use of hydrographic watersheds as the principal jurisdictional boundary, (2) the involvement of a wide variety of stakeholders (including interest groups, experts, and agency officials from multiple levels of government), treated more or less as equals; (3) reliance on face to face negotiations with agreed-on procedural rules (and often a professional facilitator) designed to ensure civility and engender trust; (4) a goal of seeking win-win solutions to a variety of interrelated environmental and socioeconomic problems; and (5) a fairly extensive fact-finding phase designed to develop a common understanding of the seriousness and causes of relevant problems.” This extensive definition leaves undefined how wide is a “wide variety of stakeholders,” but related scholarship by Leach, Pelkey and Sabatier (2002) specifies this includes conflicting views within the group. This definition mentions a partnership working on a variety of interrelated environmental socioeconomic problems, rather than only a particular environmental problem, so this is helpful for distinguishing collaborative partnerships from advocacy groups. It also specifies work to develop a common understanding of seriousness and causes of problems, which suggests information is important.

With a focus on collaborative processes, Innes and Booher (2010, p. 6) write, “A process is collaboratively rational to the extent that all the affected parties jointly engage in face to face dialogue, bringing their various perspectives to the table to deliberate on the problems they face together. For the process to be collaboratively rational, all participants must also be fully informed and able to express their views and be listened to, whether they are powerful or not. Techniques must be used to mutually assure the legitimacy, comprehensibility, sincerity, and accuracy of what they say…They have to seek consensus.”

Collaborative partnerships are a component of collaborative governance, which Emerson et al (2011, p. 2) define as “the processes and structures of public policy decision making and management that engage people constructively across the boundaries of public agencies, levels of government, and/or the public, private and civic spheres in order to carry out a public purpose that could not otherwise be accomplished.” This definition emphasizes working across boundaries for a public purpose. Ansell and Gash (2008, p. 544) define collaborative governance as: ‘‘A governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process that is formal, consensus-oriented, and deliberative and that aims to make or implement public policy or manage public programs or assets.” Here we see the concept of policy and management, but this government-centered definition excludes instances of citizen-based collaboration. Douglas et al (2020 p. 498) define collaborative governance more broadly as “a collective decision-making process based on more or less institutionalized interactions between two or more actors that aims to establish common ground for joint problem solving and value creation.”

In our initial stage of developing a catalog of collaborative partnerships in the Puget Sound region, we cast a wide net. Our research team started with a list of 57 organizations involved in environmental knowledge networks in the Puget Sound region, from a prior study (Scott and Thomas 2015). Browsing the websites of these organizations generated a snowball sample through web links to other organizations, which were examined as possible collaborative partnerships. At this stage we included any organization with evidence indicating it worked with a variety of partners on environmental issues in the region. We searched for Facebook pages of these organizations and used Facebook’s suggestion algorithm that suggested other similar pages, and we used Facebook’s search bar to enter key words for searching. We also found some partnerships using general google searches with terms including “Puget Sound” with “conservation”, “environmental education“, “partnership,” watershed groups,” “watershed alliance,” “collaboration,” and “citizen groups,” as well as, “King County watershed councils”, “Pierce County watershed councils”, “Watershed groups near me”, and “Thurston county watershed councils,” etc. We next searched Chamber of Commerce websites for registered groups in areas within the region. We also located several lists of organizations including “We Are Puget Sound,” which aggregated 34 groups that contributed to the publication of a book on the Puget Sound, the University of Washington Bothell and Cascadia College Campus Library’s “Directory of Local Organizations :Environment,” the Washington State Recreation and Conservation Office list of Boards and Committees, the Washington Association of Conservation Districts area association directory, the Washington Fish and Wildlife Salmon Recovery Regional Organizational Directory, and several directories from the “Puget Sound Info” website, including the National Estuary Program Atlas, and the Action Agenda Tracker. We also searched a published list of non-profit organizations listed by the Internal Revenue Service, checking for groups beginning with “Friends of” to search the various streams and rivers of the Puget Sound basin. These web searches yielded 190 possible collaborative watershed partnerships in our study area.

Upon closer inspection of these 190 possible partnerships, we decided to exclude groups that conducted citizen science for other organizations but did not themselves deliberate and plan as a collaborative entity. We excluded advocacy groups that focused on a single issue such as saving orcas rather than bringing together place-based stakeholders with diverse viewpoints. We excluded land trusts because while these organizations often partner with other organizations, they themselves are not comprised of members representing diverse and conflicting interests. We excluded groups whose mission was educational programming or support for a particular facility such as an arboretum. The process of deciding which groups to exclude helped us hone our working definition based on the literature and the aims of our study, as follows: A collaborative watershed partnership is a place-based organization whose members represent diverse interests across jurisdictions and engage in systematic deliberation to develop management plans, recommendations, and/or projects covering multiple social-environmental challenges. Our catalog included 59 partnerships that fit this definition.

 From within the catalog of 59 partnerships, we purposefully selected nine partnerships for in-depth case study research. These nine were chosen to include one citizen-based partnership, one government-based Local Integrating Organization, and one government-based Marine Resource Committee in each of three different geographic areas within the Puget Sound.

Identifying geographic boundaries is not straightforward

This project examines collaborative partnerships in the Puget Sound region. But defining the boundaries of the region is not straightforward. The original inhabitants of the area, indigenous peoples who have made the region home for over 12,000 years, did not attach a particular place name to the area. The oldest known term for the waterway in Lushootseed, the language of the Coastal Salish people, can be written in English as *whulge*, meaning a stretch of saltwater. The term refers less to a specific location than a relationship to place that the inhabitants have with the waterway (Williams 2021).

The name Puget Sound originated from the first European expedition to the area, led by Captain George Vancouver in 1792. Vancouver’s lieutenant Peter Puget sailed a week-long exploration south of modern-day Seattle, to the far reaches of the waterbody, and Vancouver subsequently named the area south of the Tacoma Narrows “Puget’s Sound”. Over time, “Puget Sound” came to refer to a larger area, extending north of Tacoma and Seattle to the Strait of Juan de Fuca (the strait running east-west along the current U.S.-Canada border). In 1985 the Washington State Legislature created the Puget Sound Water Quality Authority, an agency that defined its scope as including the waters commonly called the Puget Sound as well as the area known as the Strait of Juan de Fuca. Geographically, this definition is more in line with a hydrological understanding of the Puget Sound basin, including land that drains into the waterway. Further expanding the boundaries of this waterway, in 1988 the term “Salish Sea” emerged as a way to refer to the water body including the Puget Sound, the Strait of Juan de Fuca, and the Strait of Georgia in Canada (which runs along the east side of Vancouver Island). This broader extent of the Salish Sea reminds us of the interconnected estuarine ecosystem, irrespective of political boundaries. It also better fits the historical human use of this region, whose Native peoples traveled and interacted throughout this waterway for generations (Williams 2021).

The Puget Sound Partnership, a state agency which funds and provides information to 10 Local Integrating Organizations in the region, includes the broader Puget Sound basin in its area of focus. Even so, our initial discussions with a leader of a collaborative partnership whose local area includes the Strait of Juan de Fuca suggested that to learn about use of science in Puget Sound collaboratives, we should talk to partnership members south of her location. A leader of a different partnership, in the north part of the region, said that the Local Integrating Organization work is more of a south Puget Sound concern, less relevant to his focal area. These discussions suggest not everyone views the same boundaries of the Puget Sound.

The Puget Sound basin is densely populated with collaborative partnerships

The Puget Sound basin is a productive test bed for collaborative watershed partnerships. A wide variety of governmental efforts at all levels – federal, state, county, and city – are underway to lessen humans’ impact on the ecosystem and recognize the interconnected socio-ecological system in the region. Our initial catalog of organizations includes many we do not include in our final list, but nonetheless represent significant investments of time and money. Over 100 educational organizations, land trusts, and advocacy organizations (especially around the iconic orca) perform work alongside numerous government jurisdictions. While we don’t classify these as collaborative partnerships, most actively partner with other organizations for particular projects.

 The 59 collaborative watershed partnerships we identified undertake a wide range of activities, as indicated on their websites and documents. These organizations often have overlapping geographic and functional boundaries, which can provide a rich array of resources but also may challenge partnership members in seeking relevant sources of information. One of our initial discussions with a partnership leader included the request for our research team to generate an “institutional map” showing who is doing what in the region with regard to watershed issues.

 The dense set of organizations – collaborative or otherwise – in the region generate substantial amounts of information related to the Puget Sound region. This includes scientific information about water quality, salmon populations, historical conditions, habitat status, shoreline development, contaminant sources, and countless related topics. Evidence of this information can be found in many of the partnerships’ plans and project proposals, and a state agency was created to help local organizations navigate the vast amount of data and information available and use it in developing coherent local ecosystem recovery plans that align with regional goals. This agency represents a substantial investment in the challenge of putting scientific information to use: beyond generating the information, how can collaborative partnerships put the science to use to inform their plans and projects?

 Collaborative partnerships include many overlapping members. By definition, partnerships draw in representatives from other organizations as a way to build networks of people and groups who might complement each others’ work. At times this can include competition for scarce resources such as grants. This can challenge members in their use of time, as burnout is possible when an individual is pulled in too many directions. It can also challenge the ability of the partnership to form a common identity, if members identify primarily with their “home” organization rather than the partnership.

Next step: Case study interviews

To date we have collected a variety of documents for each of our nine case study partnerships. This includes plans, meeting minutes, memoranda of understanding, newsletters, annual reports, and project updates. Across the nine partnerships, those that are government-based have most information publicly available on their websites. In order to not bias our study towards partnerships with more information available, it is important to collect substantial amount of data from interviews with several members of each group, to put citizen-based partnerships on an even footing.

 Pandemic realities have caused us to shift from in-person group interviews, to individual Zoom interviews. This approach has the advantage of providing more hours of interview time, and more easy to schedule multiple interviews because we are not restricted by travel times. Since by now Zoom video meetings have become familiar to many, so we expect few technology challenges in conducting the interviews. Zoom includes easy recording and also transcriptions, but our experience suggests the Zoom transcription program is not robust with respect to built-in laptop microphones, with many words incorrectly written. Thus we will save the audio recording from each Zoom session and use a professional transcription service for greater accuracy. In addition, or pilot research with collaborative partnership interviews revealed even a professional transcription service has inaccuracies with specific place names and acronyms relevant to our policy context, so our research team will proofread each interview transcript to make corrections and fill in place names as needed.

 We have drafted and revised our interview protocol through several iterations, based on results from practice. Our team member who will be conducting most of the interviews has had training through five practice interviews, with other team members playing the role of different kinds of interviewees (scientists, non-scientists, loquacious, reluctant, etc.) The authors of this paper have previously conducted interviews with collaborative partnership members in the region, which formed the basis for our interview questions, which are as follows:

*Interview questions*

First, please confirm your name and affiliation so that we have it on the transcript.

Please tell me about your role with the group and how long you have been active with the group.

What do you consider to be the primary expertise you bring to the group?"

The first set of questions focus on how collaborative groups such as [...insert group name…] use scientific information when developing plans and projects that address environmental issues. We interpret the term “scientific information” to mean any systematic collection of data or analysis of that data, whether produced by your group or found elsewhere.”

1) For what purposes does your group seek scientific information?

2) Where do you search for scientific information that would be useful for your group’s work?

2a) Do you look for peer-reviewed journal articles as well as other sources, such as government documents, conferences, people you know, etc…..? Why?

3) What makes the scientific information more or less useful?

Can you provide an example of scientific information that was useful for your group?

What made it useful?

4) In contrast, can you provide an example of scientific information that was not useful for your group.

What made it not useful?

We would now like to ask several questions about challenges you may face in finding or applying scientific information.

5) Have you confronted any obstacles in finding scientific information?

6) Are there challenges you have encountered in applying scientific information in your group’s plans, projects, or recommendations?

 Can you give an example?

How did you deal with this challenge?

Now I have several questions about other types of information, in addition to scientific information, that your group uses.

7) What types of information do you get from stakeholders?

a) how was it used/useful?

b) Have you confronted any obstacles in gathering this information from stakeholders?

c) Are there challenges you have encountered in applying this information in your group’s plans, projects, or recommendations?

8) What types of information do you get from local, state, or federal agencies, or Tribal governments?

a) how was it used/useful?

b) Have you confronted any obstacles in gathering this information from these agencies or tribal governments?

c) Are there challenges you have encountered in applying this information in your group’s plans, projects, or recommendations?

9) In addition to gathering information from stakeholders and government agencies and tribes, are there other places you gather information?

a) What’s the information?

10) Based on your experience, how should these other types of information (from stakeholders, agencies or tribal governments) be considered alongside or separate from scientific information in making decisions?

a) Can you give an example of when scientific information has appropriately taken a backseat to some of these other types of information?

11) In closing, now that you have heard our questions, what would you like to see happen that would improve the use of various types of information in your group’s decision-making processes?

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