**Policy-relevant science? How collaborative groups seek, evaluate, and use science for watershed planning**

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Studies of how science is used in policymaking typically focus on policy made by professionals, especially civil servants in government agencies. Yet much environmental policy today is shaped through collaborative governance. Recent research has examined the use of science in collaborative watershed partnership meetings and ecosystem recovery plans. In the study at hand we investigate the use of science in partnership decision-making via group interviews with members of 6 different partnerships in the Puget Sound basin of Washington, USA. Results suggest patterns in when and how scientific information is sought, from which sources, and what makes it more or less useful. Results also suggest key barriers and bridges to incorporating science into management decisions.

**Introduction**

Increasingly complex environmental issues abound. From biodiversity loss to changes to biogeochemical cycles, and from watershed management to global climate change, we see multiple interacting systems that span physical, biological, and human components. These “wicked” problems are marked by disagreements over problem and solution definition, cascading effects where solutions give rise to additional problems, and solutions that work differently in different places (Remington-Doucette 2017, Brown et al. 2010). The problem solving challenges come not only from the difficulty in comprehending these interacting components, but also from the nature of our problem solving boundaries. Crossing jurisdictions, they exceed the capacity of individual decision centers. Multiple decision centers have created a variety of co-existing institutions to deal with these problems.

 As policy makers and managers seek to address such challenges, collaborative governance arrangements may emerge to enable multiple stakeholders to work together (Emerson et al 2012; Ansell and Gash 2008). A key aim of collaborative governance is to promote creation and sharing of knowledge to enable coordinated action (Ison et al. 2013; Muro and Jeffrey 2012; Koontz 2014). Useful knowledge includes scientific research to identify cause-effect relationships among system components. This becomes difficult when phenomena of interest span traditional scientific fields (e.g., physical, social, and biological sciences), requiring interdisciplinarity as well as systems science expertise. Moreover, opening up decision making to a wider range of stakeholders brings more nonscientists into the discussions, which further challenges common understanding.

 The divide between scientists and policy makers has been much studied. Such research typically examines how knowledge is transmitted from one community to the other. For example, the degree to which policy makers take up scientific research is a function of the interactions between the two sides as well as characteristics of the research product (Landry et al. 2003; Jacobs 2002; McNie 2007). While much has been written about the science-policy divide, our aim here is to examine settings where scientists and nonscientists collaborate together to develop plans and make recommendations for tackling complex environmental challenges. Thus rather than asking how scientific studies travel from scientists to policy makers, we ask how collaborative partnership members access, evaluate, and use scientific research in developing collaborative plans and recommendations.

**Prior Research**

Boundary organizations explicitly recognize and work to overcome the barriers between science and society (McNie 2007; Cook et al 2013; Cockburn et al 2016; Jasanoff 1987). These organizations begin with participants “prospecting” for possibilities to engage with other stakeholders, followed by “scoping” to develop initial objectives of the partnership, then “consolidating” to formalize commitments, and finally “integrating” research outputs with management (Cockburn et al 2016). While there is plenty of advice about how to promote organizational success at these four steps, there exists a gap in understanding how participants actually access, evaluate, and use scientific research in the partnership.

 McNie (2007) and Cash et al (2002) argue that boundary organizations can help scientists produce research that is salient, credible, and legitimate, because those characteristics make it more likely that policy makers will use the research in their decisions. Saliency refers to the relevance of particular information for an actor’s decision choices. Credibility refers to whether the information meets scientific standards of plausibility and is believable. Legitimacy refers to perceptions about procedural fairness in how the information was produced. McNie argues that a key factor for research to meet these criteria is that researchers ask end users what information they need and design research to address those users’ needs, including tailoring findings to the local context. Also, inclusion of stakeholders in decision making is expected to improve decisions. Cultivating trust between policymakers and scientists, institutions, and participatory processes is expected to help. Others scholars have emphasized the importance of doing “boundary management” to keep science and policy distinct so it isn’t coopted but is still communicated across the divide (Guston 2001). Some recommend improved communication and translation of science into more common language (Schiller et al 2001). These studies of boundary organizations echo findings from literature more broadly on factors that help bridge the science-policy divide: stakeholder engagement, adaptive management, university-based science shops where research questions are provided by end users, boundary organizations that translate and mediate and communicate across the divide, and boundary objects such as reports and conferences.

But these studies do not investigate how scientists and stakeholders behave in deciding when to seek scientific research, how to access and evaluate it, and how to use this in collaborative reports and recommendations. Rather, they focus on the link between scientists producing reports/studies and policy makers acting on those reports/studies. The focus is on linking knowledge (science) to action (policy) (Cash et al 2002), or linking information producers (scientists) to information users (policy makers)(Kirchhoff, Lemos, and Engle 2013). For example, one study of state government agencies in the U.S. examined the frequency and weight given to different sources of information, including scientific information (Jennings and Hall 2012). In contrast, our focus in the study at hand is the production of knowledge among collaborative partnerships, to understand how these knowledge producers access scientific research, evaluate it, and use it to produce reports/studies to inform policy. In other words, what makes scientific studies usable to the collaborative knowledge producers as they create outputs?

 We do have some initial clues from a study of Collaborative Forest Landscape Restoration projects led by the U.S. Forest Service. Colavito (2017) examined five such cases in SW USA and concluded the partnerships relied heavily on informal, face-to-face interactions and formal presentations to access scientific findings, although their most preferred source was peer-reviewed journal articles. The most frequently mentioned barrier was conflicting socioeconomic and political viewpoints that limited the use of science. Other barriers were concerns about research quality, communication, and applicability to the local context.

 Another way to understand how collaborative organizations use scientific research is through document analysis. In a study of Local Integrating Organizations in the Puget Sound, USA, Koontz and Thomas (2018) found that local ecosystem recovery plans included references primarily to government agency reports rather than to peer reviewed journal articles or scholarly books. In another study, Koontz (2020) investigated the references included in 12 salmon recovery plans also in the Puget Sound, USA. Results suggest collaborative groups draw on a wide range of sources for information, especially government agency sources (federal, state, local, and tribal), and also peer reviewed journals, scholarly books, and other collaborative organizations. Moreover, different kinds of sources were used to support different kinds of arguments, with government agency sources used predominantly to support arguments about salmon population status/trends and proposed solutions, while peer reviewed journal articles were used predominantly to support arguments about causes of salmon population conditions.

 To build onto knowledge about how science is used in collaborative partnerships, this study addresses seven research questions as follows:

Research Questions

1. For what kinds of decisions do collaborative partnerships seek scientific findings?

2. How do collaborative partnerships search for and access scientific findings?

3. What are the key sources of scientific findings that collaborative partnerships draw on, and why?

4. What are the barriers and bridges for partnership members to access scientific findings?

5. How do collaborative partnerships evaluate the quality of scientific findings?

6. What makes scientific findings more or less useful for collaborative products?

7. What are the barriers and bridges to using scientific findings for collaborative products?

**Methods**

We developed an inventory of collaborative partnerships conducting ecological restoration work in the Puget Sound basin in the state of Washington, USA. This region is an institutionally thick, complex social-ecological system with substantial ecosystem restoration efforts underway. These efforts have been catalyzed and supported by a wide range of programs across levels of government, and they involve high levels of scientific information combined with stakeholder knowledge to generate management plans and policy recommendations (Koontz and Thomas 2018). The ecosystem being managed includes particular species for which federal and state laws require government agencies to use “best available science” in decision making, including the federal Endangered Species Act and the Magnuson-Stevens Fishery Conservation and Management Act (Doremus 2004).

Following reports from the Puget Sound Partnership, as well as prior studies of watershed networks in the region (Scott 2016), we developed a contact list of collaborative watershed partnerships in the region. We contacted 57 of these groups between July and October, 2017. 41 of these groups expressed interest in working with us, from which we subsequently completed six group interview sessions, based on group meeting time availability and selection for diversity of types and locations of partnerships. These six groups are all collaborative partnerships with members from a range of government agencies, nonprofit organizations, citizens, and industry. Two of the groups are Marine Resource Committees (MRCs), established under the Northwest Straits Marine Conservation Initiative and comprised of citizen volunteers appointed by local elected officials. Two of the groups are Lead Entities (LEs), established under the state’s Salmon Recovery Planning Act of 1998 and comprised of local government officials and citizens working to develop and manage salmon habitat protection and restoration projects. Two of the groups are Local Integrating Organizations (LIOs), watershed-based organizations established by the Puget Sound Partnership (a state agency), comprised of government agency personnel, citizens, nongovernmental organizations, and industry to facilitate local recovery efforts that matched with regional priorities.

For the interviews, we developed a semi-structured interview protocol (see Appendix) and digitally recorded sessions, with a two-person team for five of the group interviews – one to facilitate and one to take notes. For the sixth group interview the first author both facilitated and took notes. The group interviews lasted approximately one hour each and occurred between August 16 and November 7, 2017, at the location of the group’s monthly or quarterly meeting. Participants numbered between 2 and 12, with most of the groups having at least 6 participants. In total we included 38 participants across the six groups, representing five counties in the region.

 The digital recording of each group interview was professionally transcribed and augmented with notes taken during the interview (for example, we filled in some blanks in the transcripts and corrected some place name spellings). We analyzed results from the six focus groups through qualitative analysis using the software package RQDA, open source program affiliated with the statistical package R. Following Bernard (2006) and Creswell and Poth (2017), our qualitative analysis involved developing initial codes from the interview transcripts, assigning those codes to chunks of text, and using categorical aggregation to establish themes. Initial codes were identified inductively, based on occurrence in the data, and categories aligned with our semi-structured interview questions. The first author identified chunks of text and then both authors coded each transcript following “consensual” coding with each author assigning codes independently and then meeting to compare assignments, check for inter-coder reliability, and discuss and reconcile any differences (Kuckartz 2014). inter-coder reliability across the six transcripts (247 text chunks), before discussion and reconciliation, was 80%, and after discussion 100%.

**Results**

Kinds of Decisions for which Partnerships Seek Scientific Findings

Not everything these partnerships do entails seeking out scientific information. For many tasks, group members rely on their own experience and knowledge. We asked about which actions regularly lead members to seek out scientific information. Most of the discussions around this question centered on the partnerships seeking science for developing plans (13 of the 29 comments in this category of kinds of decisions for which partnerships seek scientific findings) (see Table 1). These plans included a wide range of particulars: management plans, project proposals, funding requests, research design, and monitoring protocols. Closely related is work to identify priorities for where to conduct specific projects, what projects to do, and where to spend resources (7 of 29 comments). A few comments focused on science being sought for scoping or defining problems. One comment emerged regarding how science helps the partnership connect across ecosystem scales, including ensuring their data would be compatible with other data sets and how their local context fit with larger scale planning. One partnership mentioned seeking science for training volunteers, and another for their “adaptive management” approach. Finally, science is sometimes sought in response to a request from governmental bodies – in one instance partnership members described bringing science to county commissioners who were discussing a coastal management issue (salmon net pens for aquaculture), which is a classic case of policy makers asking scientists to bring them scientific data. But this was a rarity in our discussions; far more common was partnership members seeking science for partnership outputs such as management plans and funding proposals.

Table 1: Themes about the kinds of decisions for which partnerships seek scientific findings

|  |  |  |  |
| --- | --- | --- | --- |
| **Theme** | **Frequency of mention** | **Illustrative quote** | **Source of quote** |
| Developing plans and proposals:How to do projects | 13/29 (45%) | the most recent one was developing an Ecosystem Recovery PlanIf we’re writing a proposal, then that’s when the structure of the proposal is that it’s defensible with published literature, and that’s when you go to the literature.I'd say it starts at the beginning when we're developing projects, and writing proposals. So, you get funding to do the projects. I think it's helpful to be able to demonstrate that you're familiar with what others have done along these lines. And, to be able to refer back to those previous works, and describe how you're basically building onto what they've learned from what they've done.[we sought science for] protocols for the actual monitoring -- For how we would go about collecting our data set | LIO 1MRC 2LE 2MRC 1 |
| Choosing sites or projects | 7/29 (24%) | what this particular committee does is attempt to rank projects as candidates for funding.I’ll cite the document, but I’ll also look at some outside information on occasion about what’s going on with prioritized habitats, what areas of the watershed need restoration, and the science behind those types of analysis that says, “Here is a higher priority than over here.” | LIO 2LE 1 |
| Connect across ecosystem scales | 1/29 (3%) | And it might be helpful to know that the data from the eelgrass and the data from the guillemot is being fed into state systems that are putting this into a data set. . . So, what we're doing with our data on those projects is giving it to, and planning it in a way that's compatible with WDFW or the DOEfor Sound-wide goals. . . part of the struggle is, well, how do you bring that down to our part of the ecosystem, down here in the South Sound?... So, to me, a lot of that is the science | MRC 1LIO 1 |
| Training volunteers | 1/29 (3%) | We have a lot of need to reference scientific materials just to train our interns and our volunteers | MRC 1 |
| Adaptive management | 1/29 (3%) | we’re supposed to go back and do adaptive management. And so we definitely got into some science doing adaptive management and we used some open source Miradi software and did logic models | LE 1 |
| Responding to a request | 3/29 (10%) | when we're asked by the county commissioners for scientific advice or scientific information, as an advisory group, that's part of our role, is to provide that feedback to the commissioner. So, when we're specifically asked to give scientific information. | MRC 1 |
| Scoping or defining problems | 3/29 (10%) | The question in my mind: What are the primary drivers behind decline of the salmon population itself? And so I've looked at, did Google searches to try to discover what some of these other things areif you’re gonna concentrate on let’s say water quality, again, what’s the science tell us about where are the worst problems, or biggest sources of pollution, | LIO 2LIO 1 |

Sources of Scientific Findings

When partnership members seek scientific information, they must decide which sources they want, and how to access those sources. These decisions are closely intertwined, as described by interviewees. Key themes in this part of the process include asking people they know, gray literature/non-journal sources, conferences/meetings, and scientific journals via online searching (see Table 2).

Table 2: Themes about sources of scientific findings

|  |  |  |  |
| --- | --- | --- | --- |
| **Theme** | **Frequency of mention** | **Illustrative quote** | **Source of quote** |
| asking people they know | 15/58 (22%) | That's the strength, though, of the organization that we're in… Somebody who either knows or knows somebody who would know. So, we're kind of lucky in that.And often times, if we’re looking for a specific answer, first place I would go is our rolodex. You know, “Who do we know that either is doing that work, or who might know?” | MRC 1MRC 2 |
| Ask people doing the study | 2/58 (3%) | And often times, if we’re looking for a specific answer, first place I would go is our rolodex. You know, “Who do we know that either is doing that work, or who might know?” | MRC2 |
| gray literature/non-journal sources | 16/58 (23%) | A lot of times, with this group, when we're developing a project, we're relying on planning documents that had been fed by science, previously. So, we look at – for the most part – just a select few guidance documents to guide our work, unless we're trying to develop new information for our area.The Puget Sound Partnership puts out a weekly digest, Eclipse, which is extremely good. I've already found things before they show up in there, but it's an extremely good overview of what's been going on the past week in salmon recovery, both news and research reports. | LE 2LIO 2 |
| conferences/meetings | 19/58 (28%) | I really think that half the value of the conferences is the hallway conversations that you have with people, sometimes about the presentation you just heard, or one that’s gonna be upcoming. But also, just, hey, I heard you were working on such-and-such, can you tell me where you’re at on that, kinda thing, with the scientists, and the other managers.the tribes will have – twice a year they’ll have environmental research forums various places and they’re very well attended. People talk for 20, 30 minutes on what they’ve been doing. It’s good stuff. | LIO 1LE 1 |
| scientific journals via online searching | 6/58 (9%) | [We’re generally looking for] peer reviewed journals that we can cite, and have some credibility. And in other words, a credible appeal at the time.Once you find a paper, you go to the citation, that pretty much leads you on a pretty rapidly expanding trail. | LE 1LE 1 |

A commonly mentioned source for obtaining scientific information is to reach out to people in their networks. Interviewees are inclined to ask people they know, such as project partners, people they serve on committees with, people on the partnership’s advisory board, or individuals in government agencies, universities, and nonprofit organizations. These folks could be non-scientists, but in many cases they are scientists. These exchanges can serve as a substitute for accessing particular scientific studies, or they can help the partnership member learn about and obtain scientific studies. The diversity of expertise in the partnerships facilitates asking members for scientific information, as illustrated in this exchange:

Interviewee 1: That's the strength, though, of the organization that we're in…

Interviewee 2:There's somebody who knows.

Interviewee 1: Somebody who either knows or knows somebody who would know. So, we're kind of lucky in that. (MRC 1)

In this category, it is notable that interviewees rarely mentioned reaching out to the scientists who conducted a study. If the investigator is unknown to them, it is more likely they will ask somebody in their network, even if that person did not author the study in question.

Another commonly mentioned avenue for scientific information expressed by interviewees is being aware of reports and other documents they find helpful, and going to get those sources: government agencies, nongovernmental organizations, and tribes. These are not peer reviewed scientific studies, but rather information put out by trusted organizations, which may themselves be grounded in science . One interviewee (MRC 1) noted that if it’s an area he has expertise in, he will seek scientific journals, but for other areas he prefers a more general document from a government agency or nongovernmental organization . Another interviewee (MRC 1) mentioned starting more generally with an agency or NGO document and then following up by asking people for more specific information. Guidance documents provide the legwork so that partnership members don’t need to go to the scientific journals on which the guidance documents are based, only if they need to dig deeper or get more specific (LE 2). Two interviewees also mentioned government websites as a place they like to get scientific information (LE 2, LIO 1) . Weekly bulletins from state agencies were cited by interviewees in two partnerships (LIO 2 and LE 1) . Interviewees mentioned the value of government agencies as aggregators of scientific information, especially for cutting-edge topics.

Another important theme that emerged was the role of conferences, symposia, science talks, workshops, and meetings. These venues include opportunities to hear about locally-relevant scientific research and interact with scientists. Interviewees reported checking the conference program to identify talks directly relevant to their own work, as well as additional talks of interest. Interviewees cited the value of networking with scientists, hallway conversations, and a time-efficient way to get caught up on what’s happening in the field and locally. This source of information was mentioned in all six partnership interviews.

Interviewees in four of the partnerships specifically mentioned Google as a search strategy, and one mentioned Twitter as a way to discover the most recent scientific information -- if you subscribe to the right tweeters. Online searches can sometimes yield peer-reviewed scientific articles, which members sought for instances where they were answering a research question in their area of expertise or wanted to “drill down” to greater details about a topic. Once in possession of a peer-reviewed journal article, two interviewees (LE 1, MRC 2) said they sometimes do literature searches from the References section of scientific papers. This is one of the venerable academic methods for doing a literature review, although today it has been supplanted by online keyword searches in Google, Google Scholar, and subscription-based journal databases.

Evaluating the quality of scientific findings

The most commonly occurring theme in the discussion of how to evaluate the quality of scientific findings was the institutional reputation and legitimacy of the organization that produced the findings. One participant noted the importance of familiarity when it came to judging the reputation of a source. “If I heard of it before, and I know that it’s a good journal, then I’m much more likely to trust it. If I find something that is a journal that I’ve never heard of before, and I’m not really sure if it – I don’t know anything about it, then I’m much less likely to trust it.” (LIO 1). Interviewees acknowledged that there were often entities with interests in particular scientific findings: “Now we have all this ‘alternate science’ that’s out there, and a lot of the alternate science ends up being funded, usually, through industry groups, or lobbyists, or things like that.” (MRC 2) Additionally, an interviewee commented how examining the money trail was an important step in evaluating the quality of scientific findings from a new source. “I'd probably try to look at who they're funded by. That would be the next step to kind of vet them, if I wasn't familiar with them. Like who funded the research for that scientific finding. That would be a way that I would try to vet something.” (MRC 1)

Particular sources are deemed credible, for example peer-reviewd journals. One interviewee mentioned trusting peer-reviewed: “Well, is it a trusted source? … I mean, the peer-reviewed journals, I mean you figure they're peer-reviewed, and have that credibility to it.” (MRC 1) Government agencies were typically regarded as a trustworthy source, although the following exchange illustrates some potential complications based on politics.

Int 1: I tend to trust the government probably more than anything else, simply because most of the agencies, especially if they’re a regulatory agency, they tend to have to make sure that they’re doing things that are legally defensible. So, they’re very conscious about the information that they’re putting out there. And if they find something that’s not accurate, they’re usually pretty good at –okay, I’ll qualify that. Not underneath the Trump administration. Typically, that’s the way that it’s been in the past. I wouldn’t trust most anything I’d look at in the EPA cover page or anything anymore, but…

Int 2: No, but you might talk to a direct employee who’s been doing the work for the last ten years.

Int 1: Yes, yeah. Exactly. Right.

 Some groups had connections with individuals or organizations that were conducting research. Those connections made it more likely that scientific findings from those sources were trusted. One participant remarked, “We also tend to trust people that we know. Like if we’re looking at research that X did.” (LE 2)

The methods used to arrive at scientific findings were also apparent as part of the evaluation process. Literature that uses methods that are “questionable or lacking” (LE 2) is noted as lesser quality. Some methods, such as using big data, may invite extra caution. One interviewee remarks “The big data stuff is, I mean now, a lot of our stats approaches are very cookbook, plug and play without understanding assumptions. And so, I’m always very cautious about you know, when you say, “Oh, our mean salinity in this system is ‘x’.” You know, well, is that de-trending tides? You know, that’s just a bit complicated, how we deal with big data. Because there’s a lot that we can come out of it that’s really informative, but I also try and look at it very critically.” (MRC 2)

In a similar vein, interviewees also noted that the nature and quality of the data matters as well. “I often look at how long ago the study was. You know, and how broad the study was. So that you find out whether you're getting a snapshot, or are you getting 20 years of data.” (MRC 1) Additional interviewees commented on looking at sample size as well as the data collection process.

 Finally, participants remarked that scientific findings had to be interpreted in context. As most of the work that these groups do is focused locally, all the information they receive has to be filtered through their context and experience. One interviewee explained how their experience shapes the lens by which they view scientific findings: “It has to be logical. It has to make sense. It has to be something that you can – when you read the science, it has to say something to you that really fits real life and real life experiences. If it's something that just doesn't seem like it could possibly work, well, my hypothesis could be wrong, and a new science could be coming along, but it will take a while to convince me.” (MRC 1)

Table 3: Themes about evaluating the quality of scientific findings

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| --- | --- | --- | --- |
| **Theme** | **Frequency of mention** | **Illustrative quote** | **Source of quote** |
| Institutional legitimacy and reputation of the source | 8/32(25%) | If I heard of it before, and I know that it’s a good journal, then I’m much more likely to trust it. If I find something that is a journal that I’ve never heard of before, and I’m not really sure if it – I don’t know anything about it, then I’m much less likely to trust it. | LIO 1 |
| Legitimacy and reputation of author | 3/32 (9%) | We also tend to trust people that we know. Like if we’re looking at research that Person X did | LE 1 |
| Who funded the research | 5/32 (16%) | Now we have all this “alternate science” that’s out there, and a lot of the alternate science ends up being funded, usually, through industry groups, or lobbyists, or things like that.I'd probably try to look at who they're funded by. That would be the next step to kind of vet them, if I wasn't familiar with them. Like who funded the research for that scientific finding. That would be a way that I would try to vet something. | MRC 2MRC 1 |
| Peer reviewed | 6/32 (19%) | Well, is it a trusted source? … I mean, the peer-reviewed journals, I mean you figure they're peer-reviewed, and have that credibility to it. | MRC 1 |
| Methods | 4/32 (13%) | How I generally assess the quality of the literature that I'm looking at is I will get who the authors are, and the next thing I do is I assess the methods that were used. And, if I find them to be questionable, or lacking in a particular – you know, weighted one way or another – that's how I assess the quality.The big data stuff is, I mean now, a lot of our stats approaches are very cookbook, plug and play without understanding assumptions. And so, I’m always very cautious about you know, when you say, “Oh, our mean salinity in this system is ‘x’.” You know, well, is that de-trending tides? You know, that’s just a big complicated, how we deal with big data. Because there’s a lot that we can come out of it that’s really informative, but I also try and look at it very critically. | LE 2MRC 2 |
| Data quality | 4/32 (13%) | I often look at how long ago the study was. You know, and how broad the study was. So that you find out whether you're getting a snapshot, or are you getting 20 years of data. | MRC 1 |
| Matches experience | 2/32 (6%) | It has to be logical. It has to make sense. It has to be something that you can – when you read the science, it has to say something to you that really fits real life and real life experiences. If it's something that just doesn't seem like it could possibly work, well, my hypothesis could be wrong, and a new science could be coming along, but it will take a while to convince me. | MRC 1 |

Barriers and bridges to accessing scientific findings

Our group interviewees described a range of barriers and bridges that partnership members experienced in seeking to access scientific findings. These included barriers of cost, time, finding information online, and non-published data (see Table 4). Conversely, members described bridges to access such as a curated repository of scientific information, conferences and conference proceedings, volunteers, and strategies to access journals without paying.

Table 4: Themes about barriers and bridges to accessing scientific information

|  |  |  |  |
| --- | --- | --- | --- |
| **Theme** | **Frequency of mention** | **Illustrative quote** | **Source of quote** |
| Barrier: cost | 11/36 (29%) | It’s very hard, as a government person, to get access to scholarly journals. We don’t have a subscription to say, the UW libraries. So, I miss that, as a former academic myself, because I did not appreciate it enough, to have access to the library system[F]unding got cut. That was one of the first things to go. And then after that was attendance at conferences. So it really got limited to – maybe you'd go to one, maybe two a year. So it's been … harder to stay on top of the latest research | LIO 1LIO 2 |
| Barrier: time | 3/36 (8%) | [We’re] not so much doing a lot of exhaustive literature, and research. Again, it would be great if we could do more of that, but we're just pretty limited. We meet once a month for two hours | LE 2 |
| Barrier: finding it online | 2/36 (5%) | I also think a big barrier is now, since so many people use Google Scholar to search, that if you don’t build a tech report website properly, then Google Scholar doesn’t find itSometimes just not knowing what's out there. I mean sometimes you don't know – where to start – what you need to look for until you happen upon it | MRC 2MRC 1 |
| Barrier: Non-published data | 4/36 (11%) | There is a lot of really good information that our various groups have, either in reports or in databases that don't always make it to the journals where they would have a much broader audience, and be much more accessible | LE 2 |
| Bridge: curated repository of scientific info | 6/36 (16%) | We shouldn't all be spending our time doing literature searches for common goals, and I think that government, and organizations that are charged with facilitating goals such as salmon recovery should do a better job of doing that work upfront, and organizing it such that it's available | LE 2 |
| Bridge: conferences and conference proceedings | 3/36 (8%) | That’s where proceedings are really helpful, because you can go back – you can also say, well, wasn’t their paper on this the year before, too? And, there’s those other proceedings. So, you can kinda track those things, a little bit, through time. Especially in an area where the science might be developing over time | LIO 1 |
| Bridge: volunteers | 3/36 (8%) | Volunteers - people who have been in the kind of work that X and I have been in our whole lives – and, we're retired... People want to be involved, and they want to have their expertise used. Is there some way to tap into that, and some people will do it for free? | LE 2 |
| Bridge: find ways to access journal articles without paying | 4/36 (11%) | I email the – I hunt down the professor or the authors – primary author – and through their agency online, and I tell them directly, tell them … why I'm interested in their work, in their paper, and how what I do, and how I'd like to see it related, and then they usually send me back, plus a few other things, because they get excited | LIO 2 |

The biggest barrier to accessing scientific findings is financial cost. This was especially prominent in discussions about retrieving papers in scientific journals. Interviewees lamented the fact that they can’t access these paywalled articles because their organization doesn’t have subscriptions. As one interviewee said, “It’s very hard, as a government person, to get access to scholarly journals. We don’t have a subscription to, say, the University of Washington libraries. So I miss that, as a former academic myself, because I did not appreciate it enough, to have access to the library system” (LIO 1). Another said, “Having access to that sort of thing, is not something at our agency we have. I’ll find abstracts, but I won’t be able to get into them. So it’s a resource barrier, basically. Is it worth spending the money to get the scientific article for what I’m trying to do?” (LE 1).

Financial cost can also be a barrier to accessing scientific findings by attending conferences. One interviewee said, “I've been in government for about 20 years, and it used to be, we could be a member of a professional organization, and get a journal. You'd read it. Society for Ecological Restoration is one that I've spent throughout the years, before its funding got cut. That was one of the first things to go, and then after that was attendance at conferences. So it really got limited to – maybe you'd go to one, maybe two a year. So it's been – at least for me personally, I'm sure others have experienced this – harder to stay on top of the latest research.” (LIO 2)

 Lack of time was mentioned as a barrier to accessing scientific information in a few instances. One interviewee said, “We're working with policy and documents from the Puget Sound partnership, and from the salmon Recovery Funding Board, and other organizations that are part of what we do, and not so much doing a lot of exhaustive literature, and research. Again, it would be great if we could do more of that, but we're just pretty limited. We meet once a month for two hours.” (LE 2)

 Another barrier is the vast amount of scientific research to sift through in order to find relevant information online. In this exchange two interviewees focus on this barrier:

Interviewee 1: Sometimes just not knowing what's out there. I mean sometimes you don't know

Interviewee 2: Where to start.

Interviewee 1: – what you need to look for until – yeah – you happen upon it. (MRC 1)

One interviewee suggested a related problem with making scientific research findable to users of Google and Google Scholar: “I also think a big barrier is now, since so many people use Google Scholar to search, that if you don’t build a tech report website properly, then Google Scholar doesn’t find it. So, when I added the publications page, I had the web master follow Google Scholar’s instructions to make sure that it would be searchable by Google, and so all of our tech reports are now found. But, you have to have a certain format. Otherwise, the robots or whatever they’re called don’t find them.” (MRC 2).

 Interviewees in two different groups said a barrier to accessing science is non-published data. The problem is that people collecting data do not always make it available to others: “There is a lot of really good information that our various groups have, either in reports or in databases that don't always make it to the journals where they would have a much broader audience, and be much more accessible.” (LE 2) This problem is compounded if members are not integrated enough with research beyond their area: “I feel like a lot of us work in silos, and because I also rely so much on Google, if it isn't linked or searched successfully through Google, it's very unlikely that I'll find out that some organization that's the next county over has done some work that's very relevant to what I'm trying to understand.” (LE 2)

To overcome such barriers, and improve access to research findings, interviewees made several suggestions. Several participants described the value of boundary organizations to provide accessible science. One interviewee suggested a curated set of information, where somebody collects, distills, and organizes studies by topic to make it easy for users to access relevant information. Such a repository of scientific studies would provide a function that is currently provided through asking other people and finding government or nongovernmental organization documents and reports that summarize scientific information. Similarly, one interviewee said “We shouldn't all be spending our time doing literature searches for common goals, and I think that government and organizations that are charged with facilitating goals such as salmon recovery should do a better job of doing that work upfront, and organizing it such that it's available.” (LE 2)

The value of conferences as a source of scientific information was described above, and some additional aspects of conferences were identified as fostering accessible science. Interviewees in two partnerships noted that publishing conference proceedings allows them to better find scientific information in the future, as new questions arise. Another said having a synthesis panel to wrap up the conference was helpful.

In terms of overcoming access barriers to peer-reviewed journals, some interviewees had developed workaround strategies. One interviewee mentioned that a way to get access is to go to a university and get a guest pass to use their journal subscriptions (LIO 2). Another said she contacts the study author directly and asks for the paper: “I email the – I hunt down the professor or the authors – primary author – and through their agency online, and I tell them directly … why I'm interested in their work, in their paper, and how what I do, and how I'd like to see it related, and then they usually send me back, plus a few other things, because they get excited.” (LIO 2). In another case (MRC 2) the discussion included the following exchange as an interviewee shared a different technique:

Int 1: I found a website that actually hacks into any journal, so you can get any PDF you want.

Int 2: Can you send that to me please?

Int 1: It’s totally awesome, it’s like, from Russia or something.

Int 3: You will need to give your social security number and your bank routing number.

Int 2: Will you send that to my private email?

This exchange includes joking about shady Russian websites, but drives home the point that members have barriers to accessing scientific studies when those studies are behind paywalls, and they may seek creative ways to access those studies.

Finally, one interviewee suggested an increased role for volunteers: “Volunteers - people who have been in the kind of work that [name] and I have been in our whole lives – and, we're retired... People want to be involved, and they want to have their expertise used. Is there some way to tap into that, and some people will do it for free?” (LE 2). The idea of volunteers to do citizen science also came up in some discussions of usable science, which is the subject of the next section.

Usable Science

Finally, our interviewees discussed what factors affect the usability of the scientific findings they access. These factors fall into six themes: collaboration, applicability to local context, political acceptability and understandability by policy makers, practical problem solving, and degree to which the findings are up to date, from trusted sources, and clearly described (see Table 5).

Table 5: Themes about usable science

|  |  |  |  |
| --- | --- | --- | --- |
| **Theme** | **Frequency of mention** | **Illustrative quote** | **Source of quote** |
| Political acceptability | 19/63 (30%) | we've been grappling a lot with… the relationship between the restoration community and the sport fishing community, and even though the science shows that habitat leads to more fish naturally spawning within rivers… the political environment still puts us at a head because all they want is more days on the river. They don't care about more logjams [habitat]We self-censor… It happens on a subtle level with every project we look at. And we filter everything through the lens of are the commissioners gonna buy off on it?... if it has anything to do with climate change [we don’t use the term]If we can't create something that's going to fit within the parameters of what's going to be politically acceptable, I think there are limitations. | LE2LIO 2LIO 2 |
| Applicability to local context | 14/63 (22%) | Because it just seems that’s when we’re hearing about a project about the same kind of fish that we have, or it’s just similar ecosystems and it just, it’s – we’re gonna latch onto that more. Although, I don’t know. I’m not sure if that’s always – if everybody did that, we’d be in big trouble. But at kind of the science user level, it seems like it’s appropriate. | LE 1 |
| Collaboration | 8/63 (13%) | Well, given the work that we're doing here. . . I kind of need my scientists to start talking to each other. So, we tend to – I confirm the more physical science there, the agriculture – But then we need quality of life science to be wrapped in with economic science with the physical sciences and the marine sciences, because all this stuff's hooked together.having collaboration and having groups like this really helps a lot. I mean, the more opportunities that you have for people with different backgrounds to come together and discuss things, you’re not siloed in these different areas, forming your own opinions that aren’t receiving input from other areas. So, we become more informed.If the scientific communities would embrace that kind of collaborative relationship with local residents, I think that would begin to – it would create a source for data, create a way of asking practical questions, and engage people locally in what's being learned, and becoming better informed. | MRC 1MRC 2MRC 1 |
| Understandability by policy makers | 8/63 (13%) | To design practical work that is understandable, especially by our elected officials. And it can't be too far-removed from that. If we use it as a reference, we need to be able to talk about it in kind of ordinary terms and understand it. | MRC 1 |
| Practical problem solving: project location and timeliness | 7/63 (11%) | Science helps me in my role of helping strategize, it’s like where should we focus first? … I can say, “Okay, this is where we should be doing work,” and then write a grant around why it’s so important to be doing work right there.They weren’t integrating ground-breaking science, necessarily, either. They were taking pretty common science, and then putting it all together to identify hot spots, if you will. So, it's not like it was outside the box science, new. It was pretty straight-forward. | LE 1LE 2 |
| Scientific study is from trusted source, “good” quality and clearly described | 7/63 (11%) | they have a very good reputation for solid studies, so that also helps persuade others.the government agencies tend to be really good at documenting SOPs, and documents that you can download, and say this is exactly how we do this, because we have to be standardized. . . That’s really important for us in my organization too, because normally we’re looking to try and come up with comparable data sets | LIO 1MRC 2 |

Much of the discussions about usability of science centered on political acceptability. Discussions along these lines were more about how partnership outputs (e.g., plans or recommendations) would be taken up by policy makers, as opposed to how scientific information would be taken up by partnership members. Partnership members are aware of how their outputs are received and thus adjust not only which science they report out, but also which science they take up for producing partnership outputs (MRC 1). For example, interviewees described the advantage of scientific findings that don’t lead to implications that powerful stakeholders object, and also scientific findings that address politically salient issues. In addition to political acceptability, interviewees noted the importance of scientific findings being understandable by policy makers: “Work that is understandable, especially by our elected officials. And it can't be too far-removed from that. If we use it as a reference, we need to be able to talk about it in kind of ordinary terms and understand it.”

Many interviewees mentioned the importance of collaboration across stakeholders and scientists for usability. This includes mentions of citizen science that produces highly regarded data (LIO 2) and can help cross the scientist-citizen divide to create more usable science (MRC 1). Interviewees in two groups mentioned the importance of having end users of the scientific information be involved with research design and analysis (MRC 1, LIO 1). Having a collaborative process with many steps can help participants become familiar with the data and understand the results (LE 2). Interviewees in one partnership stressed the value of including potentially dissenting voices in their work, to better use science (MRC 2)

Applicability to local context is an important consideration for partnership members. Geographic proximity was mentioned by several interviewees, as well as similar species and ecosystems in other places. (LE 2,MRC 1, LE 1]. One interviewee stressed that the group is “dealing with science that connects on a practical level” so it is helpful to have a scientific finding that addresses a “practical question” (MRC 1)

Interviewees in a couple of the partnerships, in answering the question about usability, focused on practical problem solving. This includes science that can help the member identify where to locate a project most effectively and that can be used to strengthen funding requests (LE 1).

Finally, characteristics of the scientific study itself affect usability. Interviewees described the importance of research that is up to date (LE 2), from a trusted source (LIO 1, MRC A), and with clearly described methods and analysis (MRC 2,LE 2). Members of one partnership also noted that scientific studies that synthesize across multiple studies are especially helpful (LE 2). One partnership identified its role as synthesizing literature from many studies to provide information to project partners (LIO 2). Thus this partnership provides a source of scientific findings – gray literature --that is commonly sought across the partnerships (as described in Table 2 above).

**Discussion**

Looking across the partnerships, our results paint a picture of how partnership members navigate the process of deciding when to seek scientific findings, searching and accessing findings, evaluating their quality, and then using them to produce outputs such as plans and recommendations.

Partnership members primarily draw on scientific findings from other people, and gray literature, rather than from peer-reviewed journals directly. This is due to cost barriers (lack of journal subscriptions) as well as a need to solve local, place-specific challenges for which peer-reviewed journal articles are not readily applicable. It is also a function of the wide variety of scientific fields germane for addressing complex ecosystem management challenges – journal articles are seen as hard for non-experts to understand. In terms of usability of scientific findings, peer-reviewed journals are useful to the degree that they are up to date, from a trusted source, and with clearly described methods and analysis. But partnership members often find non-journal article scientific findings to be more useful, in that they are more likely to be applicable to the local context.

The role of collaboration emerges as a critical factor for usability. It is clear that in discussing usability, many interviewees were thinking about the degree to which science could be used to make plans and recommendations that policy makers would view as actionable. Collaboration was seen as a way to bring in multiple perspectives and information, which helped produce a more usable partnership output. Interestingly, the collaboration about which they spoke was of several varieties: multiple stakeholders talking with each other, scientists learning from other scientists, scientists learning from citizens, and citizens learning from scientists. Each of these varieties has been the subject of scholarship, though often treated separately in the literature (e.g., collaborative governance scholars focus on multiple stakeholders working together, while sociology of science scholars focus on scientists interacting with each other, traditional ecological knowledge scholars focus on scientists learning from citizens, and science education scholars focus on citizens learning from scientists). In collaborative partnership settings we can see all of these varieties of exchange occurring together.

An interesting finding that emerged was the value placed on conferences and meetings. Time and again interviewees mentioned the importance of these events, highlighting specific regional conferences as important sources of information regarding cutting-edge, local phenomena. They also highlighted the networking benefits of connecting with people to whom they could turn for information at a later date.

Our findings are in line with some aspects of prior research on boundary organizations and how to bridge the science-policy divide. In particular, McNie (2007)’s review of the literature highlights the importance of having end users involved in research design, including tailoring findings to the local context. This idea was described by many interviewees across the partnerships. Relatedly, inclusion of stakeholders was seen as valuable to the process, and indeed is a foundation of the establishment of each of these partnerships. Although trust between policymakers and scientists wasn’t always high – especially for elected officials-- interviewees did place a high premium on trust in sources of information in their evaluation of scientific quality. Moreover, they indicated a high level of trust in government agency scientists and manangers to provide valid and context-relevant scientific information. Many interviewees also described boundary organizations and their boundary objects as important bridges to accessing scientific findings.

As a practical matter, the means to overcome barriers to accessing and using science are not new: more resources in terms of funding and also time are needed. But living with the reality that such resources are not easily gained, members rely on other strategies as well. Many are likely to turn first to the accessible gray literature, and to people they know. Both of these sources are more readily accessible than are journal articles, and they have the added bonus of providing more locally applicable information.

**Conclusion**

This study set out to examine how collaborative partnerships access, evaluate, and use scientific findings. Unlike prior studies focusing on how science is communicated to policy makers, we focus on how collaborative partnership members use science as they craft outputs that will be transmitted to policy makers. Through qualitative analysis of group interviews across 6 collaborative partnerships in the Puget Sound region, including 38 participants, we inductively developed codes and themes.

Results highlight the importance of scientific journals not so much because members directly access them, but because they are the basis for the guidance documents from government agencies and nongovernmental organizations that members find so helpful and accessible. Moreover, members rely heavily on asking people in their networks when they have a scientific question. Thus in answer to the question “How much do collaborative participants access and use scientific findings?,” it is important to identify not only journals but these other, indirect sources.

Further inquiry should examine the degree to which our findings are applicable beyond the Puget Sound region. Our study cases represent a science-oriented collaborative focus that may not be present in other locations or other types of partnerships. In particular, it would be instructive to conduct interviews with members of watershed partnerships that have less government involvement, e.g., citizen-driven groups that meet in the evening and are not comprised of government agency personnel. In addition, it would be interesting to examine government agency and nonprofit organization production of gray literature such as the guidance documents that collaborative partnerships rely on to do their work. Finally, these six collaborative partnerships share some common features of advisory committees, which have been long studied. Advisory committees are charged with providing advice to a variety of government agencies, and they often include scientists or are provided resources to hire scientists. Yet we know that the use of science in federal advisory committees is subject to political rollbacks, as in the Trump administration actions to replace scientists with industry representatives on a variety of advisory committees. How do these advisory committees search for, evaluate, and use science, and how does this change with politically appointed members? These and other questions can inform theory and practice moving forward, as we increasingly employ collaboration and science to address complex social-ecological problems.

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**Appendix: Interview Questions**

In your work with the this group, for what kinds of decisions do you seek scientific findings?

How do you search for scientific findings that would be useful for the work of your partnership?

When you seek scientific findings, are you more likely to search in scholarly journals or publications from government agencies or nonprofit organizations?

● Why?

● Are there any other sources you might use?

What criteria do you use to assess the quality of scientific findings?

Now we will ask several questions about what makes scientific findings more or less useful for the work of your partnership.

● Please give us an example of a scientific finding that was useful for your partnership. What made it useful?

● How did you incorporate this useful finding into the work of your partnership?

● What was the scientific finding used for?

● In contrast, please give us an example of a scientific finding that was not useful for your partnership. What made it less useful?

Are there barriers to finding scientific findings?

Are there barriers to using those findings in finalizing plans, projects, or policy recommendations?

● How can these barriers be overcome?

Are there any other ideas you have about how scientific findings can inform the work of your partnership or collaborative partnerships in general?