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Institutional Analysis of Small Dam Removals: A Comparison of Non-Federal Dam Removals in Washington and Oregon

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ABSTRACT: The vast majority of dams in the US, and thus the majority of those removed, are small structures that are governed primarily by state and local institutions. Important differences between large and small dams suggest that the existing work on the governance of large dam removals should not be expected to explain decisions about small dam removals. It is, for example, unclear which policies and organisations drive dam removals when there is no direct federal nexus. It is also unclear how the relevant policies and organisations shape the local decision-making process and how the design of the decision-making process influences stakeholder opinions on the decision to remove the dam. The objective of this study is thus to characterise and evaluate the governance that has driven recent decisions to remove small dams. A modified version of Ostrom's Institutional Analysis and Development framework was applied to two dam removal case studies, that of the Beeson-Robison Dam in Oregon and the Nelson Dam in Washington state. In each case, an online survey was distributed to stakeholders involved in the dam removals in order to characterise the design and costs of the governance process and to investigate how those variables were associated with stakeholder opinions on the decision to remove the dam. Results found little difference in governance processes between the two case studies, suggesting that the organisation that led the removal – a local government and an NGO, respectively – was not an important determinant in the governance process. Instead, the case studies suggest that a governance mechanism characterised by passive threat, active support led to the decision to remove both dams. It is hypothesised that a similar governance mechanism is at play in other environmental management and restoration activities. Other key findings include the high levels of satisfaction and optimism among stakeholders of both projects, likely a result of the time and energy invested in a collaborative decision-making process at both sites. Further work should be conducted to more fully characterise the governance mechanisms behind small dam removals, which may help reduce the conflicts and costs of future projects.

KEYWORDS: dam removal, Institutional Analysis and Development framework, governance, US Pacific Northwest

INTRODUCTION

While the physics, engineering, and biology of dam removals have increasingly been studied (see Foley et al., 2017, for a review), the science around the governance of dam removals is largely undeveloped. There are unanswered questions about how different governance structures determine if and how a dam is removed, and how this may lead to increased conflict and project costs. Most of the limited research on the governance of dam removal has focused on large dams removed under the auspices of federal

hydropower relicensing (Chaffin and Gosnell, 2017; Amos, 2014). The majority of dams in the United States, however, are not large hydroelectric dams; they are less than ten metres high, produce little or no hydroelectric power, and are over fifty years old (ASCE, 2017). These small non-hydroelectric dams – which are often owned at the local level by counties, cities, individuals, or irrigation districts – are also the most commonly removed dams (American Rivers, 2019). This study focuses on the governance surrounding the removal of small dams. In this context, small dams are defined as those which are less than ten metres in height, provincially or locally owned, lacking direct federal oversight, and not producing hydroelectric energy.

The existing research on large hydroelectric dams indicates that governance is primarily centralised. Centralised governance refers to governance that "concentrate[s] a great deal of power in the hands of a small number of authorities at the national level" (McGinnis, 2011). The centralised governance of large hydroelectric dams is primarily overseen by the Federal Energy Regulatory Commission (FERC). FERC enforces legal mandates under the *Federal Power Act*, the *Endangered Species Act*, and under its federal trust responsibilities to American Indian tribes (Chaffin and Gosnell, 2017). Together, these federal laws impose strict conditions, such as mandatory fishways, on hydroelectric dam owners through a permit renewal process (Amos, 2014). Under this largely federally-controlled governance system, dam removal most often occurs when FERC imposes environmental mandates, which are expensive to implement and make removal more cost effective than compliance. Research by Chaffin and Gosnell (2017) and Amos (2014) document the federal relicensing process for large hydroelectric projects and conclude that relicensing creates a window of opportunity that may lead to dam removal. Chaffin and Gosnell (2017) summarise FERC's responsibilities under several federal statutes and treaties, whereas Amos (2014) examines the specific sections of the *Federal Power Act* that play a strong role in determining the conditions that FERC places on dam owners for relicensing.

Small dams fall outside of FERC's jurisdiction; they are not governed under the centralised, FERC-driven framework described above. Small dams continue, however, to be the most commonly removed class of dams (American Rivers, 2019), yet little is known about the larger governance system that drives these removals. It is unclear whether power is concentrated and centralised within an institution, as with large dam removals, or whether decision-making on small dam removal is more distributed (or "polycentric") with policy goals reached through the efforts of multiple actors at multiple levels (Ostrom et al., 1961). The limited research on small dam removals broadly identifies the main reasons for removal as being safety concerns and environmental restoration (Pohl, 2002). In the absence of a direct federal nexus such as FERC relicensing, however, the limited research fails to identify a broadly applicable governance regime; it focuses instead on a single regulatory regime for one purpose (dam safety) in one state (Wisconsin) (Born et al., 1998; Orr et al., 2004). The limited research on small dam removals also fails to address important questions such as who leads the projects and how the decision-making process is designed.

The objective of this research was to characterise the governance system surrounding two small dam removals and to investigate the association between governance decision-making and stakeholder experiences. The research aims to pose and answer exploratory questions in order to inform more detailed hypotheses and research plans (Yin, 2018) around the governance of environmental management and restoration. In the two case studies analysed, one represented a small dam that was removed by a local NGO and one was removed by a local government. Ostrom's (1990) Institutional Analysis and Development (IAD) framework was applied in order to help articulate the governance dimensions around dam removal. Three research questions were defined:

1. What were the driving contextual factors in the discussions to remove the dams?
2. Comparing the two dam removal case studies, what governance strategies and decision-making processes were used?

3. In what ways were the differences in these decision-making processes associated with stakeholder satisfaction and optimism for the replacement infrastructure’s long-term viability?

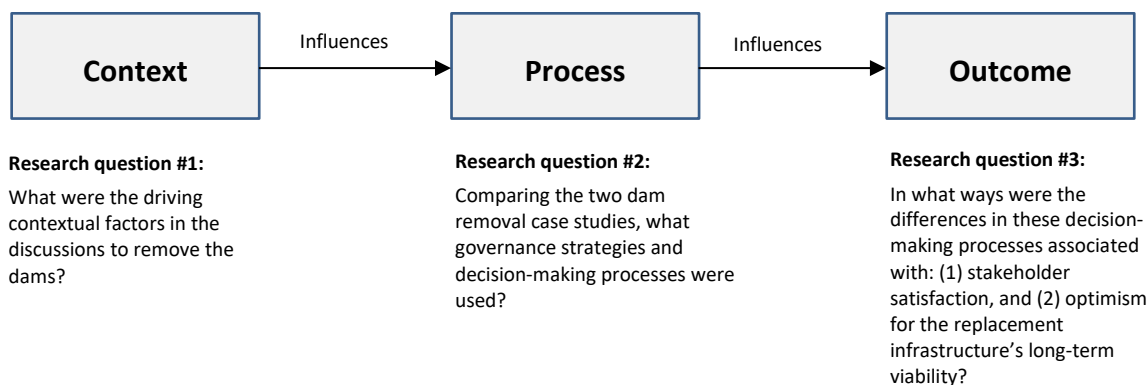
METHODS

This study used a mixed methods approach (Creswell and Creswell, 2018). Key informant interviews, document analysis, and an online survey were used to characterise and evaluate the governance that has driven recent decisions to remove the two small dams. Key informant interviews and document analysis were used to identify the sources of support and regulatory ('carrot and stick') mechanisms that influenced decisions about the two dam removals and to inform the development of the survey instrument. An online survey was sent to the stakeholders of the two case studies. A stakeholder was defined as any person or entity that showed an interest in the dam removal project. The stakeholders were identified by the leader of each dam removal project and included government agencies, water rights holders, landowners, non-profit organisations, funding organisations, and other members of the public. The goal of the survey was to identify and characterise the differences between decision-making processes led by a local government and those led by a state-sanctioned, non-profit organisation known as a watershed council.¹ The survey also assessed the effect of the governance process on (1) stakeholders’ satisfaction with the outcome, and (2) optimism about the replacement infrastructure’s long-term viability. The methodological approach is described in further detail below.

Institutional Analysis and Development framework

A modified version of Ostrom’s (1990) Institutional Analysis and Development (IAD) framework was used as a frame for the research. The IAD framework is commonly used as a means of analysing governance arrangements, especially arrangements that govern the private use of natural resources (Schlager and Cox, 2017). The framework is organised according to three components of a governance system: context, process, and outcome. Each research question is associated with one of these components (Figure 1).

Figure 1. Modified IAD framework with research questions.



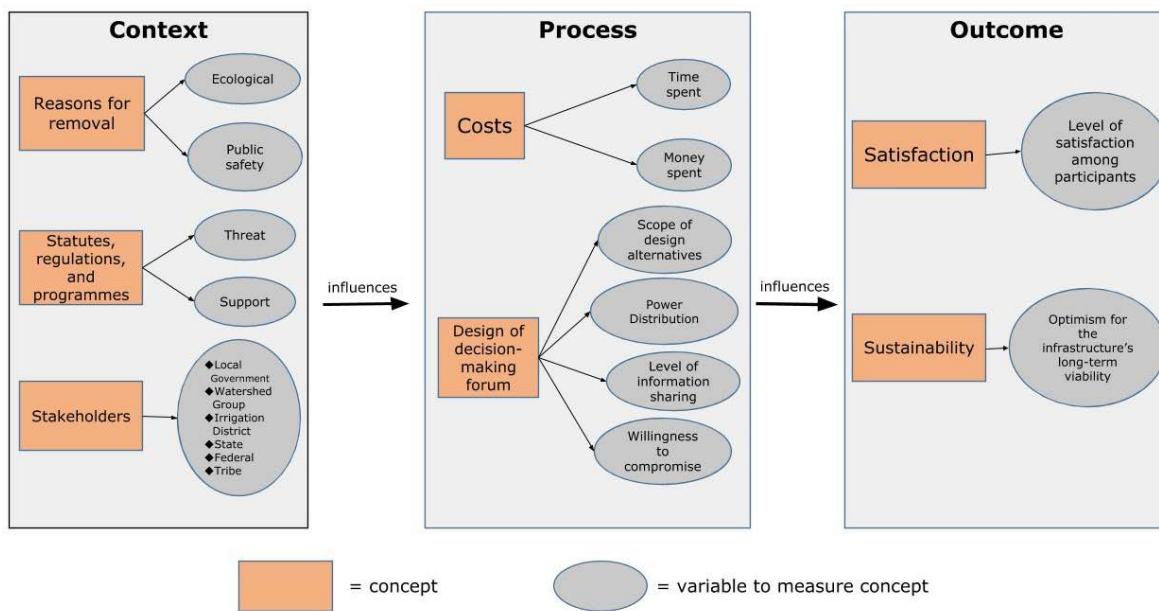
Source: Ostrom, 1990; Matthias Fostvedt.

First, the IAD framework was applied in order to characterise the context of the dam. Context, here, refers to the reasons for removal, the stakeholders, and the relevant statutes, regulations, and programmes that may intersect with the dam. Gathering the context information involved making an

¹ Watershed councils are "community-based, voluntary, non-regulatory" groups that assess conditions and conduct projects to "restore or enhance the waters and lands for fish and native plants in their area". They are considered to be state-sanctioned because they further state environmental goals, are recognised by local governments, and receive significant funding from the state of Oregon through a competitive grant process (Network of Oregon Watershed Councils, 2020).

inventory of the property interests and relevant policies, as well as of the available sources of support for removal such as funding or planning resources. Second, the framework was applied to delineate the decision-making process as characterised by the following variables: (1) monetary and temporal costs, (2) scope of design alternatives, (3) power distribution, (4) level of information sharing, and (5) willingness to compromise. Finally, the framework was used to assess the outcome of the decision-making process, which, for this study, involved the participants’ satisfaction with the decision and their optimism for the new infrastructure’s long-term viability. All three of these IAD areas (Figure 2) were evaluated using the methods described below.

Figure 2. Modified IAD framework with concepts and variables relevant to small dam removal.



Source: Ostrom, 1990; Matthias Fostvedt.

Case studies

Two case studies were selected based on two criteria. The first criterion was the dam’s jurisdiction. We deliberately chose case studies which were not directly regulated by the federal government; they are not located on federal land, nor do they operate under a federal license. This choice was made because federally-regulated dam removal under the *Federal Power Act* has received greater attention in the legal and scientific literature (Amos, 2014; Chaffin and Gosnell, 2017). The second selection criterion was leadership. One case study was selected because it was led by a watershed council, an NGO that has no legal authority (i.e. property rights or regulatory authority) over the dam. The second case study was selected because it was led by a local government that owned the dam and thus held legal authority.

Figure 3. Beeson-Robison Dam.



Source: Brian Barr, Rogue River Watershed Council.

The first case study was based on the removal of the Beeson-Robison Dam. The dam was 1.7 metres high and approximately 4 metres wide. The structure was located on Wagner Creek, a second-order tributary of the Rogue River in Southern Oregon. It was built in 1912 with the sole purpose of diverting water for several private water rights, which it continued to do until it was removed (National Park Service, 1998; Resources Legacy Fund, 2015b). This project was primarily motivated by ecological concerns, with no apparent public safety concerns (ODFW, 2013b). It blocked juvenile salmonids from accessing the cold-water refuge and rearing habitat above the dam. Due to these concerns, the Oregon Department of Fish and Wildlife (ODFW) placed the Beeson-Robison Dam on the 2013 ODFW Fish Passage Priority List (ODFW, 2013a). A non-profit consulting firm initially led the project by reaching out and discussing options with the Beeson-Robison Ditch Association, which manages irrigation deliveries from the dam (OWEB, 2017). In 2014, the consulting firm passed the project on to the Rogue River Watershed Council (RRWC). In 2015, the RRWC secured a voluntary agreement from the landowners to remove the structure and replace it with a roughened channel, a constructed riffle that aids fish passage while still maintaining the head level for gravity-fed irrigation (RRWC, 2015b). Through a series of meetings and discussions, the decision to remove the dam was reached through stakeholder consensus rather than by a vote. The dam was removed in 2017.

The second case study focused on the Nelson Dam in central Washington state. The structure is 2.5 metres high and approximately 23 metres wide. It is located on the Naches River, a first-order tributary of the Yakima River. The dam was built in the 1920s and rebuilt in 1985. Its sole purpose was to divert water for municipal and irrigation uses (Resources Legacy Fund, 2015a). The primary motivation for removal is the desire for the increased public safety that would result from the elimination of a structure that contributes to upstream flooding (Yakima County, 2018). Removing this structure is part of a much larger effort to improve flood resiliency in the area, which will reduce stress on the municipality's budget and provide the community with more favourable flood insurance rates from the National Flood Insurance Program (NFIP). The local government also had an eye towards ecological concerns, as this stretch of the Naches is used by steelhead trout and other threatened species (Yakima County, 2018). Yakima County and the City of Yakima (together, the 'local government') led the project, which involved arranging public meetings and hiring consulting firms to design the project (Resources Legacy Fund,

2015a). Through consensus rather than a vote, the County and all participants agreed to replace the dam with a roughened channel (YTAHP, 2017). The dam is expected to be removed in 2021.

Figure 4. Nelson Dam.



Source: Thomas O'Keefe, American Whitewater.

Document analysis

Documents at a general and specific level were analysed to identify the 'carrot and stick' mechanisms driving each case study. This involved documents at a general and specific level. The term 'general documents' refers to statutes, regulations, legal decisions, and programmes that can apply to more than one case study (for example, the National Flood Insurance Program). The term 'specific documents' refers to meeting minutes, press releases, funding applications, design documents, and programme documents that are associated with an individual case study (for example, the ODFW Fish Passage Priority List). These documents were gathered by searching the Westlaw database and agency websites and by requesting documents from the project managers.

The analysis for each case study began with a narrative that describes the context of each dam removal. All of the threats and sources of support were then consolidated into a table. Threats included any administrative or judicial order to take an action, such as an order to provide fish passage at a small dam. Sources of support, on the other hand, included anything that could facilitate removal (for example, planning documents identifying the dam removal as a priority, or grant funding) or could incentivise the dam owner to remove the dam.

This table of threats and sources of support was analysed based on the three levels of action articulated by Ostrom's (1990) IAD framework: constitutional, collective, and operational. Constitutional action sets out the general purpose and goals of an initiative. An example of this would be the legislative statute that created the National Flood Insurance Program (NFIP), and the delegation of authority to an agency such as the Federal Emergency Management Agency (FEMA) to administer that programme. Collective action sets out a general strategy for implementing the constitutional action. Continuing with the previous example, collective action would be FEMA issuing a policy statement or regulation that specifies how that agency will administer the programme. Operational action implements the strategy defined in the collective action (Hardy and Koontz, 2009). Operational action, again following on the NFIP example, would be an agency making an individualised decision on a flood claim.

Key informant interviews

Key informant interviews were conducted by telephone with the project managers of each dam removal. Information from these interviews was used to inform and guide the document analysis and online survey (Bernard et al., 2017). The interviews identified key actors, events, and documents related to the dam removal. Subsequent follow-up interviews with the same project managers helped fill information gaps that could not be answered by analysing documents. These interviews also helped in the interpretation of survey results; for example, they provided supplemental information on the full scope of design alternatives, including alternatives that were briefly considered but did not appear in official documents.

Online survey

An online survey was distributed to the stakeholders involved in each case study. Stakeholders were identified by sign-in records from meeting minutes and from personal communication with the project managers. Surveys were distributed by the project manager for each case study. Stakeholders received three emails inviting them to complete the survey. For the Beeson-Robison case study, 17 surveys were completed out of a total of 27 distributed, yielding a response rate of 63%; for the Nelson case study, 11 surveys were completed out of a total of 42 distributed, yielding a response rate of 26%. (Basic characteristics of the survey participants are listed in Table 1). The sample size does not allow for generalisations about all dam removals; in combination with the document analysis and key informant interviews, however, it affords us a detailed look at the processes and outcomes in these two cases.

Table 1. Basic characteristics of survey respondents.

	Beeson-Robison	Nelson
Median age	49	45
Median level of education	Graduate/professional school	Graduate/professional school
<i>"Which stakeholder group do you primarily identify with?"</i>		
Farmer/rancher/homeowner	2	0
Environmental group	3	3
Indian Tribe	0	0
Federal, state, local agency	4	4
Consultant	5	3
Other (conservation district)	0	1
Other (contractor)	1	0
Other (design engineer)	1	0
Other (funder)	1	0
Other (local non-profit)	1	0
Prefer not to say	1	0

Source: Survey results; Matthias Fostvedt.

The survey aimed to gather information from the stakeholders on both the process and the outcome of the dam removal project. The process was measured by independent variables outlined in the IAD framework: (1) scope of design alternatives, which measured how many alternatives the group considered and why the group considered those specific alternatives; (2) power distribution among participants, which measured stakeholder perceptions of how much power other participants had to affect the decision; (3) level of information sharing, which assessed stakeholder opinions on what topics needed to be discussed among all participants; (4) willingness to compromise, which examined whether stakeholders compromised on certain issues and why they compromised on those specific issues; and (5)

time and money spent on the decision-making process. The outcome was measured by two dependent variables: (1) level of satisfaction, and (2) level of optimism about the long-term sustainability of the selected alternative. To ensure that all opinions and perspectives were heard, at the end of the survey respondents were invited to offer any other comments or concerns about the dam removal.

RESULTS

Context of the dam removals

Document analysis and key informant interviews with project managers highlighted the similarities and differences between the two case studies. Key differences included reasons for removal, ownership of the dam, and relevant threats and sources of support. Key similarities included the outcome of removal and replacement with a roughened channel, as well as a general mechanism of passive threat, active support that motivated the dam removal decisions.

Beeson-Robison Dam

The Oregon fish passage statute (ORS, 2019) was one of the most significant factors in the Beeson-Robison Dam removal. While the statute did not currently pose a threat to the dam owners, future enforcement was a likely threat under the trigger event provision of the fish passage statute. The trigger event provision establishes that any dam that requires greater than 30% reconstruction by structure volume is required to provide fish passage (OAR, 2019). A consulting firm independently – that is, not under a recurring dam safety assessment – concluded that the dam would likely fail within the next several decades, with major repair or reconstruction triggering the fish passage provisions of the fish passage statute. Under the reconstruction scenario, the dam owners would be solely responsible for paying for the installation of the fish passage. Thus, while the fish passage statute did not pose an active threat to the dam owners, the water users expected future enforcement. As one survey respondent summarised, "[There was an] assumption that we would eventually be forced to comply".

The passive threat of future regulation under federal law played a role similar to the aforementioned state-level legal threat. Had the dam failed, reconstruction would likely have triggered a Section 404 Removal/Fill Permit under the *Clean Water Act* (CWA). Requiring this federal authorisation would thus trigger Section 7 consultation under the *Endangered Species Act* (ESA), whereby the National Marine Fisheries Service (NMFS) would likely require fish passage for ESA-listed salmonids. In the absence of this type of administrative enforcement, judicial enforcement under the ESA's Section 9 "take" liability was also a possibility (Sumner, 2018). This section prohibits the "take" of any endangered or threatened species, which can include "any act which actually kills or injures wildlife", including "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioural patterns, including breeding, feeding, or sheltering" (16 U.S.C. § 1538.; 50 C.F.R. § 17.3(c)). Actions can be brought against dam owners by either a federal agency or any citizen with Constitutional and prudential standing to bring the suit (16 U.S.C. § 1540; *Lujan v. Defenders of Wildlife*, 1992). Despite this theoretical possibility of a Section 9 lawsuit, nothing in the document analysis, key informant interviews, or survey responses suggested that the stakeholders were concerned, or even aware of, this threat.

While the regulatory threat played a passive role in the context of the Beeson-Robison Dam removal, sources of support played an active role. Two major sources of support (planning and grants) helped incentivise the dam owners to act immediately rather than wait for the dam to fail. The Beeson-Robison Dam, due to its location in a stream containing critical habitat for ESA-listed salmon species, was identified in several environmental restoration plans as a priority restoration project. Wagner Creek, for example, was identified as a critical habitat in the ESA Recovery Plan for coho salmon (*Oncorhynchus kisutch*), which are listed as threatened under the ESA. (See NOAA Fisheries, 2014, for details on the

Southern Oregon Northern California Coast Coho Salmon Recovery Plan.) The Beeson-Robison Dam was also identified as a priority barrier by the state ODFW Fish Passage Priority List and in the local watershed restoration plans (Rogue Basin Partnership, 2013; RRWC, 2015a). According to project documents and survey responses, the dam’s presence in these plans played an integral role in leveraging grant funding from public and private sources for the project. Furthermore, the project’s voluntary nature helped leverage funding that would otherwise have been unavailable under non-voluntary terms, such as from the Oregon Watershed Enhancement Board (OWEB), which has a firm policy against funding non-voluntary projects (OWEB, 2019).

Likely due to the dam’s small size and rural location, concerns related to public safety did not play a role in the Beeson-Robison Dam removal (Table 2). The threats and support were thus limited to those related to ecological health. Overlaying the threats and support on the IAD levels of action, a pattern of polycentric governance appears. First, several different initiatives from various entities played a role. Further, within single initiatives, decision-making is delegated to different entities at all three levels of action, for example, legislature, agency, or NGO (Table 2). The least specificity is found at the operational level where many of the initiatives delegate decision-making power to local groups, allowing for these local groups to handle the on-the-ground work. In administering the fish passage statute, the ODFW enables local groups such as watershed councils to negotiate with landowners and reach voluntary agreements.

Table 2. Context map for Beeson-Robison Dam removal, broken down according to IAD levels of action.

Level of action	Ecology		Public safety	
	Support	Threats	Support	Threats
Constitutional (Cn)	Cn1) <i>Endangered Species Act</i> Cn2) Fish passage statute Cn3) Rogue Restoration Action Plan Cn4) Oregon Plan for Salmon and Watersheds Cn5) Private donor funds established	Cn1) <i>Endangered Species Act</i> Cn2) <i>Clean Water Act</i> Cn3) Oregon fish passage statute		
Collective (Cl)	Cl1) ESA §4 Recovery Plan guidelines Cl2) ODFW Fish Passage Priority List guidelines Cl3) Rogue Restoration Action Plan delegation of authority to working groups Cl4) Oregon Watershed Enhancement Board criteria for eligible projects Cl5) Private donor criteria for eligible projects	Cl1) ESA §9 Prohibited Acts; §7 Agency Consultation Cl2) CWA §404 Removal/Fill Permit guidelines Cl3) ODFW fish passage criteria		
Operational (Op)	Op1) NOAA Fisheries Coho Recovery Plan Op2) ODFW listing of dam on the ODFW Fish Passage Priority List Op3) RRWC implementation of plan Op4) Private donor release of funds			

Source: Schlager and Cox, 2017; Matthias Fostvedt.

Note: Each mechanism of threat or support is individually numbered and should be followed from the top down through the levels of action, by its corresponding number.

Nelson Dam

In contrast to the Beeson-Robison Dam removal, the Nelson Dam removal was primarily focused on public safety and secondarily on ecological health. The dam owners did not face any legal or regulatory threats requiring them to fix the upstream flooding issues caused by the dam. Although Brewitt and Colwyn (2019) suggest that dam owners may be liable for floods, that analysis pertains to floods caused by catastrophic dam failures (Ibid). By contrast, Nelson Dam is just one piece of a complex system of infrastructure that exacerbates flooding. As such, liability for widespread flooding would be unlikely to attach to the dam owners. Although the owners did not face any public safety threats, however, they did have several sources of support for improving public safety. First, the dam's removal was identified in the Yakima County Flood Control Zone District's (FCZD) local planning documents as a way to decrease flood risk upstream of the dam (Yakima County, 2018). These plans helped leverage funding, including a US\$2.5 million² grant from Floodplains by Design, a public-private partnership between the Washington Department of Ecology, The Nature Conservancy, and the Puget Sound Partnership. The Floodplains by Design grant was awarded to the Nelson Dam removal project because it aimed not only to fix a public safety flooding issue, but also to restore ecological health. Second, the FCZD's planning documents (Ibid) indicate that the local government was incentivised to take several structural and nonstructural actions to enhance flood resilience, which would in turn lead to lower NFIP flood insurance rates for the community. Removing the Nelson Dam was one of several recommendations proposed by the local government to the Federal Emergency Management Agency (FEMA, 2017) to enhance community-wide flood resilience in Yakima County. In the local government's report, modelling showed that removing the Nelson Dam would enhance sediment passage through the area, improving the upstream area's capacity to convey large run-off events.

The threat of federal regulation under the ESA and CWA played a role in the Nelson Dam removal that was similarly passive to the one it played in the Beeson-Robison Dam removal. Any reconstruction of the dam would require a Section 404 Removal/Fill Permit under the CWA, thus triggering Section 7 consultation under the ESA. Section 7 consultation would likely require the local government to provide fish passage for ESA-listed salmonids. Similar to the Beeson-Robison Dam, none of the documents, key informant interviews, or survey responses suggested that the stakeholders were concerned, or even aware of, the threat of a Section 9 'take' lawsuit under the ESA. The threat of state regulation played a smaller role in the Nelson Dam removal than it did in the Beeson-Robison Dam removal. While the Washington fish passage law (RCW 77.57.030) gives the Washington Department of Fish and Wildlife (WDFW) authority to impose fish passage requirements on any dam in the state, the decision to enforce is discretionary. Document analysis did not reveal any evidence to suggest that this law posed an active threat to the dam owners.

In addition to the passive threat posed by federal environmental statutes, the Nelson Dam owners faced the potential threat of a treaty violation lawsuit from the federal government on behalf of the Yakama Nation. While it is unclear to what extent this threat played into the decision-making process for the Nelson Dam removal, survey responses show that the Yakama Nation was seen as an important partner in the project. This perception of the Yakama Nation's importance may have been due to the legal precedent set by a recent win for American Indian tribes in the US Supreme Court. The case, *Washington v. United States*, held the state of Washington accountable for removing state-owned fish barriers on salmon-bearing streams, which implies an affirmative duty for states and counties to conserve and protect salmon habitats (*Washington v. United States*, 2018). With *Washington v. United States* in mind, private dam owners like Yakima County may be wary of the consequences of owning a small dam on salmon-bearing streams; at any time, the Yakama Nation could potentially receive a court-ordered injunction requiring the local government to immediately provide adequate fish passage.

² All dollar amounts are in US dollars.

Like the Beeson-Robison Dam, the Nelson Dam was provided with several sources of active support. The Middle Columbia River Steelhead Recovery Plan (NOAA Fisheries, 2009) recommends that all fish passage barriers in Yakima River tributaries should be corrected. The plan did not, however, specifically identify the Nelson Dam removal as a priority project. Regardless, these references in the Recovery Plan helped leverage funding from state programmes such as Floodplains by Design, and from other private sources such as the Open Rivers Fund, which is supported by the William and Flora Hewlett Foundation.

In contrast to the Beeson-Robison Dam removal, several sources of support for enhancing public safety – primarily by reducing flood hazards – were available to the Nelson Dam removal project (Table 3). These public safety programmes provided additional support that facilitated the decision to remove the Nelson Dam.

Table 3. Context map for Nelson Dam removal, broken down according to the three IAD levels of action.

Level of action	Ecology		Public safety	
	Support	Threats	Support	Threats
Constitutional (Cn)	Cn1) <i>Endangered Species Act</i> Cn2) Washington fish passage statute Cn3) Washington Department of Ecology (WDOE) established Cn4) Private donor funds established	Cn1) <i>Endangered Species Act</i> Cn2) <i>Clean Water Act</i> Cn3) Washington Fish Passage Statute Cn4) Yakama Nation Treaty of 1855	Cn1) Yakima Flood Control Zone District (FCZD) established Cn2) <i>Flood Control Act</i>	
Collective (CI)	CI1) ESA §4 Recovery Plan guidelines CI2) WDFW Fish Passage Inventory List guidelines CI3) WDOE creates Floodplains by Design, a public – private partnership CI4) Private donor criteria for eligible projects	CI1) ESA §9 Prohibited Acts; §7 Agency Consultation CI2) CWA §404 Removal/Fill Permit guidelines CI3) WDFW fish passage criteria CI3) <i>Washington v. United States</i> defining scope of treaty violations	CI1) Upper Yakima River Comprehensive Flood Hazard Management Plan CI2) National Flood Insurance Program	
Operational (Op)	Op1) NOAA Fisheries Middle Columbia River Steelhead Recovery Plan Op2) WDFW listing on WDFW Fish Passage Priority List Op3) Private donor release of funds		Op1) Project negotiation with stakeholders Op2) Dam removal to obtain favourable flood insurance rates	

Note: Each mechanism of threat or support is individually numbered and should be followed from the top down through the levels of action, by its corresponding number.

Source: Schlager and Cox, 2017; Matthias Fostvedt.

Survey results on process

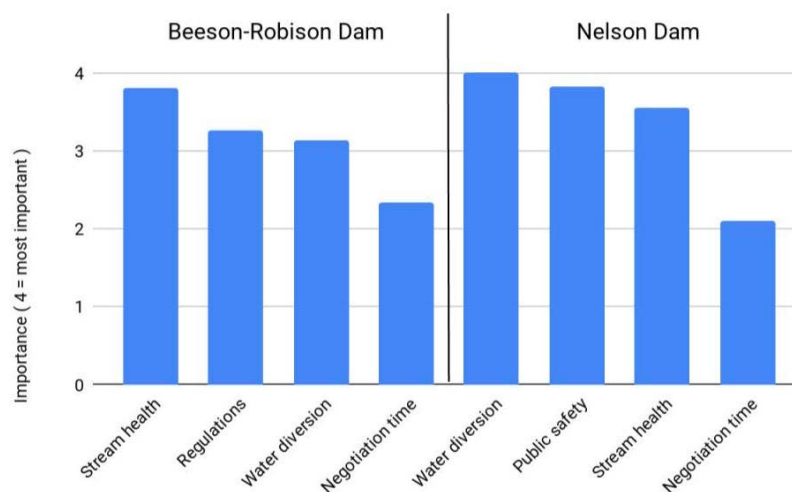
The decision-making process of each dam removal – referred to as the operational phase in the IAD framework – was examined in order to evaluate whether there were differences in the amount or type of process that was engaged in to reach the final decision to remove the dams and replace them with roughened channels.

Scope of design alternatives

One of the main inquiries in the IAD framework is an examination of the scope of design alternatives considered in the decision-making process. This involves examining how many options were considered, why the options on the table were chosen, the perspectives on the feasibility of each option, and whether respondents felt that their preferred option was adequately considered.

The number of design alternatives considered in both case studies was narrowed down by several criteria, such as "stream health", "negotiation time", or "aesthetics". On a 0-4 scale, survey respondents rated the importance they ascribed to each criterion in deciding how many and which designs would be considered. The average responses in each case study were aggregated to determine the overall most important factors for respondents in the case study. In the Beeson-Robison project, the three most important factors in choosing design alternatives, in order of priority, were stream health, regulations, and maintaining the water diversion (Figure 5). In the Nelson Dam project, the three most important factors, in order of priority, were maintaining the water diversion, public safety, and stream health (Figure 5). Interestingly, respondents in both projects identified negotiation time as the least important factor when choosing the design alternatives.

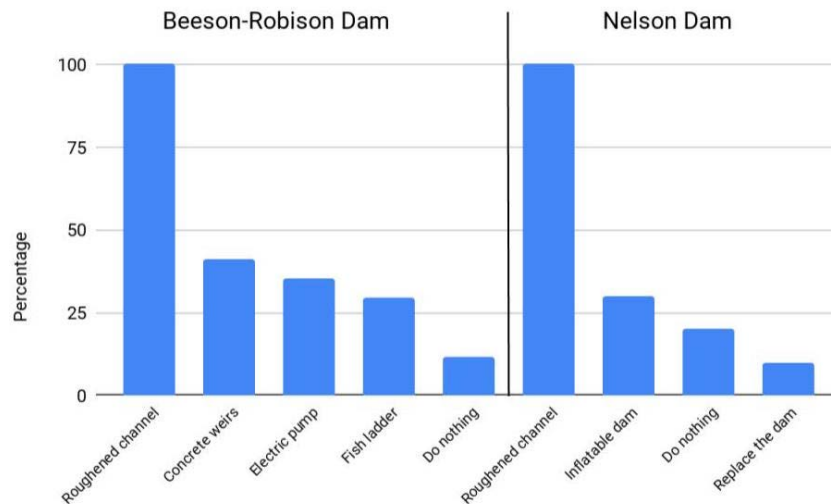
Figure 5. Criteria used by stakeholders for evaluating design alternatives.



Note: Respondents were asked, "How important were the following factors in choosing which potential approaches were considered in-depth?" They then rated each factor on a 0-4 scale according to the importance they ascribed to that factor. This helped determine how many and what types of design alternatives would be considered by the group. All values were then aggregated to arrive at the plotted number. (Additional factors that were identified by stakeholders as being less important are not included.)

Participants considered five design alternatives (Figure 6) for both the Beeson-Robison and Nelson Dam removals. In both case studies, all the respondents agreed that the roughened channel was feasible. In contrast, none of the other design alternatives were deemed feasible by a majority (more than 50%) of the respondents. It is also noteworthy that only 20% of Nelson Dam respondents and 12% of Beeson-Robison Dam respondents felt that "Do nothing" was a feasible option. As a result of the significant deliberation between several design alternatives, nearly all stakeholders indicated that their original preference had been adequately considered. Only one respondent, associated with the Nelson Dam removal, reported "No opinion" on whether their original preference had been adequately considered.

Figure 6. Stakeholder perspectives on the feasibility of different design alternatives.



Note: Respondents were asked, "Which alternatives were feasible?" Given the similarity between two of the options for the Nelson Dam removal (both were variations of roughened channel designs), these results consolidate the two variations into a single 'Roughened channel' option.

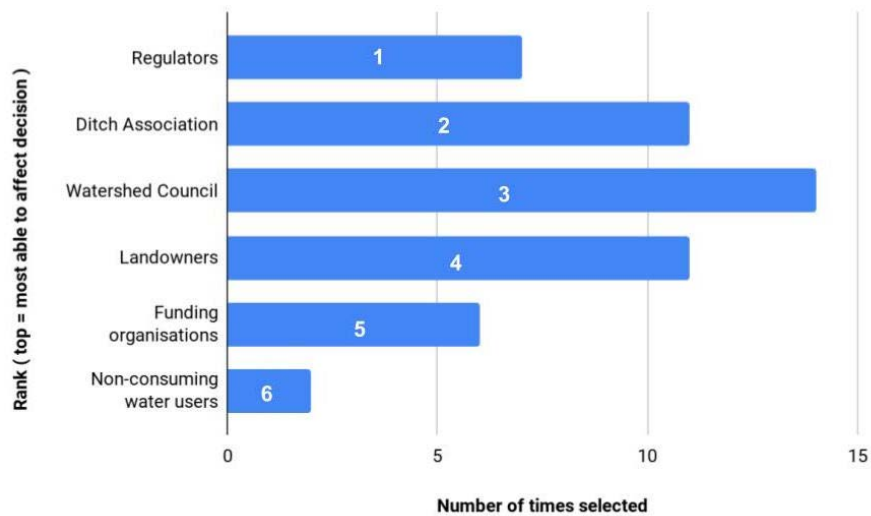
Power distribution

The IAD framework also examines the perceived power distribution among the participants. In the Beeson-Robison Dam project, the RRWC was selected the most times as being an actor affecting the decision to remove the dam. However, when asked to rank the participants in order of relative power, the RRWC was perceived as having less power than regulators and the ditch association (Figure 7). In the Nelson Dam project, the local government was not only selected the most times as affecting the decision to remove the dam, but it was also perceived as having the most power relative to other participants (Figure 8). These results suggest a more concentrated power distribution in the Nelson Dam project. This may be attributable to the dam owner also serving as the project leader.

Information sharing

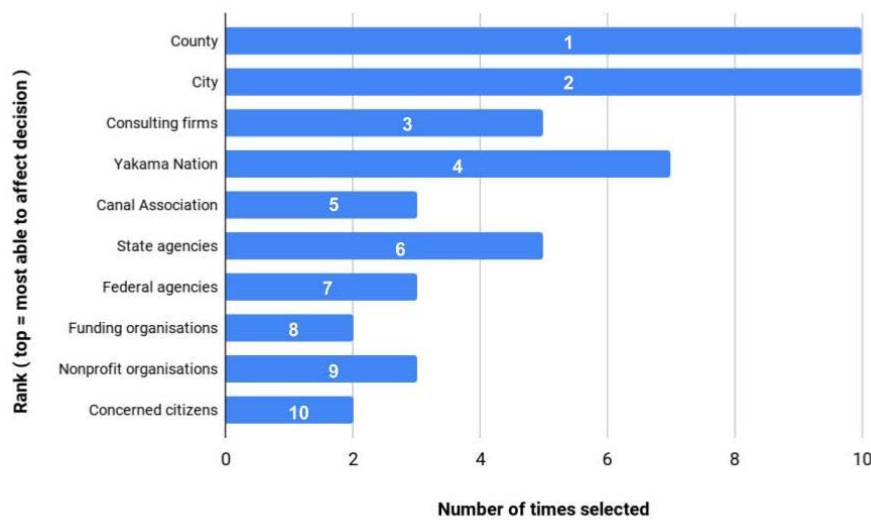
The IAD framework identifies information sharing among the participants as an important component of equitable governance. Participants were asked, "What information must be fully understood by everyone in the decision-making process?" (Figure 9). This question elicited the topics that participants felt must be discussed among all participants. The most notable difference between the case studies was the importance that stakeholders placed on information related to impacts on landowners, regulatory processes, and project costs. Important topics for the Beeson-Robison Dam project were impacts on landowners and water rights, as well as regulatory processes. Important topics for the Nelson Dam project were impacts on water rights and public safety, as well as cost of the final project. Information on reference/historical conditions was relatively unimportant to the stakeholders in these dam removal projects. Other issues raised by respondents were more logistical in nature, such as time and location of meetings.

Figure 7. Power distribution among participants in the Beeson-Robison case.



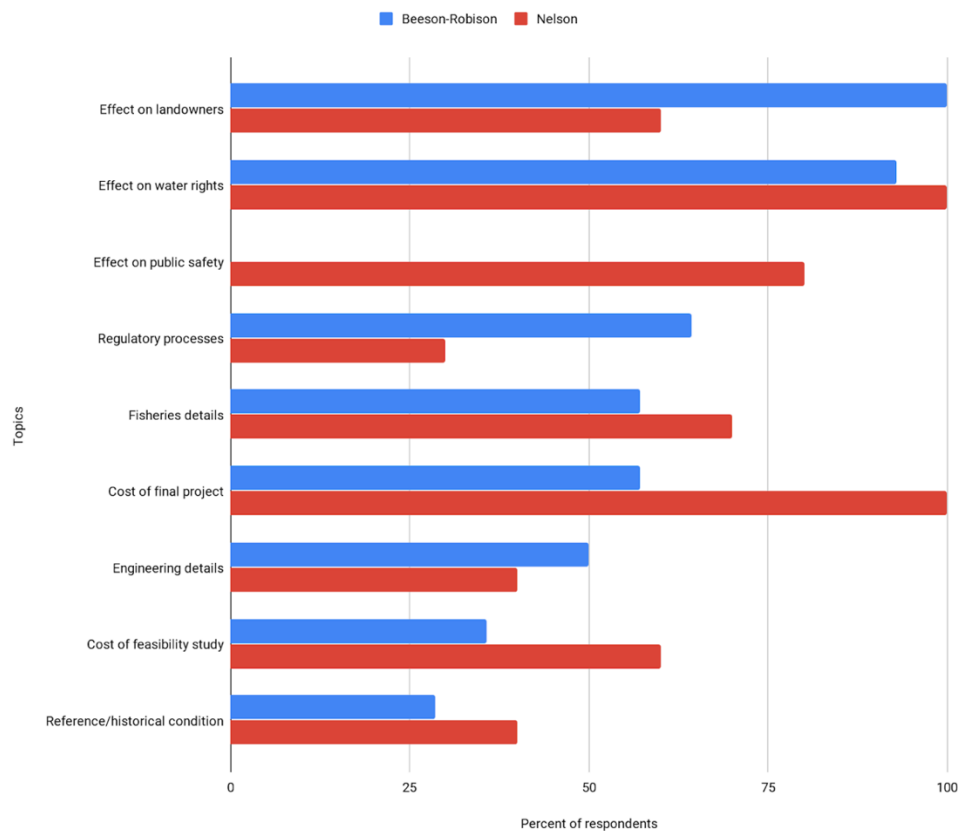
Note: Respondents were asked, "In your opinion, who affected the decision to remove the dam? Select all that apply". Respondents selected options from a list of stakeholders and then were asked to rank these selections based on their perception of who held the most power to alter the decision. These figures show two metrics: on the horizontal axis, they show the number of times that a participant was selected as affecting the decision; on the vertical axis, they show their average rank in relation to the other participants holding power to affect the decision.

Figure 8. Power distribution among participants in the Nelson Dam case.



Note: Respondents were asked, "In your opinion, who affected the decision to remove the dam? Select all that apply". Respondents selected options from a list of stakeholders and then were asked to rank these selections based on their perception of who held the most power to alter the decision. These figures show two metrics: on the horizontal axis is shown the number of times that a participant was selected as affecting the decision; on the vertical axis is shown their average rank in relation to the other participants holding power to affect the decision.

Figure 9. Responses to information sharing.



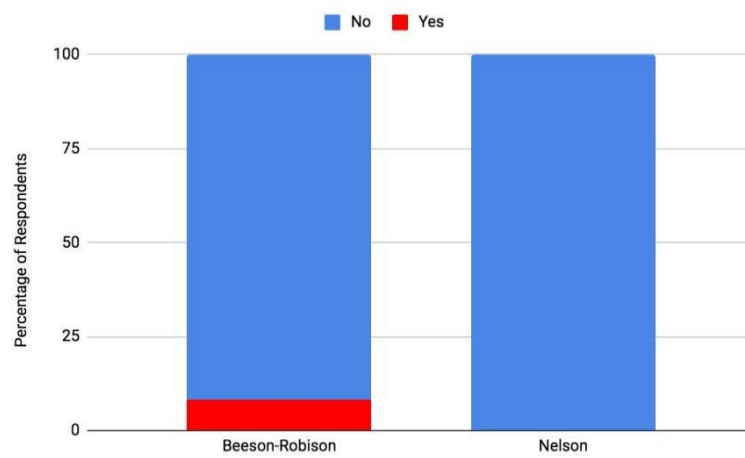
Note: Respondents were asked, "What information must be fully understood by everyone in the decision-making process?" This identified the specific topics that, when shared with the whole group, could lead to greater satisfaction.

Willingness to compromise

The IAD framework identifies rewards and sanctions for certain behaviours as being key defining factors in governance systems. Both case studies show evidence of stakeholders compromising, or at least being willing to compromise (Figures 10 and 11). Some Beeson-Robison respondents, for example, reported compromising on their first-choice design because "the landowners weren't willing to pay for [pump-fed] irrigation". Other Beeson-Robison respondents also compromised on some issues in order to use grant funds before a certain date. One Beeson-Robison respondent indicated that "[t]hese foundations needed a success in the Rogue Basin during the 2017 instream construction season and Beeson-Robison was the only priority barrier with designs far enough along to be addressed".

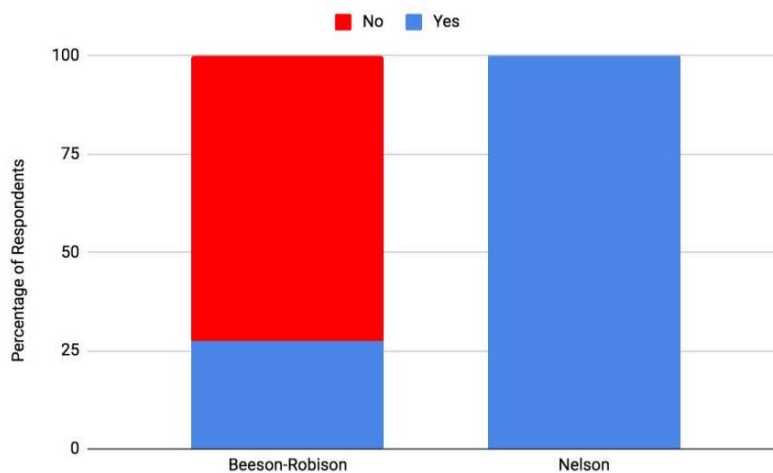
Respondents in the Nelson Dam removal project also reported compromising for various reasons. These participants, for example, reported compromising on details such as the roughened channel's size in order to strike a balance between "restoring natural processes versus providing reliable diversion". They also reported compromising due to lack of power to change details late in the decision-making process. For example, the local river recreation group in Yakima, whose members only attended the final two meetings, expressed disappointment that they were "not notified earlier in the process", which required them to compromise on their ideas for recreational opportunities in the replacement infrastructure. One Beeson-Robison respondent who did refuse to compromise on certain issues said that it was because of "laws and requirements" (Figure 11).

Figure 10. Refusal of Beeson-Robison and Nelson Dam respondents to compromise.



Note: Respondents were asked, "Did you refuse to compromise on certain issues?"

Figure 11. Beeson-Robison and Nelson Dam’s respondents’ acceptance of compromise.



Note: Respondents were asked, "Did you compromise on other issues?"

Costs of project

Estimates from the project leaders of both dam removals show that substantial resources of both time and money were invested in the decision-making process. The decision-making process for the Beeson-Robison Dam removal took five years and an estimated \$15,000-20,000. The Nelson Dam removal is a much larger project, involving floodplain restoration activities, levee setbacks, property acquisitions, and the additional infrastructure costs associated with consolidation of multiple diversions. After four years of discussions and designs, investment in the decision-making process has reached an estimated \$400,000. These investments in the decision-making process include the cost of hiring engineering and consulting firms to perform studies on the potential projects. They also reflect the cost of running meetings, which includes incidental costs such as hiring a neutral facilitator.

The Beeson-Robison Dam removal spent a significantly larger proportion of their total project budget on the decision-making process. A \$125,000 project in total, up to \$20,000 was spent on the decision-making process, which represents 16% of the entire budget. The Nelson Dam removal, a \$12 million project, spent \$400,000 on the decision-making process, which represents 3% of the entire budget. While the ultimate decision to remove and replace the Nelson Dam with a roughened channel has been made, stakeholders continue to be informed on the project's progress, so it is foreseeable that spending on the decision-making process will continue.

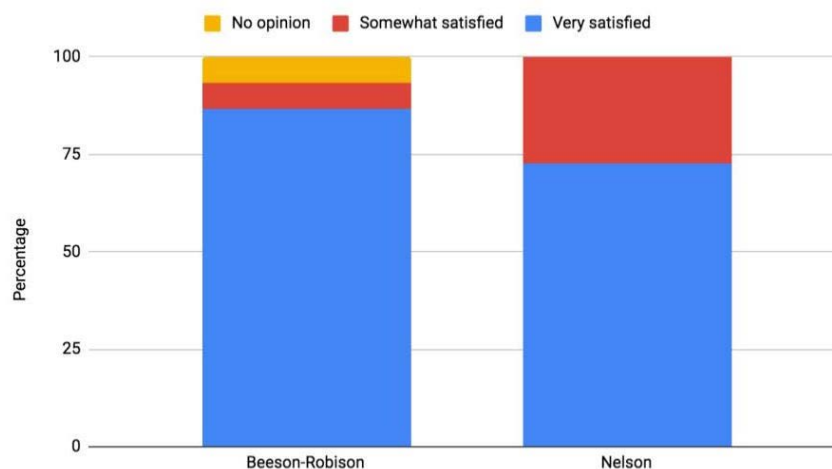
Survey results on outcome

Outcome was measured by two metrics: (1) overall satisfaction with the project; and (2) optimism about the new infrastructure's long-term viability.

Overall satisfaction

Overall satisfaction with both projects was high, with the Beeson-Robison Dam removal receiving slightly more positive results (Figure 12). Beeson-Robison respondents felt that the project went "better than expected" and "reasonably well", and ultimately described the project as "very good". The difference in stakeholder satisfaction between the two projects was small, which indicates that both types of leadership – NGO and local government – were capable of leading a dam removal project in a way that led to high levels of stakeholder satisfaction.

Figure 12. Beeson-Robison and Nelson Dam respondents' overall satisfaction.



Note: Respondents were asked, "Overall, how disappointed or satisfied were you with the decision to replace the dam with a roughened channel?"

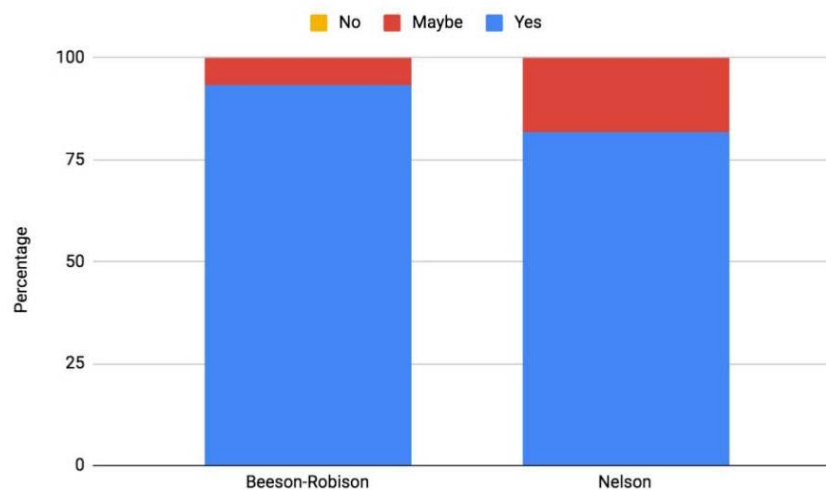
Optimism

Optimism was very high for both projects, with the Beeson-Robison Dam removal receiving slightly more positive results (Figure 13). Many of the respondents' comments in both case studies attributed their optimism to the win-win nature of the projects, satisfying ecological interests while also respecting human needs in the watershed. One Nelson Dam respondent summarised this sentiment, explaining that the roughened channel "minimizes infrastructure within main channel, accounts for sediment, fish, and vessel passage". Optimism was also expressed about the investment in social capital that the project helped build for future projects. For example, one Beeson-Robison respondent noted that, "I hope that

we can learn from it, improve processes and engagement, and reduce time and challenges of future similar removals where community and environment benefit".

Some participants in both dam removals, however, expressed a number of concerns about the long-term viability of the projects. First, some Nelson Dam participants were concerned with the roughened channel being "susceptible to large hydro events", referring to large floods that could erode the natural materials used to construct the roughened channel. Beeson-Robison Dam participants expressed similar concerns as to "how long the [roughened channel] would last". Second, some were sceptical of the project itself, with one Nelson Dam participant referring to the practice of replacing dams with roughened channels as the "flavor of the week". This sceptical respondent argued that more focus should have been placed on other issues in the watershed, such as expanding the river's floodplain.

Figure 13. Optimism of Beeson-Robison and Nelson Dam respondents that the roughened channel would be a long-term solution.



Note: Respondents were asked, "Do you think that the roughened channel is a long-term solution? Why? Please explain".

DISCUSSION

Common governance approach: Passive threat, active support

The context mapping that was performed in both case studies demonstrates the variability in the support and threats that lead to small dam removal across the US. These range from ecological health (Fox et al., 2016) to public safety (Born et al., 1998). Several factors account for this variability, including ownership, political jurisdiction, type of dam, and overarching project goals. While removing small dams is thus an increasingly common method of improving ecological health and public safety across the United States, no singular statutory or regulatory mechanism has emerged as the definitive governance institution driving small dam removal, confirming expectations expressed nearly two decades ago (Doyle et al., 2003).

While dam removal decisions may be determined by place-based politics (Magilligan et al., 2017), results of this study suggest that a policy of passive regulatory threats and active sources of support (passive threat, active support) may be common among dam removals in the Pacific Northwest. The passive nature of the regulatory system comes from a place of scarcity; the public agencies with the duty and authority to enforce the removal of small dams lack sufficient time and money to address dam safety

issues or to require fish passage at the thousands of small dams across their state (Brewitt and Colwyn, 2019). In the Pacific Northwest, therefore, agencies rely on the passive role – the threat of future enforcement – played by fish passage and dam safety laws. In lieu of immediately ordering repair or removal of a dam, the agencies mostly rely on voluntary modifications that are supported by various incentives such as planning support, lower insurance premiums, or restoration grants. This administrative approach was demonstrated in both case studies. Neither dam faced an immediate, official need to take action; there was no judicial or administrative order to remove or modify the dams. Notably, even in the absence of such an order, nearly all the stakeholders in both case studies agreed that "do[ing] nothing" was not a feasible option. This suggests that the threat of future enforcement constituted a threat that was sufficient to spur the stakeholders into action. Combining passive threats and active sources of support creates a window of opportunity for the dam owner to proactively address a problem at the lowest cost possible to themselves, a strategy that has been in place for decades (Born et al., 1998).

While both case studies were driven by a combination of passive threats and active sources of support, individual projects were motivated by different proportions of the two. In the Beeson-Robison Dam removal, the threat of enforcement played a larger role. This was due to the certainty brought about by the trigger event provision of Oregon's fish passage statute. This threat of regulatory action in Oregon is stronger than in Washington because Oregon's fish passage statute identifies a specific time when ODFW will require an owner to provide fish passage. Enforcement under Washington's fish passage statute, which lacks a trigger event provision, is uncertain. The dam owner is thus left to speculate as to if or when the WDFW will require fish passage at a dam.

In the case of the Nelson Dam, sources of support may have played a larger role than at Beeson-Robison. Due to its multiple objectives and benefits, the Nelson Dam project was able to leverage additional sources of support that were rooted in public safety. In addition to the federal and private grants for eliminating the fish passage barrier that they, Nelson Dam was also able to access resources for improving public safety. This expansive branding led to two major sources of support, sources that may not have been available for purely ecological removals such as the Beeson-Robison project. These included a \$2.5 million grant from Floodplains by Design, which emphasises both reduced flood risk and ecological restoration, and an improved community flood insurance rate under the NFIP. Interestingly, it appears that labelling a dam removal project as a multi-benefit project can positively correlate with additional sources of active support. Ecological restoration funding has long been used for dam removals (Brewitt and Colwyn, 2019; Zinder et al., 2009). However, as society begins to prioritise hazard reduction from its aging infrastructure, the availability of support for improving public safety may come to more strongly influence dam removal decisions. Furthermore, identifying public safety as a priority may help overcome some of the conflicts witnessed in regions of the US, where local stakeholders appear to feel that their values are threatened by the prioritisation of ecological restoration by outsiders (Fox et al., 2016, Magilligan et al., 2017).

Planning as a vehicle to leverage meaningful support

Planning documents played a significant role in leveraging the necessary support to implement the dam removals. This finding stands in contrast to some literature which criticises planning documents, such as ESA Recovery Plans, for their "hortatory nature" (Corn and Wyatt, 2016). Critics of recovery plans argue that they are non-binding and thus pose no threat to small dam owners (ibid). Similarly, they provide no actual support such as funding for collaborative facilitation, feasibility studies, or construction. For the cases studied here, however, planning documents led to critical sources of support for the project managers. The Beeson-Robison project, for example, significantly increased its competitiveness for OWEB grants by meeting the OWEB's requirement that "the proposed restoration project [be] identified in a local assessment or other plan". Similarly, the Nelson Dam, in receiving the multimillion dollar grant from Washington's Floodplains by Design, was required to show that "the project is consistent with local flood hazard plans, salmon recovery or habitat restoration plans" (Washington Department of Ecology,

2018). Thus, while their role does not fit neatly into the threat or support categories of the IAD framework, this study's results suggest that planning documents are critical in leveraging the necessary support to remove a dam. As noted by one Beeson-Robison respondent, "[The dam] was identified as high priority by ODFW, which helped fuel the availability of grants". Given the importance of this component, and its incongruity with the traditional carrot and stick concept, the IAD framework may benefit from including a third category for the effect of strategic planning.

Similarity of stakeholder satisfaction and optimism regardless of project manager

Despite differences in the amount of legal authority the respective project managers had over the dam, the outcome variables – stakeholder satisfaction, and optimism for the replacement infrastructure's long-term viability – were consistent across the projects. Both project managers reached a decision through consensus and collaboration, which may be one reason why both dam removal projects were largely viewed with satisfaction and optimism by stakeholders.

The collaborative nature of the decision-making process was noteworthy in the case of the Nelson Dam removal because the local government had legal authority over the dam. As Figure 8 suggests, this legal authority led other stakeholders to see the local government as the most powerful stakeholder. Holding this legal authority, the local government could have reached the decision through a vote or even a managerial process, relying on agency experts rather than public opinion (Ansell and Gash, 2008). Instead, the process had a collaborative foundation that was based on consensus, on creating space for compromise, and on the modelling of several design alternatives. This was aimed at ensuring that every stakeholder's concerns were adequately considered. This collaborative approach recognised that dam removal decisions involve not only engineering and/or ecological decisions, but also political decisions (Barraud, 2017). One possible explanation for the local government's collaborative approach is that project leaders are required to take such an approach if they wish to receive funding from Floodplains by Design (WDOE, 2018). Another possible explanation, however, is that the local government's collaborative approach stems from the history of such collaboration in the Yakima Basin. This history of collaboration set the stage for effective collaborative governance (Ansell and Gash, 2008) that has yet to be achieved in other regions of the US (Fox et al., 2016, Magilligan et al., 2017). The results suggest that investment in a collaborative decision-making process may lead to higher satisfaction and optimism among stakeholders.

Beyond the requirement for, and history of, collaboration, several aspects of the process followed by the two projects may have helped minimise the conflict between stakeholders that has been seen in other regions of the US (Born et al., 1998; Fox et al., 2016, Magilligan et al., 2017). Narratives from the surveys support findings in the literature that highlight the importance of recognising local values and experiences and of negotiating compromises between dam owners, agencies, and local stakeholders (Fox et al., 2016; Sneddon et al., 2017b). The public process gave stakeholders a forum for their concerns, sometimes at the cost of efficiency. One Nelson Dam respondent, for example, noted that "issues were seemingly overstated to enhance any given group's voice in the process". Results also highlighted the importance of engaging local stakeholders early in the process in order to develop the shared understanding that leads to compromise (Ansell and Gash, 2008). An example of this is the Nelson respondent who ultimately reported feeling "very satisfied" and "very optimistic", attributing their satisfaction and optimism to the "modelling[,] which showed that things I thought were important were not really that important". Ultimately, these results suggest that the project manager may be less important than the process used to reach the decision.

Effect of additional process on satisfaction and optimism

In addition to regulatory mandates and financial resources (Born et al., 1998; Orr et al., 2004), cooperation, institutional transparency, and collaborative decision-making have been described as some

of the necessary conditions for dam removal to occur (Magilligan et al., 2017). One of the biggest challenges of collaborative decision-making, illustrated by the two case studies, is the time and money that the process requires (Ansell and Gash, 2008). These high monetary and temporal costs can be attributed in part to the requirement that the ultimate decision be reached by consensus rather than vote (Coglianese and Allen, 2003; Yaffee and Wondolleck, 2003). Reaching consensus can involve a lengthy consideration of alternatives that do not meet the needs of many of the participants. The Beeson-Robison group, for example, considered and studied the feasibility of a pumping station despite the fact that the irrigators were not willing to pay the costs of running the pump. Considering unfeasible options, however, may lead to greater satisfaction in the longer run, as it can help avoid the place-based politics that can cause local stakeholders to feel like outsiders in a process with a predetermined outcome (Fox et al., 2016). Survey results from this study and previous research, furthermore, confirm that participants prefer an open timetable in order to allow for complete discussions (Freeman, 1997). Investing the necessary time and money to reach a decision by consensus rather than vote can help avoid these sources of conflict, which may in turn lead to longer lasting solutions, as well as increased social capital for other collaborative projects in the area (Ansell and Gash, 2008; Flitcroft et al., 2009).

CONCLUSIONS

While small dams are by far the most commonly removed dams, they differ from large hydroelectric dam removals because their removal is not driven by a centralised policy such as hydropower relicensing. The IAD framework was applied to the framing of research on the governance of small dam removal because it facilitated in-depth analysis of the entire spectrum of threats and sources of support that drove two communities to remove a small dam. The IAD framework highlighted the variability in environmental and public safety concerns, which together may trigger different threats and sources of support resulting in dam removal. While there is no specific statutory or regulatory mechanism that motivates all small dam removals (Sneddon et al., 2017a), the two dam removals studied here were guided by a common governance approach, which we characterise as the passive threat, active support model. In securing active support, restoration planning documents that prioritised the projects were able to facilitate access to resources that could be used for dam removal. It is expected that a similar prioritisation of public safety would facilitate access to resources for addressing hazardous dams, given that dam safety also lacks strong regulatory threats in many states.

For the two dam removals studied here, the passive threat, active support governance approach – and in particular the way in which it was executed – led to high levels of satisfaction and optimism for the replacement infrastructure’s long-term viability, though the process required considerable time and financial resources. Conflict among the project stakeholders was limited. In part, this was due to the various ways in which collaboration was encouraged, including efforts to provide a voice for local stakeholders, recognising their priorities, and engaging stakeholders early in the process. All of these factors contributed to a strong willingness to compromise and a high level of satisfaction with the projects. This result supports the hypothesis that the outcomes of a dam removal project depend more on how a project manager leads than on who the project manager is. Further analysis is required to determine whether this result, and the passive threat, active support governance approach, is common among the roughly 1600 small dam removals in the US, as well among other environmental management projects. While we selected the two case studies within the Pacific Northwest in order to isolate the effects of different ownership and governance approaches, other work (Fox et al., 2016, Magilligan et al., 2017) has demonstrated the importance of regional identity and place-based politics in determining dam removal outcomes. Threats driving dam removal are often (Brewitt and Colwyn, 2019), but not always (Born et al., 1998), passive, and the removal of small dams is often (Brewitt and Colwyn, 2019), but not always (Fox et al., 2016, Magilligan et al., 2017) without controversy. These case studies, however, support the growing body of literature that emphasises the value of providing venues and resources for

a kind of collaborative governance that relies on building trust and relationships, valuing local knowledge and experiences, and engaging stakeholders in the information sharing that leads to compromise and ultimately consensus.

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