HABITAT RESTORATION INCENTIVES FOR MAJOR INFRASTRUCTURE PROJECTS

by

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EXECUTIVE SUMMARY

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Major infrastructure projects are undertaken by an agency or organization to provide public services such as transportation, utilities, waste collection, recreation, or other amenities. These projects are typically funded by public agencies or organizations and are highly scrutinized for cost, schedule, and performance. Additionally, due to the magnitude of these projects, construction and operational impacts can be lengthy and diffuse, resulting in environmental impacts that must be addressed. Early consideration of habitat restoration measures as part of a project has the potential to offset environmental impacts caused by the project and provide other incentives for project proponents to consider, as explored in this study.

Three case study projects in Washington State were used to explore the incentives for incorporating habitat restoration at the onset of a major infrastructure project. Washington was selected due to its unique regulatory environment and because it provided a consistent platform for detecting trends over a range of infrastructure projects types. The case study projects include the Elliott Bay Seawall Project, the State Route (SR) 520 Bridge Replacement and High-occupancy Vehicle (HOV) Program, and the Yakima River Basin Integrated Water Resource Management Plan.

This study utilized existing environmental documentation for the case study projects, interviews, and literature review. Interviews included 14 case study participants from different backgrounds using semi-structured interviews. These case study projects, and the supplemental literature review, showed that early consideration of habitat restoration measures as part of a project can help to increase public support, streamline regulatory review, save money, and provide opportunities for innovation.

Public support is a critical component of major infrastructure projects due to their reliance on public funding for construction. However, this process can be lengthy and unpredictable. Early consideration of habitat restoration measures can increase agency and public acceptability of a project and potentially reduce costs that would result from opposition or delays. The Yakima River Basin Integrated Water Resource Management Plan was a successful effort to garner public and stakeholder support for water management efforts in the Yakima River Basin. Early in the program, a work group was formed to prioritize public support, bringing in constituents that represented a range of public interests. The program provided a balanced approach to water management and habitat restoration that catered to needs of multiple parties and provided the necessary public acceptance to get the program approved and secure initial funding.

The permitting process for major infrastructure projects can also be lengthy and unpredictable. Determining habitat restoration options early in the design process in coordination with regulatory agencies can help with agency and public acceptance and streamline the permitting process. For the SR 520 Bridge Replacement and HOV Program, the Washington State

Department of Transportation formed a multi-agency permitting team composed of multiple agencies and stakeholders. This early involvement was paramount in building consensus and quickly advancing each of the projects and mitigation sites through the permitting process.

Cost savings is another important consideration when designing a major infrastructure project. Considering habitat restoration early on can save a project proponent time and money by increasing public support and streamlining the regulatory review process. Ecosystem services and long-term benefits from habitat restoration are other values to consider. For example, in the Yakima River Basin Integrated Water Resource Management Plan, habitat restoration added value by increasing flood storage capacity, improving water quality, restoring salmonid habitat, and removing or relocating development outside of the floodplain.

Major infrastructure projects also provide opportunities for innovation in ecosystem science and habitat design. The Seattle Department of Transportation developed an innovative, science-based approach to the habitat restoration design for the Elliott Bay Seawall Project. During the conceptual design phase, the Seattle Department of Transportation partnered with the University of Washington and a local consulting firm to implement a low-cost pilot program to study the various features being considered for the habitat design. The project incorporated habitat features studied during this pilot program and integrated features from habitat restoration projects successfully implemented nearby in Elliott Bay to maximize habitat value, providing a model approach for other jurisdictions to consider for future projects.

As agencies contemplate major infrastructure projects, it is important that they consider incorporating habitat restoration at the onset of the project. As demonstrated by the three case study projects, the project proponents maximized partnerships to evaluate habitat restoration design concepts and garner agency and public support early in the project process. This early public support of the design and habitat components of the projects allowed the proponents to obtain funding through bonds or other legislative measures necessary for the construction of project elements. Using these same partnerships, project proponents were also able to save time and money by streamlining the permitting process through early buyoff from the agencies. In addition, the project proponents were able to develop innovative design approaches and partnerships to accommodate multiple stakeholder interests and provide lasting ecosystem improvements.

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INTRODUCTION

The infrastructure that supports our communities and commerce provides public services such as transportation, utilities, waste collection, recreation, and other facilities. Major infrastructure projects are undertaken by project proponents, such as agencies or organizations, to develop or maintain these public facilities. For projects of this scale, funding is generally obtained through voting measures such as public bonds or levies. In these instances, project cost, schedule, and performance are heavily scrutinized and are important considerations for the project proponent (De Jong, Annema & Van Wee, 2013).

Due to the magnitude of major infrastructure projects, construction and operational impacts can be lengthy and diffuse, affecting surrounding habitat and degrading ecological processes (Labarraque, Roussel & Tardieu, 2015). Therefore, it is also important for project proponents to consider these impacts and incorporate impact avoidance and minimization measures into the project design. If project impacts are unavoidable, offsets can be provided through compensatory mitigation. Adding mitigation activities to a project provide ecosystem benefits, but they can also add cost and time to a project.

The practice of implementing habitat restoration activities with major infrastructure projects has developed since regulatory agencies began requiring mitigation for impacts on wetlands under the Clean Water Act of 1972 (33 U.S.C. 1251–1376). These requirements gained traction in 1987, when the U.S. Environmental Protection Agency established the “no net loss” policy requiring project proponents to mitigate for unavoidable impacts on wetlands (Bendor, 2009). The no net loss concept provided a formal compensatory mitigation policy for replacing or restoring wetlands affected by development.

Since the no net loss policy was enacted, the requirements for environmental impact compensation have extended beyond simple mitigation for wetland impacts to replacement of ecosystem function (Martz, 2016). The policy of no net loss includes replicating or enhancing affected ecosystem functions, such as habitat connectivity for migrating terrestrial species, nesting habitat for birds, tides and currents that maintain water quality, or riparian buffers that provide sources of food and shading for fish. Projects with unavoidable impacts on such

ecological functions are required to offset impacts through mitigation, after impact avoidance and minimization measures have been considered (Martin, Evans, Rice, Lodhia & Gibbons, 2016).

Mitigating for losses in ecological function is accomplished through on-site or off-site compensatory mitigation. On-site mitigation includes restoring habitat or ecosystem functions in the immediate vicinity of a project. Off-site mitigation, while it does not provide the direct spatial benefits of on-site mitigation, can be implemented through other programs, such as in-lieu fee programs or mitigation bank instruments. These off-site programs are designed to prioritize projects that achieve regional or watershed-scale goals (Olander & Young, 2017). In some cases, projects that propose habitat restoration as part of the project purpose, or include habitat restoration in the design at the onset of the project, may be considered self-mitigating and no additional mitigation would be required.

When considering mitigation for environmental impacts, project proponents commonly neglect to incorporate habitat restoration into the project design until regulatory agencies enforce it for mitigation purposes. This type of situation occurs when early agency coordination is not part of the design process, and agencies are instead engaged when permit applications are filed. In these circumstances, mitigation measures are incorporated near the end of the design process and take extra time to address. Waiting for agency direction on a project can result in costly delays while mitigation measures are vetted by the agencies and design submittals undergo revisions (Ulibarri, Cain, & Ajami, 2017).

Alternatively, project proponents could consider a proactive approach in which habitat restoration measures are incorporated early in the design process in coordination with the regulatory agencies. As stated in Kahn (2000), projects and project mitigation that meets or exceeds agency and public expectations early on can lead to a more efficient regulatory process. Taking this approach can also increase public support and lead to potential cost savings, in addition to the ecosystem benefits that habitat restoration measures provide.

This study explores the incentives that may be realized by major infrastructure project proponents by drawing upon the themes and lessons learned from three case study projects in Washington State. Many of the environmental policies in Washington are driven by the

protection or enhancement of salmonid species and habitat, some of which are listed as threatened or endangered by the Endangered Species Act. As such, project proponents recognize the need to provide some level of mitigation or restoration on their projects (Muck, 2016). Despite Washington's unique regulatory environment, it is expected that these case studies can offer a new perspective for project proponents elsewhere.

CASE STUDY PROJECTS

The projects selected for this study include three major infrastructure projects in Washington State. These projects were selected due to their wide representation of infrastructure project type, including coastal protection, transportation, and water resource management. Each project is also led by a different agency and project team, and differs in habitat restoration approach. Additionally, each project is undergoing various phases of development, so the projects represent relatively recent agency undertakings. The projects and locations are shown in Figure 1.

Table 1 provides a summary of the case study projects, including the project proponent, location, waterbody, and purpose of the project.

TABLE 1. CASE STUDY PROJECT SUMMARY

Project	Lead Agency	Location	Waterbody	Project Purpose
Elliott Bay Seawall Project	Seattle Department of Transportation	Seattle, Washington	Elliott Bay	Seismic protection and ecosystem enhancement
State Route 520 Bridge Replacement and High-occupancy Vehicle Program	Washington State Department of Transportation	Seattle to Bellevue, Washington	Lake Washington	Floating bridge replacement
Yakima River Basin Integrated Water Resource Management Plan	U.S. Bureau of Reclamation and Washington State Department of Ecology	Multiple counties, Washington	Yakima River Basin	Watershed management and ecosystem enhancement

Elliott Bay Seawall Project

The Elliott Bay Seawall Project is a seawall infrastructure replacement and nearshore ecosystem improvement project being constructed along the historic downtown waterfront in Seattle, Washington. The Seattle Department of Transportation (SDOT), the project proponent, obtained funding for the first phase of project construction through a \$290 million bond measure in 2012. The second phase of the project is currently unfunded and will be constructed in the future as funding allows. The purpose of the seawall replacement is to “reduce the risk of damage to critical infrastructure along the downtown Seattle waterfront due to coastal storms and seismic events, to improve public safety, and to protect associated economic activities” (SDOT, 2013).

Due to the project location along a degraded urban shoreline, the “City quickly recognized the fact that the seawall was the only opportunity to install a large, continuous swath of habitat” (Mazzola, 2016). Therefore, the project was designed to serve the dual purpose of storm and seismic protection and Elliott Bay nearshore improvement. Ecosystem improvements incorporated into the project design included setting back the existing seawall to increase aquatic habitat availability and installing habitat features along the seawall including intertidal

habitat benches, textured seawall face panels, and light-penetrating overwater sidewalk surfaces.

State Route 520 Bridge Replacement and High-occupancy Vehicle Program

The Washington State Department of Transportation (WSDOT) is the proponent of the State Route (SR) 520 Bridge Replacement and High-occupancy Vehicle (HOV) Program, in coordination with the Federal Highway Administration. The SR 520 Bridge Replacement and HOV Program is a \$4.56 billion infrastructure replacement program that comprises five main projects between Seattle and Bellevue, Washington. The projects being constructed under the program include: Interstate 5 Lake Washington Project, West Approach Bridge North Project, Floating Bridge and Landings Project, Eastside Transit and HOV Project, and Pontoon Construction Project.

The purpose of the program is “to improve mobility for people and goods across Lake Washington within the SR 520 corridor from Seattle to Redmond in a manner that is safe, reliable, and cost-effective, while avoiding, minimizing, and/or mitigating impacts on affected neighborhoods and the environment” (FHWA & WSDOT, 2011). Although habitat restoration was not incorporated into the purpose of the program, it was proposed at the onset of the project in coordination with the multi-agency permitting team, composed of various regulatory agencies, stakeholders, and tribal representatives.

Yakima River Basin Integrated Water Resource Management Plan

The Yakima Integrated Plan is a joint watershed management effort between the U.S. Bureau of Reclamation and Washington State Department of Ecology located in the Yakima River Basin in south central Washington. The plan was prepared by the Yakima River Basin Water Enhancement Project Working Group, a coalition of agency, stakeholder, and the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation) representatives. Overall, the plan proposes a 30-year, \$3.8 billion effort intended to “restore ecological functions in the Yakima River system and to provide more reliable and sustainable water resources for the health of the riverine environment, and for agricultural, municipal, and domestic needs” (Ecology &

USBR, 2012). A range of efforts are included in the plan, divided into seven main program elements: 1) fish passage, 2) structural and operational changes, 3) surface water storage, 4) groundwater storage, 5) habitat protection and enhancement, 6) enhanced water conservation, and 7) market-based reallocation of water resources. Since the plan's approval in 2013, several projects have already been constructed using a combination of state and federal funding sources.

METHODS

Major infrastructure projects are generally located in political and environmental settings that influence the design, regulatory strategy, construction, and eventual implementation of each project. These projects are multidisciplinary in nature and come with multiple factors and relationships that must be vetted throughout the lifespan of the project, starting from conceptual design. For this reason, the case study method (Fidel, 1984; Zucker, 2009) was selected as the appropriate method for exploring the relationship between habitat restoration and major infrastructure projects.

The criteria used for the selection process was that projects must be contemporary major infrastructure projects in Washington that represent a range of infrastructure types and habitat restoration approaches. The geographic scope of this study was limited to Washington due to its unique regulatory environment and to more easily detect trends over a range of infrastructure project types that are subject to similar requirements and processes. Other potential projects were reviewed, but the three selected for this study meet the selection criteria.

The three case study projects selected for this study also include innovative approaches to habitat restoration. For example, the Elliott Bay Seawall Project was approved and funded as a dual-purpose project, integrating a range of ecosystem improvements into the seawall replacement design. Similarly, the Yakima Integrated Plan is a multi-faceted watershed management program that includes habitat protection and enhancement in addition to a variety water resource infrastructure projects and management efforts. The SR 520 Bridge Replacement and HOV Program did not propose habitat restoration as part of the purpose of the project. However, the program included a robust habitat restoration plan that was

developed in collaboration with the multi-agency permitting team and proposed at the onset of the project.

For the purposes of this study, these projects were evaluated by reviewing existing environmental documentation and further supplemented by interviews. Fourteen study participants were interviewed over 6 months between September 2016 and February 2017. The study participants were selected based on their direct involvement in each project and influence in the habitat restoration design, public outreach, project management, and/or regulatory review elements (Table 2). The interviews were a critical component of the study because they provided additional background and perspective on the habitat restoration component of the case study projects not typically included in the environmental documents.

Prior to conducting the interviews, a Duke University Institutional Review Board exemption was applied for and obtained. An informed consent script was recited prior to each interview. Interviews were conducted via telephone or in person, and took approximately 30 minutes to 1 hour to conduct. The same semi-structured list of questions was used for all case study projects, with minor deviations as the discussions allowed. The questions were developed to explore various perspectives of habitat restoration from a project coordination and implementation framework. Topics included participant background in the project, habitat restoration design, public perception, permitting process, and advantages or disadvantages to the habitat restoration approach.

TABLE 2. CASE STUDY PARTICIPANTS

Study Participant Title	Organization	Years on Project
<i>Elliott Bay Seawall Project</i>		
Construction Outreach Lead	EnviroIssues	2010 to present
Environmental Manager	Seattle Department of Transportation	2012 to present
Environmental Lead	Tetra Tech	2009 to 2013
Endangered Species Act Biologist	U.S. Fish and Wildlife Service	2010 to present
Habitat Biologist	Washington Department of Fish and Wildlife	2007 to present
<i>SR 520 Bridge Replacement and HOV Program</i>		
Endangered Species Act, Permitting, and Mitigation Task Lead	Confluence Environmental	2008 to present
In-lieu Fee Program Manager	King County	2011 to 2013
Environmental Services Office Mega Projects Environmental Director	Washington State Department of Transportation	2007 to 2015
<i>Yakima River Basin Integrated Water Resource Management Plan</i>		
Principal Water Resources Engineer	Anchor QEA, LLC	2007 to present
Project Manager and Lead Facilitator	HDR/Anchor QEA	2009 to present
Fisheries Biologist	National Oceanic and Atmospheric Administration Fisheries	2010 to present
Fisheries Biologist	U.S. Bureau of Reclamation	2009 to present
Senior Research Scientist	Yakama Nation	2009 to present

Upon the completion of each interview, a transcribed copy was sent back to the study participant to be reviewed for accuracy.

DISCUSSION

Four main themes arose from the three case study projects reviewed for this study: increased public support, streamlined regulatory review, cost savings, and opportunities for innovation.

Increased Public Support

“Overall we received amazing feedback [on the Yakima Integrated Plan]. The plan won a national award for coalition building and ecosystem restoration. Federal agencies are calling us to solve resource problems in other areas of the United States. We had a meeting with a D.C. leadership group with representatives from other agencies, including the Secretary of the Interior, and everybody was really positive about all of the work that was being done.”

Ben Floyd, Anchor QEA

Major infrastructure projects are typically undertaken by public agencies that rely upon public support for project funding. Yet, the public process can present one of the more unpredictable risks for these projects (Cuppen, Bosch-Rekvelde, Pikaar, & Mehos, 2016). Project proponents that conduct public outreach early in the design process can increase the public acceptability of the project, and potentially reduce costs that would result from opposition and delays (Goodfellow, Wortley, & Azapagic, 2014). Thus, early and frequent communication is important to identify and work through any significant concerns that may arise throughout the lifecycle of the project (Li, Ng, & Skitmore, 2012; Page & Jensen, 2015).

The Yakima Integrated Plan, first published in April 2011, demonstrated a collective effort to garner public and stakeholder support for water management efforts in the Yakima River Basin. The Yakima River Basin is affected by various water issues that impact fish populations, agriculture and irrigation, and municipal and domestic water supplies (Ecology & USBR, 2011). To address these issues, the U.S. Bureau of Reclamation and Washington State Department of Ecology established a work group early in the planning process. The Work Group was inclusive of the various interest groups and composed of agency, stakeholder, and Yakama Nation representatives. All Work Group meetings were open to the public, and approximately 20 to 30 members of the public attended each meeting (Ecology & USBR, 2011). The Work Group prioritized public support, bringing in constituents that represented a range of public interest early in the process (Gross, 2017).

The social climate in the Yakima River Basin was not always so cordial. Prior to the Yakima Integrated Plan efforts, conflicts of interest made it difficult to get approvals for any water

management project. According to Dave Fast, Yakama Nation, during these times interest groups could not agree on feasible alternatives for addressing water issues and the tribe could not meet with the local irrigation districts without lawyers present to mediate (Fast, 2017). As a result, it would take up to 3 or 4 years of legal action and negotiations before a project would get off the ground, adding time and cost to the project.

In 2010, the Work Group was established to begin the Yakima Integrated Plan planning process. While the program included a variety of water infrastructure projects, those projects were balanced with major fish passage and habitat restoration projects located throughout the Yakima River Basin (Ecology & USBR, 2011). This provided a balanced approach to a comprehensive water management program that catered to the needs of multiple parties throughout the Yakima River Basin. Because of this coalition building and public support, the Yakima Integrated Plan was approved in 2012, and achieved its initial funding milestone of \$137 million in capital funding from Washington State in 2013 to begin the initial phase of construction.

The Elliott Bay Seawall Project was similar to the Yakima Integrated Plan in that it depended on public support for implementation. The project is a critical infrastructure replacement project, providing seismic protection and ecosystem enhancements along the downtown Seattle waterfront. At the onset of the project, SDOT worked with regulatory agencies, stakeholders, tribes, and the public to design a robust ecosystem enhancement project in the immediate vicinity of the seawall. Ecosystem enhancements vetted through interested parties include restoring the intertidal habitat adjacent to the seawall to support migrating salmonid species exiting the mouth of the nearby Duwamish River.

SDOT Environmental Manager Mark Mazzola stated, “Project proponents can certainly broaden stakeholder support by incorporating benefits into the project upfront. It also helps to get more buy-in from agencies and tribes early in the project by working with them to incorporate these benefits, particularly those interested in habitat.” Including habitat restoration as one of the purposes of this dual-purpose project, SDOT received the necessary public support for the first phase of seawall replacement.

Streamlined Regulatory Review

“Habitat restoration and the multi-agency coordination was one of the biggest advantages in streamlining the permitting process. Coordinating with the agencies and stakeholders early and often, making them feel like part of the process, giving them a forum to provide input along the way, was really invaluable.”

-Chris Berger, Confluence Environmental

The permitting process for any project can be lengthy and unpredictable. Major infrastructure projects typically require an extensive review process by multiple agencies to determine the extent of environmental impacts and mitigation requirements (Patterson, Trim, & Trohimovich, 2014). These regulatory review processes include several layers of approval, including public comment periods and review by multiple agency departments. Efforts have been made in the United States by both the Obama administration, and more recently the Trump administration, to streamline the review process and ease the regulatory burden on critical infrastructure projects (CEQ, 2011; The White House, 2017).

Incorporating habitat restoration at the onset of a project, and obtaining early agency buyoff on the approach, is one method that can be used to help streamline the permitting process (Berger, 2016). Taking this approach provides opportunities for streamlining the environmental review process by reducing the agency review time and iterations in design. In some instances, the habitat restoration elements can also be considered self-mitigating for potential environmental impacts. This gives the project a unique advantage in gaining advance regulatory compliance, and reduces the potential for costly delays that can occur as mitigation measures are vetted by the project team and permit and design submittals undergo revisions.

One example of an agency that encourages habitat restoration as part of the permit process is the U.S. Army Corps of Engineers. As stated in Patterson et al. (2014), the U.S. Army Corps of Engineers’ regional permit process is designed to incentivize habitat restoration by offering more streamlined permits in exchange for individual permits. Obtaining these “programmatic” regional permits can save the project proponent time, money, and avoid duplication of efforts

during the review process, compared to the individual permit process, which typically requires a lengthier review.

To streamline the permitting process for the SR 520 Bridge Replacement and HOV Program, WSDOT formed a multi-agency permitting (MAP) team to provide input throughout design and mitigation planning process. The MAP team was formed early in the project and included multiple agencies and stakeholders that would eventually be involved in the permit review process. Each of the parties on the MAP team came to the project with a different set of objectives, so involving them early was paramount to building consensus and advancing each of the sites through the permitting process (Berger, 2016).

To determine the appropriate mitigation value, the team developed a “mitigation currency” or standard debit/credit system for the project that allowed the team to calculate the type and size of each mitigation site (Berger, 2016). According to WSDOT Environmental Services Office Mega Projects Environmental Director Allison Hanson, the “process wasn’t happening in a black box until permit applications submitted, like what can happen on other projects” (Hanson, 2016). This led to a no-surprises permitting process that helped streamline regulatory review.

Because of the early agency coordination for the project, WSDOT was able to submit a pre-approved mitigation plan at permit submittal, streamlining the permitting process and saving WSDOT time and money that would have been spent on a more traditional, iterative review process. Chris Berger, the mitigation lead with Confluence Environmental, said that “working with everyone to develop an acceptable accounting system for impacts to mitigation value was a key component to [the program’s] success” (Berger, 2016).

Similarly, the Elliott Bay Seawall Project and Yakima Integrated Plan both included early agency coordination and recurring meetings at the onset of the projects. This early-and-often coordination garnered agency support prior to permit submittal. In the case of these projects, both incorporated ecosystem enhancement as part of the project purpose, so the review process included early vetting of the habitat-related elements by the agencies as well. For both projects, study participants acknowledged the early agency input as critical for streamlining the regulatory review process.

Cost Savings

“Putting together a coalition around this [Yakima Integrated Plan], including the water structure side and communities around the river, has really helped. So you could say there was a cost savings there by being able to get things through and obtain funding for these projects. It’s a design that should be used throughout the West showing how to put forward a full program to get needed funding.”

-Dave Fast, Yakama Nation

From an economic standpoint, it is difficult to quantify the value that habitat restoration provides in terms of goods and services produced (Robbins & Daniels, 2012). However, per Bernhardt et al. (2005), the number of restoration projects in the United States has increased exponentially over the past 20 years with billions of dollars spent on these projects annually. The amount of annual expenditures on habitat restoration efforts shows that there is a strong desire to repair degraded ecosystems as standalone projects, or as offsets to development.

In addition to improving the health of an ecosystem, habitat restoration can also provide ecosystem services that have more tangible economic benefits. Ecosystem services are defined by Murray (2016) as “the flow of goods and services generated by natural systems that are beneficial to humans.” These services can improve the local economy and are calculated using market valuation techniques. While some these services are difficult to monetize, the benefits, such as improved air quality, water quality, or human health, are important to consider when planning a project.

In the context of major infrastructure projects, habitat restoration, when not proposed as part of the project purpose, might be viewed as an add-on to the project cost and not considered as a value-added or cost-saving measure. Habitat restoration projects take time and cost money to design and construct and, in many cases, include additional costs to monitor and manage over the long-term. Despite the time and associated costs, there are circumstances where habitat restoration can produce direct or indirect cost savings opportunities for the project proponent.

Early in the program, the Yakima Integrated Plan proponents, U.S. Bureau of Reclamation, and Washington State Department of Ecology sought to build consensus among a broad spectrum of stakeholders, including regulatory agencies, irrigation districts, agricultural producers, environmental interest groups, and the Yakama Nation. Because of the public support for the program, it has been lauded as an example for developing a comprehensive water resource program that not only tackles long-standing water management challenges through coalition building, but provides a funding-ready program (Colman, 2016).

Ultimately, this coalition building provided a cost-effective solution by streamlining the permitting process and making it easier to obtain state and federal funding to begin implementing projects. The cost savings were especially prevalent considering previous project efforts in the Yakima River Basin that were stalled by opposition or litigation due to lack of consideration of other parties during the planning process (Fast, 2017).

The Yakima Integrated Plan also built cost savings into the design through habitat restoration activities that also acted as flood storage projects, which were designed to store water and prevent future flooding and damages. One of the projects under the program, the Kachess Drought Relief Pumping Plant, included moving an outfall so bank protection could be removed, restoring the floodplain, and effectively removing long-term operation and maintenance costs. Other projects were incorporated into the program that added cost-effective water management and habitat restoration features designed to increase flood storage capacity, improve water quality, restore salmonid habitat, and remove or relocate development outside of the floodplain (Floyd, 2016). These features included ecosystem enhancements that doubled as cost-saving opportunities over the long term of the program.

Other values to consider are the ecosystem service benefits provided by habitat restoration. A common method used for valuing ecosystem services is a benefit-cost analysis (Murray, 2016). This decision-making tool considers the cost of a project and compares it to the longer-term environmental benefits. For example, the Yakima Integrated Plan is a \$3.8 billion program, with estimated long-term benefits ranging from \$6.2 billion to \$8.6 billion (Yoder, Adam, Brady, Cook, & Katz, 2014). Benefits were calculated by assessing multiple project elements, including

benefits from improved water management and ecosystem improvements such as fish passage projects. As calculated in the Yoder et al. (2014) benefit-cost analysis, fish passage projects comprise a relatively small proportion of the projects but provide an estimated 75% to 80% of the benefits through their role in returning wild sockeye salmon runs to the Yakima River Basin.

Other cost savings from incorporating habitat restoration activities into major infrastructure projects can also be realized through early outreach efforts, which can also increase agency and public support for the project and streamline the permitting process. Regarding the permitting process, Mark Mazzola, with the Elliott Bay Seawall Project, said that “in projects where [the project proponent has] incorporated mitigation into project design and proposal, it was easier to get those projects permitted and reviewed.” Ecosystem improvements through project design or mitigation provide less tangible benefits, but for agencies that rely on public funding and agency support for project implementation, they provide good incentive to consider ecosystem improvements as part of the project. Incorporating habitat restoration into the design can also provide opportunities for project proponents to obtain grant funding, which “would not only speed up the process, but get money to help fund these parts of the project” (Martz, 2016).

Opportunities for Innovation

“Hopefully one of these days when we are traveling to Vancouver, B.C., or other cities, we can look at their seawalls or other infrastructure projects and see their great habitat enhancements, and we can then come back home and borrow their ideas for improving our local projects and vice-a-versa.”

-Laura Arber, Washington Department of Fish and Wildlife

Major infrastructure projects are often undertaken by agencies with ample public funding and large project teams that allow for innovation in the design and implementation of all project components, including habitat restoration (Berger, 2016). Even when faced with limited funding, project proponents should consider forming local partnerships with environmental organizations or universities to develop creative solutions for addressing environmental

impacts or restoring nearby habitat. Partnering with these groups can provide a cost-effective solution for evaluating habitat restoration opportunities in the vicinity of the project.

The Elliott Bay Seawall Project is a major seawall replacement project located in a constrained urban environment along the downtown Seattle waterfront. Due to these space constraints, SDOT established a science-based partnership to study innovative habitat restoration features that would provide ecosystem improvements appropriate for an urbanized environment. Using a science-based approach better informed the design and provided supporting evidence for environmental documentation. SDOT partnered with the University of Washington and a local consulting firm, Anchor QEA, to implement a low-cost pilot program to study the various features being considered for the habitat design. Eventually, the team developed an extended fish migratory corridor that included a variety of ecosystem improvements along the face of the seawall including light-penetrating surfaces, habitat benches, and textured seawall face (SDOT, 2013).

One component of the science-based partnership approach included assessing fish community composition and migration patterns in response to light and shading from overwater structures along the urban waterfront. This assessment was conducted through a series of daytime and nighttime snorkel and land-based fish surveys. These surveys were designed to inform alternative selection for rebuilding or replacing the seawall, understand the potential effects of the project, and select project features designed to enhance fish populations along the waterfront (Anchor QEA, 2012).

The main element related to the surrounding waterfront development that was studied during the fish surveys was the effect of overwater cover on the migration pattern of juvenile salmon (Anchor QEA, 2012). The Elliott Bay shoreline consists of several large historic piers supporting a variety of commercial businesses and tourist attractions that extend over the water and shade large portions of the substrate. The shading effect caused by overwater structures is correlated with the inhibited growth of aquatic vegetation that provides aquatic habitat, which provides foraging and refuge opportunities for juvenile salmonids (Nightengale & Simenstead, 2001). Overwater pier structures are also attributed to deterring fish from passing through, and instead swimming around the shaded areas into deeper waters, which presents a greater risk of

predation (Nightengale & Simenstead, 2001; Anchor QEA, 2012). Based on design recommendations from this science-based approach, alternatives such as light-penetrating sidewalk surfaces were incorporated into the final project design (SDOT, 2013). These light-penetrating sidewalks allow light transmittal to the aquatic habitat below, providing visibility and improved habitat conditions along the fish migratory corridor (SDOT, 2014).

The Elliott Bay Seawall Project incorporated other habitat design features comparable to similar projects near the seawall, such as the Olympic Sculpture Park habitat beach. The Olympic Sculpture Park, is an outdoor public park that was constructed just north of the project at a former oil storage facility and brownfield site. The park includes a publicly accessible habitat beach featuring nearshore habitat improvements, including a habitat bench and subtidal kelp forest (Anchor QEA, 2015; LAF, 2015). The *Olympic Sculpture Park: Year 5 Monitoring of Shoreline Enhancements Report* (Toft, Ogston, Ambrust, Levy, & Morgan, 2012) documented an overall increase in ecological function and use by juvenile salmon near the habitat improvements since construction. The Landscape Architecture Foundation (LAF, 2015) reported that within the first 3 years of monitoring, a 530-fold increase of juvenile salmon use at the habitat beach was observed. The project has been praised for its success at restoring degraded habitat while providing public access in an urbanized environment.

The final project design included habitat features studied during the pilot program and integrated features similar to the nearby Olympic Sculpture Park habitat beach to maximize habitat value. Laura Arber of the Washington Department of Fish and Wildlife suggested that the habitat restoration components for the project provide “a great model for other cities around the world for possible options to include along their seawall.”

CONCLUSIONS

“From an environmental manager perspective, habitat restoration can be most rewarding in terms of what you see at the end of the day for a project. These tend to be things that people will really rally around and see the benefit in.”

-Allison Hanson, HNTB Corporation

There is an urgency that must be met in addressing infrastructure improvements throughout the United States (Doyle, et al., 2008; Burchell, Crosby, & Russo, 2010). As agencies contemplate these projects, it is important that they consider the impact on the surrounding environment, and in turn consider the less tangible, but important benefits that incorporating habitat restoration can have for a project.

As demonstrated by these three case study projects, the project proponents maximized partnerships to evaluate habitat restoration design concepts and garner agency and public support early in the project process. This early public support of the design and habitat components of the projects allowed the proponents to obtain funding through bonds or other legislative measures necessary for construction of project elements. Using these same partnerships, project proponents were also able to save time and money by streamlining the environmental review process through early buyoff from the agencies. In the case of the Yakima Integrated Plan, incorporating floodplain restoration elements into part of the project is anticipated to alleviate long-term costs related to operations and maintenance activities as well.

Major infrastructure projects are frequently undertaken by agencies that have the public support and resources to realize opportunities for innovation in their habitat restoration approach. On the Elliott Bay Seawall Project, SDOT worked with the University of Washington and local consulting firm to develop a science-based approach, coming up with an innovative ecosystem enhancement concept despite being in a constrained urban environment. Through innovation in science and partnerships, agencies can accommodate multiple stakeholder interests and leave the environment better than it was before the project was constructed.

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