EVALUATING SMALL DAM REMOVAL PLANNING IN THE SAN FRANCISCO BAY AREA

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by

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CERTIFICATION OF APPROVAL

I certify that I have read Evaluating Small Dam Removal Planning in the San Francisco Bay Area by Andrea Sarisky Sproul, and that in my opinion this work meets the criteria for approving a thesis submitted in partial fulfillment of the requirement for the degree Master of Arts in Geography: Resource Management and Environmental Planning at San Francisco State University.

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EVALUATING SMALL DAM REMOVAL PLANNING IN THE SAN FRANCISCO BAY AREA

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Dam removal is now commonly being considered as a river restoration tactic as millions of small dams in the United States outlive their intended purposes and become liabilities or cause environmental degradation. This study evaluates two cases of small dam removal in the San Francisco Bay Area, gauging what aspects of the decision-making and planning process facilitated successful removal. Through the study of the setting, actors, steps of progression, and treatment of risks for each dam removal project, the cases are evaluated against one another via pattern matching and comparing factors of analysis. Planning at the watershed scale, the presence of protected salmonids, available funding, and strong leadership that incorporates multiple stakeholder viewpoints and embraces adaptive management were all found to be important factors leading to successful outcomes.

I certify that the abstract is a correct representation of the content of this thesis.

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Chair, Thesis Committee Date

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ABBREVIATIONS

ACA Alameda Creek Alliance

ACFCWCD Alameda County Flood Control and Water Conservation District

ACFRW Alameda Creek Fisheries Restoration Workgroup

ACPW Alameda County Public Works

ACWD Alameda County Water District

CCC California Coastal Conservancy

CDFW California Department of Fish and Wildlife

CEMAR Center for Ecosystem Management and Restoration

CEQA California Environmental Quality Act

CWA Clean Water Act

EIR Environmental Impact Report

ESA Endangered Species Act

FERC Federal Energy Regulatory Commission

IWRP Integrated Watershed Restoration Program

NMFS National Marine Fisheries Service

NOAA National Oceanic and Atmospheric Administration

SFBRWQCB San Francisco Bay Regional Water Quality Control Board

SFPUC San Francisco Public Utilities Commission

USACE United States Army Corps of Engineers

RCD Resource Conservation District

RWQCB Regional Water Quality Control Board

Introduction

Dams are a fundamental part of the U.S. hydrological landscape and have been used to support irrigation, protect from flooding, provide drinking water, energy, and recreation, among other uses (Heinz Center 2002, 32-33). More than 80 percent of the dams in the U.S. were built in the 20th century, with a majority built between 1950 and 1970 (Heinz Center 2002, 33). As this epoch of dam building in the United States ended and dams began to age, their effects began to be more acutely felt (Graf 1999). Many dams have been removed as they have become obsolete, unsafe, or detrimental to the environment, and dam removal is now commonly considered as a river restoration technique (Pohl 2002, Doyle et al. 2000). According to American Rivers (2016), approximately 850 dams have been removed in the United States since 1999; many of were small non-hydroelectric and run-of-river dams (Pohl 2002, Doyle et al. 2000). With more than two million small dams in the United States, a majority of dam removal projects will occur in smaller watersheds on smaller structures (Doyle et al. 2000).

Despite this recent proliferation of dam removals, there is a striking lack of research available on the planning processes and outcomes associated with such projects (Rhoads et al. 1999). This topic is worthy of exploration, as small dam removals entail distinctive problems and different outcomes than better-studied large dam removals (Heinz Center 2002). For example, most studies examining the impacts of small dam removal on sediment only examine individual projects, and few compare projects or look at them longitudinally (Sawaske and Freyberg 2012). There are large gaps in the

literature covering dam removal, which leads decision-makers to rely on modeling and theory rather than site-specific and applied research (Heinz Center 2002, Bellmore et al. 2017). There is a compelling need for more information about the planning, execution, and outcomes of small dam removals.

When a dam removal is proposed, multiple factors must be evaluated regarding potential changes to the river system as well as broader socio-political implications. Federal, state, and local stakeholders have developed a wide variety of approaches to the often complex and intertwined factors that affect decision making and planning efforts. This study seeks to elucidate which aspects of the planning process had the greatest impact on the success of two small dam removal projects in the San Francisco Bay Area: Niles Dam in Alameda County and Memorial Park Dam in San Mateo County.

Literature Review

To effectively analyze the planning process for a river restoration project such as a dam removal, it is important to understand the multitude of factors that must be evaluated prior to the physical removal of the dam. According to the Heinz Center (2002) report's general framework for small dam removal planning and Pejchar and Warner's (2001) evaluative criteria for dam removals, these factors can be placed into six general categories: physical, ecological, economic, social, legal, and political. A cursory review of each of these aspects of the planning process follows.

The physical aspects of a small dam removal project can have profound, watershed-wide impacts, and thus require careful study during the planning process. The effects of dams on river systems can include "Fragmenting the lengths of rivers, changing their hydrologic characteristics (especially peak flows), and altering their sediment regimes …caus[ing] downstream landscape changes, including channel shrinkage and deactivation of floodplains" (Heinz Center 2002, 7). Dams can also alter channel patterns, often leading to changes in sinuosity (Heinz Center 2002, 124). These effects are highly variable by site and depend on factors such as channel geometry, the length of time the dam has been in place, slope, hydrology, and the size of the dam, among other factors (ICF Consulting 2005, Kibler et al. 2011). Small dams often only affect specific sites or short reaches (Heinz Center 2002). Despite their reduced impact compared to larger dams, small dams can still create major geomorphic impacts relating to sediment transport, trapping as much as 95 percent of deliveries from upstream (Heinz Center 2002). Generally, the removal of a small dam can lead to outcomes such as, "increased water and sediment discharges resulting in decreased channel gradients, increased depths, and increased widths" (Heinz Center 2002, 125). Additionally, sedimentation patterns can change, with sediments below the dam becoming finer as the sediment trapped behind dam is released over time (Heinz Center 2002). When dam removal is considered, stored sediment and subsequent changes to the river channel must be a major focus of modeling and studies attempting to determine what a river will look like post-removal (Doyle et al. 2000).

Sawaske and Freyberg (2012) evaluated 12 case studies of dam removal on low-head sediment-impacted systems in the United States. Their study established that variables such as sediment type, removal timelines, and channel geometry merit consideration in the planning process. While studies such as the Heinz Center report (2002) describe general outcomes for small dam removals, newer field studies are collecting results that show that outcomes depend on a variety of factors within the river system. This notion is addressed by Sawaske and Freyberg (2012), who describe how individual factors play a role in the outcome of a removal project, leading to a unique outcome for each individual dam removal project. The physical aspects of small dam removal projects related to sediment and water quality are important considerations that should be better studied and incorporated into planning (Heinz Center 2002, 132). To facilitate planning for the physical effects of a dam's removal, Pejchar and Warner (2001) suggest that the watershed must be the "fundamental unit of analysis" (565).

Small dams are often removed for environmental reasons, unlike large dams which are more typically removed for economic reasons (Pohl 2002). While sediment and geomorphic outcomes of removal are often a major focus of planning, improved ecological outcomes are commonly the goal of dam removals (Foley et al 2017, 5234). The ecological impacts of a small dam's removal can be profound; in California, dams have affected 90 percent of the historical spawning habitat of Chinook salmon and steelhead trout, as well as contributing to the decline of numerous other anadromous species (Pejchar and Warner 2001, 562). Dam removal for the benefit of anadromous fish

can have favorable economic outcomes as well (Null et al. 2014, 130); ecological outcomes of dam removal can also be negative, however, as mobilization of sediment can harm habitat and mobilize contaminants, and has also enabled invasive species to spread (Bellmore et al. 2017, 2).

In the United States, many dam removals are initiated and pursued in support of ecological considerations (Doyle et al, 2000, 6). The possibility of improving habitat for protected species can often be the impetus for a removal project (Bowman 2002). Other ecological considerations can include impacts on habitat quality and quantity for species if the dam is left in place, the potential to restore habitat if the dam is removed, changes to water temperature, nutrient loads, sediment loads, and more (Pejchar and Warner 2001, 566). Planning for potential changes to the ecosystem is difficult because it is impossible to precisely predict outcomes. Despite this uncertainty, the costs of allowing a particular dam to continue degrading habitat have to be weighed against the potential of its removal to cause more harm (Pejchar and Warner 2001, 567).

In the dam removal planning process, the economic benefits of the project's outcomes must be weighed against the costs of removal. For small dams, removal projects are pursued more often than repairs because of high repair costs and limited economic utility (Born et al. 1998, 369). Often the actual removal of the dam itself is less expensive than the management of sediment trapped behind the dam (Pejchar and Warner 2001, 568).

The cost-benefit economic analyses used to evaluate a dam's removal can include aesthetic and ecological features of the dam, as well as the more concrete and easily measured factors of operational and potential liability costs (Born et al. 1998). Whitelaw and MacMullan (2002) suggest that these cost-benefit analyses should be wholly inclusive, incorporating all subsidies and externalities in an appropriate context (730). Despite the need to understand the value of what will be gained and lost if dam removal is pursued, the use of cost-benefit analysis in the decision-making process for removal can be challenging because environmental outcomes are often uncertain and it is difficult to assign monetary value to them (Heinz Report 2002, 9). Also, in many cases involving small dams, there is not a "no action" alternative to be included in an analysis for comparison, such as in cases when the dam must be removed due to safety concerns (Heinz Center 2002, 9).

Finally, sourcing funds for removal can be a difficult part of the planning process – often multiple sources of funding, both private and governmental are necessary, and there are very few dedicated sources of funding for dam removals (American Rivers 2000). The odds of a dam removal succeeding depend heavily on funding availability and the complete cost of the project (Orr et al. 2004, 109). Government financing for dam removals can often make or break a project (Born et al. 1998).

Rationales for dam removal have shifted, and communities are evaluating changing community needs along with technological improvements, safety issues, repair costs, clean water, and recreation potential when deciding if a dam should be removed

(Johnson and Graber 2002). Many dams have become obsolete and no longer serve their intended purpose; the associated values have changed as a result, and many dams are prized more for historic or habitat features than for economic values (Doyle et al. 2003, 453). Economic support for the continued maintenance of older, smaller dams is often quite low (Doyle et al. 2003, 454). This imbalance between the value communities see in small dams against an inability to fund their upkeep can lead to conflict.

The removal of a small dam typically engages the local community in different ways than large dams, often because of differing value associations between locals and non-locals (Doyle et al. 2000, 9). Case studies indicate that when dam removal is considered for river restoration, there is often local opposition, but removal typically proceeds anyhow as a result of "top-down" decision making (Doyle et al. 2000, 9). "The main reason for such discrepancies is because scientists and many environmentalists often do not fully respect the knowledge, experiences, and interests of local communities, and … often fail to distinguish between their knowledge and their values" (Doyle et al 2000, 9). As a result, when the planning process is managed by non-locals, there are often concerns raised about exclusion of locals from decision-making (Born et al. 1998, 361). Dam removal projects may have better outcomes for more stakeholders when the local community and culture are incorporated in the decision-making process (Johnson and Graber 2002, Doyle et al. 2000).

There is often a lack of consensus among scientists, dam removal advocates, and local communities about the "precise biophysical endpoints of their efforts" in dam

removals (Fox et al. 2016, 95). Even in cases where stakeholders agree that dam removal is the best course of action, there is often disagreement about the necessary extent of the work. There is a profound lack of research on the social and political aspects of dam removal projects in relation to river restoration, but a political ecology framework that incorporates the socio-political, historical, and geographical contexts and their influence on power dynamics in the decision-making process could help address social conflicts that can arise in dam removal planning (Fox et al. 2016, 95-96, Magilligan et al. 2017, 982). Developing frameworks for dam removal planning that acknowledge the dynamics of the political and social can also facilitate projects:

> "…In some ways our learning from rivers has eclipsed our learning from each other. Developing truly coordinated studies that bridge disciplinary gaps…dam removal, like other large disturbances to rivers, is inherently transdiciplinary. Our science, languages, and concepts are not" (Foley et al 2017, 5241).

The legal context of the dam removal planning process can involve a variety of state, local, and federal regulations. Smaller dams are not as heavily regulated or inspected. Often the decision to remove a dam is a result of legal action (Bowman 2002, 739). Hydropower dams are licensed by the Federal Energy Regulatory Commission (FERC), but FERC does not regulate small non-hydroelectric dams (Bowman 2002). The Endangered Species Act (ESA) has had a direct effect on dam removal decisions, and has led to voluntary removal projects, although it has not been used to force a removal to date (Bowman 2002). In California, the Department of Water Resources' Division of Safety of Dams has jurisdiction over dams taller than 6 feet with a reservoir capacity of 50 acre feet

or more, or 25 feet in height and impounding at least 15 acre-feet of water. Further legislative considerations in the planning process may include adherence to the Clean Water Act (CWA), the California Environmental Quality Act (CEQA), the National Environmental Protection Act, as well as further state and local permitting processes (O'Reilly 2010).

Politics often poses greatest obstacle to dam removals, as the dam removal planning process involves a wide range of stakeholders with varying perceptions and levels of influence and power; failure to account for this in the planning process can play a primary role in the failure of dam removal proposals (Pejchar and Warner 2001, Fox et al. 2016). The political complexity of dam removals is often rooted in the fuzzy nature of goal-setting when it comes to planning for a dam's removal (Fox et al. 2016). Every dam removal faces a unique set of circumstances, and research on outcomes, as well as a lack of "scientific certainty regarding the magnitude and spatial extent of the restoration response" can make it very difficult to come to a collective conclusion about what to plan for and how to proceed (Fox et al. 2016, 96).

Conceptual Framework

This study seeks to ascertain what aspects of the planning process facilitated removal projects' success based on three propositions:

1. By planning for removal at each dam in context of the larger watershed, it was more likely to be successful (Pejchar and Warner 2001),

2. That addressing and incorporating the underlying political ecology during planning helped lead to successful removal (Fox et al. 2016), and
3. That involvement of local interests played a fundamental role in getting removals to progress (Doyle et al. 2000).

Planning at the watershed scale, incorporating downstream and upstream areas of concern, rather than via political boundaries is more effective in river restoration and often leads to greater community input (Pejchar and Warner 2001, 561; Moss and Newig, 2010, 2; O'Reilly 2010, 114). When dams are removed to improve fish passage, planning at the watershed scale is vital, as downstream dams of critical habitat can impede passage. By utilizing a watershed scale approach during the planning process, planners are more apt to consider the full extent of effects of all major categories of concern in dam removal planning (Heinz Center 2002). Addressing these concerns both fully and early in the process of planning allows decision-makers to tackle issues before they become major obstacles and potential stalling points.

A planning approach that acknowledges the underlying political ecology of a river restoration project can streamline a sometimes-contentious process. This type of approach, "directs attention to the political and cultural dimensions of restoration" (Fox et al. 2016, 94). To achieve this, decision makers must acknowledge the influence of local politics, as well as the social and historical contexts of the river bring restored, in addition to the dam being removed (Fox et al. 2016). This is especially vital in today's political climate:

> "Because environmental conflicts…center on intentional interventions to improve long-humanized landscapes according to specific (and often contested) ecological criteria, they will embroil new constellations of human and non human actors, competing interpretations of nature, and complex cultural dynamics" (Fox et al. 2016, 94).

The clashes between the socio-political and bio-physical aspects of a river restoration project are persistent in dam removals, and even the most carefully planned projects often face unexpected surprises as a result (Magilligan 2017). The manner in which a dam removal is framed by planners and opponents in the context of local politics can impact a removal project in many ways, and the dynamics of power between "outsiders" and "locals" have considerable effects on the decision-making process (Magilligan 2017, 991-992).

Local organizing is fundamental to the process of getting small dams removed. The planning process often hinges on multiple actors and relies heavily on positive public opinion in order for a project to both be initiated and progress (Johnson and Graber 2002,731; O'Reilly 2010, 117). Rhoads et al. (1999) states, "Watershed management, although dependent on science and engineering, is first and foremost a social process" (297). A small group of people actively opposing a small dam removal can have an outsized effect on a project in its planning stages (Magilligan 2017, 993). When these concerns are addressed early and local voices are incorporated in the planning process, small dam removals are more likely to succeed.

Methods

For this research, two case studies of small dams (<100 acre feet of storage) were completed to understand which variables of the planning process may have helped lead to successful (removal) outcomes. Using O'Reilly (2010) as a model, this study seeks to discern how the setting, actors, planning process steps and timing, and treatment of risks in planning and decision making led to removal rather than no action or repair of these dams. By focusing on small dams, this study addresses an underserved area of research, as large dams are more closely and frequently studied, although small dams are more easily removed and can often have an outsized effect on ecosystem benefits and fish passage (Bellmore et al. 2017, Sawaske and Freyberg 2012, Pohl 2002, Doyle et al. 2000, Heinz Center 2002).

The two dams chosen for review in this study are Niles Dam on Alameda Creek in Alameda County and Memorial Park Dam on Pescadero Creek in San Mateo County. The dams were of similar size, geographic location (San Francisco Bay Area), had similarly complex removal processes, and impacted watersheds with anadromous fish populations. They were both removed within a similar timeframe, Niles Dam in 2006 and Memorial Park Dam in 2015. The large number of similarities between these cases, as well as their similar outcomes, provide an opportunity for testing propositions about small dam removal planning. Finding perfectly similar dams to compare in this manner is impossible; no two dam removals are identical and each project has a unique network of factors influencing how easily it will proceed (Magilligan et al. 2017, 993). With this in

mind, dams were chosen that share enough components to make their stories worth comparing to find similarities that may have aided each in becoming successful in river restoration through dam removal.

Using four factors of analysis – the setting, actors, process steps and timing, and treatment of risks, these cases are cross-compared using pattern matching and analysis (O'Reilly 2010, Yin 1989). In each individual study, a description of the setting outlines background information relevant to the dam removal case. Actors involved in each case are introduced and interactions among actors are described to give context. Steps taken in the planning process for each dam removal are relayed to clarify how each project progressed. Finally, the evaluation of the treatment of risks for each project discusses the manner by which each removal project handled uncertainties as planning progressed. The treatment of risks is the "consideration of tradeoffs between...benefits and consequences and resulting risk" (O'Reilly 2010, 39).

Data for this case study come from reviews of primary source documents from agencies and stakeholder groups, archival records, media coverage, and semi-structured interviews with actors involved in each removal project. To ensure reliability in the study, data were collected under a similar protocol for both cases, and multiple sources of evidence were used for each case for corroboration (Yin 1989).

Niles Dam Case Study

Setting

Niles Dam (Figure 1) was built in 1887 by the Spring Valley Water Company to supply water for the city of San Francisco (SFPUC 2006, 83). The dam was built atop an older stone dam that was part of the Mission San Jose, making the structure historically significant (Geomatrix 2003, 38-39). The dam as built in 1887 was approximately 120 feet in length, 8 feet wide, and 8 feet tall (Geomatrix 2003, 38). By 1900 the dam was no longer needed for water supply, but was left in place until 2006 when it was removed (Figure 2) by the owner, the San Francisco Public Utilities Commission (SFPUC) along with nearby Sunol Dam primarily for liability reasons and fish passage improvements (SFPUC 2006, 196).

The dam impeded the flow of Alameda Creek in Alameda County (Figure 3) and stood in Niles Canyon, between the Hayward and Calaveras geologic faults. The Alameda Creek watershed encompasses 633 square miles, consisting largely of park land and other protected areas in the upstream region, and densely populated cities in the downstream region (Geomatrix 2003). The watershed has two main drainage units; Niles Dam stood within the southern, smaller drainage unit of about 175 square miles (Geomatrix 2003, 15). The land use in this catchment was characterized by open-space and cattle grazing at the time the dam was under review for removal, but was developing rapidly (USACE 2005, 2).

The three equal objectives of the removal of Niles Dam as stated by the SFPUC were fish passage, liability and safety concerns, and taking the dam out in an environmentally sensitive manner (SFPUC 2006). These objectives are mirrored in documents and statements from outside agencies, as well as advocacy groups that were involved in the removal planning (USACE 2005, Miller 2017).

Figure 1: Niles Dam (SFPUC 2006)

Figure 2: Former site of Niles Dam (Gragg 2008)

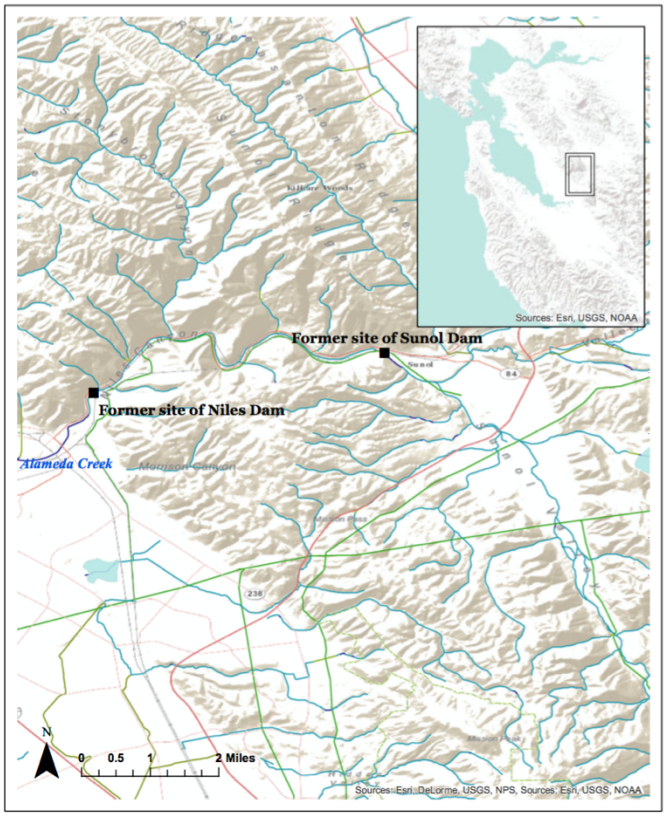

Figure 3: Map of Niles Dam area

Actors

The removal of Niles Dam was initiated by the owner of the dam (SFPUC) with encouragement from local interest groups. Despite the small stature of the dam, planning for removal proved quite intricate, involving numerous private groups and government agencies at the federal, state and local levels including the Alameda Creek Fisheries Restoration Workgroup (ACFRW), CalTrans, The U.S. Army Corps of Engineers

(USACE), and the San Francisco Regional Water Quality Control Board (SFRWQCB), among others.

An initial push for dam removal began in the late 1990s when the Alameda Creek Alliance (ACA) was created to advocate for the restoration of the Alameda Creek watershed (Miller 2016, CEMAR 2013). Jeff Miller, the Executive Director of the ACA described this event:

> "The ACA formed in 1997, when steelhead trout in the central California coast were listed as a threatened species under the ESA…We began lobbying agencies to remove or modify instream barriers to provide fish passage. The SFPUC volunteered to remove Niles and Sunol dams, and we supported the dam removal" (Miller 2016).

The Alameda County Fisheries Restoration Workgroup (ACFRW), organized to "cooperatively address steelhead restoration issues", formed in 1999 as an umbrella organization to coordinate the efforts of the ACA, the Alameda County Water District (ACWD), the Alameda County Flood Control and Water Conservation District (ACFCWCD), the California Coastal Conservancy (CCC), the SFPUC, and American Rivers (CEMAR 2013, 2). Prior to the removal of Niles Dam, the group would grow to include ACFCWCD Zone 7 Water Agency, the San Francisco Public Works Department, the San Francisco City Attorney's Office, the California Department of Fish and Wildlife, East Bay Regional Parks District, CalTrans, Alameda County Supervisor District 1 and 2, Pacific Gas & Electric, the National Oceanic and Atmospheric Administration (NOAA), CH2M Hill, and the Center for Ecosystem Management and Restoration (CEMAR)

(CEMAR 2013, 2; Geomatrix 2003, 8). Local groups such as the ACA pushed for the removal of Niles Dam, and the successful removal of the dam is due in large part to the cooperation fostered through the ACFRW, as well as the support and management by the SFPUC. Most of the impetus for removing the dam was the goal of anadromous fish population restoration through fish passage improvements in the Alameda Creek watershed.

The local community was generally supportive of the efforts to remove the dam. A preliminary study by Geomatrix (2003) interviewed ten individuals from local non-profit organizations, Alameda County, and the East Bay Regional Parks District that were familiar with Sunol, the community closest to the dam, to get a better understanding of the sentiments regarding the potential removal of the dam. The majority of those interviewed agreed with the removal of the dam and thought locals would as well, although two of those interviewed wanted other methods of restoration to be studied because they saw the removal project as too costly (Geomatrix 2003, 9-10). Residents near the dams actively worked to protect the area from encroaching development and supported the work of restoring Alameda Creek's steelhead trout population (Geomatrix 2003, 9-10).

Inter-agency and community-wide involvement and coordination in planning for the removal of Niles Dam were extensive. This is due in no small part to the efforts of the ACFRW, which worked to get local actors working together early in the planning process, facilitating coordination amongst various groups. The SFPUC also included

locals in the planning process, stating in one of its grant proposals that, "SFPUC communications staff will notify neighbors, interest groups, stakeholders, federal, state and local agencies regarding project plans, construction and management issues. SFPUC will contact local schools to provide site tours of the Alameda Creek Watershed and this particular project" (SFPUC 2002). The California Department of Water Resources in 2001 also described the ACFRW as a "model of cooperation" (CEMAR 2013, 5).

Process

After the formation of the ACFRW, a study to assess potential improvements to support the return of steelhead trout populations in Alameda Creek's watershed identified Niles Dam as a barrier to fish passage. (ACFRW 2000). The SFPUC was already evaluating removing both Niles Dam and nearby Sunol Dam, as neither was needed any longer for water supply and both dams were potential liabilities for the city of San Francisco (ACFRW 2000, 52). Plans were put in place by the SFPUC to begin evaluating the removal Niles and Sunol dams within the year, and the agency began setting aside funds for removal; completion of the project was scheduled for 2004 (CEMAR 2013).

The next step was to acquire funding. By 2001, the SFPUC had set aside funds to initiate the removal process and filed for a Proposition 13 grant for funding to remove both Niles and Sunol dams (CEMAR 2013). Proposition 13 grants are funded through a 2000 water bond by the State of California to support "safe drinking, water quality, flood protection, and water reliability projects" (SWRCB 2007). In 2002 the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) got involved, granting $1 million

toward the removal (SFBRWQCB 2006). The SFBRWQCB also coordinated permitting for removal with state and federal agencies, including the USACE, California Department of Fish and Wildlife (CDFW) and the United States Fish and Wildlife Service (USFWS) (SFBRWQCB 2006).

In 2003, the SFPUC presented plans for the project at an interagency coordination meeting (SFPUC 2006, 55). The National Marine Fisheries Service (NMFS) had raised concerns about the post-removal channel configurations and sediment management options based on the draft conceptual engineering report (SFPUC 2006, 55). As a result, a secondary geomorphology report was produced by Weiss Associates (SFPUC 2006, 55). A draft environmental impact report (EIR) was produced, and in 2005 public comments about the planned dam removals were collected in both public hearings as well as in writing (SFPUC 2006, 270). An issue raised repeatedly through the commenting period was management options for the sediment behind the dams.

Ultimately, Alameda County Public Works threatened legal action against the SFPUC over the plan to leave sediment behind the dam in place, and the two entities eventually settled to allow the project to proceed (Ramirez 2017). The SFPUC continued to study sediment and other issues related to the removal project before proceeding (CEMAR 2013). By 2006, the issue of sediment was finally settled as the environmental review process closed (CEMAR 2013, 9). The process from inception to removal took approximately a decade (Fischer 2006). Post-removal monitoring began in 2006 and continued for 10 years (Ramirez 2017).

Date	Event
1999	Alameda Creek Fisheries Restoration Workgroup Formed
2000	Study completed identifying barriers to steelhead trout in Alameda Creek watershed
2003	Conceptual engineering report for removal of Niles and Sunol Dams completed
2004	SWRCB Proposition 13 grant approved
October 2005	SFPUC publishes Draft Environmental Impact Report
November - December 2005	Public comment meetings (in San Francisco first, then Fremont)
February 2006	Draft Environmental Impact Report draft comments and responses published
April 2006	Final EIR approved in compliance with CEQA
July - August 2006	CDFW, SFBRWQCB, USACE permits approved
October 2006	Dam removal completed
2006-2016	Monitoring

Table 1: Timeline of Niles Dam removal process

Risks and Considerations

In the planning process for a dam's removal, risks related to safety, the environment, legal issues, social issues, economics, and management require careful consideration (Heinz Center 2000). The most prominent risk that required attention in the planning process for Niles Dam was regarding sediment management, with outcomes for fish, water quality, and the historical significance of the structure also closely evaluated.

Sediment

While many factors related to the hydrology and ecology of the creek were considered during the planning process, sediment was the primary source of

disagreement. The SFPUC oscillated between two options: dredging and disposal, and natural dispersal of stored sediment over time by Alameda Creek. Several geotechnical and ecological studies as well as an environmental impact report were produced prior to implementation of the dam removal project. An initial study conducted in 2000 recommended leaving the sediment in place, finding that the small amount of sediment would not cause adverse effects downstream (Trihey & Associates 2000). Despite this recommendation, the SFPUC intended to arrange for removal of sediment behind the dam, and submitted a grant proposal to the State Water Resources Control Board in 2002 stating this was the proposed course of action. A second study from 2003 suggested the opposite, citing the risks of a heavy rainfall year leading to downstream flooding should sediments move as a result (Geomatrix 2003, 43). A third study suggested leaving sediments in place to wash downstream gradually, finding that movement would occur over decades, not quickly and with adverse outcomes (i.e. flooding); the study also found that "the estimated volume of sediment stored behind the dams is well below the average annual load of the river and within the natural variability of sediment transported by the creek" (SFPUC 2006, 295). The EIR for the project concluded that "the expected gradual nature of the sediment movement…would arrive in the flood channel over the course of decades" (SFPUC 2006, 294).

Alameda County Public Works put concerns in writing during the public comment period that downstream effects of sediment post-removal were not adequately addressed by the EIR (SFPUC 2006, 291). ACPW's comments argued that leaving

sediment in place behind the dam was counter to the primary stated objective of removing the dam: fish passage (SFPUC 2006, 292). Primarily, ACPW was worried about silt and the potential costs of flooding that could result from leaving sediment in place to wash downstream. The county requested that the SFPUC excavate and remove sediment behind Niles and Sunol dams, expressing support for the SFPUC's goal of improving of aquatic habitat, but disagreeing with the planned sediment management option to leave sediment in place (SFPUC 2006, 292-294). Eventually, ACPW and the SFPUC settled to allow the project to move forward, leaving the sediment in place behind the dam with a ten-year post-removal monitoring period to study how sediment was moving in the channel (Ramirez 2017). In the end this decision, "turned out to be fine – sediment moving downstream has not been a problem since the dam removal" (Miller 2016).

Water resources

The Alameda County Water District, which relies on Alameda Creek to supply potable water to Fremont, Newark and Union City, expressed concern about possible contamination of the water during construction as well as after removal due to suspended sediment (SFPUC 2006, 298). In response to the SFPUC's EIR commenting period, ACWD requested monitoring, enhanced mitigation measures, and best management practices to protect its water supplies from the creek (SFPUC 2006, 298-299). The SFPUC responded to these concerns by stating studies related to turbidity suggested only temporary and minimal increases, and agreed to put mitigation measures in place to

reduce impacts (SFPUC 2006, 300). The SFPUC also updated the EIR to state that any maintenance or refueling during construction that involved hazardous materials would have “provision for secondary containment” (SFPUC 2006, 301).

Historical and cultural significance

Niles Dam was eligible for inclusion in the National Registry of Historic Places for its "association with urban water supply history…its association with Don Jose de Jesus Vallejo…and its potential to yield information regarding Mexican-era dam construction” (SFPUC 2006, 202). Several letters produced during the environmental impact report commenting period addressed the dam’s historic value. To account for these concerns, the SFPUC opted to preserve the dam via documentation by archaeological and architectural professionals (Figure 4) (SFPUC 2006, 39). In addition to the dam itself, the nearby Vallejo Aqueduct was also mentioned in several public comments as a point of concern. The SFPUC did not expect construction to significantly affect this historical resource, but put mitigation measures in place (SFPUC 2006, 307).

Figure 4: Construction of Niles Dam, 1887 (Stanford Digital Repository n.d.)

Fish

Niles Dam had a simple fish ladder, but still impacted the migration of steelhead trout in Alameda Creek. The effects of the dam's removal on fish populations were carefully considered in the removal planning process. In 2005, the USACE completed a study that found although Alameda Creek formerly had self-sustaining runs of steelhead trout, "Between the barriers to upstream migration of steelhead trout and the likely entrainment of smolts moving downstream, it is not possible at present for Alameda Creek to support a self-sustaining population of steelhead trout," (USACE 2005, 7). The USACE study suggested that removal of these upstream barriers (including Niles Dam), in conjunction with other restoration projects, would allow for a "viable steelhead trout fishery to be restored in Alameda Creek" (USACE 2005, 13).

The potential for reviving the steelhead trout population in Alameda Creek has been a rallying point for many in and around the watershed over the past two decades. A multitude of local groups and government agencies have been involved with the attempt to restore Alameda Creek in a manner that would support fish passage and fish habitat. The 1997 ESA listing of the steelhead trout variant in Alameda Creek had a major impact on motivating the community around restoring the creek for fish passage. Prior to the work on improving fish passage in Alameda Creek, "The only steelhead that…made it into Fremont's Niles Canyon since the 1960s [were] those few hand-carried. While the rescues may have little effect on the steelhead population, they have left a powerful impression on the people involved" (DelVecchio 2002). The value associated with the ecological resource of steelhead trout in Alameda Creek was the focal point of the restoration of Alameda Creek, and the successful removal of Niles Dam. The efforts to remove this dam also had a greater impact within the Alameda Creek watershed; according to Jeff Miller (2016): "The dam removals were a big step in stream restoration and provided a catalyst for other dam removal and fish passage projects in the watershed".

Summary

Niles dam was removed in 2006 after the dam owner, the SFPUC, opted to remove the aging structure to improve fish passage and limit liability. Initial momentum for removing the dam was created by local advocacy groups that identified the structure as one of several within the Alameda Creek watershed that needed to be removed to

improve habitat for steelhead trout. The SFPUC worked alongside the ACFRW, a consortium of stakeholders in the watershed, to plan the dam's removal, and involved local citizens through public forums and an EIR commenting period, as well as outreach and education activities. The majority of funding for the project was from the SFPUC and a state Proposition 13 grant.

Issues of concern addressed in the planning process included sediment management, water supply, and historical significance. Sediment management was the most prominent problem, and three separate studies were conducted to address questions about what would potentially occur to sediment stored behind the dam if left in place. The SFPUC settled with the stakeholder concerned about sediment issues, and left the sediment in place. The removal of Niles dam (along with the upstream Sunol dam which was removed at the same time) took approximately seven years to conclude and led to several other similar projects in the watershed.

Memorial Park Dam Case Study

Setting

Memorial Park Dam (Figure 5) was built on Pescadero Creek in 1938 as a Works Progress Administration project of the New Deal to provide a swimming hole and a reliable water source for Memorial County Park (San Mateo County Parks Foundation 2016, Hedlund et al. 2003, CA Fish Passage Forum n.d.; Krieger 2015a). The dam, which was approximately 4 feet tall and 48 feet wide, was built with a flashboard structure, however the removable flashboards were taken out in 2001at the request of the CDFW due to the potential to impede migration of steelhead trout and Coho salmon (San Mateo RCD 2012, San Mateo County ESA 2003, San Mateo RCD 2015). The removal of Memorial Park Dam (Figure 6) occurred on public land and was initiated with the encouragement of the CDFW, and with the full support of the landowner, San Mateo County Parks (Issel 2017, IWRP n.d.). The primary goal for the dam removal was to improve fish passage for protected species (Hedlund et al. 2003, Coastal Conservancy 2005).

Pescadero Creek (Figure 7) is within the Pescadero-Butano watershed, which encompasses 81 square miles of the Santa Cruz Mountains consisting mostly of forested area, park land, agricultural land, and the small towns of Pescadero and Loma Mar (MBNMSF 2004). Pescadero Creek drains a sub-watershed of approximately 41 square miles (CCC 2005). The watershed has historically supported timber harvesting and has

"high natural rates of erosion"; the area has experienced numerous mass-wasting and major flooding events (MBNMSF 2004, 11).

The removal of Memorial Park Dam was identified as a priority for improving fish passage in Pescadero Creek as early as 2003 by organizations including the CDFW, the NMFS, and the CCC (CA Fish Passage Forum n.d.). Goals for the removal project included improving passage for juvenile salmonids, protecting the San Mateo County Parks' diversion intake upstream of the dam, increasing flood flow capacity, maintaining the pool downstream of the dam, and restoring a thalweg in the channel upstream (San Mateo RCD 2012, 3)

Figure 5: Memorial Park Dam (San Mateo RCD n.d.)

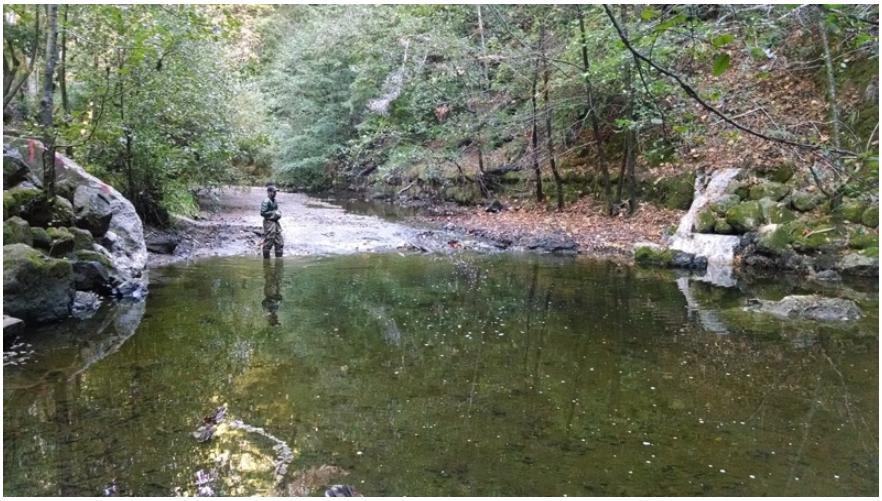

Figure 6: Former site of Memorial Park Dam (San Mateo RCD n.d.)

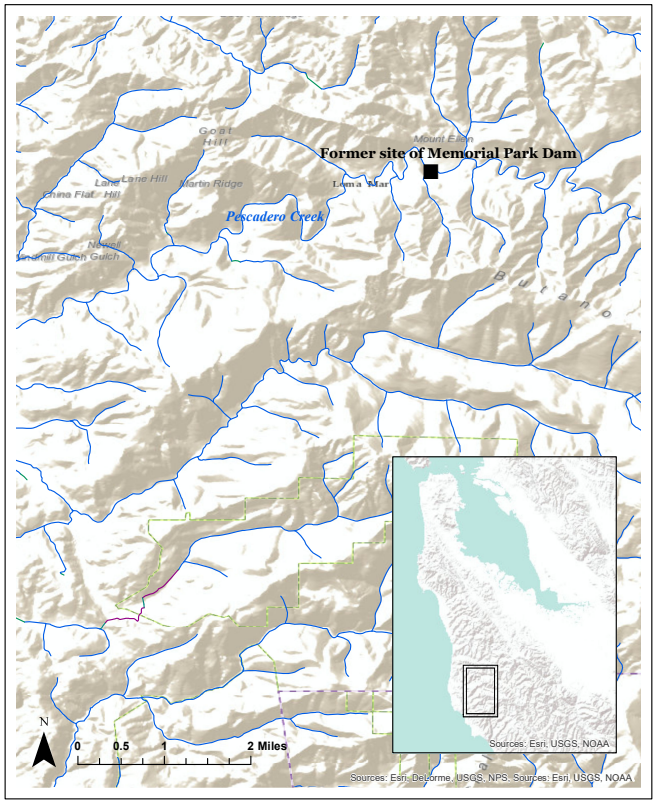

Figure 7: Map of Memorial Park Dam area

Actors

The San Mateo County Resource Conservation District (RCD) is empowered by California law to encourage and support the voluntary conservation of natural resources (San Mateo RCD 2017a). The San Mateo RCD took the lead in planning and coordination for the removal of Memorial Park Dam. Joe Issel, a Natural Resources Specialist working for the San Mateo RCD, characterized the removal of Memorial Park Dam as a "really unique example of what it takes to get a project like this done," he noted. The project involved the CDFW, San Mateo County Parks, and the CCC, among others (Issel 2017).

The federal government also played a role in promoting this removal project, having previously identified the restoration of the Pescadero-Butano watershed as an integral component of improving fish habitat on the California coast (San Mateo RCD 2012). The CDFW encouraged the San Mateo County RCD to apply for grants to help accomplish the removal of the dam along with work on the Sequoia Flats Crossing, which also impacted fish passage within Pescadero Creek in Memorial Park (Issel 2017, San Mateo RCD 2012). The primary fisheries restoration grant that funded the project was provided by CDFW through the National Oceanic and Atmospheric Fisheries Pacific Coastal Salmon Recovery Fund (NOAA Fisheries 2017).

The San Mateo RCD served as facilitator for the project, working with stakeholders to help the project move forward after it had stalled for several years (Issel 2017). This dam removal was exempt from CEQA, and much of the necessary permitting

for the project was handled by CDFW as a part of the Fisheries Restoration Grant Program, though the RCD did work to secure a stream bed alteration permit as well as additional funding (CCC 2005, Issel 2017). With a willing dam owner and the support of the local community regarding the removal of the dam, this project's actors were limited in number and worked together quite easily to accomplish the set goals. The dam's owner, San Mateo County Parks, also provided funding to help move the project forward (San Mateo RCD 2012, San Mateo County Parks Foundation 2016, San Mateo RCD 2015). The Integrated Watershed Restoration Program (IWRP) for San Mateo County also had involvement in this project via the San Mateo RCD, its partner through the California Coastal Conservancy (CCC), "invest[ing] in design work for the fish passage barrier removals" (Issel 2017, IWRP n.d.).

Some in the local community, which had enjoyed use of the swimming area created by the dam, were disappointed by the loss of the structure, but others were generally understanding and upbeat about the restoration project; a public education component was incorporated as part of the removal process (Issel 2017). Community feedback concerning salmonid restoration projects had also been incorporated into a prior study in the watershed in order to "conserv[e] and restor[e] the salmon and steelhead fishery, while continuing the long-standing land uses of agriculture, forestry, recreation, and open space, and preserving the rural character of the watershed," all highly valued uses of the land surrounding Pescadero Creek (MBNMFS 2004, 10).

There was a clearly delineated relationship between the landowner, San Mateo County Parks, and the organization that took the lead on removal planning and execution, the San Mateo RCD, with San Mateo RCD handling all project and financial management, and San Mateo County Parks allowing access onto the property for removal work, as well as contributing staff support and matching funds (San Mateo RCD 2015, 24). Funding for the project came primarily from the Fisheries Restoration Grant Program of the CDFW, and was supplemented by contributions from Pacific States Marine Fisheries Commission, San Mateo County, and the Joseph and Vera Long Foundation (San Mateo RCD 2017b).

Process

Preliminary planning for the removal of Memorial Park Dam began around 2003 with the commissioning of a study by San Mateo County to better understand the watershed with regard to water supply, fish passage, and streambed conditions (Hedlund et al. 2003). The study focused on identifying options for the management and restoration of Pescadero Creek within Memorial Park to improve all of the above-listed issues with the smallest number of trade-offs (Hedlund et al. 2003). Multiple additional studies between 2000 and 2010 identified Memorial Park Dam as a high priority for removal with regard to fish passage; two were published by the CCC, one by the IWRP, and one each by the CDFW and the NMFS (CA Fish Passage Forum n.d.). A NMFS study of the watershed from 2004 found that in Pescadero Creek, “migration barriers may be a

primary factor limiting the extent of available steelhead habitat" (MBNMSF 2004, 22-23).

Organizations at the federal, state and local level sought to have the dam removed to improve habitat and passage for salmonids. The CDFW listed the creek as a priority for Coho Salmon recovery efforts in its 2004 Recovery Strategy for California Coho salmon and the 1996 Steelhead Restoration and Management Plan for California, and the NMFS listed it as a conservation priority in its 2010 Coho salmon Recovery Plan (San Mateo RCD 2012). San Mateo County Parks had also worked for years to eliminate all stream barriers in its system; Memorial Park Dam was one of the last to be removed (Issel 2017, Hedlund et al. 2003). For decades preceding the first attempt at removing the dam, fish were the motivating factor behind the endeavor to remove the dam, and multiple studies reflected this reality.

Despite this motivation, efforts to move ahead with the removal of the dam were hampered by several setbacks. San Mateo County secured $280,000 for the removal of the dam in 2005 with an anticipated start date of 2007, but this first attempt to begin removal ultimately halted due to varying problems, including delays due to ESA-protected Marbled Murrelets near construction, as well as a key member of the construction crew suffering a heart attack (Issel 2017). When the project did not progress on schedule, the primary grant had to be returned and the project stalled until 2014, when the CDFW approached the San Mateo RCD and requested the organization's assistance in mobilizing efforts to resume the project (Issel 2017). With San Mateo County Parks on

board for the removal, planning for the second attempt began in earnest in 2014, and continued throughout 2015 (San Mateo RCD 2015; CCC 2005, 2). The dam was removed completely in 2015.

Date	Event
2003	Initial study completed with alternatives analysis
2005	Grant money secured by County Parks for initial attempt at removal
2007	First scheduled removal date
2013	Project resumes with RCD coordinating
Fall/Winter 2014	Pre-Construction, permitting
Summer 2015	Construction
Winter 2015-present	Monitoring

Table 2: Timeline of the Memorial Park Dam removal process

Risks and Considerations

During the planning process for Memorial Park Dam's removal, several issues required an increased level of attention and consideration. Although by most standards this removal was straightforward, risks regarding fisheries, sediment, and management decisions led to a need for innovative thinking and considerable efforts to continue moving the project forward.

Management issues

Several management issues developed in the course of planning and execution of the dam removal project. After the beginning of construction, the design of the project had to change, resulting in the need to for updated permitting, and additional funding also had to be secured for the project beyond the Fisheries Restoration Grant from the CDFW

(Issel 2017). The design change permit issue was handled through good working relationships and communication between the permitting agency (the CDFW) and the agency in charge of coordination and planning (San Mateo RCD); additional funding was secured early by the San Mateo RCD in the process as cost overruns were anticipated (Issel 2017). Additionally, construction windows were planned to manage risks to the protected Marbeled Murrelet that have habitat in the vicinity of the dam (Issel 2017).

The resources and efforts of groups such as the IRWP and the San Mateo RCD, as well as the support of CDFW were important factors enabling removal to resume and succeed despite issues in the management of timing and funding. With many different entities in support of the dam removal project for improving habitat and passage for salmonids, getting support for management decisions or changes to the project was easier; planning and decisions focused on what actions would make the project work best for salmonids post-removal. Having an organization besides the dam owner leading planning of the project may have also contributed to the ease by which management decisions were handled; Issel described the San Mateo RCD's function during the project as follows: "We try not to have our own agenda…we try to build consensus around projects that meet landowner's goals and natural resource management goals…we try and balance demands for limited resources" (Issel 2017).

Water resources

San Mateo County Parks diverts water from Pescadero Creek for use in several local parks, as well as for a few nearby residents (San Mateo RCD 2015). A 2003 water supply study of the park found that removal of the dam would, "…preclude a summer recreation impoundment on the stream and tail-water ponding upstream of the water diversion intake, a major change in the purposes and uses of the park" (Hedlund et al 2003, 46). The same study also noted "compromising seasonal ponding behind the flashboard dam potentially exposes the water diversion intake at very low streamflows and constrains water supply" (Hedlund et al. 2003, 41).

Questions about impacts to this water supply had to be settled satisfactorily before proceeding with the dam removal. As the intake from Pescadero Creek was just upstream of Memorial Park Dam, San Mateo County Parks expressed concerns that dam removal would affect the intake volume, and also that downcutting in the creek after removal could make the water level too low for intake (Issel 2017). Studies found that the dam had no impacts on storage upstream, and that in the reach of concern, downcutting was limited by bedrock (Issel 2017).

Fish and sediment

Both steelhead trout and Coho salmon were historically present in Pescadero Creek, however by the time planning began for Memorial Park Dam's removal, only steelhead trout were still present, and in vastly smaller numbers than in previous decades

(CA Fish Passage Forum n.d.). While Pescadero Creek no longer had viable runs of Coho salmon, the species was listed by the state as an endangered species in 1995, and the "Central California Coast evolutionary significant unit was listed as a 'threatened' species under the ESA in 1996" (Frucht 2013, 6). The listing of this species garnered more attention and support for stream restoration projects on the creek, and Memorial Park Dam was removed primarily due to the presence of protected salmonids and the need to improve population numbers to meet resource agency goals. While multiple studies supported dam removal to address this problem, outcomes were not guaranteed. Questions regarding how steelhead trout used the structure as it stood and potential impacts on these fish from dam removal were difficult to answer, with one study suggesting the removal of the dam could reduce habitat for spawning upstream of the dam by mobilizing sediment (Hedlund et al. 2003, 85). Ultimately, an overwhelming amount of evidence in support of removing the dam to improve fish habitat and passage outweighed the potential adverse effects to spawning habitat for steelhead trout upstream of the dam. Removal proceeded with limited pushback from stakeholders.

Pescadero and Butano Creeks were both listed as impaired by sediment on the California 303(d) list under the CWA, requiring that watershed managers needed to develop a plan to reduce the pollutant and improve water quality (SFBRWQCB n.d.). The listing stated the sediment impairment specifically affected the protected salmonids within the creek (MBNMFS 2004, Frucht 2013). The sediment stored behind the dam was potentially impairing habitat for juvenile fish, reducing spawning and rearing habitat

for fish, and diminishing water quality (San Mateo RCD 2015, 23). Because of issues with sediment in the watershed, the removal of this barrier was proposed not only to allow anadromous species easier access to upstream areas, but also to increase the complexity of habitat in areas downstream by allowing for easier movement of sediment within the creek (San Mateo County Parks 2016).

Summary

Memorial Park Dam was a small dam in the Pescadero-Butano watershed in San Mateo County. The removal planning process for Memorial Park Dam was managed by the San Mateo RCD with the consent and support of the dam owner, San Mateo County Parks. Multiple state and federal studies identified Memorial Park Dam as a priority for removal to improve fish passage, and the majority of the funding for the project came from a CDFW Fisheries Restoration Grant. The primary goal of removal was to improve passage and habitat for ESA-protected salmonids.

Although San Mateo County Parks attempted to remove the dam in 2006, the dam was not removed until 2015 when the San Mateo RCD took over managing the project as suggested by CDFW. The removal of the dam in 2015 occurred in tandem with another project in the park to improve fish passage. Stakeholders in the project included San Mateo County Parks, local residents, the CCC, IWRP, and CDFW. Concerns about impacts to water supply intake for San Mateo County Parks as well as potential negative effects on salmonids from removal were addressed through studies completed in the

planning stage. The project took approximately twelve years to complete, and monitoring is ongoing.

Analysis and Discussion

No two dam removals are identical; every case has a unique set of factors that will influence how easily a project progresses (Magilligan et al. 2017). The aforementioned cases share enough similarities that they can be compared to derive information as to planning aspects that support a small dam's removal. Both Niles Dam and Memorial Park Dam were aging; they had outlived their original purposes and were in need of repair or removal to limit liabilities and enhance salmonid habitat. The Alameda Creek watershed and the Pescadero-Butano Creek watershed are historical habitat for federally protected fish species, and had land uses primarily characterized by rural, open-space and agriculture. The major differences between these watersheds were their size and Pescadero Creek's excessive sedimentation rates.

These two case studies demonstrate how planning and decision-making efforts can support successful removal of small dams. Even though Niles Dam was larger and had a more complex planning process because of the need for CEQA compliance, the timelines for both projects are remarkably similar. Comparing each of these projects against a prescriptive planning and decision-making framework, the similarities in the chronology of their planning efforts are notable. A prescriptive framework for small dam removal planning developed in 2002 by the Heinz Center report lists the following steps:

"1. Identify the goals and objectives of the dam removal project.

2. Identify the major issues of concern.

3. Gather and assess the data.

4. Decide whether to keep or remove the dam.

If a decision is made to remove a dam, then the following steps may apply:

5. Dam removal

6. Data Collection, Assessment, and Monitoring" (Heinz Center 2002, 96)

For both Niles Dam and Memorial Park Dam, this framework applies. In both cases the main goal of dam removal was fish passage. Major issues of concern were then addressed for each; in the case of Niles Dam, through the process of attaining CEQA compliance, concerns relating to the environmental, social, legal and other ramifications of removal were addressed through a lengthy environmental impact study and public commenting period. For Memorial Park Dam, several smaller studies were carried out to ensure these same concerns were addressed. In both cases, removal was the option selected over alternative methods of handling the dams' impacts on protected fish species and potential environmental degradation that were studied at length. Finally, each dam was removed in an environmentally sensitive manner and went through monitoring post-removal. The timeline for each project varied; Niles Dam removal took approximately seven years from inception to monitoring; Memorial Dam took approximately 12, due to several years of stalled progress in the middle of that period.

Just as the planning processes were similar for each project, the actors involved in these projects also shared several features. Both included public and private stakeholders

at the local, state, and federal level, and required cooperation of multiple organizations and individuals. Neither project had to work with a private dam owner; both the SFPUC and Memorial County Park (part of San Mateo County Parks) are public institutions. Motivation behind starting evaluation for each removal project also developed similarly; for Niles Dam non-owner advocacy groups (such as the Alameda Creek Alliance and Alameda Creek Fisheries Restoration Workgroup) initiated the call for removal of the dam. For Memorial Park Dam this process was also initiated by a non-owner group, as the CDFW and NMFS identified Pescadero Creek as a priority for salmonid habitat and passage and Memorial Park Dam as a high priority barrier for removal. San Mateo County Parks and the SFPUC had both evaluated removal of the dams independently as well prior to removal. The SFPUC had ceased using Niles Dam for water supply (its primary benefit when built) decades earlier and mostly viewed the dam as a liability. Memorial County Park had removed two other small dams within the park and had wanted to remove Memorial Park Dam for a period of time before removal was undertaken.

Primary management and coordination for each, as well as local community involvement varied considerably. For Niles Dam, the primary management of the project including coordination, fundraising, and permitting was handled by the dam's owner, the SFPUC. Local citizen and community feedback was solicited to a much greater degree than at Memorial Park Dam, perhaps because of the need for CEQA compliance. Memorial Park Dam's removal was managed in the first unsuccessful attempt through

San Mateo County Parks, but during the second successful removal attempt, a group that did not own the dam – the San Mateo RCD – managed the project by facilitating communication among stakeholders, fundraising, and obtaining permits.

The treatment of risks and issues in the planning process of each dam removal are more challenging to compare. Issues including the best course of action for fish populations and sediment management developed in both cases, but at different scales. At Niles Dam, major concerns about sediment management were handled through ongoing communication and extensive research, finally concluding in a settlement to ensure the buy-in of potentially affected stakeholders. Memorial Park Dam's removal planning ran into issues with the dam's owner regarding water supply. This was handled through demonstrating to San Mateo County Parks that the project could proceed with no impact on water supply. In general, both projects managed to address concerns raised by stakeholders through researching the issues further, adapting plans and coming up with alternatives, as well as prioritizing communication.

The three basic propositions of this study – that planning at the watershed scale, understanding and incorporating the political ecology of each project, and securing buy-in from local stakeholders helped secure a successful outcome – are reflected throughout both the Niles and Memorial Dam removal planning processes. The driving goal behind both projects, improving anadromous fish habitat by removing barriers, led to each project being managed at the watershed scale. Both dams were identified for removal because opening up each watershed to anadromous fish helped meet goals of natural

resource agencies such as CDFW. Focusing on how each dam fit into the larger picture encouraged the progress of planning efforts. For Memorial Park Dam, the CDFW was so invested in the restoration of the watershed for salmonids that it resurrected the project after the first attempt at removal failed. Operating at this scale also encouraged multiple agencies' involvement from the outset, meaning more stakeholders had input on the project from an earlier point in the process, and more resources and viewpoints were available for moving the project forward and addressing problems along the way.

More evidence of watershed-scale planning can be found in that both dam removals were coupled with other fish passage improvement projects. Niles Dam was removed at the same time as the larger Sunol Dam upstream, also owned by the SFPUC. The EIR for Niles Dam also covered impacts from the removal of Sunol Dam; the two dams together were treated as a single project. In Memorial County Park, the dam removal happened concurrently with remediation of a vehicle crossing that was also impacting fish passage. The vehicle crossing was also owned by San Mateo County Parks and treated as part of a "package deal" with the removal of the dam. The pairing of each of these small dam removals with other fish passage improvements reflects momentum to improve entire watersheds for protected salmonids in the San Francisco Bay Area, rather than projects to address one barrier at a time.

In general, the San Francisco Bay Area has a favorable political environment for river restoration projects. At Niles Dam, the SFPUC was easily convinced of the ecological advantages of removal promoted by local stakeholders. The incorporation of

multiple viewpoints was encouraged by the SFPUC as a part of the environmental impact study and public commenting period, and many of the comments collected raise concerns about the manner in which the dam removal was to be handled, not a desire to leave the dam in place. The SFPUC's acknowledgement of the historic runs of steelhead trout in Alameda Creek and the dam's impacts on the potential for future steelhead trout populations to thrive in the watershed demonstrates attention to local issues of concern (as seen in groups such as the Alameda Creek Alliance). As a local organization, the San Mateo RCD successfully managed the removal of Memorial Park Dam removal, incorporating public outreach into the project. The dam had a local historical component as it had created recreation opportunities for generations. This was addressed by the San Mateo RCD through public education about positive outcomes made possible by removing the structure. Both projects included local viewpoints in the planning process.

Setbacks in the planning process were treated differently for each project, but this could be due to the difference in the types of setbacks faced. For Memorial Park Dam, delays in construction eventually led to the temporary cessation of work. Approximately six years passed before the dam removal was reinitiated, and at that point the process was managed by a new organization that was able to secure and coordinate funding from a willing CDFW that wanted the project completed to meet agency goals regarding salmonids. Meanwhile, the major setback of disagreement about how to manage stored sediment behind Niles Dam was handled over a matter of months, with concerns from the county raised in 2005, and construction completed in 2006. The necessity of the CEQA

process may have made it easier for this project to continue progress more quickly than the other project despite a setback; the CEQA process and environmental impact reporting provide structure that forces the organization undertaking a dam removal to plan for and mitigate negative environmental outcomes. By the time the EIR for the Niles Dam Project was published, multiple studies had already been completed regarding potential outcomes for both leaving the sediment in place and dredging and disposal. Additionally, the dam owner (SFPUC) funded a good portion of removal costs – Memorial Park Dam was more reliant on outside grants to complete the project. For these two cases, funding and the structure associated with the planning process appear to have impacted how expeditiously each was able to address and overcome setbacks.

Searsville dam, an aging dam in the San Francisco Bay Area, is an interesting point of comparison. Although the dam is much larger than the two considered in this study at 65 feet tall and 275 feet wide, it remains in place despite significant local organizing that promotes removal and the potential for steelhead trout restoration within the watershed (Krieger 2015b). The propositions of this study – that planning at the watershed scale, understanding and incorporating the political ecology of each project, and securing buy-in from local stakeholders help secure successful outcomes – are also reflected in the planning efforts behind attempts to have Searsville dam removed.

According to O'Reilly (2010), local stakeholder groups comprised of multiple stakeholders (the Beyond Searsville Coalition), and multiple governments within the watershed (the San Francisquito Creek Joint Powers Authority) have worked together on

flood control issues and steelhead trout restoration within the watershed. A great deal of watershed-scale planning happens in the area, and local stakeholders are invested in pursuing the dam's removal. The Beyond Searsville Coalition has also carried out public education and engagement within the watershed to increase local support for the removal of Searsville dam for steelhead restoration and sediment management (O'Reilly 2010). Despite this organizing from local governments and stakeholder groups, the dam's owner, Stanford University, has expressed little interest in removal (O'Reilly 2010).

In 2015 the university committed to either allow water and sediment to pass through the dam through a new opening in the structure (which could potentially lead to full removal at a later date), or to allow the reservoir to completely infill, create a new course for the creek, and add a fish ladder (Krieger 2015b). Like other dam removal projects, sediment management has been a significant issue; at Searsville dam downstream areas are heavily populated and dredging the reservoir is not environmentally feasible (Krieger 2015b). O'Reilly (2010) suggests the concentration of power in the hands of the university makes this case unique; the university controls if a feasibility study for removal is conducted and if dam removal is pursued (barring government action to force removal such as a failed inspection).

While Searsville dam meets this study's propositions, it has not been successfully removed. Confounding factors such as the owner's unwillingness to remove the dam, the location of the dam (and proximity to populated areas), and the size and construction of the dam may all be factors contributing to why the structure still exists. Although the dam

still stands, the university's willingness to work towards a solution for improving sediment and water movement around or through the dam suggests that the involvement of local stakeholders and watershed-scale planning have led to at least consideration of removal or remediation at a later date.

Conclusion

Planning for the removal of a small dam is a complex process and requires careful attention to the physical, ecological, economic, social, legal, and political features of the process (Heinz Center 2002, 96). Failure to acknowledge and account for the complexity of this process can hinder progress and prevent projects from meeting goals (Orr et al. 2004, 109). A conceptual model describes this process as follows:

> "Dam Removal = O + E + F + P1 + P2 where O is the Opportunity or impetus for change, E is the Economics, F is the Fortitude, the time investment by an interested party, P1 is the Place attachment and community pressure, and P2 is the Political involvement." (Orr et al. 2004, 108).

It takes all of these separate components working well to complete a dam removal. Better and earlier understanding of all components of this process can help future projects progress through the planning stages with greater ease. The case studies presented here demonstrate how incorporating multiple perspectives in planning and addressing issues beyond just the physical and ecological, as well as planning at the watershed scale, can support small dam removal projects' forward progress and enable stakeholders to meet restoration goals.

The underlying motivation for these two dam removals can be traced back to policy shifts at the state and federal level. The listing of steelhead trout as a protected species appears to be the foundation of all efforts to move toward removal, as well as a motivating factor behind keeping these projects in the pipeline and progressing. As science continues to demonstrate constructive bio-physical outcomes of free-flowing rivers and communities grow to value the benefits provided by undammed rivers, perhaps continued efforts to promote policy that can fund, support, and regulate dam removals can help make these projects more commonly successful. In the United States, barriers to fish were placed for benefits such as water supply, recreation, and, flood control, and many citizens have grown attached to dam structures as part of their communities. However, as society has shifted to valuing other aspects of the natural resources the river provides for (such as fisheries) that conflict with the values dams were built for, the movement to remove more barriers has grown (Born et al. 1998).

With thousands of smaller dams reaching the end of their usefulness and becoming liabilities rather than assets, communities of stakeholders will have to evaluate these values alongside difficult questions regarding financing and consensus. Fundamental necessities to successful small dam removal planning in this study included factors such as willing owners, available funding for both construction and evaluation, local community and stakeholder buy-in, and a lead organization able to manage the process in a manner that both incorporated multiple viewpoints and built consensus out of them.

Further analysis of more small dam removal projects could provide insight about what opportunities can lead to dam removal as well as how projects are managed, perhaps at the state scale, due to differences between states regarding permitting, dam regulations, and politics.

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