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The Disconnect Between Restoration Goals and Practices: A Case Study of Watershed Restoration in the Russian River Basin, California

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Abstract

Over the past two decades, watershed restoration has dramatically increased internationally. California has been at the forefront, allocating billions of dollars to restoration activities through legislation and voter-approved bonds. Yet, the implications of restoration remain ambiguous because there has been little examination of restoration accomplishments and almost no analysis of the political context of restoration. This article addresses these gaps, utilizing a case study of the Russian River basin in Northern California. We identify trends that shed light on both the ecological and the political implications of restoration at a basin scale by examining a database of 787 restoration projects implemented in the Russian River basin since the early 1980s. Although a total of over $47 million has been spent on restoration in the basin, dominant forms of restoration are limited in scope to small-scale projects that focus on technical solutions to site-specific problems. The majority of restoration efforts are devoted to road repair, riparian stabilization, and in-stream structures, accounting for 62% of all projects. These types of projects do not address the broader social drivers of watershed change such as land and water uses. We suggest that restoration can become more effective by addressing the entire watershed as a combination of social and ecological forces that interact to produce watershed conditions.

Key words: ecological restoration, geographic information systems, Mediterranean-climate streams, post project monitoring.

Introduction

The amount of public investment in restoration is increasing, accounting for more than a billion dollars annually in the United States alone (Bernhardt et al. 2005). Yet, there is limited understanding of ecological patterns (Kondolf 1995, 1997; Downs and Kondolf 2002) and social implications associated with restoration (Gobster and Hull 2000; Higgs 2003). A recent study compiled coarse-scale data on restoration efforts nationwide (Bernhardt et al. 2005), concluding that little is known about the outcomes of restoration because postproject monitoring and assessment are extremely limited. A growing literature on biophysical monitoring has attempted to address this gap, focusing primarily on site-level analyses of ecological and geomorphic metrics (Harris et al. 2005). However, these measures do not address social aspects of restoration like the institutional context, which many credit as determining where and how restoration is done (Lufkin 1991).

The objective of this article is to better understand how and why restoration occurs the way that it does. The central questions that we address are: (1) Where is restoration happening; (2) How is restoration happening?; and (3) How has the practice of restoration changed over time? In answering these questions, we discover a disconnect between restoration goals and practices that we investigate further in the Discussion and Conclusions by asking: Why does this disconnect exist? and How can it be bridged? Our methods focus on analyzing a database of 787 restoration projects implemented in the Russian River basin, California, over 21 years. Although this article primarily analyzes the long-term dataset, we have also conducted extensive interviews with restoration practitioners and participated in restoration activities throughout the Russian River watershed, which informs our interpretation of the data (Christian-Smith 2006).

In order to understand where restoration is happening, we examine the spatial distribution and landscape attributes of restoration projects using a geographic information system (GIS) database of restoration project locations throughout the basin and available data layers on landscape features such as land use/land cover and lot size. This examination provides insight into the types of landowners who are primarily benefiting from the current practice of restoration and the ecological context in which it occurs. In order to understand how restoration is happening, we devote particular attention to the often overlooked institutional framework—the agencies and organizations involved in funding and implementing restoration. We analyze how policy language and funding priorities are translated into on-the-ground practices,

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focusing on the three agencies most involved in funding restoration activities in the Russian River basin. Finally, in order to understand how the practice of restoration has changed since the early 1980s, we examine trends in the types of projects implemented, their costs, and the organizations involved.

Methods

We employ a case study approach, focusing on an area of concentrated restoration effort and funding for several decades. The Russian River basin is located on the North Coast of California, straddling Mendocino and Sonoma Counties (Fig. 1). It is roughly 80 miles long, drains 1,485 square miles, and has an average annual discharge of 1.6 million acre-feet. Current land uses include timber harvesting, ranching, gravel mining, and intensive agriculture. Approximately 98% of the Russian River basin is privately owned. Although the majority of the basin is characterized by low-density rural development, the southern portion is experiencing a boom in suburban and urban development around the city of Santa Rosa (U.S. Census 2006*a*, 2006*b*).

Over the past three decades there have been several major institutional sources of funding for restoration projects in the Russian River basin. These include the California Department of Fish and Game (CDFG), the U.S. Department of Agriculture (USDA), and the Sonoma County Water Agency (SCWA). These agencies have

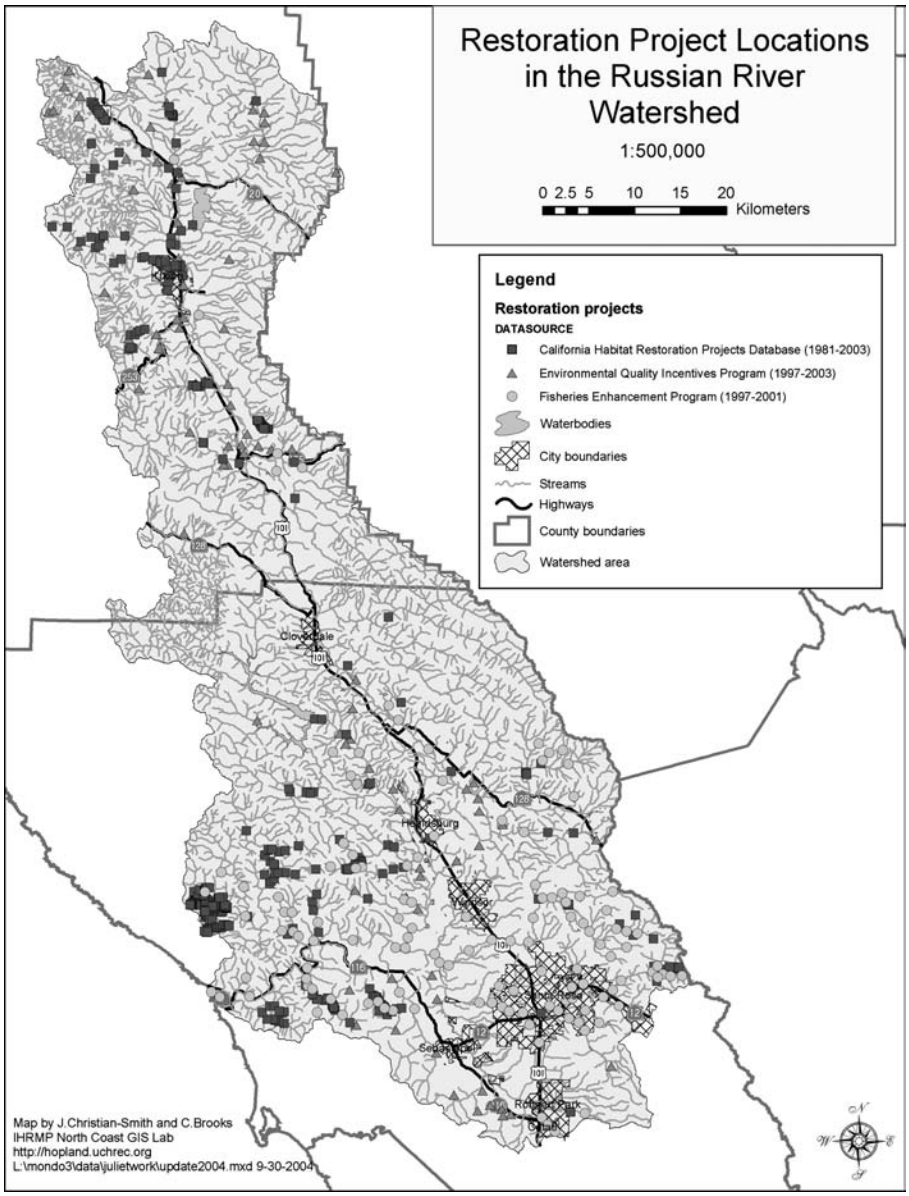

Figure 1. Restoration project locations within the Russian River Basin.

distributed funds for restoration activities from federal sources (Pacific Salmonid Fisheries Act) and state sources (California Senate Bills and voter-approved Propositions) through a variety of grant programs including: CDFG's Fisheries Restoration Grant Program, the USDA's Environmental Quality Incentives Program, and SCWA's Fisheries Enhancement Program. The priorities of these grant programs vary and thus, the characteristics of projects associated with each differ in some interesting ways that will be noted in the Results and Discussion sections.

In order to analyze the spatial distribution of restoration projects at the basin scale, we built upon an existing GIS of the Russian River basin. The first step was to collect and compile geographic coordinates and project details for restoration projects throughout the Russian River basin in an ArcMap database. We gathered GIS data from the CDFG California Habitat Restoration Projects Database describing projects funded through the Fisheries Grants Restoration Program (1981–2003). Second, we gathered and digitized map-based data and associated project information for restoration activities funded by the USDA Environmental Quality Incentives Program (1997–2003). Finally, we gathered and converted AutoCAD data and associated project descriptions describing restoration activities funded by the SCWA Fisheries Enhancement Program (1997–2001). We clipped the combined spatially explicit databases to the boundaries of the Russian River basin.

The resulting database of restoration projects included a total of 787 projects that were implemented in the Russian River basin between 1981 and 2003. Although this encompasses a variety of funding sources, it does not capture many of the smaller projects implemented without agency funding. Therefore, it does not represent the entire universe of restoration projects present in the basin and may bias the outcomes toward larger-scale projects. However, it does provide a comprehensive representation of the types of projects that receive the majority of public funds. The spatial distribution of these projects, along with associated grant programs, is displayed in Figure 1. To determine the randomness of the spatial distribution of restoration project locations in relation to land use classes, we utilized a Monte Carlo simulation that took the empirical probabilities of land uses in the basin and simulated the distribution of the 787 project locations 1,000 times, using a macro script in Excel. We then calculated the z statistic by comparing the means from the observed and simulated distribution of project locations across four major land use categories. The test is considered statistically significant if the difference between the two means is significantly different than zero (as measured by the p value of the z score).

In order to analyze the practice of restoration, we looked at the various kinds of restoration projects that were implemented over time. First, we extracted the "work types" associated with restoration projects from the GIS database to define the most prevalent forms of restoration. Projects that involved more than one practice were categorized based on the practice that received the greatest amount of funding. In addition, we examined how restoration project types, costs, and associated organizations have changed over time. Second, we examined the economic context of restoration by extracting restoration costs from the GIS database and associating these with policy changes and a growing restoration industry (Gustaitis 2004; Baker 2005). Finally, we examined the institutionalization of particular restoration practices by analyzing the policy language and funding priorities of three agencies most involved in restoration activities in the Russian River basin.

Results

Our research reveals distinct patterns in the locations and types of projects that are funded by three major funding institutions in the Russian River basin. The following results demonstrate the prevalence of site-specific, technical approaches (particularly in-stream, riparian, and road-related improvements). Other objectives that are included in restoration goals and policies such as water quality, water quantity, habitat acquisition, and education are not widely addressed by the current practice of restoration in the basin. These results are relevant not only in a regional context but also internationally because an international survey of river restoration across 35 countries documents the prevalence of technical approaches and the implementation at reach or subreach scales (Wheaton et al. 2006).

Where is Restoration Happening?

To examine different landscape attributes associated with restoration project locations, we first looked at land cover and land use. Over half of the restoration projects had associated land use data available from the county tax assessor's office and Landsat TM satellite imagery. Based on this data, from both Sonoma and Mendocino Counties, the majority of restoration projects were located on four land uses classes: timberland, rangeland, rural residential land, and vineyards. "Rangeland" includes land classified by the tax assessor as rangeland or pastureland along with areas without land use data that are classified by Landsat TM satellite imagery as having hardwood/chaparral land cover. "Rural residential" includes land that has one or fewer units per acre. Higher densities are classified as suburban and urban.

Figure 2 displays the percent of restoration projects associated with each of the four most common land use classes and juxtaposes that with the percent of the watershed area in each of the four land use classes. Timberland and rangeland had the highest number of restoration projects associated with each land use class (117 and 116 projects, respectively). However, it is important to note that rangeland occupies a much larger area, accounting for nearly 60% of the total acreage in the Russian River basin, whereas timberland accounts for less than 10% of the total acreage in the basin. The difference between the

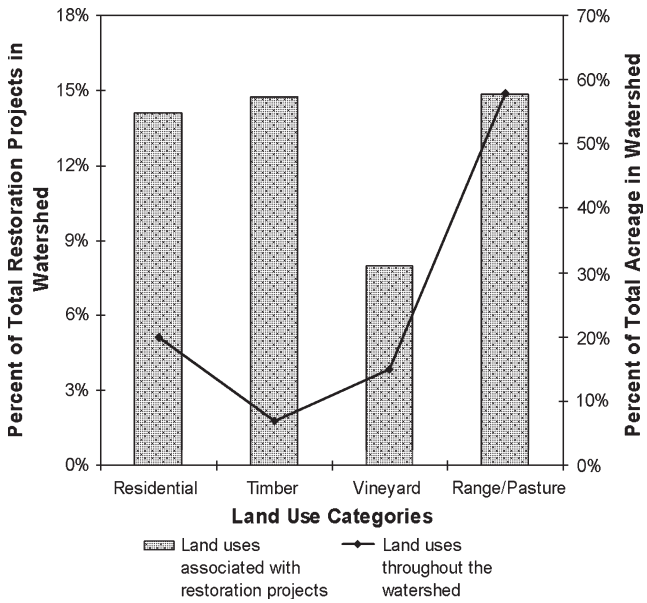

Figure 2. Restoration and land use.

observed and the expected values for residential and vineyard land use classes were not statistically significant (p values of 0.26 and 0.42, respectively). The difference between observed and expected values for timber and rangeland land uses was highly significant (p values of <0.0001 and 0.003, respectively). Therefore, the real difference in land uses between the restoration project locations and the basin as a whole is due to the over-representation of restoration project points on timberland and the under-representation of restoration project points on rangeland.

Similarly, we examined the distribution of average lot sizes within a 500-m buffer of restoration project locations and compared these to the distribution of average lot sizes throughout the basin. We used five lot size categories: 0–4, 4–14, 14–26, 26–40, and greater than 40 ha. Almost 45% of restoration projects are located in areas with an average lot size of greater than 40 ha. This is not particularly surprising because the basin is dominated by very large, rural properties. However, restoration projects are over-represented on medium to large average lot sizes of 14–40 ha. There are approximately 15% more restoration projects in areas that have average lot sizes of 14–40 ha than would be expected by looking at the distribution of lot sizes across the basin. We theorize that this is associated with the goals of the funding programs and the privatized landscape (Discussion section).

How is Restoration Happening?

Here, we examine the practice of restoration as a physical and political process, beginning with an analysis of how policy language and goals are translated on-the-ground by three primary agencies involved in restoration activities in the Russian River basin. First, the CDFG Fisheries Restoration Grants Program is the dominant funding source in the Russian River basin and in many coastal areas of California. Between 1981 and 2006, CDFG invested over $180 million and supported approximately 2,600 salmonid restoration projects (CDFG 2006). California Senate Bill 271 (Thompson & Ducheny 1997) created the Salmon and Steelhead Trout Restoration Account that provides the CDFG with much of the funding to support projects that improve fish habitat. Section 4 of Senate Bill 271 states restoration goals:

"Projects that restore habitat for salmon and anadromous trout species that are eligible for protection as listed or candidate species under state or federal endangered species acts shall be given top funding priority…Projects may implement instream, riparian, water quality, water quantity, and watershed prescriptions and shall be designed to restore the structure and function of fish habitat" (Senate Bill 271 1997, sections 4b & 4c).

The legislation goes on to define that 65% of the money shall be used for on-the-ground salmon habitat protection and restoration, with 75% of that amount going specifically to "watershed (upslope) and riparian area protection and restoration activities." Only 35% of the money can be allocated to other uses like watershed evaluation, watershed planning, watershed organization support and assistance, public school watershed, and fishery education programs (Senate Bill 271, section 4d 1 & 2).

The Fisheries Restoration Grants Program project solicitation package reiterates that the objective of the program is to fund projects that are consistent with the goal of salmon and steelhead trout conservation and restoration (CDFG 2006). This package includes a list of 22 approved project types like habitat acquisition, upslope restoration, watershed education, flow meters, and other relatively diverse restoration practices. However, an analysis of the 726 funded projects between 2001 and 2006 reveals that there are clear trends in the types of projects approved (Fig. 3). Habitat acquisitions and conservation easements, postproject monitoring and maintenance, water conservation, and water measuring devices are

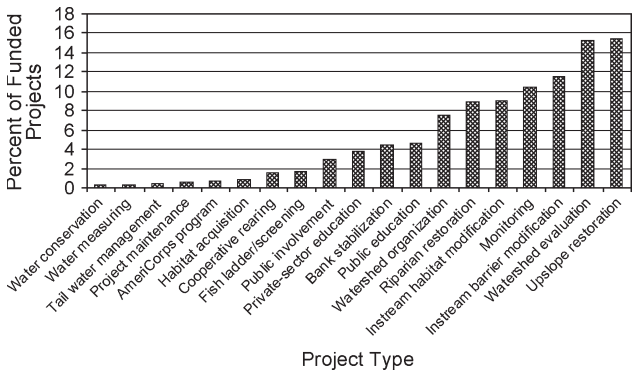

Figure 3. Project types funded by CDFG fisheries restoration grants program, 2001–2006.

among the project types with fewer than 20 funded projects. On the other hand, upslope watershed restoration and watershed evaluation each account for over 100 funded projects.

A closer examination of project descriptions reveals that almost 40% of projects focus on site-specific in-stream and riparian work (this includes projects from several different categories: in-stream barrier modification, in-stream habitat restoration, riparian restoration, and in-stream bank stabilization), 28% of projects are associated with some sort of assessment, and 28% of projects are associated with road improvement (almost all of the projects categorized as upslope restoration are road related). In addition, nearly half of the projects categorized as watershed evaluations and assessments involve inventories of road crossings and sediment production from road surfaces. This clearly illustrates the disconnect between broad policy goals that suggest a wide variety of restoration strategies and the comparatively narrow on-the-ground practices, as 91% of practices can be categorized as assessment, in-stream, riparian, or road repair work.

Second, the USDA's Environmental Quality Incentives Program implemented 499 projects in Sonoma and Mendocino Counties between 1997 and 2002 (Natural Resources Conservation Service 2002). The Environmental Quality Incentives Program Final Rule, issued by the USDA Commodity Credit Corporation (Federal Register 1997) explains that it is a voluntary program for agricultural producers, authorized at $1.3 billion over 7 years. Section 1466.6 of the Final Rule explains that "the participant shall develop and submit a conservation plan for the farm or ranch unit of concern that, when implemented, protects the soil, water, or related natural resources in a manner that meets the purpose of the program, is acceptable to NRCS [National Resource Conservation Service], and is approved by the conservation district. This plan forms the basis for an EQIP [Environmental Quality Incentives Program] contract." Although particular conservation techniques are not specified by the legislation, they are provided in the state of California's approved practices that list over 100 approved practices.

Again, by examining the actual categories of funded projects, a less diversified picture emerges. In Sonoma and Mendocino Counties, the majority of implemented practices involve constructing access roads (9%), fencing (11%), riparian protection (13%), and structures for water control (21%). Many of these measures address sediment production and nonpoint source pollution, which are increasingly being regulated—most recently by the Environmental Protection Agency's new total maximum daily load provisions that specify the maximum amount of a pollutant that a waterbody can receive from point and nonpoint sources.

Finally, the SCWA Fisheries Enhancement Program funded 63 projects in the Russian River basin. The restoration program was funded, in part, through the Pacific Salmonid Restoration Act that the head of the Water Agency played a key role in coordinating and lobbying for in Congress. The specific goals of the program are stated as: (1) to work cooperatively and in conjunction with other federal, state, and local agencies to preserve, enhance, and restore fishery habitats and resources; (2) to develop research programs to study the fisheries within affected watersheds; and (3) to assist the environmental compliance section of the agency in the assessment of impacts, the writing of environmental documents, and permit compliance for the agency for projects which may effect fisheries resources (SCWA 2006). It is the last of these that is particularly interesting because restoration is specifically being linked to mitigation in the program's stated objectives.

Examining the Fisheries Enhancement Program's annual reports from 1997–2001 reveals a clear preference for funding internal agency projects along with surveys, studies, and research—much of which is required to protect endangered species. For instance, a "Fish Rescue Activities" project was awarded $15,000–20,000 during the 1997–1998 funding cycle. An examination of the project description reveals that the agency operates several pumping stations and infiltration ponds for its water supply and distribution network that trap fish (including endangered salmonids). The project paid for labor to capture and release trapped Chinook salmon and steelhead trout back into the Russian River main stem.

In summary, the results presented in Figure 4 show that the most common types of restoration across all three funding sources were riparian improvements (including bank stabilization, invasive plant removal, and riparian revegetation), road improvements (including culvert replacements/removals, road paving, and installing rolling dips), surveys (including field studies of fish habitat and abundance), and in-stream improvements (including altering the channel morphology to meet Rosgen [Rosgen 1994] stream-type classifications, installing structures such as large woody debris, and barrier removal). Less common in practice are activities related to education, water conservation, and upland restoration.

How Has the Practice of Restoration Changed Over Time?

Finally, we examine how the proportion of different project types changed between 1981 and 2003. The results

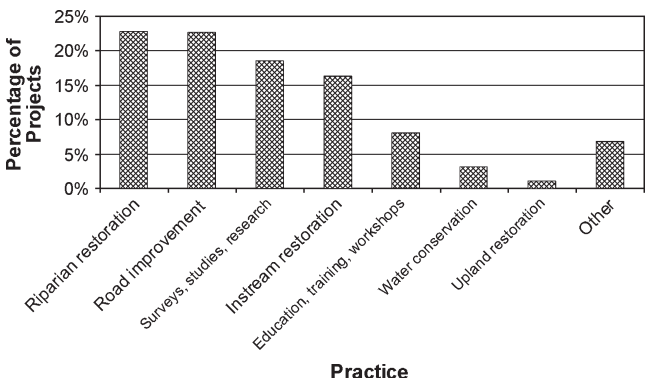

Figure 4. Restoration project practices.

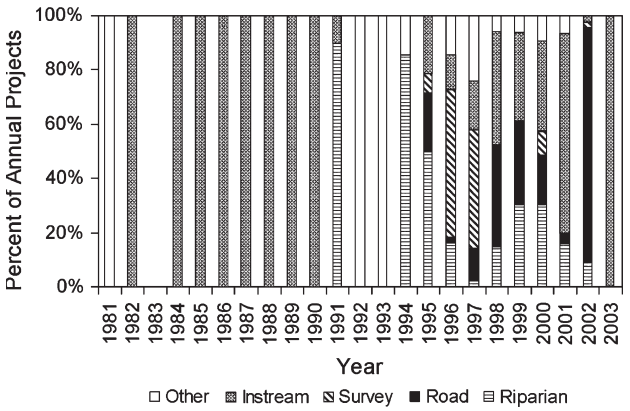

Figure 5. Restoration practice, 1981–2003.

show that restoration practice has shifted over time from primarily in-stream work through the 1980s to include a higher proportion of riparian- and road-related work in the 1990s and 2000s (Fig. 5). Major changes in practice can be seen at several time points. In 1991, riparian-related restoration activities became important (accounting for 90% of the annual projects), though they have since declined in prevalence. In 1995, both road-related work and surveys began to be common practices. Although the survey and research work dropped off after 2001, road-related work has persisted. In 2002, road-related work accounted for nearly 80% of all projects.

Along with changing practices, there have also been changing costs associated with restoration activities. The total investment in restoration has, predictably, increased over time (Fig. 6). Still, there has been considerable fluctuation and some substantial increases. Most markedly, between 1997 and 1998, the total cost of restoration activities rose from below $1 to $8 million, and from 2002 to 2003, costs jumped from just below $3 million to nearly $16 million. The per project cost of restoration has also increased from an average of almost $19,000 in 1981 to a little over $700,000 in 2003.

With the increased funding, there have been an increasing number of institutions and organizations associated with restoration activities. The organizations involved

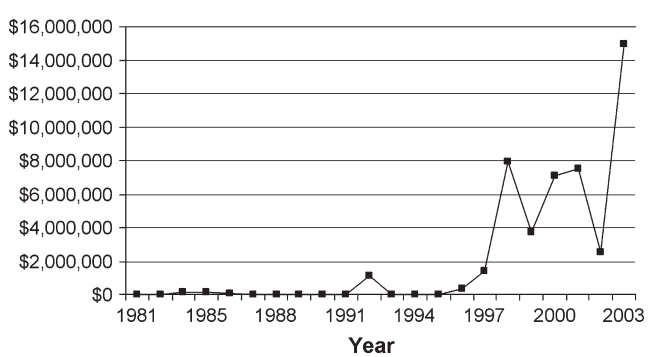

Figure 6. Total investment in restoration, 1981–2003.

with restoration significantly increased in 1998 from a handful of agencies to over 20 different entities. Interestingly, between 1998 and 2003, the character of these organizations changed from primarily federal and state agencies along with local nonprofits to an increasing number of private restoration, design, and engineering firms including Pacific Watershed Associates, Bioengineering Associates, Prunuske and Chatam, Dragonfly Stream Enhancement, Forest Soil and Water Inc., Doyle and Company, and Watershed Science. This growing "restoration industry" (Gustaitis 2004; Baker 2005) specializes in particular types of work, primarily engineering-oriented solutions at a site scale.

Discussion and Conclusions

Our results illustrate where and how hundreds of restoration projects were done over a 20-year period in the Russian River and compare these outcomes with the intended goals of restoration as articulated by the agencies involved in restoration statewide. The resulting disconnect between restoration goals and outcomes on the ground points to a restoration implementation crisis that requires new directions in order to bridge the gap between intension and practice.

In terms of where restoration happens, the over-representation of restoration project points on timberland and the under-representation of restoration projects on rangeland may be attributed to the focus of several granting programs on restoring upstream salmonid spawning habitat, which is often timberland in the Russian River basin. Two of the main restoration funding programs are interested in fisheries restoration and thus are more focused on spawning regions that are found in higher elevations of the basin. These steep uplands have lower population densities and larger parcel sizes. In addition, landownership in the basin is almost completely private and therefore conducting restoration requires finding willing landowners, gaining the legal right to access property through landowner agreements, and establishing trust and cooperation to ensure the restoration project is implemented correctly and maintained. There can be diminishing returns when attempting to work with many small property owners. Thus, large, rural landowners who are primarily engaged in agriculture and timber extraction benefit most from the current pattern of restoration.

When looking at the entire database, the most common restoration practices in the Russian River basin include: riparian, road, and in-stream improvements, which together account for 62% of the projects in the database. Some surveys and research were conducted, but the funding source that provided almost all of the support for these activities terminated in 2001. The focus on stream and road improvements can be explained, in part, by the emphasis on the California Salmonid Stream Habitat Restoration Manual (Flosi et al. 1998), which past restoration grant recipients refer to as the "Bible" of stream restoration. Section VI of the manual (Project Planning and

Organization) defines five fish habitat restoration categories: (1) upslope improvements; (2) riparian and bank stability improvements; (3) in-stream habitat improvements (with the stipulation that "Rosgen's stream classification system…provides a basis for evaluating instream structure suitability"); (4) artificial propagation; and (5) watershed stewardship programs. Although there is diversity in the restoration practices outlined, the implementation section is much narrower in scope. Section VII (Project Implementation) covers only in-stream large woody debris and boulder structures (pp. 1–46), fish passage structures (pp. 47–61), and bank stability structures (pp. 62–97) with dozens of design drawings depicting plan views and cross sections. There is little to no guidance regarding upslope improvements, watershed stewardship, education, and land and water conservation—despite that the Department of Fish and Game itself has prioritized water quantity as one of the key "limiting factors" for salmonid survival in the basin (CDFG 2002).

A panelist discussing restoration on the 16 March 2006 edition of the National Public Radio program *Forum* remarked that although road repair and barrier removal projects may not be their top priority in terms of restoring the ecological processes of a stream or bringing back a fishery, the funding is there for this type of work and therefore they "have to get on the boat." Indeed, although the California Salmonid Stream Habitat Restoration Manual defines upslope restoration as improving road drainage, road or trail obliteration, reforestation, or changes in land management (section VI, p. 3), in practice, it is almost exclusively road repair.

Our results demonstrate the increasing costs associated with these types of repairs and show that the total number of restoration projects has increased over time resulting in a greater expense to the public. Examining changing environmental legislation reveals significant incentives and regulatory action to encourage or require restoration like California Senate Bill 271 that passed in 1997, providing substantial funding for restoration in the area. As a response to this increased funding for restoration, a growing restoration industry has emerged that specializes in technical restoration practices. As the results indicate, road improvement has become one of the most prevalent practices in recent years. The design and implementation of road improvements were initially popularized in California by the private firm, Pacific Watershed Associates. One of the founders of the firm was quick to point out that they only work on technical matters of road improvements and do not discuss larger watershed issues (Hight 1998).

Equally significant are those practices that are *not* well represented, which include education for the public and school children, land and water conservation projects to address harmful activities beyond the riparian zone, and upland projects that are focused on changing land use patterns or activities beyond the riparian zone. Therefore, although the goals of restoration are broad, addressing watershed-scale ecological processes and social issues, the actual practice of restoration is primarily restricted to repairing streams and re-routing sediment at specific sites. Why does this disconnect exist? How can it be bridged?

We suggest that the disconnect between restoration goals and practice is closely related to a lack of attention to the social, political, and economic drivers of watershed degradation. Water quantity and flow levels in the Russian River are examples of a larger, and critical, watershed issue that is currently not being addressed by the practice of restoration. In the summer of 2007, the Water Resources Control Board mandated reductions of water use by municipalities and agriculture in the Russian River basin (Rose 2007). This request was made because there was not enough water in existing reservoirs to provide adequate flows for salmon migration and could result in a violation of the Endangered Species Act. Restoring stream flow during the dry season, when almost no rain falls in the basin and demand for water is at its peak, is critical for salmon recovery and requires that the practice of restoration addresses water quantity as listed in the agencies' programmatic goals for their restoration programs. Water quantity in streams is currently not part of the restoration efforts in upland streams, with the exception of the recent efforts by the Mattole Restoration Council and Sanctuary Forest in Humboldt County, California. There, restoration practitioners are tackling the issue of water quantity by working with water attorneys to draft "forbearance" agreements where riparian water rights holders forebear their summer water rights in exchange for off-stream reservoirs (McKee, unpublished report).

Similarly, in the Russian River basin, the Salmon Coalition is exploring ways to provide incentives for altering the use of historic rights in order to improve stream flows in areas designated as critical for salmon recovery. These efforts are currently not seen as "restoration projects" per se and therefore have not received restoration dollars, yet they are critical for salmonid survival. In conclusion, real solutions will only be found when restoration looks beyond the stream to address the entire watershed as a combination of social and ecological forces that interact to produce watershed conditions. Bridging the disconnect between restoration goals and practices will require better coordination of agencies involved in restoration to focus on larger, watershed-scale concerns.

Implications for Practice

- Restoration must address the social and ecological forces that interact to produce watershed conditions in order to create sustainable ecosystems and equitable policies.
- More research needs to be done on the root causes of environmental degradation, and these causes should be understood within a social context, particularly in terms of policy mandates and economic incentives that motivate particular land and water uses.

- Funding should be targeted at modifying the social drivers of environmental degradation by focusing on more transformative changes at a basin-scale, particularly in terms of land and water conservation and management, policy, and education.
- Restoration practices must also include efforts to protect upland habitat from harmful activities beyond the riparian zone associated with land use. Reducing sprawl and agricultural conversion in the uplands would both reduce the demand on water and protect remnant upland habitat.

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