RESILIENCE IN A TIME OF DROUGHT: BUILDING A TRANSFERABLE MODEL FOR COLLECTIVE ACTION IN NORTH COAST WATERSHEDS

By

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ABSTRACT

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For thousands of years, an abundance of salmon coincided with the development of numerous human communities in Northern California. When Euro-American settlers arrived the 1800s, water diversions and a slough of other behaviors were introduced, contributing to a steep decline of native salmon populations. Today, cumulative human impacts—coupled with California's extreme drought—have resulted in the degradation of salmon habitat and a decrease in water security for rural residents who rely upon local watercourses for their household and irrigation needs.

In Southern Humboldt County on California's North Coast, longer dry seasons and an observable trend toward low water flows in the Mattole River inspired a local land trust called Sanctuary Forest to implement a collaborative watershed restoration effort from 2005-2013, focused on managing water diversions among rural residents. Their strategy for self-governing a common pool resource resulted in measurable improvements in streamflows within their program area and a cultural shift toward watershed stewardship.

The objective of this project was to produce a technology transfer guide for stakeholders in North Coast watersheds on how to replicate or scale-out water

conservation strategies from one setting to another while accounting for the complex socio-cultural and ecological variables that exist in every populated rural watershed. The guide is based on methods that were employed during the feasibility study for transferring Sanctuary Forest's streamflow improvement strategy to Redwood Creek on the South Fork of the Eel River. Within a participatory action research framework, place attachment and place dependence are emphasized as significant factors that can promote rational behavior among local residents.

Key Words: Salmon, Northern California, water diversions, drought, water security, rural, Southern Humboldt County, North Coast, low water flows, Mattole River, Sanctuary Forest, collaborative watershed restoration, self-governing, common pool resource, watershed stewardship, technology transfer, feasibility study, Redwood Creek, South Fork Eel River, participatory action research, place attachment, place dependence, rational behavior

DEDICATION

To the peoples and the salmon of the Eel River basin.

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First and foremost, I would like to thank Dr. Betsy Watson and Tasha McKee, my Committee Chair and Project Placement Advisor, respectively. Dr. Watson's guidance made my participation in this project possible. Tasha McKee is the local visionary who developed a functional collective action strategy for the Mattole River watershed. Without her creativity and tireless advocating for people and for fish over the years, there would be no transferable model for collectively managing streamflows and markedly less hope for improving water security for rural residents on the North Coast.

I feel fortunate to have had an opportunity to learn from and work with some of the most passionate and knowledgeable watershed advocates and restorationists in the region. For the sake of brevity, I would like to thank a few individuals who were particularly active during the development of this project, though this list falls far short of acknowledging all of the people who have made personal or organizational contributions to the effort. I offer my sincere gratitude to Dana Stolzman of Salmonid Restoration Federation, whose leadership and investment in this project resulted in a fledgling feasibility study developing into what will become a long-term water conservation program in the Redwood Creek watershed. Additionally, I would like to acknowledge the

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CHAPTER ONE
INTRODUCTION

Preface

My involvement in this project began in the fall of 2012, while I was enrolled in a Dispute Resolution course with Dr. Elizabeth "Betsy" Watson. She approached me after class one day and explained that she sat on the Board of Directors for a non-profit land trust based in the southern region of Humboldt County called Sanctuary Forest, and that they had an idea for a project that they wanted to pursue. Dr. Watson explained that the project involved technology transfer and would attempt to address the problem of low summertime water flows that impact people and endangered salmon in a rural watershed. While I did not yet understand what a "technology transfer" project might entail, I knew immediately that this undertaking would be an ideal fit for me based on my interest in the nexus of resilience, public engagement, and responsible stewardship of finite natural resources. There are few environmental challenges as seemingly intractable or alarming as fresh water scarcity, and this project presented me with an opportunity to learn from seasoned watershed restoration practitioners, to engage with local community members, and to build on applied social theory concerning rural environmental problems.

Ultimately, the result of my collaboration with Sanctuary Forest would be the completion of a manual that could be shared with individuals and institutions concerned with low summertime water flows in their watershed. Sanctuary Forest's vision was to

provide a step-by-step guide for watershed stakeholders in Northern California and elsewhere on how to transfer successful water conservation practices and technologies from one setting to another while accounting for the unique social and ecological variables that exist in every watershed. In order to produce a manual that would be applicable to a diverse range of watershed stakeholder groups, we felt that the guidelines for a transferable water conservation model should be based on methods that had been tested and vetted in a real-world scenario. We partnered with another locally-based non-profit called Salmonid Restoration Federation in order to conduct a feasibility study for technology transfer that would ultimately provide the foundation for the steps outlined in the manual.

This project embeds the feasibility study of a collaborative watershed restoration effort in the southern region of Humboldt County (hereafter referred to as Southern Humboldt) within its socio-cultural context, in order to bring to light some of the intersecting variables that can promote or hinder transferability to other watersheds on the North Coast. From the onset, my intention has been to contribute sociological insight and strategic support to efforts that have been underway for years, if not decades. As such, I claim no ownership over this project; it belongs to the people who have invested countless hours and resources toward restoring a balance between local communities and the North Coast watersheds that they call home.

Chapter One describes the research setting and need for the project, followed by a broad historical overview of the paradigmatic shifts that have contributed to the transformation of Humboldt's watersheds over time, and concludes with an examination

of Elinor Ostrom's (1990) theory of collective action as an appropriate framework and strategy (under certain circumstances) for self-governing a scarce natural resource. In Chapter Two, relevant literature regarding place attachment, collaborative watershed restoration, and technology transfer is reviewed. The methodological framework for this project is outlined in detail in Chapter Three, followed by a discussion in Chapter Four on several factors that should be considered when attempting to transfer a collective action strategy from one rural North Coast watershed to another. In Chapter Five, I offer recommendations on how to address specific challenges that may surface during the development of a collective action endeavor, based on observations and lessons learned during the feasibility study that took place in Redwood Creek on the South Fork of the Eel River.

The step-by-step guide, entitled "Resilience in a Time of Drought: A Transferable Model for Collective Action in North Coast Watersheds", was designed for use in watersheds where a rural population is dependent on a local watercourse for their agricultural and household needs, and where changing human use has the potential to increase streamflows. The guide has been included in this document as an Addendum and has also been prepared separately for distribution in a printer-friendly PDF format. Relevant watershed maps, tables, guidelines, and educational materials that relate to or were developed for the feasibility study in the Redwood Creek watershed are included as appendices and referenced as appropriate throughout this document.

Research Setting

In Southern Humboldt on California's North Coast, the lands are dominated by the magnificent Eel River, which reaches into five counties and drains the third-largest watershed in the state at a total of 3,684 square miles (see Appendix A). The basin is comprised of the Van Duzen River (a major tributary of the Eel), as well as the Middle Fork, North Fork, and South Fork, with the latter being the area of focus for this project. As the largest tributary of the Eel, the South Fork meanders for 105 miles from its headwaters west of Laytonville to the point where it meets the Main Stem of the river near a stand of ancient redwood trees known as Founder's Grove along the scenic highway of the Avenue of the Giants.

While archaeologists suggest that humans may have inhabited the Humboldt region from as early as 8,000 B.P. (Before Present), it wasn't until around 3,000 B.P. that the climate shifted from the hot and arid post-glacial age to cooler and wetter, favoring "an ecological mix that has lasted to recent times: in the hills, mixed forests of Douglas fir, tanoak, chinquapin, and madrone, which often unless in check by fire, intrude on the open oak grasslands; in the valleys, redwoods and/or alders, willows, and California bay; in the mountain, pine and/or chaparral adapted to periodic fires" (Raphael & House 2007:10). The shift to a Mediterranean climate—characterized as warm and dry in the summer and wet in the winter—was favorable to at least five distinct species of anadramous fish, including fall-run Chinook salmon (Oncorhynchus tshawytscha), coho salmon (Oncorhynchus kisutch), and steelhead trout (Oncorhynchus mykiss) (NOAA

2012:49; Yoshiyama & Moyle 2010). Anadramous species spend much of their adult lives at sea but spawn and rear as juveniles in the cool fresh water of rivers, and in the Humboldt region their numbers multiplied.

The South Fork was once home to the largest runs of coho and Chinook salmon in the Eel River, and quite possibly the entire state, with historic estimates prior to the mid-twentieth century ranging from 100,000 to 800,000 per year for Chinook and 50,000 to 100,000 per year for coho (NOAA 2012; Yoshiyama & Moyle 2010). In recent decades, the South Fork's salmon populations have been decimated by a range of impacts that will be discussed later in this project. The Chinook population is listed on the Federal Endangered Species Act and the coho population, an ecologically significant unit (ESU) that is considered vital for conservation and recovery in the Pacific Northwest, is on both the California and the Federal Endangered Species List (NMFS 2012; Spence et al. 2012). Protecting juvenile spawning and rearing habitat is critical in order to prevent these important coho and Chinook populations from becoming extinct, and poor water quality resulting from low water flows is considered to be one of the highest impediments for species recovery (NOAA 2012).

Low water flows during the dry summer months are a significant source of concern not only for juvenile fish—which can become trapped in evaporating pools of water if a stream or tributary dries and becomes disconnected—but also for the rural residents who depend on a regular supply of fresh water from local watercourses to provide for their household and irrigation needs. In several of Southern Humboldt's watersheds, including those of the South Fork, residents have raised the alarm that

summertime water flows are observably lower compared to historic levels. Low water flows can result in a marked decrease in *water security* for rural residents, which UN-Water (2013:vi) defines as:

> The capacity of a population to safeguard sustainable access to adequate quantities of and acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability.

The observable trend toward low flows in some of Southern Humboldt's watersheds cannot be pinpointed to one cause. However, there are cumulative impacts of concern that should be taken into consideration, several of which will be discussed later in this chapter. One is climate change, which is understood to be an influencing factor in California's persistent and extreme drought (Gleick 2014). While this research project was underway, California was experiencing its worst drought since recordkeeping began in the 1840s, with one paleoclimatologist suggesting that 2013 "could potentially be the driest water year in 500 years" (Ingram 2014 cf. Hockensmith 2014). While climatologists predict that changes in global climate will continue to manifest in unexpected ways in the Pacific Northwest, longer dry seasons (i.e. months without rainfall) are an impact already being felt in Northern California, which can result in reduced water quality and quantity for increased periods of time.

The challenge of low water flows galvanized many concerned residents and stakeholders in Southern Humboldt to raise a challenging question: How can we become more resilient in a time of drought, and what can we do to keep more water the rivers, tributaries, and streams so that people and fish have enough to survive?

History and Culture Beyond the Redwood Curtain

> "One could not design a better creature on which to base culture than the salmon." –Richard Manning (2003:35)

The distance from the San Francisco Bay Area to the "redwood curtain"—the southern border of Humboldt County where the road narrows and winds through a towering grove of old-growth redwood trees that block the sunlight with their dense canopy—is nearly two hundred miles. Once you pass through the redwood curtain and continue your journey north on Highway 101, it is hard not to feel as though you are entering a place where time has progressed more slowly and where development has not left the same scars as in other more densely populated regions of California. With its dynamic landscapes of rugged mountains, fertile grasslands, mighty salmon-bearing rivers, and redwood forests that continue to mark the passing of time in their ancient growth rings, Humboldt elicits the impression that in this place, wilderness still reigns supreme. However, the view from Highway 101 is deceiving; it veils a complex history that has indeed left scars, some visible and some not. In this section, my objective is to broadly situate this research project within its historic environmental and socio-cultural context, in order to illustrate why a paradigm shift toward manipulation and control of natural resources—introduced by the arrival of Euro-American settlers in the nineteenth century—has had far-reaching implications for Humboldt's presently ailing watersheds.

It is hard to ignore the symbolic beauty of the "moment" in human history when at around the same time the salmon began to flourish, so too did human settlements in the

Pacific Northwest. Raphael & House (2007:10) note that the increased carrying capacity of the land due to the abundance of salmon likely resulted in a significant cultural shift for humans:

> After about 3,000 B.P., some groups seem to have established more permanent settlements near local rivers. Along the Mattole River, archaeologists have dated some of their findings at 2,600 B.P. to 1,600 B.P. Projective points from this area, worked on only one side, are referred to as "McKee unifaces," and that name is applied to similar points found in faraway locations. Nearby on the South Fork of the Eel River, artifacts date from a similar period, as do artifacts from the vicinity of Redwood Creek.

Plentiful annual salmon runs in the Pacific Northwest helped to ensure the development of numerous indigenous communities—distinct and divided according to "village, band, family, and language" (Raphael & House 2007:15)—stretching from Alaska to British Columbia and southward down the coast of California (Woody 2003). Ceremonial practices regarding the annual or semi-annual return of salmon were elaborate and coordinated between many different peoples, emphasizing consideration for one's downstream and upstream neighbors:

> Enough time was allowed to pass during ceremonial practices so that ample numbers of fish were assured passage to their preferred spawning grounds, protecting future fish populations. Of equal importance, the practices guaranteed that upstream peoples had plenty to eat, which made a large contribution to keeping the peace. (Raphael & House 2007:31).

In Humboldt and other coastal regions in the Pacific Northwest, feasts and celebrations are still held in honor of salmon, which continue to embody a significant cultural and spiritual totem for many native peoples (Amirsoleymani et al. 2011; Reed & Norgaard 2010; McCovey Jr. 2002).

Salmon are a highly adaptable species and have evolved over time within dynamic ecosystems characterized by “active disturbance regimes (volcanic eruptions, landslides, wildfires, floods, variations in marine and freshwater productivity) that occur on a variety of spacial and temporal scales” (Waples et al. 2008). However, no disturbance seems to have impeded the stability of salmon populations more wantonly than the arrival of Euro-American settlers in the nineteenth century, when a slough of human impacts were introduced that have contributed to an unprecedented and steep decline of what were once magnificent salmon runs.

Numerous historical impacts have been studied and documented including the fur trade, logging, over-fishing, the damming of critical salmon habitat, and the diversion of water for residential and agricultural use (Raphael & House 2007; Lichatowich & Zuckerman 2003; House 1999; Yoshiyama & Moyle 2010; Sawyer 2010). These and other environmentally damaging behaviors practiced by many Euro-American settlers were indicative of a mindset that still permeates much of western culture today, where “human use of the land and its resources in the near term seemed more important than protecting ecological bounty in perpetuity… Surrounded by native abundance, those settlers acted as though the riches of nature were put there expressly for people” (Lichatowich & Zuckerman 2003:18). A cultural ethic of stewardship that had enabled human communities to live as common inhabitants of a complex and dynamic ecological system for thousands of years was replaced in the span of a few decades (Platt 2011), coinciding with the systematic and barbarous massacre of native peoples in the region. Thus, the arrival of Euro-American homesteaders and ranchers in the 1800s signaled a

paradigmatic shift in the Pacific Northwest toward a culture of manipulation and control of natural resources for the purposes of economic development.

If we fast-forward to Humboldt in the mid-twentieth century, the salmon populations were still at relatively high levels compared to current estimates, numbering in the tens of thousands annually in the South Fork of the Eel River despite "more than fifty years of commercial harvest and decades of increasingly disruptive habitat alteration" (Yoshiyama & Moyle 2010). Of particular significance to Humboldt's watersheds during this time was the Douglas-fir logging boom of the 1950s and 1960s, made possible by enormous earthmovers that were developed based on tank technology from World War II (House 1999). By the 1970s, countless miles of logging roads had been cut into steep hill slopes and large swathes of riparian habitat had been cleared (NOAA 2012; Yoshiyama & Moyle 2010; Mount 1995). To this day, the logging roads in Humboldt contribute significantly to "erosion… and increased sediment loads in the region's rivers, leaving streams shallower, warmer, and more prone to flooding" (SONCC 2012 cf. Raphael 1974; Bodin et al. 1982).

By the time the Z'berg-Nejedly Forest Practice Act was adopted in 1973, establishing a code for timber harvesting in California, more than 80-percent of the old-growth trees in the region had already been cut, leaving glaring scars on the landscape, as House (1999:43) describes:

> Whole mountainsides that had been shaded by large old conifers were now grown up with brush species, and abandoned roads patterned the slops like lace. In 1983, crossings and culverts long abandoned were still collapsing into the waterways. The rootwads that had continued to hold the slopes in place for an additional twenty to twenty-five years after the trees had been

> cut were now rotted away; as the roots rotted, the structural integrity of the slopes was undermined, and they collapsed in massive landslides.

The industrial logging boom slowed at around the same time that a new wave of settlers began to arrive in Southern Humboldt. They were the "back-to-the-landers," a "rebellious subculture [and] a reaction against the materialistic excesses and the spiritual complacency of mainstream America" (Raphael 1985 in Boal et al. 2012:187). One long-time resident of Southern Humboldt explains, "As the energy of the '60s counter-culture waned in the urban centers, particularly San Francisco, many young people chose to continue the Utopian experiment by moving into rural areas where they could live off-grid, closer to nature and out of the prying eyesight of authorities" (Jakubal 2013).

Those who identify as a Humboldt back-to-the-lander tend to emphasize a "humanistic, low-budget, innovative, make-do approach to living, and a desire to live in harmony with the environment" (Myers 1976), espousing similar tenets to those of bioregionalism. McGinnis (1999:13) describes bioregionalism as "a body of thought and related practice that has evolved in response to the challenge of reconnecting socially-just human cultures in a sustainable manner to the region-scale ecosystems in which they are irrevocably embedded." It has also been suggested that a bioregion is defined not only by its geographical terrain, but by its "terrain of consciousness" as well, delineated by a cultural unity between people who are learning to "live in place" and who have "spiritual identification with a particular kind of country" (Berg 1976 cf. Parsons 1985:2). There are many critiques of bioregionalism as a social movement and philosophy that I see as valid (Mason 1987; Taylor 2000; Pepper 2007); however, I will not be addressing these

critiques for the purposes of this project. By drawing attention to the similarities between bioregionalism and Southern Humboldt's back-to-the-land movement, my intent is only to emphasize that with the arrival of the back-to-the-landers, a new shift in cultural thinking about how people live on and interact with the land and its resources was introduced.

Humboldt's back-to-the-landers moved to a countryside marred by decades of environmental degradation. A desire to "make things right" (House 1999:49) and to establish homesteads with sufficient access to food and fresh water instigated numerous and varied attempts to undo some of the most egregious damage (House 1999; Mattole Restoration Council 2005; Gienger 2006), with a growing focus on the "watershed" as a useful basis for organizing rural residents to heal the landscape. Early on, some of Humboldt's most dedicated proponents of restoration were recognizing the benefits of organizing their efforts at a watershed-scale:

> As if to accommodate perceptual differences among people, a watershed organizes itself into ever more available scales—from river to tributary to swale. Any individual might be able to create a relationship with some small part of it. Neighborhood groups might be able to see their activities as a part of the function of a tributary basin. And thus we might build a community sensitive enough to understand adjust itself to the opportunities and constraints of an ever larger whole. (House 1999:157)

The Winter 1976 edition of The CoEvolution Quarterly, a publication of The Whole Earth Catalog read by many Humboldt homesteaders, was known as "The Watershed Issue" and contained articles from dozens of contributing authors. An entire section of the catalog was dedicated to "watershed consciousness," which the author Peter Warshall (1976:5) described as a kind of "Middle Way between Mind and Planet" that attempts to

restore “the disconnectedness of mind, body, heart and breath to water, soil and other creatures.”

The Watershed Issue of The CoEvolution Quarterly also discussed the practical implications for restoration at a watershed-scale. In an article entitled “Healing the Land: The Redwood Creek Renewal Project,” author Gerald Myers described his attempt to establish a restoration-based economy in the economically depressed and ecologically impaired watershed of Redwood Creek, which, coincidentally, is the same watershed where the feasibility study for this technology transfer project took place.

Myers’ (1976:74) motivation for initiating The Redwood Creek Renewal Project echoed those shared by many Humboldt back-to-the-landers: “It’s your heritage, this ripped-off land. What are you going to pass on to your kids?”

With impressive foresight, Myers (1976:75) “pipe-dreamed” an idea for addressing erosion and sediment control in the Redwood Creek watershed: develop “a project approach that recognizes the social context within which the project operates” by reflecting “the unique local factors of both the physical and social environment.” In his words (1976:76):

> The project [was] a deliberate move away from the large-scale, energy intensive projects of the past, and [was] a move toward smallness, diversity, local control, and the use of appropriate technology in a labor-intensive, energy-efficient manner.

Obstacles were foreshadowed in the 1970s that still apply today (Myers 1976:75-76): local attitudes and lack of consensus on how to address the problem; the need for balancing a “property rights” ethic with a “property responsibility” ethic; bureaucratic fences posed by a list of agencies and legislation that “seems endless”; current

economics; and, lastly, the "sheer magnitude" of the problem complicated by "large land areas, diverse ownerships, difficult technical problems and...a jungle of overlapping agencies."

The Redwood Creek Renewal Project received some state funding in the early 1970s (Gienger 2006) to implement an action plan that paired small-scale watershed restoration projects with part-time jobs that met the expressed needs of local residents. As the local economy became "ever more deeply rooted in [the] illegality" (Raphael 1985 in Boal et al. 2012:187) of marijuana production (discussed later in Chapter Four), the need for restoration-based jobs diminished and The Redwood Creek Renewal Project was ultimately disbanded, though it's founders continue to engage in important restoration and fire protection efforts in Southern Humboldt to this day.

With the economic motivation for participating in watershed restoration largely removed, an exploration of alternative means for facilitating a behavioral shift toward stewardship and conservation is needed. The following section discusses a framework for organizing people to participate in the self-governance and stewardship of a scarce natural resource.

Theoretical Framework

When attempts to restore *streamflow* (the flow of water in streams, tributaries and channels) in a watershed necessitate a shift in behavior toward water conservation and stewardship on the part of local residents, it is useful to apply a theoretical framework that informs an understanding of how individuals can be organized to act collectively for

the continued enjoyment of a shared resource. In *Governing the Commons: The Evolution of Institutions for Collective Action*, Elinor Ostrom (1990:30) provides a seminal examination of collective action as a model for self-governing a *common-pool resource* (CPR), defined as a "natural or man-made resource system that is sufficiently large as to make it costly (but not impossible) to exclude potential beneficiaries from obtaining benefits from its use."

If the CPR of concern is a biological resource, the over-allocation of available *resource units* (such as cubic feet of water diverted from a watercourse) may result in a reduction of the ability of the *resource system*—a river, for example—to continue to produce resource units. Beyond the ecological implications, this is especially problematic for *appropriators*, or individuals who withdraw resource units from resource systems, when they are dependent on a CPR for both subsistence and economic purposes. In this situation, appropriators are faced with the inescapable reality that they are "tied together in a lattice of interdependence" for as long as they continue to share a single CPR (Ostrom 1990:38).

In instances where policy prescriptions and state control of resource systems have been unsuccessful in accomplishing specific restoration goals, a move toward self-governed collective action by appropriators may be a viable alternative. One of the central challenges of self-governance of a CPR is how to avoid the "free-rider" problem, in which an individual who cannot be excluded from the benefits of labor that others provide is motivated to free-ride and act opportunistically, rather than to contribute to the collective effort. Ostrom (1990:39) suggests that the free-rider problem is actually an

issue of organizing; in other words, "how to change the situation from one in which appropriators act independently to one in which they adopt coordinated strategies to obtain higher joint benefits or reduce their joint harm."

To organize for collective action, a set of contingent activities (i.e. activities that are contingent on 'conditions in the world') in a sequential order should be specified and the participation of a minimal number of appropriators should be secured. Appropriators are frequently willing to "forgo immediate returns in order to gain larger joint benefits when they observe many others following the same strategy" (Ostrom 1990:39).

What are the variables that might influence an appropriator to engage in strategic behavior that could solve a CPR problem, rather than to free-ride? Unfortunately, the answer is not streamlined, nor is it static. The behavior of an appropriator is influenced by *time horizons* (i.e. whether or not the individual will be present to reap the benefits of collective action, and the amount of time it would take for the benefits to manifest), *discount rates* (the amount of physical and economic security faced by an individual), and *norms of behavior*, or "valuations that individuals place on actions or strategies in and of themselves, not as they are connected to immediate consequences" (Ostrom 1990:35).

If shared norms in a given setting emphasize self-interested behavior, the motivation for appropriators to participate in collective action may be reduced. Individual choice will also influence the actions of an appropriator, and Ostrom (1990:37) cites four variables to consider: expected benefits, expected costs, internal norms, and discount rates. While these are defined as internal norms of behavior, it should be noted that each

of these variables will be influenced by external factors. For example, the internal discount rates of an appropriator will be affected by the economic opportunities available to them in a given setting.

The logic of collective action requires that appropriators self-organizing to solve a CPR problem must make a binding commitment to a cooperative strategy of their own device that significantly constrains their behaviors. Pertinent examples include "how many resource units an individual can appropriate, when, where, and how they can be appropriated, and the amounts of labor, materials, or money that must be contributed to various provisioning activities" (Ostrom 1990:43).

Sources of uncertainty that influence the ability of appropriators to solve a complex CPR problem vary from the external (e.g. ecological factors such as rainfall and temperature) to the internal (e.g. lack of knowledge or understanding regarding the structure of a resource system). Additionally, how the actions of appropriators will affect the resource system, the availability of resource units, and the behavior of others must be taken into consideration (Ostrom 1990:33).

Ostrom (1990:58) discusses some of the fundamental similarities of successful CPR management efforts through an examination of field settings where "(1) appropriators have devised, applied, and monitored their own rules to control the use of their CPRs and (2) the resource systems, as well as the institutions, have survived for long periods of time." These similarities include: variable and complex physical environments; relatively stable human populations where appropriators have a "shared past and expect a shared future"; narrowly defined norms of "proper" behavior; and

"most of all… the sheer perseverance manifested in these resource systems and institutions" (Ostrom 1990:89).

With these similarities in mind, a set of design principles illustrated by enduring CPR institutions is outlined as follows (Ostrom 1990:90):

1. **Clearly defined boundaries**: Individuals or households who have rights to withdraw resource units from the CPR must be clearly defined, as must the boundaries of the CPR itself;

2. **Congruence between appropriation and provision rules and local conditions**: Appropriation rules restricting time, place, technology, and/or quantity of resource units are related to local conditions and to provision rules requiring labor, materials and/or money;

3. **Collective-choice arrangements**: Most individuals affected by the operational rules can participate in modifying the operational rules;

4. **Monitoring**: Monitors, who actively audit CPR conditions and appropriator behavior, are accountable to the appropriators or are the appropriators;

5. **Graduated sanctions**: Appropriators who violate operational rules are likely to be assessed graduated sanctions (depending on the seriousness and th context of the offense) by other appropriators, by officials accountable to these appropriators, or by both;

6. **Conflict-resolution mechanisms**: Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials;

7. **Minimal recognition of rights to organize**: The rights of appropriators to devise their own institutions are not challenged by external governmental authorities;

8. And, for CPRs that are part of larger systems, **nested enterprises**: Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

When devising a CPR strategy for collective action in a rural watershed, these design principles should be considered and applied as appropriate, based on the social and ecological context where implementation is to take place.

In the following chapter, I discuss relevant literature regarding the themes of place attachment, collaborative watershed restoration, and technology transfer, and their applicability in the context of designing an effective collective strategy for managing streamflows.

CHAPTER TWO
LITERATURE REVIEW

I begin this chapter with an examination of place attachment as a powerful socio-psychological experience, in order to demonstrate how a deeply felt connection to a physical setting can influence whether or not individuals will participate in a collective action strategy. Next, I provide an overview of relevant literature on collaborative watershed restoration to highlight how ecological and social variables interact to shape watersheds and the outcomes of efforts to restore them. Lastly, I attempt to illustrate that technology transfer—a concept typically reserved for programmatic transfers between governments and institutions—could prove resoundingly useful for restoration practitioners interested in scaling-out their efforts to other watersheds. These reviews draw on a broad range of disciplines, including anthropology, environmental and social psychology, biology, geography, and sociology.

Place Attachment

The emotional bonding that human beings experience in relation to their intimate environment has been the subject of numerous theoretical and empirical studies. In his seminal work investigating “place” and “space” as common and merged human experiences, Tuan (1977:6) explains: “What begins as undifferentiated space becomes place as we get to know it better and endow it with value.” In this way, space can be understood as abstract geometries separate from geographic location, material form, and

cultural interpretation, and place is a center of meaning in the human experience of space, shaped by social relationships, memories and emotions (Gieryn 2000).

Across disciplines, the concept of place emerges as a physical setting where meaning and value develop through lived experience (Williams et al. 1992; Tuan 1977), and place attachment becomes representative of the emotional and cultural bond that people develop toward their physical settings (West 2002; Massey 1994; Spain 1992; Bhabha 1994; Soja 1996). However, the methods used to investigate place attachment and its practical implications vary (Vaske and Kobrin 2001; Davenport and Anderson 2005).

Much of the literature surrounding the concept of place is divided between phenomenological and positivist studies. In the latter tradition, place has been examined through quantitative methods and traditional hypothesis testing (see, for example, Shamai 1991; Hidalgo & Hernández 2001). Empirical studies run the risk of falling short when they neglect to consider "the relationship between symbolic meanings and evaluations, the importance of landscape characteristics as natural capital out of which sense of place may be created, and the effect of sense-of-place variables on subsequent behavior" (Stedman 2002:562). Phenomenological studies are more common and explore place as an active agent in the human psyche with detectable effects on social life and structures (Werlen 1993), paying particular attention to the specific and variegated ways in which place is experienced by an individual or their group(s).

In the nearly forty years since scholars began investigating place attachment as a category of analysis, the scope and range of phenomenological studies has expanded to

account for the complex interrelationship between human beings and their physical environment. A significant development in the spectrum of place-based academic research has been the exploration of how place intersects with class and gender, and how place is understood inside and outside dominant western culture (Gieryn 2000; Manzo 2003, 2005; Manzo & Perkins 2006; West 2002; Massey 1994; Spain 1992; Bhabha 1994; Soja 1996). One gender-related example can be found in the study of the disruption of relations between men and women in nineteenth-century Britain, where different modes of capitalist production and economic development were analyzed based on region in order to understand how varying geographic locations "presented distinct conditions for the maintenance of male dominance" over women (Massey 1994:191). This and other studies illustrate that place attachment is not a static, homogenous socio-psychological phenomenon. Intead, there is a marked need to understand place attachment in a shifting, historically specific and culturally relevant context, taking into consideration the multifaceted ways in which class and gender alter individual and group experiences of place.

In the context of this research, perhaps the most salient example of how place attachment is experienced and defined differently by culture would be to compare dominant western and non-western perspectives. Building on the western definitions of place that have been outlined earlier in this section, it has been argued that time-space compression—geographer David Harvey's (1989) concept of the altering of space and time in relation to global expansion of capital—has produced "a feeling of disorientation, a sense of the fragmentation of local cultures and a loss, in its deepest meaning, of a

sense of place" (Massey 1994:162). Nested in this argument is the assumption that spatial disturbance leads to insecurity and feelings of vulnerability as geographical and physical boundaries lose meaning, become altered or disappear entirely. Thus, (the desire for) place attachment becomes a form of romanticized escapism coupled with the search for security and stability. Massey (1994:147) argues that this postmodern definition of place attachment is insufficient, ethnocentric and colonizing, in that it does account for place attachment (or "place disruption") as it is experienced by colonized peoples and defines the significance of place primarily in terms of its relationship to global capitalism.

In contrast to a western perspective that might view place as an individualistic experience, many native cultures are more likely to understand place from a spiritual and ecologically holistic perspective. A common thread in some Native American philosophies is "the way in which people think about the land as intimately tied to how they think about themselves, how they act in the world and how they treat the landscape" (Cajete, 1994 cf. West 2002:8). In his doctoral dissertation on Native American perspectives of place psychology, West (2002:45) suggests that native peoples "are a diverse mixture of indigenous cultures that have in common beliefs, values, attitudes and behaviors that are central to their commitment to place." He uses the term "place wisdom" to delineate the core values associated with ancestral homelands that are formed—generation after generation—by the "spiritual heritage intimately connected with places" (2002:45). In 1985, Gwaganad of Haada Gwaii (the Queen Charlotte Islands) illustrated this point in a statement made before British Columbia's Supreme Court in response to the logging of her people's ancestral homeland:

> There is pride in being Haida, in being Native. The only thing we can hold on to to maintain that pride and dignity as a people is the land. It's from the land we get our food, it's from the land we get our strength… So I want to stress that it's the land that helps us maintain our culture. It is an important, important part of our culture. Without that land, I fear very much for the future of the Haida nation (Andruss et al. 2007:49-51).

By highlighting one difference in how western and non-western cultures might value and perceive place, I do not mean to romanticize the concept or imply that one perspective is morally superior over the other. Rather, I wish to highlight the significance that place holds for different cultures and would propose that a progressive exploration of place attachment should reflect an understanding of the concept as fluid and culturally specific.

Place attachment as a component of identity is a common conceptual framework found in literature regarding the social-psychological bond between humans and the physical environment. Ryden (1993 cf. Stedman 2002:76) describes identity as a crucial component of place:

> Through extensive interaction with a place, people may begin to define themselves in terms of…that place, to the extent that they cannot really express who they are without inevitably taking into account the setting that surrounds them as well.

Proshansky (1978) conceived of the phrase "place identity" to describe the cognitive characteristics—in the form of values, emotions, and preferences—that define the self in relation to the local environment. He later went on to suggest that an individual's relationships with other people in a given location also aids in the construction of place identity (Proshansky et al. 1983). As an individual constructs and suffuses various meanings onto a physical setting, they then become attached to those meanings (Stedman 2002), which can then promote or result in a sense of belonging (Davenport 2005). Tuan

(1977) notes that specific and visible features of an environment, whether constructed by humans (e.g. a landmark such as a bridge or statue) or naturally occurring (e.g. a river or mountain range), may enhance a sense of individual identity and loyalty to a place.

I would suggest that it is important to pay attention to whose identities are being considered—and whose are not—in academic investigations of place. A poignant example, which I believe illuminates the significance of this argument, can be found in literature that describes identification with place as developing subtly over time "simply with familiarity" and with the "assurance of nurture and security" (Tuan 1977:159). In contrast to this oversimplified and arguably ethnocentric understanding of place identity, Massey (1994:169) offers an opposing view:

> Such understandings of the identity of places require them to be enclosures, to have boundaries and negative counterposition with the Other beyond the boundaries. An understanding of the socio-economic geography of any place… reveals that such a view is untenable. The identity of place does not derive from some internalized history. It derives, in large part, precisely from the specificity of its interactions with 'the outside.'

Harvey (1996:356) suggests that it is possible to circumvent the process of "internalizing otherness" in the construction of place identity by understanding the phenomenon through a dialectical lens of "situated knowledges." It is helpful, then, to examine emerging indigenous perspectives on situated knowledges, which recommend a critique of western methodologies and discourse in relation to social action research (Genat 2009; Smith 1999; Denzin et al. 2008). For example, Tuhiwai Smith (1999 cf. Wilson 2001:214) suggests that a decolonizing methodology is concerned with "a more critical

understanding of the underlying assumptions, motivations and values that inform research practices".

By acknowledging that each individual in a given physical setting will maintain a different place identity and hold varying meanings associated with a place, it is possible to move beyond a dichotomizing view of identity (i.e. Self vs. Other) to find a basis for "political alliance and solidarity" (Hartsock 1987). Furthermore, it should also be noted that place identities are not fixed in time. As social and environmental landscapes shift within a physical setting, so too will the varied identities connected to or associated with that setting.

Over time, individual and group interactions with place, coupled with the development of cognitive beliefs and attitudes about one's role in that place, contribute to the development of place identity (West 2002). It has been argued that as a result, place identity (as well as place attachment) can be used to predict behavior associated with place.

If place attachment is understood to hold significant meaning in the socially constructed sense of self, one could logically surmise that a disturbance of place attachment can lead to a disruption of identity. For example, the concept of place attachment has been used to underscore the significance of the local environment to the social relationships of the urban working class, focusing on the psychological implications of forced relocation resulting from redevelopment (Gold & Burgess 1982).

This psychological phenomenon has been explored through a non-western lens as well. Cultural relationships between native peoples and their land can be profound, when

social and psychological well-being are interwoven with a physical and spiritual connection to ancestral homeland. A disruption in this connection can lead to identity crisis, psychological distress and emotional trauma (West 2002; Genat 2009; Smith 1999; Denzin et al. 2008). This socio-psychological experience—described as "place disruption" by some scholars (Altman & Low 1992; Possick 2006; Brown et al. 1992)— has been broadly analyzed with the recognition that people, processes, and places have equal potential for being instigators of disruption.

In the context of ecological restoration, the concept of place disruption is particularly important in that a disruption of attachment or place identity (due to environmental degradation) has been shown to lead to individual or collective action in restoring the emotional and functional bonds with place (Devine-Wright & Howes 2010; Burley et al. 2007). As such, place dependence (as external, functional attachment) and place identity (as internal, emotional attachment) directly relate to the willingness of appropriators to participate in collective action strategies aimed at governing a CPR.

Collaborative Watershed Restoration

Academic and professional discourse regarding watershed restoration is too-often dominated by the natural sciences, with little attention paid to the social context that informs how politics and culture interact with and shape the outcomes of restoration. Collective self-governance of natural resources in a watershed is, like any restoration endeavor, an inherently social undertaking that will produce "unique geomorphologies

and geographies of labor, ownership, and power" (Christian-Smith 2001 cf. Mitchell 1996; Massey 1994). Furthermore, collective watershed restoration efforts in North Coast watersheds will have multiple situated knowledges to consider (Woolley & McGinnis 2002; Rhoads et al. 1999; Berkes et al. 2000; Kimmerer 2011), ranging from those of scientists to non-profit staff to residents of varying and diverse cultural backgrounds. For a collective action strategy to be successful, it must not only make space for these situated knowledges, but also consider the complex ecological characteristics of the location(s) where restoration is needed (Weber & Khademian 2008).

Management efforts focused on freshwater resources need to be conducted at a scale that appropriately addresses the significant components that feed into the resource system in question. Recognizing that "riverine ecosystems are multidimensional and interactive" (Williams et al. 1997:7), many ecologists, hydrologists, biologists and natural resource managers have identified watersheds as an appropriate scale for addressing the degradation of freshwater resources and habitats (Williams 1997; Zedler 2003; Bohn & Kershner 2002). Watersheds are defined as the land area that drains into a specific river, lake or marsh (Hamann & Drossman 2006), and restoration is the reestablishment of the structure and function of an ecosystem, including its natural diversity (Cairns 1988).

Williams et al. (1997) notes that restoration is different than rehabilitation; where the former works to benefit the entire watershed through a comprehensive and long-term process, the later is typically associated with site-specific project, such as attempting to repopulate a particular species. Watershed restoration thus rests under the purview of ecosystem management because of its emphasis on applying a holistic understanding of

the interconnectedness between all components of nature (Cortner & Moote 1999) at a "larger temporal and spatial scale than previous management activities" (Raedeke et al. 2001). Furthermore, Cheng & Daniels (2003:841) suggest that because ecosystem restoration requires that analysis and decision-making happen at different geographic scales, it is a "place-based" enterprise that calls not just for the participation of technically skilled resource professionals, but also for the participation of individuals and groups who are interest in, or affected by, the decisions being made about the ecosystem.

In response to inefficient environmental policies that have historically failed to address the interrelationship between human beings and the ecosystems in which they live (Korfmacher 2000), multi-stakeholder collaboration has emerged as a popular archetype in watershed restoration. According to Hauser *et al.* (2012), collaborative methods of addressing environmental degradation developed in the 1990s in tandem with the rise of citizen-based groups that were forming in order to address the failing health of their local environments. One result of this new paragon of grassroots environmental organizing was the emergence of collaborative watershed management (Sabatier et al. 2005). Kenny *et al.* (2000, cf. Hauser *et al.* 2012:2) defines collaborative watershed management as:

> a primarily self-directed and locally focused collection of parties, usually featuring both private and intergovernmental representatives, organized to jointly address water-related issues at the watershed level… and typically reliant on collaborative mechanisms of group interaction characterized by open debate, creativity in problem and solution definition, consensus decision-making, and voluntary action.

Streamflow restoration efforts under a collaborative watershed management model require not only a sound understanding of the biological, geological and ecological

functions and systems of the entire watershed, but also effective multi-stakeholder cooperation across different social sectors. Complications or intractability can arise in watershed management when the social ecosystem (i.e. human geographic boundaries) conflicts with traditional administrative-political boundaries (i.e. counties, states, or national forests) or the actual geo-physical boundaries that define the watershed itself (Williams et al. 1997). Collaborative watershed restoration strategies rely upon the active participation of private and public stakeholders across disciplines, levels of authority and sometimes (varying scales of) ownership, resulting in social terrain that can be difficult to navigate.

The challenges and benefits associated with collaborative watershed restoration have been the subject of extensive research over recent years (Cortner & Moote 1999; Buckley & Crone 2008; Cheng & Daniels 2003; Margerum & Whitall 2004). Of particular interest in relation to this project are the socio-political challenges that can arise. Collaborative restoration efforts can be understood as inherently political because they presuppose complex relationships involving authority and power between individuals and groups in a social setting. Mollinga (2008:10) advocates for a "political sociology of water resources management" based on the idea that "*water control* [emphasis his] is at the heart of water resources management and should be conceived as a process of *politically contested resource use* [emphasis his]."

Citizen apathy—or a lack of interest and involvement in political processes—and government inaccessibility and unresponsiveness as perceived by the general public are factors that have been identified as potentially hindering participation in collaborative

restoration projects (Cortner & Moote 1999). Problems may also arise if the prescribed restoration activity is incompatible with how local residents perceive the land should be restored and to what extent (Buckley & Crone 2008), or if residents are not brought into the decision-making process in the early stages of the development of the restoration project when citizen participation is an implicit goal (Poff et al. 2003; Leach et al. 2002).

Research also suggests that restoration efforts in rural settings are generally more challenging than those located in urban settings, because working at a landscape scale involves "higher degrees of personal stake in outcomes, higher sensitivities to planners as 'outsiders,' more pronounced power dynamics, challenges to implementation due to diverse land ownerships, more diffuse social and community structure, and greater opportunities for incorporating technology" (Cheng & Daniels 2003:843). Moote et al. (1997 cf. Cheng and Daniels 2003:843) suggest that the problem of large-scale projects complicating social participation among stakeholders can be remedied by breaking "the larger region into smaller subregions with which stakeholders more readily identify."

In addition to potentially failing due to lack of active participation, restoration activities are also unlikely to succeed when they are conducted with little to no scientific context (Williams et al. 1997). Wohl et al. (2005:1 cf. Pedroli et al. 2002; Bernhardt et al. 2005) explains:

> Many projects lack 1) the inclusion of a solid conceptual model of river ecosystems, 2) a clearly articulated understanding of ecosystem processes, 3) recognition of the multiple, interacting temporal and spatial scales of river response, and 4) long-term monitoring of success or failure in meeting project objectives following completion.

In order to circumvent these challenges, it is recommended that practitioners of collaborative watershed restoration include representatives from a broad range of stakeholder groups early in the analytical and decision-making phases of the project, including citizens, scientists, and representatives from appropriate governing agencies (Poff et al. 2003; Leach et al. 2002; Leach & Pelkey 2001; Mattor 2013). Overall, trends in the literature analyzing the challenges of collaborative watershed restoration suggest that accurate scientific modeling, transparency, public education and outreach, civic engagement, and responsiveness to the perceived and expressed needs of the local citizenry are likely to lead to increased active participation among stakeholders.

A growing body of research suggests "collaborative processes that center on specific places can improve the chances of bridging divides in ways of knowing, fostering shared ways of knowing, and coming to agreement on outcomes and actions to improve ecological conditions" (Cheng & Daniels 2003:843). Herein lies one of the key socio-political benefits to collaborative watershed restoration: the potential for increased civic engagement across varying social sectors of a local community.

In making this statement, I am not implying that participation in a collaborative restoration effort automatically results in citizens working well with local or state authorities or vice versa. On the contrary, "citizen groups frequently cite bureaucratic barriers such as agency inertia, administrative red tape, lack of interagency coordination, jurisdictional conflicts, and 'reactionary policies' as impediments to their efforts" (Cortner & Moote 1999 cf. Wondolleck & Yaffee 1994). My intention is to underscore

that collaborative watershed restoration efforts can lead to a more actively and politically engaged civil society at varying scales.

Cortner & Moote (1999:92) describe the socio-political significance of citizen collaboration with local organizations as follows:

> Citizen participation in organizations is considered important to democracy in part because it is through participation in these voluntary institutions that people develop the trust and skills needed for participation in political groups. Citizens' capacity and willingness to engage in governance depend on a reserve of social capital, which, to reiterate, are those features of social life—networks, norms, and trust—that facilitate citizen association and enable participants to act together more effectively to pursue shared objectives.

In the interest of understanding the democratic potential of collaboration, Leach (2006) employed a framework that measured variables of inclusiveness, representativeness, impartiality, transparency, deliberativeness and empowerment among the numerous watershed partnerships of two western states. His study concluded that deliberateness—or "the amount of effort a group devotes to the mutual education of its members before or during negotiations" (Leach 2006:107)—rated highest among the other criteria measured, while representativeness—or ensuring that all relevant stakeholders are represented in negotiations—rated weakest among watershed partnerships. Overall, the findings in this study suggest that there is notable democratic potential in collaborative partnerships, but that more attention needs to be paid to ensuring that all critical interests are included in the planning and decision-making process from the onset (Leach 2006:108).

Group characteristics of watershed partnerships are important if civic engagement is an objective of the collaboration. Koehler & Koontz (2007:145) describe key characteristics of watershed groups as "member composition, group goals, the ability to

achieve tangible results, member agreement, and location." Watershed groups can be categorized into three types based on composition: government-based, citizen-based, and mixed; citizens, and specifically rural landowners, are increasingly wary of government involvement in issues related to private property, and for this reason citizen-based or mixed groups are in some ways more likely to foster active participation (Koehler & Koontz 2007:145).

Cortner & Moote (1999:95) note that collaborative restoration movements have been flourishing in rural communities since the 1990s as a direct result of pressures on the natural resource bases upon which those communities depend. In situations such as the one investigated in this project, where riparian landowners are a key demographic in the place-based governance of a CPR, the "localness" of those landowner groups, coupled with their dependence on the degraded resource for economic and/or subsistence purposes, is understood to be an asset in fostering participation and obtaining support for collective action (Rosenberg & Margerum 2008).

While an oft-expressed goal of collaborative watershed restoration is the active and equitable participation of both landowners and broader citizenry within a local community, gendered perspectives on motivations for and barriers to participation in these endeavors—at least in the United States—is markedly lacking in the literature. For example, landowner concerns related to private property rights and government infringement have been cited as potential barriers to participation in collaborative watershed management (Cortner & Moote 1999) with no mention of how a woman's perspective might skew this analysis. As Meinzen-Dick et al. (1997:1304) point out, "the

focus of property rights analysis has too often been on the rights held by a household, and *de facto* or *de jure* the male household head, without a recognition of how these are differentiated between individuals based on gender, age, or other intrahousehold characteristics."

In Agarwal's (2000:304) study examining why gender matters for collaborative environmental projects in "developing" countries, she highlights the fact that "neither households nor communities are ungendered units," and I would argue that her assessment can be similarly understood in the context of collaborative watershed efforts in the United States. She suggests that ignoring gender can distort policies and analysis resulting from collaborative projects in three key ways:

> One, it could lead to a misevaluation of community resource management institutions from both equity and efficiency standpoints, suggesting success even where serious inequalities and inefficiencies exist on account of gender. Two, the absence of a gender perspective would result in significant opportunities to promote effective collective action being missed, due to a failure to recognize the potential for such action specifically among women. Three, the absence of a gender analysis can obscure the gap between having a stake in environmental protection and the ability to act on it… and can fail to note some essential differences in the ways in which men and women typically organize environmental action.

Feminist scholars have pointed out the problematic nature of the participatory development paradigm, citing the propensity of this model to result in 'tokenism,' or the assignment of women to join committees or perform other tasks for the sake of fulfilling a superficial gender balance (Cornwall 2003; Hayward et al. 2004; Cahill et al. 2010). Singh (2008:939) further suggests: "though ostensibly aiming at propagating a 'bottom-up' approach, the institutional set-up for ushering gender participation in local water

governance is not actually grounded in the community." In this instance, the author is once again referring to participatory projects in "developing" countries, but in situations where collaborative watershed efforts are being spearheaded by local organizations in the United States, I believe that her warning is applicable. Requiring the representation of women in collaborative watershed groups is not sufficient in ensuring the equitable participation of both men and women in these efforts. Instead, "making a difference calls for an approach that can deal with the diversity of experiences and interactions that are part of everyday life, rather than imposing categories and concepts from conventional 'gender' approaches" (Cornwall 2003:138). With this in mind, strategies for promoting participation in watershed restoration need to be sensitive to the specific and local dynamics that shape the gendered reality for men and women in a given setting.

As previously discussed in this review of the literature, understanding landowner motivations for participating in environmental restoration efforts is essential to this project. Rogers (1983) employs an adoption-diffusion model to describe why landowners choose to adopt specific soil and water conservation practices, suggesting that different sources of information will be preferred at different points in the information diffusion process based on geographic location. In the fields of environmental and social psychology, the Theory of Planned Behavior has been used to explain environmentally responsible behavior and the adoption of stewardship and conservation practices on private property (Harland et al. 1999; Beedell & Rehman 2000).

Rosenberg & Margerum (2008:483) applied these and other theoretical models to a mixed-method study of five watershed groups in western Oregon and concluded that

riparian landowner motivations for participation in watershed restoration include concern for maintaining and improving their property for future generations, coupled with a perceived moral obligation for being a good steward and giving back to the land. Interestingly, there is a gap in the literature regarding the motivations of minority landowners as compared to white landowners in environmental conservation and restoration, though studies do suggest that a lack of awareness about available programs and concerns related to economic costs are barriers to participation among minority landowners in forestry programs (Gan et al. 2003:2005).

In their empirical examination of youth-oriented natural resource work programs in Colorado, Vaske & Kobrin (2001:20) applied a place-based social-psychological model to measure variables that influence environmentally responsible behavior. Their study concluded that, "As predicted, place dependence preceded place identity that, in turn, mediated the place dependence/ERB [Environmentally Responsible Behavior] relationship." In other words, their findings suggest that place identity (internal, emotional attachment) and place dependence (external, functional attachment)—concepts described earlier in this literature review—lead to environmentally responsible behavior as manifested through participation in a collective restoration effort.

Technology Transfer

Technology as a concept has been investigated and defined in multiple ways across varying disciplines (Zhao & Reisman 1992), and its applications have been philosophically categorized as both liberatory (in its capacity to serve as a resource for

solving problems created by human beings) and as a potential mechanism of social control (Zweers 2000; Goulet 1989). For the purposes of this project, I refer to Sahal (1981; 1982), a theorist who provides a clear conceptual definition of technology and its relationship to knowledge. Bozeman (2000:629) explains:

> [Sahal] refers to technology as "configurations", observing that the transfer object, the "technology", must rely on a subjectively determined but specifiable set of processes and products. Simply focusing on the product is not sufficient to the study of transfer and diffusion of technology; it is not merely the product that is transferred but also knowledge of its use and application. This approach resolves a major analytical problem: the difference between technology and knowledge transfer. By Sahal's concept the two are not separable — when a technological product is transferred or diffused, the knowledge upon which its composition is based is also diffused. Without the knowledge base the physical entity cannot be put to use. Thus, the knowledge base is inherent, not ancillary.

The definition of technology transfer also varies significantly by discipline (Zhao & Reisman 1992), but can be generally understood as "the movement of know-how, technical knowledge, or technology from one organizational setting to another" (Roessner, in press, cf. Bozeman 2000:629). Manning (1974:7) specifies that technology transfer can be named as such "only when the receiver actually uses or at least is capable of using information or technology that becomes available", otherwise the process becomes simply the moving of a commodity from one location to another.

Technology transfer has also been discussed in terms of innovation. Where an innovation can be described as "an idea, practice, or object perceived as new by an individual", technology transfer can be understood as "the diffusion of an innovation, or the rate and extent of an innovation's acceptance and use" (Rogers & Burdge 1972; Orr & Wolfe 1979; cf. Roggenbuck & Watson 1980:1).

It is clear from the literature that the phrase *technology transfer* has been applied in a multitude of contexts by a diverse range of organizations and institutions. Most frequently, the concept has been used to describe the transfer of technology—ranging from Research & Development to institutional programmatic structures to manufacturing processes—between universities, laboratories, governments, corporations and occasionally non-profit organizations (Zhao & Reisman 1992; Etzkowitz & Leydesdorff 2000; Lee 1996). When the concept is applied to the process of transferring an environmental program or technology from one location to another, it is almost always from global North to global South as part of a larger economic development program (see Holder 2006; Pierce et al. 2006 for examples).

Research on technology transfer is often centered upon the factors that inhibit or promote social acceptance of a new technology. In attempting to understand the processes that led to an innovation being successfully diffused through the U.S. Forest Service, Roggenbuck & Watson (1980) applied Rogers' (1972) adoption-diffusion model (referenced earlier in this literature review), and this model enhanced the researchers' understanding of the personal and behavioral characteristics that led an individual to accept a technological innovation at different points in time through different modes of communication. Venkatesh & Morris (2000:116) used the technology acceptance model (TAM), which suggests that user acceptance of technology is determined by perceived usefulness and perceived ease of use, to examine social influences of how technology is perceived and accepted differently between men and women. Klingner (2005 cf. Cleveland 2002:200) employed an information and communications technology (ICT)

equation to understand how social interactions can lead to organizational effectiveness through the adoption of technology:

> The most general way of understanding the importance of ICT is by viewing the relationship among information, knowledge, and wisdom. *Information* is simply raw bits of data. *Knowledge* is categorized or sorted data, with the sorting carried out based on some implicit or explicit relationships. And finally, *wisdom* is the application of knowledge to make individual or organizational choices. This means that receiving, sorting, and using information is a process determined not only by the nature of the information itself, but also by the perceptions, values, and instincts of the people who perceive and interpret it.

Post-adoption, many scholars have applied the concept of social capital to highlight why technology transfer might (or might not) be successful, as well as what the impacts of the transfer are likely to be within a given social setting (see Bixler 2011; Holder 2006; Pierce et al. 2006). Bixler (2011:6) suggests that *social capital*—a group-level phenomenon that can be explained "in terms of norms of reciprocity and mutual trust"—is essential in collaborative settings where the transfer of technology has been established as a goal of the group.

Some theorists have raised moral concerns on the social and ecological implications of technology transfer. For example, in Goulet's (1989:129) analysis of technology transfer as both a "bearer and destroyer of values", the author explains the social justice implications:

> …it seems obvious that if technology transfers do not benefit the masses, the reason is that they are not *designed* [emphasis his] to benefit them, but rather to create marketable new products and processes… It only follows, then, that transference of these technologies impedes social justice by contributing nothing to enhance it and, furthermore by siphoning off resources for lesser priorities. Technology transfers, as now conducted, tend only to improve the relative position of those already favored.

Goulet's point is exemplified in the study of how development and non-governmental agencies in Guatemala worked to meet their goals of increased economic activity by transferring technologies of hydroelectricity and broccoli production to a rural and impoverished region of the country (Holder 2006). Technology transfer in this case resulted in negative impacts for the day-to-day lives of Chiasco residents; conflicts over water resources became more frequent, and subsistence crops that the residents relied upon were replaced with water-intensive broccoli production bound for export out of the region.

While the circumstances in the Holder (2006) study vary significantly from how technology transfer might be applied in the context of watershed restoration in the United States, certain conclusions are still relevant. When considering technology transfer as a tool for watershed restoration, the question of "who benefits?" needs to be raised.

Other concerns related to technology transfer have been raised as well. When universities are involved in technology transfers, their role typically involves developing and packaging research for purchase by governments or private corporations, who then apply that research for for-profit or economic development purposes (Matkin 1990). Mohanty (2003) points out that "the moment we tie university-based research to economic development—and describe this research as fundamentally driven by market forces—it becomes possible to locate the university as an important player in capitalist rule." Etzkowitz et al. (1998 cf. Mohanty 2003:173) go on to describe a "triple helix" of "knowledge 'capitalization' in the sciences", where industry, state and university are interdependent. Thus, when a university participates in technology transfer with

governments and/or private corporations, it runs the risk of playing an integral role in perpetrating global capitalist rule.

Relying on technological fixes to solve human-caused environmental problems is an approach imbued with western values of rationality, efficiency, and problem solving, which Goulet (1989:19) suggests can "breed impatience with contemplation or harmony with nature." On this subject, Goulet cites Brazilian educator Paulo Freire:

> …the problem-solving stance favored by technology differs totally from the revolutionary "problematizing" stance. …According to Freire, one can know truly only to the extent that one "problematizes" the natural, cultural, and historical reality in which one is immersed. And how does "problematizing" differ from technocratic "problem-solving"? In problem-solving, an expert steps back some distance from reality, breaks it in two and analyzes its component parts, devises means for solving difficulties in the most efficient way, and then dictates a strategy or policy. This approach, Freire contends, distorts the organic totality of human experience by reducing it solely to those dimensions which can be treated as mere difficulties to be removed.

Recognizing this concern to be valid and applicable, if an individual or group is considering technology transfer as a strategy for solving a CPR problem, they should strive to problematize the situation that they are hoping to solve with technology. This will allow for the engagement "of an entire populace in the task of codifying its total reality into symbols capable of generating critical consciousness and empowering them to alter their relations with nature and social forces" (Goulet 1989:19). I would argue that collaborative watershed partnerships—comprised of community members, academics, government, and others (Hamann 2006)—are an ideal social mechanism through which watershed degradation can be problematized, with technology transfer being just one solution for place-based restoration at a watershed-scale.

In the opening statement of the Symposium on Water Issues, Huber (2006:viii) succinctly describes the significance and challenge of dealing with technology transfer in relation to water issues:

> The transfer of technology, when it deals with water (an essential element of life, economic development, social communities, and national politics), is one of the most complex areas facing the world today… the desperate need for water and our dependence on it make it one of the most contentious substances on earth—and thereby vastly complicates the challenge of diffusing the technical capacity to provide better methods for water supply and use for the citizens of the world.

Having already described the social and ecological justifications for restoration at a watershed-scale, I would like to highlight how technology transfer is already playing a role in collaborative watershed restoration efforts in the United States.

Applying technological solutions to water problems is not a new practice. There are any number of techniques, programs and point source fixes—informed by hydrology, biology, geography and ecology, to name a few—which can help mediate the negative impacts that human populations have on freshwater resources (Wiessman & Welty 1985; Replogle & Renard 1984; Toch 2003; Committee on Social and Environmental Objectives 1984). However, only recently has the transfer of technology been recognized as a beneficial tool in collaborative place-based efforts to restore watersheds, as evidenced by the relative lack of literature on the subject.

In 1999, The Committee on Watershed Management recognized the need to begin transferring knowledge of "watershed processes and innovative management techniques to the public", and further acknowledged that scientists and universities can be part of efforts to disseminate this information in a way that is accessible and understandable for

audiences with little to no scientific background. In her review of networks, programs and institutes working on watershed restoration, Hamann (2006:306) suggests that the role of watershed partnerships is ideally "to facilitate the transfer of technical information from educational institutions to those enacting policy and management." She categorizes three different models of watershed partnerships that incorporate technology transfer into their efforts via information dissemination: *monitoring-based programs* (comprised of both students and independent actors, where activities include nationally coordinated collection and analysis of data by students); *experiential project-based programs* (which requires the integration of "monitoring, research, and watershed projects into curricula to enhance learning" (2006:314), with a primary objective of student learning versus community outreach); and *service- or community-based learning programs* (where students are expected to gain hands-on experience and applied academic knowledge through community projects).

A key difference between the first two models and service learning can be found by asking where the research question is initially generated. In a service-learning model, agency or individual partners from within a community typically identify the research question or problem before students are asked to become involved. I would argue that service-learning is more likely to see long-term success because the research need is first identified and legitimated by the community members who will later be expected to participate and maintain the restoration efforts.

In a search for case studies and articles relating to collaborative watershed restoration and technology transfer, examples surfaced relating to dam removal on rivers

in the Pacific Northwest and subsequent positive impacts on Native American communities, though they did not specifically define technology transfer as the mechanism through which dam deconstruction took place (Gosnell & Kelly 2010; Cronin & Ostergren 2007).

In particular, there is one report linking technology transfer and collaborative restoration that is highly applicable in the context of this project. In Bixler's (2011:19) examination of the transferability of a collaborative conservation model based on research conducted with the Blackfoot Challenge, the researcher explores the pertinent (and difficult to answer) question: "How [can] success in one place with certain people [sic] be transferred to another place with different people?" While this question on the surface might seem simple enough to answer, Bixler's (2011) analysis illustrates that this issue has been inadequately addressed in relevant literature. In examining transferability or the potential for replication and 'scaling-out' of a collaborative conservation model, Bixler (2011) observes that social capital—including shared norms, shared visions, and reciprocity—as well collective action and collaboration are fundamental elements for success.

The Blackfoot Challenge report (2011:9) provides an excellent framework for collaborative restoration through technology transfer via a social-ecological-temporal (SET) model. Social dimensions that are highlighted as important are that the restoration process "needs to be landowner driven, there needs to be sense of community, and the right 'type of' leaders need to be willing to lead." From an ecological standpoint, as discussed previously, there needs to be accurate and appropriately translated scientific

data that community members can use as they are formulating their objectives. Lastly, Bixler (2011:12) notes “even with the right social and ecological conditions, ultimately it also ‘has to be the right time’” and there has to be capacity—from both professional, academic and citizen stakeholders—to invest their resources in the effort.

In summary, while there is a proliferation of literature on the definitions, practical applications, social ramifications, benefits and drawbacks of technology transfer, only minimal attention has been paid to the potential of technology transfer as a mechanism through which knowledge, cultural norms and technical skills can be scaled-out to different watershed settings for restoration purposes. The feasibility study for technology transfer in Southern Humboldt attempts to address this important gap in the literature.

CHAPTER THREE
RESEARCH METHODS

> "If our engagement with natural processes is beyond our ability to measure and quantify in the laboratory, it may be that the only way to immerse ourselves in those processes is through the long practice of cumulative attentiveness. In the close-mouthed world of reciprocal perception, there is no way to learn to live in place but from the place itself." –Freeman House (1999:99)

The research methods and design for this project are described in this chapter, beginning with a discussion of my subjective position as a researcher within a participatory action framework. Next, I provide an overview of power as it relates to the production and dissemination of knowledge, followed by a brief examination of triangulation as an appropriate mixed-methodology for the transfer of a collective CPR management effort. Because the study design for this endeavor is based upon methods that were employed at the inception of Sanctuary Forest's Mattole Flow Program, I offer a brief sketch of the steps that Sanctuary Forest underwent to implement their program. Lastly, I describe the design of the feasibility study for the Redwood Creek Water Conservation Project, which explored transferring elements of the Sanctuary Forest's program to a neighboring watershed.

Participatory Action Research

Sociology comprises a relatively new intellectual tradition, and is even less established in practice. The nineteenth century French philosopher and physicist, Auguste

Comte, is credited as being the first person to give name to a science that could potentially "[lay] bare the reality of society and thereby [help] to transform it" (Feagin & Vera 2008:9). Yet Comte, like so many after him, was a positivist thinker who worked to establish Universal and Objective truths regarding human behavior in an attempt to maintain the status quo. A long and troubling history exists of sociological research projects that "directly or indirectly reinforce the oppressive structures of society", and it was in reaction to this problematic trend that the field of liberation sociology was established (Feagin & Vera 2008:10). Within the field of liberation sociology, participatory action research (PAR) can provide a methodological framework that is empowering and liberating to both researcher(s) and stakeholder(s) (Feagin & Vera 2008; Whyte 1989).

In this project, I attempted to weave some of the founding tenets of PAR into the methodological design. The needs and objectives of the project were self-defined by stakeholders who were impacted by the research, the participation of stakeholders in the research was (and will continue to be) encouraged as much as possible, and the results of the research have been (and will continue to be) made accessible to any interested parties (Grant et al. 2008; Feagin & Vera 2008; Whyte 1989). Specifically, a *Practical/Mutual Collaborative/Deliberate* mode was applied, where the researcher (myself) "and the practitioner[s] came together and collaboratively identified potential problems and issues, their underlying causes, and possible interventions" (Holter & Schwartz-Barcott 1992:301 cf. Burg & Lune 2012), resulting in a bottom-up, solutions-oriented design emphasis.

Dynamics of Knowledge and Power

Participatory action research methodologies strive toward challenging power imbalances, not only between institutionally oppressive structures and marginalized populations, but also between the researcher and participants (Grant et al. 2008:589). Furthermore, feminist participatory action researchers (FPAR) suggest that reflexivity—or "attempting to make explicit the power relations and the exercise of power in the research process" (Ried & Frisby 2008:100)—should be included in the research process.

Power is a component of all social relationships and is inextricably tied to knowledge: "If…freedom 'is the capacity to participate effectively in shaping the social limits that define what is possible' (cf. Hayward 2004:21), then we can also more clearly situate knowledge as one resource in the power field" (Gaventa & Cornwall 2008:176). Access to and production of "legitimate" knowledge is a privilege associated with academia, a reality which can be harmful when it "under-privileges other forms of knowing, and the voices of other knowers" (Gaventa & Cornwall 2008:178).

In my role as a researcher, I strove toward epistemological awareness by recognizing that "legitimate" knowledge was produced by all of the stakeholders of this project, whether resource professionals, scientists, non-profit staff, or rural residents. Knowledge production can be inclusive and participatory when local realities are acknowledged and given voice and when the researcher recognizes their own position as learner and participant, as the epistemological theory of "dissipative structures" explains:

> …each learner goes through a period of chaos, confusion and being overwhelmed by complexity before new conceptual information brings

> about a spontaneous restructuring of mental models at a higher level of complexity, thereby allowing a learner to understand concepts that were formally opaque. The shifts in understanding… require circumstances in which there is a genuine openness to the situation rather than a commitment to the conservation of a theory, explanation or epistemological position (e.g. objectivity) which is abstracted from the situation. (Ison 2008:151 cf. Prigogine & Stengers 1994)

I would like to conclude this brief discussion by stating that while increased participation of diverse stakeholders in the production of knowledge during this project was an implicit goal, my intention was not to make claims about any common vision held by the people who live in the watersheds where the work took place. There is no singular way of knowing, just as there is no one perfect solution to the challenge of water scarcity in watersheds on the North Coast. Every participant brings their own positionality to the table, and this must be recognized in order to make room for all perspectives, dominant or otherwise.

Triangulation

This research endeavors to triangulate qualitative and quantitative methods. *Triangulation* can be characterized by any combination of distinct and intertwined modes of inquiry, theories, and multiple investigators (Denzin 1978), applied in such a way that the researcher is not only bringing together different forms of data, but also attempting "to relate them so as to counteract the threats to validity identified in each" (Burg & Lune 2012:6). Hypotheses can be validated or disconfirmed when other observers are included in the research process and are observing the same phenomenon. This can be especially valuable in research that explores cultural arenas, where "evidence of shared tacit

assumptions that is difficult to detect with questionnaires or interviews surfaces readily when one observes members of the culture in interaction” (Schein 2008:276).

Triangulation using a multi-method approach is justifiable in the context of this research due to the complicated socio-cultural and environmental dynamics of the rural places where the research took place. Quantifiable data might provision a general understanding of human water use patterns or hydrology of a watershed but would do little, on its own, to produce a meaningful understanding of the social dynamics that led to certain environmental behaviors and cultural norms. Similarly, qualitative methods in their myriad forms are better suited to providing sociological insights, but those insights alone would not be enough to tell us whether the transfer of a collective CPR management model in Southern Humboldt County would have an impact on improving streamflows for people and fish.

Sanctuary Forest’s Collective Action Strategy

Sanctuary Forest is a non-profit land trust that has been operating in Southern Humboldt’s Mattole Valley for over 25 years, with the stated mission of conserving "the Mattole River watershed and surrounding areas for wildlife habitat and aesthetic, spiritual and intrinsic values, in cooperation with our diverse community" (Sanctuary Forest 2013). Their innovative streamflow improvement program is “a seasonal water management program that uses community-based and collaborative approaches to harmonizing the needs of a growing human population with protecting and sustaining critical aquatic

habitat for endangered salmonids and sensitive amphibious species" (Sanctuary Forest 2008).

On multiple occasions, Tasha McKee, Sanctuary Forest's Executive Director and my Project Placement Advisor, expressed to me that the emphasis of the program was never solely about collecting quantifiable data or implementing water conservation projects to improve streamflows. For Tasha and many other people involved in this work, the program was just as much about cultivating a paradigm shift in the Mattole River watershed in pursuit of what one Mattole resident described as "that dream of living with the salmon and healing the relations between our species" (Zuckerman 2003:76). They strive for this paradigm shift by nurturing "cultural change in attitudes towards the use and consumption of water" among rural residents in the Mattole watershed (Sanctuary Forest 2008) through collaborative, place-based efforts that empower residents to make responsible water usage choices.

Prior to establishing a collective action strategy for the Mattole River that would effectively address the low summer water flows that were threatening the survival of endangered salmon, Sanctuary Forest undertook "basic analysis to answer the question 'will changing human use make a difference?'" (McKee & Formosa 2012). In order to do this, they first had to determine:

- The minimum flows in cubic feet per second (cfs) required in order to maintain connectivity between pools of water in the riverbed;
- Whether there was a distinct versus year-round low flow season;
- The location(s) of high priority salmon habitat (or refugia) in the Mattole watershed;
- The geographic area of human use that the program should focus on;
- The percent of water consumed in the area of human use versus available water flow.

In 2004, Sanctuary Forest began monitoring flows in the headwaters of the Mattole and found that the dry season lasted approximately 3½ months (or 105 days), typically beginning in June or July and lasting until the first rains of winter. Two years later, the data was revealing, indicating that "the 2006 summer season had the 6th lowest flows in the 55 year record" (McKee 2004). Their Mattole River Basin Study (Sanctuary Forest 2008:1) subsequently demonstrated that outside the Mattole headwaters, "monitored tributary subbasins with higher parcel density stopped flowing" during the dry season while "monitored tributary subbasins with lower parcel density sustained flow," indicating that human use was having an impact on streamflow.

Through their initial monitoring and outreach efforts, Sanctuary Forest was able to establish unequivocally that the Mattole River was in fact suffering from a low flow crisis and that "water withdrawals for domestic and agricultural purposes [were] a significant cause," with humans consuming "20-80% of all available water in the river depending on the severity of the drought season" (Sanctuary Forest 2008). After establishing that the lowest acceptable summer flows for the Mattole headwaters were 0.2 cubic feet/second (cfs) (Sanctuary Forest 2004), it became clear that just one or two households pumping water at the same time could potentially lead to the dewatering of the river, resulting in the shallow, disconnected pools of water that can strand and ultimately kill juvenile salmon.

From 2005-2013, Sanctuary Forest worked to implement a water conservation pilot project in the Mattole headwaters for the purposes of addressing low summertime water flows that impact rural residents and sensitive aquatic species. Following a "water

storage and forbearance" concept, they recruited eighteen landowners to voluntarily sign a legal agreement with Sanctuary Forest to store water from the Mattole River during the high flows of the wet winter season, and to forbear from pumping during the dry season by using the stored winter water from their tanks during low flows. In exchange for the legally binding water forbearance agreement, Sanctuary Forest coordinated the purchasing and installation of 50,000-gallon Pioneer water storage tanks on the private properties of the participating landowners. The up-front cost of the tanks (which can run in the tens-of-thousands of dollars and pose a significant financial hurdle for landowners) was subsidized by funding from the California Department of Fish & Wildlife. After siting the large water storage tanks, the landowners were able to store plentiful winter water for their domestic needs—often more than enough to last them through 105 days of low summer flows. Sanctuary Forest maintained regular communication with the participating landowners throughout the year, and would notify each household when it was time to turn off their pumps for the dry season.

Sanctuary Forest's water storage and forbearance efforts resulted in measurable improvements in streamflows. In low flow years prior to program implementation (2004 & 2006), flows dropped to 0-3 gallons per minute (gpm) at MS6, the measure point at the downstream end of the program area. Post-implementation in low flow years (2011, 2012 & 2013), flows were measured at 49-206 gpm. The threshold flow when pools become disconnected is 90 gpm and therefore the increase in flows from turning off the pumps was significant for fish and wildlife.

The positive hydrologic response of the river to changes in human use was considered by many to be a momentous achievement, as was the cultural shift that began to take root as a result of the program. Many residents who were not able to officially enroll in Sanctuary Forest's program chose instead to participate by voluntarily following Sanctuary Forest's cue to stop pumping when flows were critically low.

The participation of some Mattole residents in water storage and forbearance even without a legal agreement was made possible by Sanctuary Forest's community outreach and education efforts, which included: public service announcements, water flow awareness signs on highly-trafficked roads, tank education and best management practices materials, public announcements regarding streamflow conditions, water usage surveys, and the encouragement of community input (Sanctuary Forest 2008). As a result, an estimated "eighty-five percent of the inhabitants living in the critical reach of the Mattole headwaters participate in storage and forbearance during the dry season", which has led to an increased quality of life for many residents and their downstream and upstream neighbors:

> During the dry months, there is a communal feeling of 'we are in the this together'—at farmers markets and gatherings people talk about the river, share experiences and pointers, and excitedly recount how many salmonids they spotted in local swimming holes. There is a sense of sharing of the common resources—a recognition these lands and waters are all connected, and each part effects the whole. (McKee & Formosa 2012)

The relative success of the water storage and forbearance program in the headwaters of the Mattole prompted Sanctuary Forest and several other stakeholders vested in salmonid recovery to ask the question that was the basis for this project: How

can we use what we have learned in the Mattole to encourage watershed stewardship on an even larger scale?

The Redwood Creek Water Conservation Project

In the winter of 2012, Sanctuary Forest and Salmonid Restoration Federation initiated a study to determine the feasibility of conducting a "technology transfer" of Sanctuary Forest's Mattole headwaters water storage and forbearance program to Redwood Creek on the South Fork Eel River in Northern California. Redwood Creek is a 26 square-mile watershed that flows into the South Fork of the Eel River near Redway, California (see Appendix B); it also happens to be located adjacent to the Mattole watershed, and suffers from many of the same cumulative impacts that led to serious concerns about low summertime flows. To address these concerns, the Redwood Creek Water Conservation Project was designed in order to gather data about human water use and low flows in the watershed, to gauge community interest in establishing a voluntary water conservation program similar to the one in the Mattole, and to understand what type of water conservation program might be appropriate for the Redwood Creek watershed and its rural population. The feasibility study that was initiated at the onset of the Redwood Creek Water Conservation Project is ongoing, and was translated into a step-by-step guide in the hopes that similar collective action strategies could be scaled-out to other rural watersheds on the North Coast.

Establishing a project team

Recognizing that a successful collective action strategy would require the participation and resources (in the form of time, expertise, and/or money) of many stakeholders, the starting point for this project involved setting up conference calls and in-person meetings with a long list of potential collaborators. The list included California Department of Fish and Wildlife (CDFW) staff, directors of local environmental non-profits, as well as consulting restorationists and field biologists who were intimately familiar with the watersheds of Southern Humboldt. Individuals who provided crucial input at the start of the feasibility study included Tasha McKee of Sanctuary Forest, Dana Stolzman of Salmonid Restoration Federation, Bill Eastwood of the Eel River Salmon Restoration Project, Scott Greacen of Friends of the Eel River, Pat Higgins of the Eel River Recovery Project, Hezekiah Allen (formerly of the Mattole Restoration Council), Sungnome Madrone of the Mattole Salmon Group, Scott Downie of CDFW, and members of the Briceland Volunteer Fire Department.

My initial meetings with Dana Stolzman were particularly fruitful. As the Executive Director of Salmonid Restoration Federation (SRF), a non-profit which has been promoting “restoration, stewardship, and recovery of California native salmon, steelhead and trout populations through education, collaboration, and advocacy” (SRF 2013) since 1986, Dana was already connected to a broad network of hydrologists and fisheries biologists in the region. Additionally, SRF had the organizational capacity to provide much needed support to the fledgling feasibility study, and the location of the

office was ideal. Though SRF is a statewide non-profit, it's office is based in Garberville, the small, unincorporated town in Southern Humboldt that many residents in the region use as their social and economic center (Jakubal 2013). In what felt like an effortless establishment of leadership, Dana took on the role of Project Director and I assumed the responsibilities of a Project Coordinator. In this way, Tasha McKee was able to focus her attention on Sanctuary Forest-related matters while maintaining an active presence in the feasibility study as a Project Advisor, offering guidance and participation as the need arose.

Selecting a watershed for technology transfer

A phone call was set up in September of 2012 with Tasha McKee, Dana Stolzman, Bill Eastwood, and myself to discuss a potential location for the technology transfer. The ideal watershed needed to be accessible for flow monitoring, have salmon-bearing watercourses that were considered a high priority for restoration, and have a rural population living within its boundaries that were dependent on streamflows for their household and irrigation needs.

We concluded that the Redwood Creek watershed would be an appropriate place for a collective streamflow improvement project. Eighty-percent of the watershed is listed as either private residential or ranchland, with another ~20% in corporate timber production (see Appendix C). Five populated tributaries flow into the main stem of Redwood Creek—Dinner Creek, China Creek, Miller Creek, Seely Creek, and Upper Redwood Creek—all of which have historically supported strong runs of Chinook, coho,

and steelhead (NCRWQCB 2005). With “lots of people with straws in the creek,” as Bill Eastwood once described, and equally as many opportunities for community engagement, this watershed had all of the makings for an excellent place to establish a collective CPR management strategy.

The feasibility study

Large-scale, community-based restoration efforts require both ecological feasibility and social engagement (Bridger & Luloff 1999; Dale & Sparkes 2007; Leach et al. 2002; Ball et al. 2010). For this reason, it was helpful to conceptualize this project as having a sociological component, an ecological component, and three distinct phases following a seasonal timeline.

Both the sociological component and the ecological component were designed with the intention of gathering critical baseline data that previously did not exist for the Redwood Creek watershed, but would be necessary in order to assess the feasibility of a collective action strategy and evaluate its success in the future. The sociological component attempted to gauge public interest in establishing a voluntary water conservation program, to provide avenues for public engagement, capacity building, and solutions-oriented dialogue, and to identify potential barriers to participation in collective streamflow improvement efforts. The ecological component was designed to gather baseline data on human water use patterns in the watershed, to begin monitoring stream flows, to establish the potential impact of forbearance versus other forms of water conservation, and to compile a list of high priority salmonid refugia (i.e. habitat that

provides refuge when ecological conditions are unfavorable elsewhere) in Redwood Creek and its tributaries.

Phase I. The first phase of the feasibility study took place between December of 2012 and January of 2013, and consisted of a survey mailing and extensive public outreach efforts. The overarching purpose of the survey was to collect information on human water use in the watershed from as many households as possible; this information would be key in order to later compare an estimate of the percent of water being used for beneficial purposes (i.e. agricultural and residential) to available flows in Redwood Creek.

Using Dillman et al.'s (2009) *Tailored Design* approach, I attempted to reduce typical sources of survey error by utilizing a recommended set of procedures—given a limited budget and timeframe—in order to help ensure the highest response rate possible. The survey cover letter (Appendix D) and questionnaire (Appendix E) were reviewed and approved by the Humboldt State University Institutional Review Board prior to being mailed, to ensure informed consent and establish that no participants would be subjected to harm during the study.

Modeled after the questionnaire that Sanctuary Forest mailed to residents of the Mattole watershed at the start of their program, the Redwood Creek Community Perceptions & Residential Water Use Survey asked questions related to water source(s) for agricultural and household use, current on-site storage capacity, residential water withdrawal rates, and the length of the respondent's irrigation season, if they had one. Additionally, I included questions that helped us collect anecdotal observations of

changes in the watershed, as well as gauge resident interest in participating in voluntary water conservation efforts.

Dillman (2009:243) recommends a system of five different forms of contact—a prenotice letter, questionnaire mailing, thank you postcard, replacement questionnaire, and some other form of final contact—to increase the response rate of a survey mailing. Already constrained by the expense of the survey mailing, we prioritized the prenotice contact as our only additional mailing, which is recognized as a reliable method for increasing response rates in a survey (Dillman 2009). Approximately one week before the Redwood Creek Community Perceptions & Residential Water Use Survey was distributed, we sent a prenotice postcard to our mailing list informing recipients about the upcoming survey mailing, as well as two house meetings that had been scheduled in relation to the project (Appendix F).

While research suggests that using a personalized greeting can increase response rates (Dillman et al. 2007; Dillman 2009), we chose to open both the prenotice postcard and the survey cover letter with “Dear Redwood Creek Area Resident” in an effort to maintain a sense of anonymity for respondents. Additionally, we removed a financial barrier and brought social exchange into play by including a postage-paid envelope in the survey mailing in an attempt to “encourage respondents to reciprocate by completing the survey” (Dillman 2009:238).

For the prenotice postcard and survey mailing, we did not have access to a complete list of every home address in the watershed; the closest we could come was a public record of every parcel owner. A G.I.S. Planning Technician with the County of

Humboldt Planning & Building Department provided us with an Excel spreadsheet of the 390 legal parcels in Redwood Creek and the addresses of their respective owners.

While the parcel owner list was an immensely helpful starting point, it was also incomplete. Some parcels in Southern Humboldt, including many of those in the Redwood Creek watershed, are subdivided (sometimes legally, sometimes not) or are shared collectively, where one parcel can have multiple homesteads located within its boundaries. In cases where one individual owned more than one parcel, we mailed one survey per parcel in the interest of obtaining water usage data for each parcel that had at least one residence on it. Coverage error was an immediate concern due to the fact that not all of the households in Redwood Creek were included in the mailing list (Dillman 2009), so we relied on the help of a few local volunteers who were willing to contact their neighbors in person and by phone. We also made the survey cover letter and questionnaire available online through the SRF website so that residents could access it if the survey had not reached them by mail or their original copy had been lost.

During *Phase I* of this project, we conducted a “media blitz” in an effort to publicly address and overcome concerns that local residents had about participating in the survey, and to spread the word about the survey to additional residents who had not been reached by mail or other contact attempts. Local radio outlets provided crucial opportunities for outreach. The Project Team participated in eleven radio interviews on KMUD (Redwood Community Radio based in Redway, CA) and KHUM (a public radio station operated on HSU campus in Arcata, CA), providing opportunities to explain the purpose of the project and to emphasize the anonymity of the survey. Press releases about

the survey were submitted to The Independent, The Redwood Times, and the Winter/Spring 2013 edition of the Mattole Restoration News.

Phase II. The second phase was comprised of two house meetings, a free water conservation workshop, and a focus group, all of which occurred between January and February of 2013. The house meetings and workshop were publicized on fliers that were distributed in public places throughout Redway and Garberville (Appendix G), as well as on the radio and in local newspapers. We included a “Save the Date!” announcement for the house meetings and workshop on the outside of the survey mailing (Appendix H), as well as inside the survey questionnaire.

Planners have long recognized the need for public engagement and input from the public (Arnstein 1969), and planning circles are one method for creating equal opportunities for engagement in tandem with other engagement strategies (Ball et al. 2010). Following this tradition, the house meetings were designed to provide a forum where local residents could come together, meet the organizers of the project in person, and have an opportunity not only to ask questions, but also to share concerns and ideas regarding the scope and trajectory of a collective action strategy for improving streamflows in the Redwood Creek watershed. A recording device was not used during the house meetings, based on the input that it could have made some participants feel uncomfortable and less likely to participate in open dialogue. As required by the HSU Institutional Review Board, I obtained a letter of informed consent from every participant at the house meetings, and offered additional copies for anyone who wished to take one home with them. Other materials that were made available to residents at both of the

house meetings and the workshop were a brochure containing basic information about The Redwood Creek Water Conservation Project (Appendix I), a brochure containing Frequently Asked Questions about the project (Appendix J), and a confidential sign-up sheet for participants who wanted to kept up-to-date on the progress of the project.

Both house meetings took place from 5-7pm to account for busy weekday schedules, and since this was also dinnertime for many people, food and non-alcoholic beverages were provided by SRF. To ensure that the house meetings would be accessible to as many residents as possible, they were hosted roughly two weeks apart and at two different locations, one at a home in Miller Creek and one at a home in Seely Creek. The residents who kindly offered their homes as a space for these meetings were well known in the community, so the possibility of people getting lost in transit was reduced. However, we also put up signage along the roads to help direct residents to the correct locations.

The meetings followed a semi-structured and relatively informal format (for an example of a house meeting agenda, see Appendix K). Each meeting began with a round of introductions, where each person in the room was invited to share their name, the tributary that they lived on, and their reason for attending. Next, I took a few minutes to emphasize the importance of the surveys and the methodology behind them, including the steps taken to ensure anonymity. During this time, I also informed participants that I would be observing and taking notes during the house meeting, but that I would not be including identifying information on any resulting materials.

Sanctuary Forest staff gave presentations on their water storage and forbearance program, emphasizing the positive impact that the program had on the cultural perspectives and hydrologic function within the Mattole headwaters and why a similar program was being explored for Redwood Creek. The latter halves of the meetings were reserved for group brainstorming and solutions-oriented dialogue.

The free water conservation workshop took place from 10am-4pm on Saturday, February 2nd, 2013 at the Beginnings Octagon (or Beginnings, as it is locally known) in Briceland, CA. Beginnings represents a social and cultural hub for the people who live in the surrounding area, and because it offers the added benefit of having large seating capacity, a large kitchen, and plenty of electrical outlets, it was a logical space to host a workshop that would be welcoming to residents from Redwood Creek and elsewhere.

The purpose of the water conservation workshop was to bring residents and restoration practitioners together in order to share skills and knowledge about water conservation techniques, including water storage options, water loss prevention mechanisms, and the importance of storing enough water during the wet season so as to avoid pumping during the dry season. In the first part of the workshop, which took place on-site at Beginnings, staff from Sanctuary Forest, Salmonid Restoration Federation, the Mattole Restoration Council, and the Mattole Salmon Group gave presentations on a variety of relevant topics. At around noon, the presentations culminated in a free vegetarian lunch for attendees. After lunch, participants caravanned to the nearby property of Whitethorn Construction for a four-hour field tour hosted by Tasha McKee's father and the owner of the property, Bob McKee. The field tour was intended to

demonstrate hands-on water conservation methods that could be applied to homesteads, including permaculture techniques that can save water in a garden year-round. Stops during the field tour included appropriately designed and constructed lined ponds, groundwater recharge ponds, rainwater catchment tanks, and poly-tank farms (i.e. collections of two or more polyethylene water storage tanks with a 5,000 gallon capacity; see Appendix L for a table of water storage options).

Because my role in the house meetings and workshop had been primarily to observe and to participate only when appropriate, I invited eight local residents to join me at the end of February for a recorded focus group at Beginnings. My objective was to explore in detail some of the motivations and priorities of the more (and less) active stakeholders in the project. The focus group included members of the Briceland Volunteer Fire Department, a board member from Sanctuary Forest, and several other residents representing a diversity of ages and a roughly equal balance of men and women. A list of sample questions that were approved by the IRB for the focus group, as well as a copy of the informed consent letter, are available in Appendix M and Appendix N, respectively. In the notes taken during the focus group and the transcription of the recording, no identifying information was included that could attribute a specific statement to an individual.

During the focus group, I acted as the facilitator and asked a few leading questions in a semi-structured format in the hopes of drawing out a candid dialogue between residents regarding their concerns and perceptions for a collective action strategy in Redwood Creek. I hoped that their responses would help me to understand

how the feasibility study could be more inclusive of residents who had thus far chosen to refrain from participating in either the survey, the house meetings, the workshop, or all of the above. It is widely recognized that there are significant advantages to utilizing focus groups as a method of inquiry, including the fact that they "allow researchers to better understand how members of a group arrive, or alter, their conclusions about some topic or issue" and can "generate important insights into topics that previously were not well understood" (Berg & Lune 2012:172).

Phase III. In *Phase III* of the Redwood Creek Water Conservation Project, which began in the spring of 2013, the empirical and observational data from *Phases I* and *II* were compiled, analyzed, and shared with interested participants, a dry season flow study was initiated, and a Water Rights Education Campaign (discussed in Chapter Four) was introduced as a new component of the Redwood Creek Water Conservation Project.

In the interest of transparency and maintaining a sense of momentum and progress regarding the project, I wrote a summary report and update for stakeholders, including initial analyses and findings from *Phases I and II*, as well as an announcement of next steps for the project (Appendix O). The report was made available on the SRF website, was distributed to visitors who stopped by the SRF office, and was shared via e-mail with participants who had left their contact information with us at the house meetings and workshop. Additionally, we distributed a press release that was picked up by at least one local newspaper (see Granziani 2013) and wrote an article that was published by the Trees Foundation in their Spring 2013 newsletter.

During these outreach efforts, I gave several presentations about the project at local symposiums and conferences in the interest of keeping scientific and academic communities informed about these local efforts. In March of 2013, Tasha McKee and I gave a presentation at the 31st Annual Salmonid Restoration Conference in Fortuna, CA, on "Changing Community Water Use Practices to Increase Flows for Salmonids" to approximately two hundred watershed professionals and scientists. Additionally, I gave presentations at the following events: the Eel River Recovery Project 2013 Vision and Action Gathering in January; Water Day III in Redway, CA in March of 2013 (see Easthouse 2013); the Earth Day Symposium on Marijuana and the Environment, hosted by the Humboldt Interdisciplinary Institute for Marijuana Research in April of 2013[1]; and at a public landowner meeting hosted in Willits, CA by the Mendocino Resource Conservation District in September of 2013.

The first year of Redwood Creek's flow study was conducted by consulting geologist and long-time resident of Redwood Creek, Bill Eastwood. He established eleven monitoring sites on all five tributaries of Redwood Creek, and began collecting streamflow data using the "bucket and stopwatch method"[2] (the same method used by Sanctuary Forest), beginning at the end of July 2013 and ending with the first significant rain at the end of the September (Appendix P).

Due to the seasonal timeframe of conducting low flow studies and the amount of data required to understand if and how changing human use will impact streamflows, the

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[1] The significance of the marijuana industry in relation to water diversions and other environmental impacts is discussed in Chapter Four under the heading "The Green Elephant in the Room."

[2] This is a low-cost, alternative streamflow monitoring method. For a link to the State Water Resources Control Board's list of alternative monitoring methods, see Appendix Q.

feasibility study for the Redwood Creek Water Conservation Project could not be completed while this thesis project was being written. In May of 2014, additional funding was secured through Humboldt Area Foundation, CDFW, and the State Water Resources Control Board (SWRCB) to ensure the ongoing development and implementation of a socially and ecologically appropriate water conservation program for the Redwood Creek watershed.

CHAPTER FOUR
DISCUSSION: CONSIDERATIONS FOR TRANSFERING A COLLECTIVE ACTION STRATEGY TO A NORTH COAST WATERSHED

Political ecologists have recognized that any ecological restoration effort that does not account for its social context is likely to fail, in so far is it will continue to treat the symptoms of degradation rather than the source (Christian-Smith 2012; Higgs 2003). The same is especially true of restoration efforts that employ a collective action strategy, where geopolitical boundaries, power dynamics, cultural histories, and economic realities intersect to shape the range of behaviors available to and practiced by resource users. In this chapter, I discuss several pertinent considerations in the transfer of a collective action strategy to a North Coast watershed.

The Green Elephant in the Room

For better or worse, marijuana cultivation has become synonymous with Humboldt County, now a national center for the industry with “upwards of 4,000 commercial growers” accounting for “more than $400 million in annual sales” (Donahue 2014). The unregulated marijuana industry has resulted in the development of a spectrum of cultural attitudes and behaviors in Southern Humboldt regarding the agricultural use of land and fresh water resources (Brady 2013), as well as a swath of environmental problems. As Scott Greacen (2013), Executive Director at Friends of the Eel River

ominously points out, “Far from theoretical, the reality is that [marijuana impacts] are driving species like coho salmon in the South Fork Eel River… closer to the brink of extinction.”

First, I want to clarify why this project did not do more to emphasize the environmental impacts associated with unregulated marijuana cultivation, especially in regards to water diversions. As is typically reported by local and national media outlets (Barringer 2013; Schultz 2014), marijuana grow sites, both large and small, can be a source of multiple and cumulative environmental impacts that can have devastating effects on sensitive species, including coho and Chinook salmon, steelhead, and coastal cutthroat trout. The Northern Region of the California Department of Fish and Wildlife summarizes these impacts as follows (2012):

- No use of “Best Management Practices” (BPMs) in the design and construction of roads, stream crossings, ponds, and cleared areas for growing;
- Pollution from petroleum products, fertilizers, soils amendment, killing agents (pesticides, herbicides, rodenticides, etc.), sediment, thermal pollution (increased water temperature), and trash and human waste;
- Conversion and fragmentation of natural areas and wildlife habitat;

And lastly, of particular relevance to this project, there is the impact of water diversions:

> Water from rivers, creeks, and streams is taken via dams, pumps, and hoses throughout the growing season, including the dry weather, low-flow period of June-October. Water is taken from small tributaries that feed fish bearing waters downstream. …Industry accounts documents a 150-day watering period, at 6 gallons per plant per day, totaling 900 gallons per plant per season. A 10,000 square-foot grow may use 360,000 gallons per season. Streams cannot support fish and provide large amounts of water to growers during low flows.

Bearing this in mind, it would be easy to conclude that low flows are the fault of “the growers,” and that water diversions at grow sites are the source of the problem. The

reality, however, is far more nuanced and near impossible to accurately quantify. As Schultz (2014) explains:

> Since it flies under the radar, the illegal marijuana-growing industry can dodge the water use restrictions, efficiency demands, and environmental regulations leveled on other agricultural sectors.
>
> Pot isn't a disproportionately thirsty crop, and it certainly isn't to blame for the state's water woes. And, if it moved out from under the veil of illegality it could be grown as sustainably as any other crop.

Water diversions for marijuana cultivation are regularly focused upon in local and national news (Kemp 2013; Mintz 2013; Easthouse 2013; Anderson 2014), yet a less glamorous reality exists that is often left out of the narrative. The cumulative impacts of the historic timber industry, the sub-dividing of rural land, and changes in climate—among other compounding variables—are also considered to be contributing factors to Southern Humboldt's low summertime flows (NOAA 2012; Burns 1972; Hagans et al. 1986; Ingram & Malamud-Roam 2013).

This research project followed Sanctuary Forest's lead regarding the issue of water diversions and marijuana grows: It does not matter what a person grows on their property, but how they grow it and what the resulting impacts are. According to Campbell Thompson, Sanctuary Forest's Board President, Sanctuary Forest is "a community organization and there is no consensus in our community about this issue. So we deal with reducing water use for everyone no matter what it is used for." By emphasizing responsible land and water use practices rather than focusing the blame exclusively on marijuana growers, Sanctuary Forest was able to frame their program to

be inclusive, therefore making the program more likely to accomplish the goal of a paradigm shift toward stewardship in the Mattole River Valley.

Similarly for this project, the intent was not to disregard the very serious environmental impacts of the marijuana industry, but to emphasize accessible solutions to the problem of water scarcity and to remove barriers to responsible water use as much as possible. This approach attempts to be inclusive of all water users who are eager to be responsible stewards of their watershed, but may be lacking the knowledge, skills, or resources required to do so.

Industrial-scale and/or "trespass" marijuana grows (i.e. marijuana grown illegally on public lands) represent the darker side of the marijuana economy (Downs 2013), especially when they are maintained by people who temporarily come to Humboldt County to strike it rich (in a phenomenon known as the "Green Rush") and leave a path of egregious environmental destruction in their wake:

> …the sudden emergence of a new industrial agriculture has had an environmental impact. Many of the new farmers… use techniques divorced from simpler and smaller-scale methods. The newcomers are prone to killing pests like rats with toxic rodenticides; they use heavy-metal-laden fertilizers and they clear-cut trees on hilltops. Their operations suck irrigation water from trickling creeks that are home to three species of federally listed threatened or endangered fish — steelhead trout, coho salmon and Chinook salmon — and can drain them almost dry if not closely controlled. (Donahue 2014)

Grow sites of this magnitude fall beyond the purview of this project. The owners and farmers of industrial grow sites are arguably more likely to exhibit "free rider"

characteristics rather than those of rational behavior[3], greatly reducing the chances that they would voluntarily participate in collective conservation efforts. In recent years, it has become evident that the scope and scale of industrial scale marijuana grows necessitates regulatory oversight rather than voluntary measures: "We need to (fully) legalize marijuana and regulate it as we would any other industry… Policymakers need to tell farmers, 'Go ahead and grow if you comply with environmental standards and with public-health requirements'" (Greacen 2014 cf. Donahue 2014).

Industrial-scale and trespass grows represent only one end on a broad spectrum of marijuana growing practices and mentalities. Toward the opposite end of the spectrum are smaller-scale (sometimes called "mom and pop") grows that many rural families depend on to supplement their income. The cumulative effects of small-scale grows can also have a detrimental impact on the environment, but it must be acknowledged that there are residents who represent a "long-established community of responsible growers…who are community-oriented and environmentally responsible; who farm organically and improve the private land they're living and farming on; who don't use poisons; and who store water (with or without a permit) in the winter for use during the dry months instead of sucking it from dwindling creek flows" (Jakubal cf. Kemp 2013).

Local efforts to address the impacts of marijuana cultivation have surfaced in recent years, from a Best Management Practices Guide for Northern California Farmers (Allen & Nevedal 2013) to the formation of Grow It In the Sun, a campaign initiated by activists in Northern California that "encourages responsible, small-scale, water-wise and

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[3] A discussion on rational behavior and its significance in the context of collective action can be found later in this chapter, in the section entitled Rational Behavior.

salmon-safe, organic outdoor marijuana cultivation, and opposes the industrialization of marijuana growing, indoors or out" (Davidson 2010).

Many residents in the Redwood Creek watershed have their livelihoods vested in this controversial and valuable cash crop. For this project, it was decided early on that the most effective way to make progress in changing human water use would be to welcome every interested resident—regardless of what they grow in their garden—to join in the effort.

Access

While working to gain access to potential project participants during the feasibility study for The Redwood Creek Water Conservation Project, challenges arose that are pertinent in the context of building a transferable model for collective streamflow management in North Coast watersheds.

For example, it can be expected that some rural residents will have limited or slow access to typical communication outlets (e.g. the U.S. Postal Service, cell phone reception, or the Internet), which can make outreach difficult for project organizers. Creative methods for conducting outreach in remote areas are discussed in Chapter Five and in the Addendum.

Additionally, there are some residents in Southern Humboldt—and likely elsewhere on the North Coast—who live in "voluntary exile" (Raphael 1985) for the explicit purpose of remaining unseen by outsiders and evading interaction with "the authorities" (House 1990). Gaining access to individuals who generally prefer to not

make contact with outsiders (e.g. researchers, scientists, or anyone else whom they do not yet know or have reason to trust) is a decidedly challenging task that must be addressed.

Grant et al. (2008:591) acknowledge that building trust and relationships among project participants is one of the more difficult hurdles in the "exceedingly complex process" of conducting action research. I attempted to address this challenge by using it as a starting point for reflection and awareness on my own position as a researcher and as an outsider during the feasibility study in the Redwood Creek watershed.

Borrowing from PAR methodology, trust-building approaches that I made an effort to utilize were to include local stakeholders in all phases of the research project, to demystify the research process by limiting the use of academic jargon in written and oral communications, and to share my knowledge and skills with my collaborators with the expressed hope that they would do the same for me (Grant et al. 2008; Feagin & Vera 2008). Through the bi-directional sharing of skills and knowledge, I strove to demonstrate through my actions, rather than my words, that I could be trusted.

These measures were a necessary starting point for building trust and gaining access to rural residents, but as the Redwood Creek Water Conservation Project progresses, additional efforts will need to be made that focus on recruiting new segments of the population to participate in the development of a collective strategy for managing streamflows in the watershed. In the initial phases of the feasibility study, I observed that the vast majority of the survey participants (as indicated by the number of years that they said they had lived in the watershed) as well as the majority of workshop and community

meeting attendees were in their mid-to-late 40s or older, whereas the participation of younger generations of watershed residents was close to nonexistent.

Cultural divisions as perceived by local residents—whether in Humboldt County or elsewhere—may affect the ability of project organizers to build trust and gain access to certain demographic composites in a watershed, unless steps are taken to understand what the perceived shortcomings or sources of vulnerability in the project are. Jakubal (2013) describes a "simmering culture war" between the northern and southern halves of Humboldt County "centering around marijuana suppression", and I believe that this dynamic in particular may have contributed to the generational divide that was observed during the initial phases of the feasibility study for the Redwood Creek Water Conservation Project.

During the focus group that took place in February 2013, participants who appeared to be in their early 30s were asked for their thoughts on why young people had not been opting to participate in the project, and their candid responses help shed light on how Humboldt County's cultural divide has impeded access and relationship building between the Project Team and young people in the Redwood Creek watershed:

> Information has been used against us a lot. If everyone says 'we use X amount of water', this goes into your thesis project, it becomes public information, it comes back from Fish and Game and they say, these people are using the water. They are the problem. We are going to go to their springs and make them pay for it. Or try to get them not to live on the land. So it is a genuine and justified thing for people to be defensive against information gathering without much of a promise or a chance of it leading somewhere. Because there is often a lot more high-mindedness and enthusiasm than there is in reality anything happening. –Focus Group Participant A

> There is a lot of defensiveness with younger folks because there is a lot of finger pointing. And our generation was raised, basically with the knowledge, ‘Your world is destroyed’ and there's not much you can do about it. That is, I think, a lot of the information that young kids are coming to the table with. It seems insurmountable. -Focus Group Participant B

The younger focus group participants were not the only oeioke who expressed distrust in a local water conservation effort where outsiders from “up north” were part of the project team. In this response offered during the focus group, a long-time resident of the watershed shared his concerns about who would be collecting water flow data during the feasibility study and what that data would be used for:

> There is a little bit of a danger here. There are a few Fish and Game people who love to be water cops. And they're kinda young and they don't have a lot of perspective and they'll be out looking at a stream restoration project and there will be a water line coming down the hill, and right away they'll say, ‘Where does this go? Have you got a permit for this water?’ And all of a sudden there's a big can of worms opened up.
>
> In terms of information, there is some weirdness in the county. What are those people up north going to do with it? You go to the county courthouse, and everyone is running around in suits, and they look like they just moved here from New York or somewhere.
> -Focus Group Participant C

In summary, challenges that project organizers might face as they attempt to negotiate cultural differences in their region will vary depending on the county’s socio-cultural history and how the objectives of the collective management strategy overlap wit the perceptions of local stakeholders. Gaining access to the harder-to-reach populations in a watershed will require an understanding of those variables and an exploration of outreach strategies that can cultivate trust and

reciprocity between watershed stakeholders of diverse geographic and cultural backgrounds.

Rational Behavior

When appropriators of a CPR are physically dependent on a shared resource system that generates scarce resource units, as is the case with rural residents who divert water from tributaries and rivers for their household and agricultural needs, it seems logical that those individuals would choose to act in a way that guarantees the greatest yield of resource units in perpetuity. After all, should appropriators choose to act independently and in their own self-interest, "the total net benefits they obtain usually will be less than could have been achieved if they had coordinated their strategies in some way" (Ostrom 1990:38). Unfortunately, increasing populations in some rural watersheds and a concurrent decrease in available water flows during the dry summer months indicates a likelihood that many appropriators are not behaving rationally in the management of their scarce CPR.

The behavior of appropriators can be the result of a variety of intersecting external and internal factors, as was discussed in the *Theoretical Framework* of this project. Internal factors include what an appropriator expects to gain from their participation in a collective action strategy, what they perceive the costs will be, their internal norms of behavior, and their level of physical and economic dependence on the resource system. Externalities that can hinder or promote rational behavior include the shared norms of other appropriators in a given setting and whether or not they consider

"the assignment of access rights and duties to be unfair, uneconomic, uncertain, or inappropriately enforced" (Ostrom 1990:49), which can adversely affect their willingness to participate in a collective action strategy.

Devising a collective action strategy for managing streamflows in a watershed is, in essence, a process of institutionalizing rational behavior within the context of site-specific ecological conditions. Successful collaborations toward this end will take necessary steps in order to propagate internal and external factors that result in a voluntary shift toward responsible water use among rural residents, and to reduce or remove the factors that impede rational behavior. Those steps will vary depending on the socio-cultural and ecological composition(s) housed within designated geographic watershed boundaries. As the final product of this project, the guide for collective action (see Addendum) attempts to outline a general process for institutionalizing rational behavior in a rural watershed.

Funding

Watersheds are comprised of dynamic landscapes shaped by a mosaic of interacting determinants that contribute to streamflow, including hydrologic function, geomorphology, topography, soil profiles, and ecology. Understanding the biophysical structure and function of a watershed is necessary in order to ascertain how human behavior affects available streamflows, but obtaining this data can be a costly endeavor. Hydrologic assessments and flow studies require the skill and knowledge of trained professionals and specialized equipment may also be needed. Additionally, external

factors like the timing and quantity of rainfall will present a constant source of uncertainty. Data that spans years or even decades will be needed in order to approximate the historic and current trends of streamflows in a watershed, translating to a need for a significant investment of time and resources by stakeholders.

In addition to the collection of quantitative flow data, other expenses must also be considered and prepared for. These include outreach, implementation, monitoring and maintenance costs. These costs can be "affected by the physical attributes of the resource itself, the technology available for exclusion and appropriation, marketing arrangements, the proposed rules, and the legitimacy bestowed by external authorities on the results of institutional choices" (Ostrom 1990:203). It is important to note that in the case of a collective watershed restoration effort, monitoring refers to both streamflow monitoring as well as the monitoring of human behavior, based on the rules that have been established and agreed upon by participants.

Sanctuary Forest's collective action strategy would not have been possible without the financial support and investment of resources by a broad range of individuals, private foundations, and state agencies. Their streamflow monitoring and community outreach efforts began in the summer of 2004 and implementation of their program took place between 2005-2013, representing nearly a decade of persistent effort and investment by Sanctuary Forest staff and their collaborators. With significant funding from the California Department of Fish and Wildlife, they were able to coordinate the purchasing and installation of over one million gallons of water storage in the Mattole River watershed, resulting in a measurable increase in streamflows within their project

area. Private foundations and concerned Mattole residents also made contributions to the effort, enabling Sanctuary Forest to maintain all other aspects of the program, including community education and outreach.

Until recently, The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006 funded many of the watershed restoration efforts on the North Coast (Clark 2009). Other statewide funding programs, including the Fisheries Restoration Grant Program (FRGP)—a joint creation of the Department of Fish and Wildlife and the California Conservation Corps—were also responsible for funding many of California's restoration efforts.

At the onset of the feasibility study for the Redwood Creek Water Conservation Project, when the Project Team was working to figure out how to fund initial flow studies and community outreach efforts, we realized that the funding landscape was no longer as ample as it had once been. The 2006 Bond Act and other statewide bond measures that had previously been a backbone for restoration efforts had been nearly depleted, and the FRGP had become exceptionally competitive due to state budget reductions and the increasing number of applicants requesting funding.

California's ongoing drought has since catapulted the issue of funding for water conservation and water storage projects back into the political spotlight. Three new water bond proposals are competing for a place on the ballot in November of 2014 (Ewers 2014; McGreevy 2014), indicating that state funding may soon be available for water conservation projects at varying scales.

Water Rights[4]

In order for a collective action strategy to be successful in managing human water use, people diverting water from rivers, springs, and tributaries need to acknowledge that they are beneficiaries of a *public trust resource*; in other words, that they are reaping the benefits of a public resource that is imbued with significant aesthetic, economic, cultural, and ecological value. The *public trust doctrine* "holds that certain natural resources belong to all and cannot be privately owned or controlled because of their inherent importance to each individual and society as a whole" (Klass & Huang 2009:1). It applies to rivers and their tributaries, and to private water rights as well, where "individual water rights that affect public trust resources are rights of use that a state can revoke if the private right harms those resources" (Klass & Huang 2009:5).

Sawyers' (2010:1) Primer on California Water Rights explains: "California has a unique system of surface water rights that combines a traditional riparian system with the appropriative system found elsewhere in the West. The result is a confused approach to water rights that often leads to more questions that certainty." State water rights law requires all people diverting surface waters (from springs, streams, and rivers), including diversion of water from subterranean streams flowing in known and definite channels, to file a basic Statement of Diversion and Use. Additionally, if a resident is interested in

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[4] Parts of this section are drawn from Schremmer's (2013) article, "Water Diversion Enforcement Spawns Community Education."

conserving water through the storage and forbearance method, they are required by law to file for an appropriative water right.

Established as a legal means for protecting rivers as a shared resource and public trust value, water diversion permitting requirements have existed in California for many years, but have not been enforced in Humboldt County until recently. Prior to an enforcement sweep that began in the summer of 2013 (see Brooksher 2013), many landowners were not aware they had to report their water diversions and register their water storage to comply with state water law and avoid potentially onerous fines. According to Matt McCarthy, of the SWRCB Division of Water Rights, Southern Humboldt residents are not alone. Roughly 75% of all water diverters in California are in need of some form of action in order to come into compliance with state water law.

The SWRCB and CDFW both have a vested interest in ensuring that rural residents comply with state water law and register their water diversions and storage. When a household files their Statement of Diversion and Use, they are informing the SWRCB about their diversion amount(s), location(s), method(s), and basis of water right. In order to store water for more than thirty days—a necessity if a household intends to store winter water for use during the summer—they would then need to obtain an appropriative water right, which can be accomplished by filing a Registration of Small Domestic Use (SDU):

> The State Water Board has an existing statewide registration program for domestic use of water, allowing home water uses such as drinking and fire protection. These small domestic registrations must comply with general conditions from the State Water Board and typically receive project specific conditions from CDFW.

> Landowners eligible for the SDU program currently can request approval to divert to storage. However, this can be a lengthy process requiring site-specific evaluations that address in-stream and habitat needs (DFW 2014).

While California's unprecedented drought continued to wreak havoc on local water supplies, watershed stakeholders and state agency personnel conversed on how to streamline the registration process so that residents could begin storing water quickly, without fear of legal or regulatory repercussion from the state. In March of 2014, CDFW made a welcome announcement (CDFW 2014):

> With today's action, CDFW has essentially "pre-approved" the installation of storage tanks that meet the general criteria. The State Water Board has agreed to incorporate these criteria as conditions of approval, and to expedite the issuance of the registrations.
>
> "We have been working in these coastal communities for many years, and have good reason to believe that these emergency changes are going to be welcomed," said Charlton H. Bonham, Director of CDFW. "Many landowners who have wanted to take these steps can do so now more quickly with greater regulatory certainty from our department."
>
> Today's action was the direct result of suggestions made by local communities and fish conservation organizations such as Trout Unlimited, Mattole River Sanctuary Forest and the Salmonid Restoration Federation.

Though far from an all-encompassing solution, CDFW's pre-approval of storage tanks under the SDU registration program represented a victory for collaborative watershed restoration efforts on the North Coast. Coming into compliance with state water law can be a confusing endeavor and can lead to increased feelings of vulnerability among rural residents if not adequately addressed. Collective management efforts should aim to cooperate with state agencies in order to remove regulatory barriers to participation, and

to integrate opportunities for education and support regarding the water rights process into their strategy.

CHAPTER FIVE
RECOMMENDATIONS

Stakeholders interested in organizing themselves to address low streamflows in a rural watershed should understand from the onset that they will be engaging in a complex and uncertain endeavor. In the following chapter, I offer recommendations that can make specific challenges easier to navigate, thereby improving chances for success. These recommendations are based on lessons learned during the feasibility study for The Redwood Creek Water Conservation Project.

Previously, I discussed accessibility as a challenge that is likely to surface when working to transfer a collective action strategy to a rural watershed. Gaining access to rural residents is step that must be taken in order to encourage participation and compliance in a strategy for responsible use of a scarce CPR. By addressing challenges to accessibility and recruiting minimal participation at the onset of a collective effort, positive associations can be built around the strategy and the likelihood of outlying water users joining in the effort increases (Ostrom 1990).

In the feasibility study for technology transfer that was conducted during this project, two specific challenges arose when attempting to gain access to potential participations: rural residents having limited or slow access to common communication outlets and reduced access to residents due to an outsider being involved in the study. The former presents a challenge that can be addressed relatively easily with perseverance and a bit of creativity.

For example, if project organizers are attempting to conduct outreach by telephone but do not have access to a list of phone numbers for the residents of a watershed, a “phone tree”—asking a local resident to make five calls to neighbors, and then asking those neighbors to do the same, and so on—may be an appropriate solution. Residential phone lists and addresses may also be accessed by requesting the information from community groups, road associations, volunteer fire departments, or county planning departments. Other strategies for creative outreach include: word-of-mouth, presenting information at community events, leaving posters or brochures in public spaces (i.e. libraries, community bulletin boards, or store windows), and making regular and consistent announcements through local media outlets including newspapers, online blogs, and community radio stations. Furthermore, outreach to youth via presentations at local schools and/or through social media can increase the scope of outreach.

In all likelihood, collective action strategies for improving streamflows will involve the participation of at least one outsider. The outsider may be a student researcher, a restorationist from another watershed, or a state agency representative. Regardless of their title, steps will need to be taken to build trust and reciprocation between local residents and outsider(s) in order to demonstrate that participation in the project will not cause or result in unnecessary harm to local persons or property. In the previous chapter, I discussed a few trust-building strategies based on PAR methodologies that can help with this process. These include bringing local stakeholders in on all phases of the project from development to implementation, communicating and translating scientific information in a way that is meaningful to local stakeholders, and fostering shared ways

of knowing by making space for different perspectives and skills. Furthermore, public meetings and forums should be organized at times and locations that are accessible to as many residents as possible. Local residents should have frequent opportunities to engage in solutions-oriented dialogue with organizers in a public setting about the progress and trajectory of the collective action strategy.

During public outreach and community engagement efforts, I recommend that local stakeholders take care to notice who is participating—and who is not—during the initial phases of project development. If certain demographics are underrepresented at public meetings or workshops, steps need to be taken to find out who is being left out of the conversation and how their participation can most effectively be encouraged. In the Redwood Creek watershed, we used a recorded focus group as our method of inquiry and intentionally invited young residents to participate, since their age group had been underrepresented during the first phases of the feasibility study. From that meeting, my colleagues and I gained valuable insight into the perspectives of younger people in the watershed. We also had an opportunity to hear their suggestions on how the project could be framed to be more meaningful to local youth:

> Living in an area where relatively small changes make a huge difference, I think that's the message that when it gets across is the most impactful. That you are living in an area where your small effort will make a huge difference. Whereas when you're in the city, it feels pretty helpless. You feel like if you recycle, that's your contribution. And here, storing water makes all the difference. For me, any amount of effort that gets that message into people’s heads is worthwhile. –Focus Group Participant B

Hearing from a select number of local residents as to why they had or had not been participating in the feasibility study for the Redwood Creek Water Conservation Project

was an important step in the process of developing a socially relevant collective action strategy for the watershed. The final quote that I will share from the focus group is the one that resonated with me most:

> No offense to you, it doesn't take a thesis project to get these projects done. It takes someone like Tasha [McKee], who is going to work tirelessly for their whole life, to make sure that the watershed they live in flows. To make progress in getting tanks for people, or creating something that helps the problem rather than gathering more information about the problem, and a lot of people don't see necessarily that information can be the foundation for helping the problem. –Focus Group Participant A

This young focus group participant underscored three significant points. First, any outsider involved in developing a collective action strategy for a rural watershed needs to be willing to set their own ego aside so that local leaders can be at the forefront of the project. I suggest that the public face of a collective action strategy should be one of a trusted local individual who has the resources (in the form of time, energy, and social capital) necessary to inspire others in the community to voluntarily change their behavior. The skills and resources of outside researchers, scientists, and agency personnel will be crucial to the success of a collaborative streamflow management effort, but should be contributed in a way that augments local place-based knowledge rather than overshadowing it.

Second, Participant A’s statement highlights the importance of setting and achieving project milestones—big and small—that can be celebrated amongst local residents. In Redwood Creek, this was accomplished through occasional e-mail updates, via the Redwood Creek Water Conservation Project Update and Report (Appendix O) and through occasional presentations at local gatherings in and around Southern

Humboldt. However, it has been suggested that our project team could have done more to promote investment in the project by local residents. Specifically, it was recommended to us that we should host community-oriented gatherings and celebrations (e.g. “River Days”, film screenings, or fundraisers at the Beginnings Octagon) where neighbors would have an opportunity to mingle and cultivate a shared sense of place within the Redwood Creek watershed.

Lastly, Participant A’s quote highlights the fact that a successful collective action strategy will require time—a lot of it. In addition to possessing the social capital necessary for fostering community engagement in a streamflow restoration effort, leadership by a local resident of a watershed is more likely to result in a long-term commitment to the project from that person. From inception to implementation, Sanctuary Forest’s Mattole Flow Program was nearly ten years in the making, and their success was due in large part to the patience and perseverance of their local staff and of the landowners who agreed to participate.

If a collective strategy for improving streamflows takes place in a watershed where marijuana cultivation is a significant part of the economy, as was the case in the Redwood Creek watershed, organizers will need to keep in mind that they cannot expect consensus among residents on how to address the issue. Without a legal framework in place for regulating the environmental impacts of the marijuana industry, stakeholders can expect that opportunistic behavior will be a constant source of uncertainty and will represent a highly divisive issue among community members. My recommendations in this case are to emphasize solutions and best practices for responsible water and land use,

and to be consistent when framing the objectives of the strategy so as to be as inclusive as possible. In this way, stakeholders may be able to reduce feelings of vulnerability and distrust experienced by some rural water users, thereby increasing the likelihood of their participation in the earliest stages of project development.

Difficulties with obtaining funding are another reality that stakeholders must address as they prepare to transfer a streamflow improvement strategy to their watershed. In Redwood Creek, we applied what we had learned from Sanctuary Forest regarding how to keep a long-term flow program economically viable, and found that some of the biggest questions in a feasibility study can be answered without the cost of hiring an expert.

Cost effective steps can and should be taken to collect anecdotal and observational data from long-term residents in the watershed. Trained volunteers can employ alternative flow monitoring methods using inexpensive equipment. Additionally, we found that it is necessary to ask for financial support from a diverse mix of public and private funders; in this way, should one source of funding dry up, others will enable the project to stay afloat. Furthermore, I would also recommend that funding for a collective action strategy should be sought from local communities, since those residents stand to benefit from improved streamflows. If orchestrated strategically, fundraising for a collective management strategy can offer the dual benefits of raising necessary monies to keep the effort afloat, as well as building stronger social ties and a sense of personal investment in watershed stewardship.

Another suggestion that I would like to offer is related to the issue of water rights and state water law. During the initial phases of the Redwood Creek Water Conservation Project, water rights surfaced as a contentious issue that could have been disastrous for the progress of the project, had organizational stakeholders not responded quickly to the concerns of local residents.

The Water Rights Education Campaign (a component of the Redwood Creek Water Conservation Project) represented a coordinated effort between SRF, Friends of the Eel River, CDFW, and the SWRCB[5]. In late spring of 2013, spurred by fish kills resulting from illegal and poorly constructed water diversions in both China Creek and Seely Creek, the Division of Water Rights of the SWRCB issued notices of "Potential Unauthorized Diversion and Use of Water" and "Failure to File a Statement of Water Diversion and Use in Humboldt County" to dozens of landowners in the China Creek watershed. According to the New California Water Atlas (2013), only two landowners have legally established water rights in the entire Redwood Creek watershed, leaving hundreds more vulnerable to enforcement, especially if their water diversions have the potential to harm endangered fish.

To help inform residents about their water rights and responsibilities, SRF and Friends of the Eel River hosted a Water Rights Education Forum on Thursday, July 11, 2013 at the Beginnings Octagon. Speakers at the forum included Jane Arnold, water specialist with the California Department of Fish and Wildlife, Matt McCarthy with the Division of Water Rights, and Tasha McKee from Sanctuary Forest. Approximately 170

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[5] This section is drawn from Schremmer's (2013) article, "Water Diversion Enforcement Spawns Community Education," published in The Eel River Reporter: Volume XV, Fall 2013.

landowners were in attendance, with KMUD broadcasting the proceedings live on Redwood Community Radio.

The Water Rights Education Forum provided a crucial opportunity for residents to ask clarifying questions about the steps necessary for filing their water rights, and enabled agency representatives to explain why compliance is beneficial to both fish and property owners. In addition to the Water Rights Education Forum, an informational brochure was also developed with input from CDFW and the SWRCB. The Know Your Water Rights brochure outlined the step-by-step process required in order to come into compliance, and has been instrumental for residents in Humboldt County and elsewhere (see Appendix R). As The Redwood Creek Water Conservation Project progresses, project organizers will continue to provide support to residents through local water rights clinics, workshops, and individual consultations.

My recommendation for watershed stakeholders is to consider early on how a collective action strategy might address the issue of water rights. In Redwood Creek, educational outreach, hands-on support, and working to streamline regulatory processes were significant components of the water rights strategy, and I suggest that this approach could be equally effective in other watersheds. Filing for a water right and registering water diversions offers the dual benefits of increasing the water security of a property, while helping to quantify the amount of water being allocated for beneficial use in the watershed. This information is crucial to protecting streamflows sufficient for maintaining salmon and steelhead populations.

Final Thoughts: Place-based Collective Action on the North Coast

Place-based collective action strategies will look different depending on the social and ecological context of the watershed setting, but I suggest that in most cases, a few conditions will need to be met if stakeholders hope to achieve a paradigm shift toward responsible water use and stewardship in their watershed. Collective efforts to transfer or scale-out voluntary water conservation strategies will increase their chances for success if: a) local residents have an emotional and physical attachment to the watershed as their place; b) if the project is driven by the stakeholders and residents who stand to benefit from increased streamflows; c) if stakeholders and residents have sufficient access to ecological data; and d) if, as Bixler (2011:9) suggests, it's "the right time" and "the right type of" leaders are willing and able to lead the collective endeavor.

An assessment of how to reduce sources of uncertainty and promote rational behavior can greatly improve the ability of a collective action strategy to successfully take root. For example, in Humboldt County, many organizational stakeholders are working collaboratively to develop economic incentives for rational behavior, including potential tax rebates for off-stream water storage. Tax rebates could help reduce the financial hurdle that some property owners perceive as a barrier to increasing their winter water storage. Some of these same stakeholder groups are also exploring funding options that would enable them to provide direct support to rural residents as they begin the process of filing for their riparian and appropriative water rights, a service that may further promote rational behavior among rural residents by easing the bureaucratic

process of coming into compliance with state water law. In summary, if rural residents perceive that the cost for participating in a collective action strategy would be high, or if there are other factors affecting the ability of local residents to participate in a collective action effort, organizations and institutions should make accommodations in their strategy to address those factors in a way that is responsive to the needs and concerns of the people in the watershed.

External and internal norms are two of the most influential variables that can impact the behavior of rural water users. It can be decidedly challenging to establish long-term commitments from individuals if they live in a setting in which few "share norms about the impropriety of breaking promises, refusing to do one's share, shirking, or taking other opportunistic actions" (Ostrom 1990:36). Norms shape the range of behaviors that rural residents perceive to be available, accessible, and worthy of adopting. Adjusting internal and external norms to promote rational behavior is arguably a daunting task, but I suggest that orchestrating a CPR management strategy as a place-based endeavor has the potential to shift norms away from opportunism and toward rational behavior.

In the *Literature Review*, I discussed place attachment as a human experience that is highly relevant in the context of a collaborative watershed restoration effort. The physical and emotional connection that a person feels to a given setting has psychological (i.e. internal) and cultural (i.e. external) implications, indicating place attachment as an asset for maneuvering internal and external norms to promote rational behavior through responsible water use. But what does a place-based CPR management effort look like in

practice? Harry Vaughn (2013:16), a long-time Southern Humboldt resident and co-founder of the Eel River Salmon Restoration Project, offered these insights after attending a water conservation workshop that was organized by the Project Team for the Redwood Creek Water Conservation Project:

> Tasha McKee, a 'local' whose family came to this place back in the mid-1800s, has represented people in our community who have chosen 'living in place' and passing on inter-generational connections with the land that we call home. Working with Sanctuary Forest, Tasha has spearheaded community efforts with water storage and conservation efforts in the Mattole River. This water storage along with its effect of limiting water withdrawals from salmon-bearing streams during the dry season is now being transferred to the Redwood Creek community. This is very much a 'place-based' program. After all, the communities we call home have the ultimate responsibility of being good stewards of the land, water, and all of our watershed's inhabitants.

For stakeholders on the North Coast, and particularly in Southern Humboldt, I suggest that strategies to improve streamflows are place-based when they: a) put a high value on local and inter-generational knowledge-sharing and participation; b) emphasize the intrinsic value of non-human creatures indigenous to the watershed (particularly of native salmon); and c) are motivated by a desire to improve the landscape for the benefit and enjoyment of future generations.

Local stakeholders organizing themselves to address the problem of low water flows must recognize and prepare for the fact that a place-based collective action strategy will never accomplish the feat of fully removing opportunistic behavior from the equation. In Southern Humboldt's rural watersheds, many residents identify as back-to-the-landers and share a cultural desire to "live in place," yet they are not the only residents diverting water from streams, tributaries, and rivers. With the Green Rush came a wave of

"newcomers", who had an entirely different set of values, internal norms, and a marked lack of emotional attachment to Southern Humboldt as their place.

In what could easily be labeled a tragedy of the commons[6], the proliferation of industrial scale marijuana grows in Humboldt County has brought with it behavioral norms that promote irresponsible use of scarce natural resources and environmental degradation for the sake of short-term economic profits. Ostrom (1990:35) points out "if a CPR can be destroyed by the actions of others no matter what local appropriators do, even those who have constrained their harvesting from a CPR for many years will begin to heavily discount future returns, as contrasted with present returns." This is certainly rings true in Southern Humboldt, where several times during community meetings residents stood up and raised the question, "What difference does it make if I conserve water while [the newcomers] take all that they want and more?"

Watershed stakeholders and rural residents in Southern Humboldt will need to face the difficult reality that opportunism will continue to represent a significant external and internal norm of behavior in an unregulated marijuana economy. With the passing of a legal framework that can regulate the environmental impacts of the marijuana industry, major investments in monitoring and sanctioning can be made to help make joint CPR management efforts more feasible (Ostrom 1990:36). However, simply waiting for the state to take action is not sufficient, nor, in my mind, is it tenable. A legal framework will help regulate water diversions for marijuana grows, but it will not result in the paradigm shift that is desperately needed. Building a culture of responsible water use and

[6] An expression coined by Garrett Hardin (1968) to symbolize the degradation of the environment that can result when multiple users share a common natural resource.

promoting an understanding of water as a shared resource and public trust value are the only viable means for ensuring that our rivers will continue to flow, and this daunting task cannot be accomplished with regulation alone. Watershed stakeholders must take responsibility for both their individual and their collective behaviors, and must use water in a rational way that respects the needs of upstream and downstream neighbors, human or otherwise.

In Redwood Creek, based on a shared desire to "live in place" and to restore a cultural balance between people and salmon, Southern Humboldt's back-to-the-landers appear to be uniquely and ideally positioned—even in the face of rampant opportunism—to lead by example in adopting a place-based collective action strategy for improving streamflows that is welcoming to a diverse spectrum of local water users. That being said, even before the industrial marijuana industry sunk its roots into Humboldt County's fertile soils, back-to-the-landers represented only one portion of the region's rural population. There are ranchers, homesteaders, young individuals and families, and many other watershed residents who do not identify as back-to-the-landers or large-scale marijuana growers, but who have the potential to be brought into the fold of a place-based restoration effort. In any populated North Coast watershed, I recommend that project organizers identify the population(s) that are culturally positioned to be early adopters of a collective action strategy, as those are the people who will begin to set a new and rewarding example for their neighbors.

Here and now, the timing is most certainly right for developing and implementing collective streamflow management strategies in North Coast watersheds. California's

ongoing and extreme drought has propelled the challenges of water scarcity, water diversions, marijuana agriculture, and declining salmon populations to the forefront of public and private spheres.

Future generations will know how we responded to these interconnected crises when they see the state of our communities, our rivers, and our salmon. They will see either that we turned a seemingly insurmountable challenge into a legacy of collective action, or that we squabbled amongst each other until the fish failed to return and the rivers went dry. Personally, I still believe that we are capable of leaving a legacy worth being proud of, but we have no time to lose.

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ADDENDUM

Resilience in a Time of Drought:
A Transferable Model for Collective Action in North Coast Watersheds

Salmon Keeper, ©2001 Valery McKee

Prepared in partial fulfillment of a grant from the Bella Vista Foundation

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Sanctuary Forest is a non-profit land trust whose mission is to conserve the Mattole River watershed and surrounding areas for wildlife habitat and aesthetic, spiritual and intrinsic values, in cooperation with our diverse community.

The Bella Vista Foundation's Ecosystem Restoration program focuses on protecting, restoring, and revitalizing high priority watershed ecosystems in California and Oregon.

Section One: Introduction

> *"You enter* Whitethorn *valley, and see signs about the river. And in every driveway there is a symbol, showing this family is part of the conservation effort. There is restored groundwater hydrology in the entire headwaters, so even in drought years the tributaries are flowing. The water is clear. The forests are thinned to a healthy level. There is a stewardship balance, in the way native peoples experienced it. And the humans are a part of that, instead of cast out of the garden."* -Vision for the Mattole Headwaters, Tasha McKee, January 2012

Overview

Resilience in a Time of Drought: A Transferable Model for Collective Action in North Coast Watersheds is a practical 'how-to' guide for community members, restoration practitioners, non-profits, and other stakeholders wishing to establish a voluntary water conservation program in their watershed. This guide was developed based on the methods and findings of a collaborative technology transfer project that was initiated in Humboldt County, California in 2013 by Sanctuary Forest and Salmonid Restoration Federation in collaboration with Sara Schremmer, a graduate student in the sociology program at Humboldt State University.

While this guide was being developed, California was experiencing its worst drought since recordkeeping began in the 1840s, with one paleoclimatologist suggesting that 2013 "could potentially be the driest water year in 500 years"[7]. While climatologists predict that changes in global climate will continue to manifest in unexpected ways in the Pacific Northwest, longer dry seasons (i.e. months without rainfall) are an impact already being felt in Northern California, which can result in reduced water quality and quantity for increased periods of time.

The challenge of low water flows galvanized many concerned residents and stakeholders in Southern Humboldt to raise a challenging question: How can we become more resilient in a time of drought, and what can we do to keep more water in the rivers, tributaries, and streams so that people and fish have enough to survive?

The steps outlined in this guide have been designed for use in watersheds where a rural population is dependent on a local watercourse for their agricultural and household needs, and where changing human use has the potential to increase streamflows. Our recommendations should be considered and applied as appropriate, based on the social and ecological context of the watershed where implementation is to take place.

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[7] Quote by UC Berkeley paleoclimatologist B. Lynn Ingram, co-author of The West Without Water: What Past Floods, Droughts, and Other Climatic Clues Tell Us About Tomorrow (2013): http://newscenter.berkeley.edu/2014/01/21/states-water-woes/

Background

In instances where policy prescriptions and state control of resource systems have been unsuccessful in accomplishing specific resource management or restoration goals, a move toward self-governed collective action by local stakeholders may be a viable alternative. This section describes the voluntary model that Sanctuary Forest developed in order to collectively manage streamflows in their rural watershed[8].

From 2005-2013, a water conservation pilot project was implemented by Sanctuary Forest in the Mattole headwaters, for the purposes of addressing low summertime water flows that impact rural residents and sensitive aquatic species. Following a "water storage and forbearance" concept, they recruited eighteen landowners to voluntarily sign a legal agreement with Sanctuary Forest to store water from the Mattole River during the high flows of the winter season, and to forbear from pumping during the dry season by using the stored winter water from their tanks during low flows. In exchange for the legally binding water forbearance agreement, Sanctuary Forest coordinated the purchasing and installation of government subsidized 50,000-gallon Pioneer water storage tanks on the private properties of the participating landowners. After placing the large storage tanks in critical fish habitat reaches that overlapped with private property, the landowners were able to store plentiful winter water for their domestic and agricultural needs—often more than enough to last them through 105 days of low summer flows. Sanctuary Forest maintained regular communication with the participating landowners throughout the year, and would notify each household when it was time to turn off their pumps for the season. Sanctuary Forest's water storage and forbearance efforts resulted in measurable improvements in streamflows. In low flow years prior to program implementation (2004 & 2006), flows dropped to 0-3 gallons per minute (gpm) at MS6, the measure point at the downstream end of the program area. Post-implementation in low flow years (2011, 2012 & 2013), flows were measured at 49-206 gpm. The threshold flow when pools become disconnected is 90 gpm and therefore the increase in flows from turning off the pumps was significant for fish and wildlife.

Early in 2013, Sanctuary Forest and Salmonid Restoration Federation initiated a study to determine the feasibility of conducting a "technology transfer" of Sanctuary Forest's Mattole headwaters water storage and forbearance program to Redwood Creek on the South Fork Eel River in Northern California. Redwood Creek is a 26 square-mile

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[8] Sara Schremmer's (2014) thesis, Resilience in a Time of Drought: Building a Transferable Model for Collective Action in North Coast Watersheds, examines Elinor Ostrom's (1990) theory of collective action as a useful framework for understanding how individuals can be organized to act collectively for the continued enjoyment of a shared resource.

watershed that flows into the South Fork of the Eel River near Redway, California; it also happens to be located adjacent to the Mattole watershed, and suffers from many of the same cumulative impacts that have led to serious concerns about low summertime flows. To address these concerns, the Redwood Creek Water Conservation Project was designed in order to gather data about human water use and low flows in the watershed, to gauge community interest in establishing a voluntary water conservation program similar to the one in the Mattole, and to understand the type of water conservation program that might be appropriate for the Redwood Creek watershed and its rural residents. The feasibility study that was conducted at the onset of the Redwood Creek Water Conservation Project has been translated into this step-by-step manual, in the hopes that what we have learned can be taken and applied in other watersheds in Northern California and elsewhere.

What is "technology transfer"?

The definition of "technology transfer" varies by discipline, but can be generally understood as **the movement of know-how, technical knowledge, or technology from one setting to another**[9]. In the case of a collaborative water conservation model, transferability can be thought of as **the replication, scaling-out, or adoption of water conservation technologies or practices that were successful in one place to another place, based on the unique social and environmental needs of the watershed.**

The significance and challenge of addressing water scarcity through technology transfer was addressed in the opening statement of the Symposium on Water Issues in 2006:

> *The transfer of technology, when it deals with water (an essential element of life, economic development, social communities, and national politics), is one of the most complex areas facing the world today… the desperate need for water and our dependence on it make it one of the most contentious substances on earth—and thereby vastly complicates the challenge of diffusing the technical capacity to provide better methods for water supply and use for the citizens of the world* [10].

Applying technological solutions to freshwater problems is not a new practice. There are any number of techniques, programs, and point source fixes—informed by hydrology, biology, geography, and ecology—which can help mediate human impacts on freshwater resources. However, only recently has the transfer of technology been recognized as a beneficial tool in collaborative place-based efforts to restore watersheds.

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[9] Roessner, J.D., in press. Technology transfer. In: Hill, C. Ed., Science and Technology Policy in the US, A Time of Change. Longman, London.

[10] Huber, T. P. 2006. In This Issue: Symposium on Water Issues. *Comparative Technology Transfer and Society*, *4*(3), viii–xi. doi:10.1353/ctt.2007.0007

The Center for Collaborative Conservation Research produced a report in 2011 that provides a useful framework for understanding the feasibility of technology transfer in the context of collaborative water conservation[11]. In the social-ecological-temporal (SET) model, the social dimensions require that the restoration process "needs to be landowner driven, there needs to be sense of community, and the right 'type of' leaders need to be willing to lead." From an ecological standpoint, accurate and appropriately translated scientific data should be shared with community members that they can use as they are formulating their objectives. Lastly, the SET model notes, "even with the right social and ecological conditions, ultimately it also 'has to be the right time'" and there needs to be capacity—from both scientific, professional, and citizen stakeholders—to invest the resources that are available to them in order to make the program or project successful.

Place-based Collaborative Watershed Restoration

In response to inefficient environmental policies that have historically failed to address the interrelationship between human beings and the ecosystems in which they live, multi-stakeholder collaboration has emerged as a popular archetype in watershed restoration. Collaborative methods of addressing environmental degradation developed in the 1990s in tandem with the rise of citizen-based groups that were forming in order to address the failing health of their local environments. One result of this new paragon of grassroots environmental organizing was the emergence of collaborative watershed management, which can be defined as follows:

> a primarily self-directed and locally focused collection of parties, usually featuring both private and intergovernmental representatives, organized to jointly address water-related issues at the watershed level… and typically reliant on collaborative mechanisms of group interaction characterized by open debate, creativity in problem and solution definition, consensus decision-making, and voluntary action[12].

While there are many benefits to collaborative watershed restoration, it is helpful to understand some of the difficulties that might arise prior to initiating your project. Collaborative restoration efforts can be challenging, requiring not only a sound understanding of the hydrological, geological and ecological characteristics of the watershed, but also effective multi-stakeholder cooperation across different social sectors.

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[11] Bixler, Patrick R. 2011. *Navigating Waters Beyond the Blackfoot: Transferability of the Collaborative Conservation Model*. Report produced for the Center for Collaborative Conservation Research, Colorado State University.

[12] Kenney, D.S., et al., (2000). *The new watershed source book.* Boulder, CO: Natural Resources Law Center. Page 2.

Complications or intractability can arise during collaborative watershed management efforts when the social ecosystem (i.e. human geographic boundaries) conflicts with traditional administrative-political boundaries (i.e. counties, states, or national forests) or the actual geo-physical boundaries that define the watershed itself. Furthermore, collaborative restoration has been described as inherently political because its success relies upon the incorporation of complex relationships involving authority and power between individuals and groups in a social setting, and because it relies upon the active participation of private and public stakeholders across disciplines, levels of authority and sometimes varying scales of land ownership, resulting in social terrain that can be challenging to navigate.

It has been argued that collaborative restoration efforts in rural settings can be more challenging than those located in smaller-scale urban neighborhoods. Working at a landscape scale in a rural area involves "higher degrees of personal stake in outcomes, higher sensitivities to planners as 'outsiders,' more pronounced power dynamics, challenges to implementation due to diverse land ownerships, more diffuse social and community structure, and greater opportunities for incorporating technology."[13] The problem of large-scale projects complicating social participation among stakeholders can be remedied by breaking "the larger region into smaller subregions with which stakeholders more readily identify"[14].

Successful collaborative watershed restoration requires more than active citizen participation. It is also vital that your efforts be conducted within the scientific context of the watershed where you are attempting to work. A project is likely to fail when it lacks: "1) the inclusion of a solid conceptual model of river ecosystems; 2) a clearly articulated understanding of ecosystem processes, 3) recognition of the multiple, interacting temporal and spatial scales of river response, and 4) long-term monitoring of success or failure in meeting project objectives following completion."[15] In order to circumvent these challenges, it is often recommended that practitioners of collaborative watershed restoration include representatives from a broad range of stakeholder groups early in the analytical and decision-making phase of the project, including citizens, scientists with expert knowledge of the resource systems under investigation, and appropriate governing agencies.

Place-based collective action strategies will look different depending on the social and ecological context of the watershed setting, but Schremmer (2014:95) suggests that in most cases, a few steadfast conditions will need to be met if stakeholders hope to achieve a paradigm shift toward responsible water use and stewardship in their watershed. "Collective efforts to transfer or scale-out voluntary water conservation strategies will

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[13] Cheng, A. S. and S. E. D. (2003). Examining the Interaction Between Geographic Scale and Ways of Knowing in Ecosystem Management: Collaborative Planning. *Forest Science*, *49*(6), 841–854.

[14] Moote, M. A., M. P. McClaran, and D. K. Chickering. (1997). Theory in practice: Applying participatory democracy theory to public planning. *Journal of Environmental Management*. 21(6):877–889.

[15] Wohl, E. (2005). River restoration. *Water Resources Research*, *41*(10), 1–12. doi:10.1029/2005WR003985

increase their chances for success if: a) local residents have an emotional and physical attachment to the watershed as their place; b) if the project is driven by the stakeholders and residents who stand to benefit from increased streamflows; c) if stakeholders and residents have sufficient access to ecological data; and d) if, as Bixler (2011:9) suggests, it's 'the right time' and 'the right type of' leaders are willing and able to lead the collective endeavor."

For stakeholders on the North Coast, and particularly in Southern Humboldt, Schremmer (2014:97) advocates for a place-based emphasis when developing a collaborative streamflow improvement strategy. She suggests that such a strategy would: "a) put a high value on local and inter-generational knowledge-sharing and participation; b) emphasize the intrinsic value of non-human creatures indigenous to the watershed (particularly of native salmon); and c) be motivated by a desire to improve the landscape for the benefit and enjoyment of future generations."

Under the right circumstances, place-based collaborative restoration can provide an effective framework for encouraging local citizens to become active participants and caretakers of the places that they call home.

Section Two: Establish the Feasibility of a Voluntary Water Conservation Program

Step One: Determine the Scope of Your Study Area

Conservation efforts focused on freshwater resources need to be conducted at a scale that appropriately and sufficiently addresses the impacts that contribute to low streamflows. Choosing a specific area within your watershed where a program can be implemented and evaluated will enable you to more easily show a demonstrable increase in flows as a result of your efforts. After your water conservation program has been implemented and its progress has been evaluated, you can take lessons learned and apply them at a larger scale and/or replicate your efforts elsewhere.

Recommended Actions:

Select a main steam reach or tributary system that is an area of concern. The study area that you choose will need to reflect the problem that you are hoping to address. Consult any existing recovery or species plans that might exist for the location(s) that you have in mind, and speak with agency personnel for ideas about priority areas.

- If your primary concern is protecting aquatic species and your goal is to improve habitat conditions, select a study area that has high habitat value and where you have reason to believe that changing human use will have a demonstrable impact on increasing flows and water quality. Consider whether the lack of flow is a threat to species in that area.

- If your primary concern is water scarcity and your goal is to increase flows for both people and wildlife, select a study area where the residents are highly dependent on the water source for subsistence purposes, and where you have reason to believe that changing human use will have a demonstrable impact on increasing flows and water quality.

Step Two: Identify and Contact Stakeholders

Collaborative restoration movements have been flourishing in rural communities since the 1990s as a direct result of pressures on the natural resource bases upon which those communities depend. In situations where riparian landowners are an important stakeholder group in the restoration of a specific water body, the “localness” of those landowner groups, coupled with a reliance on the degraded water resource for economic

and/or subsistence purposes, is understood to be an asset in fostering broad support for watershed restoration efforts.

Recommended Actions:

1. Make a list of the individuals and groups whom you think should be directly involved with the project. Include representatives from a broad range of stakeholder groups early in the analytical and decision-making phase of your project, including citizens and landowners, scientists with expert knowledge of the resource systems under investigation, and appropriate governing agencies.

2. Contact the people on your list to inform them about your interest in initiating a feasibility study for a water conservation program. This outreach can be conducted individually, on a conference call, at group meeting, or all of the above, and will provide you with an opportunity to share your ideas, to gather feedback from stakeholders, and to find out what type(s) of resources those stakeholders might be able to offer as the project progresses.

Step Three: Collect and Analyze Preliminary Data

Every watershed is comprised of unique land use histories, climactic conditions, and human water use patterns. These factors interact in complex ways and need to be examined in order to understand the historic context and current conditions of flows in a watershed, as well as which causes of low flows can be controlled.

Extensive data collection and research will be necessary in order to understand what type of water conservation program will be feasible and have the greatest impact in your study area. The good news is that many of the big questions can be answered without the cost of hiring an expert.

Sending out survey questionnaires to all of the households in your study area is an ideal way to collect preliminary data from residents in the community. The surveys will provide important information on human water use in your watershed, which you will need in order to later compare an estimate of the percent of water being used (i.e. agricultural and residential) to available flows. Survey questionnaires can double as an excellent opportunity to gauge the interest of local residents in participating in a voluntary water conservation program, and to collect anecdotal information on historic precipitation patterns and flows from long-term residents (i.e. Have flows changed over time or have they always been low seasonally? Are the low flows are more severe than they used to be?).

Data on land use histories, changes in climate over time, and historic and current flow patterns in your watershed are likely available in public reports and records.

Recommended Actions for the Surveys:

1. Obtain a mailing list for the survey questionnaire. This can present a challenge in rural areas, but typically there will be at least one or two entities that should be able to assist you. For example, for the Redwood Creek Water Conservation Project, a mailing list of parcel owners was obtained from the Humboldt County Planning and Building Department. Volunteer fire departments may also be able to help.

2. Write a survey questionnaire that will help answer specific questions about water use and long-term observations in your watershed. In Appendix I, we provide a sample based on the questionnaires that Sanctuary Forest and Salmonid Restoration Federation mailed to residents in their respective watersheds. Here are some recommendations for conducting your survey mailing:

- Include a cover letter that explains the purpose of the survey and how the information will be used. A sample cover letter can be found in Appendix I.

- Make the survey anonymous. Since you are looking for general information about water usage in your watershed, there is no need to ask for identifying information like name, address, and so on.

- If possible, send a pre-notice to residents one week prior to the mailing in the form of a letter or a postcard. Pre-notices informing recipients of an upcoming survey have been shown to significantly improve response rates.

- If possible, include a stamped return envelope with the survey mailing. The stamped envelope serves as an incentive to respond, and has been shown to increase response rates in survey mailings.

- Make the survey questionnaire available online for respondents who may have missed the survey mailing.

3. Mail the surveys, collect the responses and compile the data into a spreadsheet for analysis. In all likelihood you will not receive a 100% response rate, especially if the survey recipients live in remote areas. Aim to collect survey questionnaires from 20-25% of your mailing list. Consider enlisting the help of local volunteers to spread the word about the survey using phone trees (i.e. one resident makes five phone calls to neighbors and asks those neighbors to each make five calls, etc.).

Additional Recommended Actions for Collecting Preliminary Data:

1. Analyze existing data from river gauges in your study area, annual precipitation reports, and seasonal precipitation patterns. For example, in the Mattole, Sanctuary Forest looked up US Geological Survey (USGS) gauge records in 2008 and found that in Petrolia, 6 out of the past 8 years showed the lowest flows in the 59-year record for that gauge. Residents were galvanized by this information, since it demonstrated a growing trend toward extreme low flows in the summertime.

While conducting your analysis, attempt to answer the following questions:

- Have low flows become more severe?
- Is there a trend toward more frequent low flows?
- Is annual precipitation a factor in influencing low flows?
- Are there apparent long-term trends in annual rainfall?
- Is seasonal precipitation a factor in influencing low flows?
- What sorts of changes in seasonal precipitation have been observed over the years?
- Does existing data indicate whether rainfall during one season (e.g. summer or early fall) might have more of an impact on flows than another season (e.g. late winter and spring)?
- Could changes in summer temperatures be a factor?

2. Outline the land use history of your watershed and the potential impacts that may be contributing to low flows. For example, in the Mattole watershed, the historic affects of the timber industry resulted in significant and cumulative impacts that are still being felt to this day. Sedimentation from logging roads has impacted streamflows in multiple ways, including the filling in of channels, the loss of large pools, and the loss riparian shade. The loss of groundwater storage in the region is thought to be an even larger contributor to the low flow crisis. An understanding of these and other land use impacts has helped inform the solutions that have been developed for that region.

3. Try to answer the following questions about human water use patterns in your watershed:

- What does the most current US Census data show the population of your watershed to be? Compare this information to data from 10 years ago. How much has the population increased during this time?

- In what ways has water use per person increased over time in your watershed? Answering this question may require looking at the cultural history of populations in your watershed in order to assess how changing lifestyles may be contributing to increased water use.

- Look at aerial photographs to get an idea of how different types of water use are scattered throughout the watershed.

Step Four: Work with a Hydrologist to Assess the Flow Regime in Your Watershed

A 'flow regime' refers to the changes in water flow in a river that occur over the course of a year. A quantitative hydrologic assessment of your river's flow regime can help answer the following critical questions:

- What types of fluctuations in flow take place throughout the course of the year?
- Is there a distinct low flow season or are the flows low year round?
- Are current flow patterns outside the predicted natural variation?
- For how many years does the data show that flows have been lower than average?
- What is the minimum amount of flow in cubic feet per second (cfs) or gallons per minute (gpm) required in order to maintain adequate water quality?
- Could changing human use have an impact on improving streamflows?

In addition, for all fish bearing streams, you would need to investigate the following question: What are minimum flows required for spawning, juvenile rearing, and juvenile migration?

Recommended Actions:

1. Recruit the assistance of a hydrologist to analyze any historic or current hydrologic assessments and/or flow data in your watershed for fish bearing streams. For example, Sanctuary Forest worked with a hydrologist to analyze flow data from the North Coast Watershed Assessment Program (NCWAP) and from the USGS.

2. If there are locations of interest in your watershed where no quantitative data exists, begin a monitoring project to measure streamflow, water quality, and if possible dissolved oxygen. Obtain permission from the landowners of the properties where you would like to conduct the monitoring. Map the locations of the monitoring sites using GPS. Reach out to stakeholders to see if they have resources (in the form of time, funding, expertise, or equipment) that they can contribute. Streamflow monitoring can be conducted at relatively little cost using alternative monitoring methods, such as the bucket-and-stopwatch technique (see Appendix III for resources on alternative monitoring methods).

3. At the peak of the dry season, conduct a walking survey to observe and evaluate flow conditions, water diversions and fish passage barriers. This information will provide a qualitative assessment of flow conditions and a quantitative assessment of water pump density. Streamflow monitoring should be done at the same time as the walking survey so that you can correlate the flows to what the on-the-ground conditions are. For example, Sanctuary Forest staff walked the river right as pools on the main stem were beginning to disconnect and conducted steamflow monitoring the same day. By conducting the walking survey and streamflow monitoring at the same time, Sanctuary Forest was able to establish a *threshold* for connectivity at 0.2 cfs.

Step Five: Assess the Type of Actions Required to Reduce Water Diversion Impacts

If human water use in your program area is more than 10% of available flows, then water conservation efforts should be implemented. Sanctuary Forest suggests 10% as defining percentile because it represents the limit of measurement accuracy.

Recommended Actions:

1. Prepare human water use estimates. Obtain an estimated population total for your program area, including number of individuals and households. You may already have this information on hand from the survey mailing. Daily use estimates can be calculated using the following guidelines (based on average water usage data from the State Water Resources Control Board):

- Household water use: 55 gallons per day (gpd) per person*
- Garden water use: 18.5 gpd per 100 square feet of garden*
- Fire protection water reserve: 2,500 gallons

Sample storage calculation for a 3-person household with a 1,600 sq-ft. garden:

- Household water need (August 1 – November 15): 17,325 gallons
- Garden water need (August 1 – October 15): 22,496 gallons

*Note that these water use estimates can be significantly reduced using water conservation techniques. See Section Three for additional information.

3. Compare the percentage of human water use estimates to streamflow measurements. Multiply the estimated human use per household times the number of households to obtain the total residential water use per day for the watershed area. In addition, interview farmers, businesses and institutions to estimate their daily water use. Sum all water use categories for the watershed area. Then convert the total daily use into gallons/minute or cfs such that the water use can be compared with streamflow.

In the Mattole headwaters in 2004, total human use was estimated at 130,000 gallons/day with 90,000 for residential, 25,000 for small farms and schools, businesses, public agencies, and 15,000 for non-profits. To convert this daily use to streamflow in cfs:

130,000 gallons/day x day/86,400 seconds x 1 cubic foot / 7.48 gallons = 0.2 cfs. The measured flow on Aug 28th at the downstream end of the program area was 0.1 cfs. Therefore, with sufficient water storage and conservation the flow could be increased by 0.2 cfs or 200%.

Make recommendations for reducing cumulative water use impacts using the following criteria:

- If cumulative water use is <10% of available flows, changing human use through a voluntary water conservation program will probably not have a measurable impact on improving streamflows.

- If cumulative water use is between 10-20% of available flows, coordinated water conservation measures should be explored to address human impacts.

- If cumulative water use is at 20% or higher of available flows, water storage and forbearance will likely need to be incorporated into your water conservation strategy.

If you find that changing human use will likely not have a measurable impact on improving streamflows, you may need to explore projects that could help restore the groundwater hydrology and vegetation balance in your study area. You may also need to combine changes in human use along with stewardship and restoration to address land use impacts in order to adequately restore flows. For example, in the extreme drought year of 2008, 13 out of 16 fish bearing tributaries in the Mattole headwaters dried up, and 5 of these have no human use. The results of analysis showed that the shallow groundwater resources were not adequate to sustain flows during dry seasons longer than 3.5 months, but 2008 had a 4.5 month dry season. Further research suggests that both restoration of groundwater hydrology and thinning of overstocked forests will be needed to provide resilience in drought years and adequate water for fish, wildlife and people.

See Section Three for information on coordinated water conservation measures and storage options.

Step Six: Community Outreach and Engagement

If a goal of your restoration efforts is to cultivate a paradigm shift in your watershed that emphasizes stewardship and responsible management of freshwater resources, then the engagement and participation of local residents is absolutely vital. This will require that you provide avenues for public engagement, capacity building, and solutions-oriented dialogue as frequently as possible.

Recommended Actions:

1. Utilize Local Media for Public Outreach. Radio stations, local online forums and message boards, and local newspapers are excellent venues for spreading the word about your water conservation program. If you don't already have existing relationships with a few local reporters, consider reaching out to them about the program. They may be interested in writing an article about your efforts, and/or be willing to publish press releases or event announcements for you.

2. Provide Multiple Opportunities for Public Engagement. For example, during the feasibility study for the Redwood Creek Water Conservation Project, the project team organized two house parties and a free water conservation workshop and field tour for local residents. The house parties took place at the homes of well-known local residents on two different tributaries in the watershed, and provided opportunities for residents to ask questions and share concerns and ideas regarding the scope and trajectory of a potential water conservation program for the watershed. The purpose of the water conservation workshop was to bring residents and restoration practitioners together in order to share skills and knowledge about water conservation techniques, including water storage options, water loss prevention mechanisms, and the importance of storing enough water during the wet season so as to avoid pumping during the critical dry season. The workshop was followed by a four-hour field tour of permaculture and water storage sites on a local resident's property.

3. Maintain an ongoing list of local residents who attend public meetings, workshops, or contact you with questions. Try to collect their mailing address, phone number and e-mail and keep notes on when/how they have participated.

4. Identify Obstacles and Potential Solutions. During your public engagement efforts, ask local residents what they perceive some of the barriers to participating in voluntary water conservation efforts are. Their responses may range from financial barriers to lack of technical skill to permitting or regulatory hurdles. When you understand what the perceived barriers are, you will more easily be able to develop solutions that can reduce or remove the barriers entirely, which will ultimately result in increased participation by local residents in your program.

5. Keep local residents informed about your progress. For example, after data and anecdotal information was compiled and analyzed from the surveys, house meetings and water conservation workshop, the Redwood Creek Water Conservation Project team produced a brief report that summarized the findings and next steps of the project. The report was distributed to project participants and stakeholders, and was made available online in a printable format.

Step Seven: Implement a Voluntary Water Conservation Program

Conducting a feasibility study and implementing a voluntary water conservation program can take several years. For example, Sanctuary Forest's program in the Mattole began in the summer of 2004 with their streamflow monitoring and community outreach efforts and was implemented between 2005-2013 with the installation of the water storage tanks and the signing of the landowner forbearance agreements. The time that it takes to conduct the feasibility study and implement a program will depend on how much hydrologic data is currently available, as well as what kind of stakeholder and citizen relationships already exist in your region.

Recommended Actions:

After you have conducted your feasibility study:

1. Propose projects to improve streamflows. The projects should reflect your findings from the flow studies and public outreach efforts, and be based on the recommendations that you have already developed to help reduce water diversion impacts in your watershed. Depending on the amount of water being consumed in your watershed and the type and timing of water use, appropriate water conservation options might include coordinated changes in pumping rates during the dry season and/or the installation of mechanisms on water storage tanks to prevent water loss. In watersheds with higher rates of water use, water storage and forbearance via tanks and/or ponds may be necessary. See Section Three for additional information.

2. Determine permitting requirements for implementation. It is important to note that funders will require full compliance with local and state permit requirements. Landowners need to know their permitting liability and costs prior to committing to a project.

3. Secure necessary funding to implement water conservation measures. It goes without saying that some water conservation techniques are more costly than others, in terms of both staff and volunteer time and the cost of equipment and materials. For example, shut-off valves for water tanks and water efficiency measures for households can be installed or implemented at little cost. On the other hand, water storage tanks can

cost thousands of dollars to purchase, site and install. Develop a budget that accurately reflects the costs of the project(s) that you wish to implement, and start the process of securing funding. Private foundations, state agencies and local fundraising events are all potential resources that should be explored.

4. Establish how you plan to evaluate the effectiveness of your program. In most cases, your funders will require that you have an evaluation plan and follow specific reporting guidelines. Even if they do not, take time to develop a plan that will enable you to evaluate the progress of your program at important milestones, and based on deliverables that you intend to complete.

Section Three: Water Conservation, Efficiency, and Storage Information

Water Conservation and Efficiency

Tank-filling systems and piping are thought to be significant contributors to water loss, but the good news is that they can be easily remedied. For example, many tank-filling systems do not have automatic shut-off valves, resulting in unnecessary overflows. By installing float valves, automatic shut-off valves and/or overflow piping back to the source river, tributary, or stream, countless gallons of water can be saved at relatively little cost. System leaks resulting from damage from animals, joint leaks from frost, or a dripping faucet (inside or outside a house) can also result in water waste. Conducting annual system maintenance and installing water efficient fixtures (like low flow shower heads, toilets and faucet aerators) can reduce these impacts significantly.

Water-efficient gardening and permaculture techniques can also greatly reduce water use. The average standard water use for an 800 sq. ft. garden is 150 gallons per day (gpd), 15,500 gallons total for 3.5 months (based on the State Water Resources Control Board suggested water use). These water use estimates can be reduced by 50% or more by applying different techniques that can be easy to implement at little cost. Examples include:

- Permaculture
- Drip irrigation
- Deep Mulching
- Soil preparation*
- Timing of watering and methods to avoid overwatering
- Plant selection and timing of planting
- Rainwater harvesting in the garden (build berms)
- Dry farming

*Increasing organic content of soil from 1% to 2% organic matter can reduce irrigation by 75%[16].

See Appendix III for a list of resources related to water conservation and permaculture techniques.

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[16] Hemenway, Toby. 2009. *Gaia's Garden: A Guide to Home-Scale Permaculture*. Chelsea Green Publishing Company.

The potential water savings from water conservation are roughly estimated based on an overall comparison between water-efficient households and gardens versus standard usage. Total water use (for household and garden combined) is estimated at 195 gpd for the water-efficient model and at 500 gpd for the standard usage model. Both models are calculated for a two person household and an 800 sq. ft. garden. Water conservation savings are estimated at 305 gpd (61% of standard use) and 32,000 gallons per household over a 3.5 month period. While storage along with complete cessation water withdrawals offers the greatest potential benefit to streamflows, storage may not be feasible for every household. Water conservation measures are economical and within the means of most households.

Coordinated Water Conservation Measures

In some instances, just two households pumping at the same time can completely de-water a stream, stranding sensitive aquatic species in disconnected pools and reducing the availability of fresh water for downstream neighbors. Sanctuary Forest recommends the following two coordinated water conservation measures to address these concerns:

Stream Reach Coordination: Reduce the impacts of pumping from a source river, tributary or stream by asking households on a specific watercourse to follow a pre-determined pumping rotation. This can ensure that during dry the season, when flows are lowest, multiple households are not pumping at the same time.

Reduced Pumping Rates: Instruct residents to slow their daily pumping rates during the dry season. To protect fish and wildlife habitat, individual pumping rates should never exceed 5% of streamflow at the point of diversion. If there are several pumps in one tributary or main stem reach, the cumulative effects of all of the pumps also needs to be considered. Cumulative impacts should not exceed 10%. In the Mattole River headwaters program, main stem diversion pumps are limited to 11 gpm and tributary pumps are limited to 6 gpm. In normal years these pumping rates meet the requirements during winter, spring, and early summer. However, in drought years when flows are lower, lower rates of diversion are needed. If possible, water should be diverted at a low rate by gravity into a collection tank and then a higher capacity pump can be used to move the water from the collection tank to the storage tank. The following example illustrates the difference in impact:

Household (3 people and 2600 sq ft irrigated area) using 900 gpd: If collecting water at the rate of use, then the diversion rate is 0.6 gpm (900 gallons/1440 min). At the rate of 0.6 gpm, 5 households could divert water from a tributary with a cumulative impact of 3 gpm equivalent to 10% if a tributary is flowing at 30 gpm. Alternatively, if the same 5 households all are diverting with pumps at a rate of 10gpm with a cumulative impact of 50 gpm, then the stream would need to be flowing at 500 gpm to meet the 10% requirement.

Water Storage and Forbearance

Ideally, the goal of water storage and forbearance is to prepare a household for not pumping at all during the driest months of the year, whether during a one month dry season or a six month dry season.

Sanctuary Forest and concerned residents of the Mattole researched the amount of water an average household would need to store during the wet winter season in order to forbear from pumping during the dry, low flow season. Based on their findings, water storage for 3.5 months, assuming a water-efficient, two-person household and an 800 sq. ft. garden, was calculated at 23,000 gallons. This includes 10,500 gallons for household use (based on 50 gpd per person), 10,000 gallons for a water-efficient garden and 2,500 gallons of fire safety water.

The two main options for storage are tanks and ponds. Ponds may be a viable option for small farmers with large irrigation needs. If more than 50,000 gallons of storage is required for irrigation, a pond will likely be more economical than tank storage. However, ponds raise other potential concerns, including erosion, leaks, evaporative losses, and the introduction of non-native species habitat. They also have rigorous permitting requirements. Household use cannot be supplied by pond water because of water quality issues.

Options for tank storage include large steel tanks (15,000 to 75,000 gallons) and smaller Poly tanks (500 to 5,000 gallons). If cost, permitting, or siting are limiting factors for installing winter water storage, Poly “tank farms”, or multiple 2,500-5,000 gallon tanks, may offer a more accessible solution for rural residents. They are easier to install than the large steel tanks, have more flexible permitting requirements, and can be installed incrementally to help diffuse the cost.

Bladder tanks are another option that can be easily transported to very remote areas and can offer large storage capacity at a low upfront cost, but they are susceptible to damage from outside elements such as rodents, bears, and falling tree branches, which means that they may only last for one or two seasons before needing to be replaced. Bladder tanks are not typically recommended for winter water storage, simply because they are not a cost-effective or long-term investment for a property.

Before purchasing storage tanks or suggesting that others do so, be sure to review the following recommendations:

- **Obtain a technical consultation.** It is important to speak with a professional before purchasing water tanks, to make sure that your water storage will be sited and installed properly based on the unique geological properties of your land.

- **Find out about permitting.** Permitting needs vary depending on the tank style, capacity, and the county that you live in. We recommend that you contact your county building department to determine permit requirements for your location, and there may be organizations in your area that can assist you with the permitting process.
- **Calculate your water storage needs.** It is recommended that every household store enough water to last for a dry season lasting 3 ½ months, or 105 days.

See Appendix II for tank storage option comparisons and for system design prototypes using Poly tanks prepared by Sanctuary Forest.

Section Four: A Note About Water Rights[17]

In order for a collective action strategy to be successful in managing human water use, people diverting water from rivers, springs, and tributaries need to acknowledge that they are beneficiaries of a *public trust resource*; in other words, that they are reaping the benefits of a public resource that is imbued with significant aesthetic, economic, cultural, and ecological value. The *public trust doctrine* "holds that certain natural resources belong to all and cannot be privately owned or controlled because of their inherent importance to each individual and society as a whole"[18]. It applies to rivers and their tributaries, and to private water rights as well, where "individual water rights that affect public trust resources are rights of use that a state can revoke if the private right harms those resources"[19].

State water rights law requires all people diverting surface waters (from springs, streams, and rivers), including diversion of water from subterranean streams flowing in known and definite channels, to file a basic statement of use. Additionally, if a resident is interested in conserving water through the storage and forbearance method, they are required by law to file for an appropriative water right.

Established as a legal means for protecting rivers as a shared resource and public trust value, water diversion permitting requirements have existed in California for many years, but have not been enforced in Humboldt County until recently. Prior to an enforcement sweep that began in the summer of 2013[20], many landowners were not aware they had to report their water diversions and register their water storage to comply with state water law and avoid potentially onerous fines. According to Matt McCarthy, of the State Water Resources Control Board (SWRCB) Division of Water Rights, Southern Humboldt residents are not alone. Roughly 75% of all water diverters in California are in need of some form of action in order to come into compliance with state water law[21].

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[17] This section is drawn from Schremmer's (2014) thesis: Resilience in a Time of Drought: Building a Transferable Model for Collective Action in North Coast Watersheds.

[18],[14] Klass, Alexandra B. and Ling-Yee Huang. 2009. Restoring the Trust: Water Resources and the Public Trust Doctrine, A Manual for Advocates. Center for Progressive Reform. Accessed April 2014: http://www.progressivereform.org/articles/CPR_Public_Trust_Doctrine_Manual.pdf

[20] Brooksher, Dave. 2013. "DWR enforcement sweep coming to a neighborhood near you." Redwood Times Online. Accessed April 14, 2014: http://tinyurl.com/qdnfq2p

[21] Schremmer, Sara. 2013. Water Diversion Enforcement Spawns Community Education. The Eel River Reporter: Volume XV, Fall 2013. http://eelriver.org/water_diversion/

Permits for Water Diversion and Storage[22]

The SWRCB and CDFW both have a vested interest in ensuring that rural residents comply with state water law and register their water diversions and storage. When a household files their Statement of Diversion and Use, they are informing the SWRCB about their diversion amount(s), location(s), method(s), and basis of water right.

State Water Board permits[23]: California requires an appropriative water right (or "small domestic use appropriation") for water that will be stored longer than 30 days. The riparian water rights held by landowners who withdraw water from a stream that passes by or through their property allows only for direct diversion, and does not allow water storage for longer than 30 days. A small domestic use appropriation registration can be obtained from the SWRCB if the applicant qualifies for small domestic use as defined by the SWRCB. As of March 2008, the application process requires (1) completion of the application form; (2) submission of the application to CDFW for clearance and/or terms and conditions under which water may be diverted; and (3) payment of application fees of $250.

Fish and Game Code requirements: CDFW has authority under Fish and Game Code section 1602 to regulate any water withdrawal that may have an impact on fish or other aquatic life. According to the Code, anyone who undertakes an activity that might "substantially divert or obstruct the natural flow of any river, stream, or lake" is required to notify CDFW of this activity. Such notifications are particularly important in fish-bearing streams and tributary streams where low flows have been identified as a problem. If the Department determines (on a case-by-case basis) that a water diversion could have a "substantial" impact on the resource, a Lake or Streambed Alteration Agreement (also known as a "1600 Agreement") may be required. CDFW defines fish to include amphibians and other aquatic and terrestrial life. If your stream or spring has habitat for any aquatic life or is a tributary to such a stream, then an agreement may be necessary.

Streamlined Permitting in Response to Drought

While California's unprecedented drought continued to wreak havoc on local water supplies, watershed stakeholders and state agency personnel conversed on how to streamline the registration process so that residents could begin storing winter water quickly, without fear of legal or regulatory repercussion. In March of 2014, CDFW made a welcome announcement[24]:

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[22] Information in this section is drawn from Sanctuary Forest's (2008) Water Storage Guide.
[23] Institutions will require a different permitting process than the one described in this section.

> With today's action, CDFW has essentially "pre-approved" the installation of storage tanks that meet the general criteria. The State Water Board has agreed to incorporate these criteria as conditions of approval, and to expedite the issuance of the registrations.
>
> "We have been working in these coastal communities for many years, and have good reason to believe that these emergency changes are going to be welcomed," said Charlton H. Bonham, Director of CDFW. "Many landowners who have wanted to take these steps can do so now more quickly with greater regulatory certainty from our department."
>
> Today's action was the direct result of suggestions made by local communities and fish conservation organizations such as Trout Unlimited, Mattole River Sanctuary Forest and the Salmonid Restoration Federation.

While California's Drought Emergency declaration is in effect, the Emergency Tank Storage Registration program will enable landowners to register their storage without a 1600 Agreement or a site inspection from CDFW as long as they meet the general criteria. Interested parties should complete a Statement of Diversion and Use through the SWRCB (see Appendix III for additional information). Though far from an all-encompassing solution, CDFW's pre-approval of storage tanks under the SDU registration program represents a victory for collaborative watershed restoration efforts on the North Coast.

Appendix I[25]: Sample Materials

- Sample Streamflow Monitoring Methods
- Draft Outline of Quality Assurance Quality Control Plan
- Sample Survey Cover Letter
- Sample Survey Questionnaire
- Sample Community Meeting Agenda
- Know Your Water Rights Brochure

Appendix II: Table of Water Storage Options

Appendix III: Recommended Resources

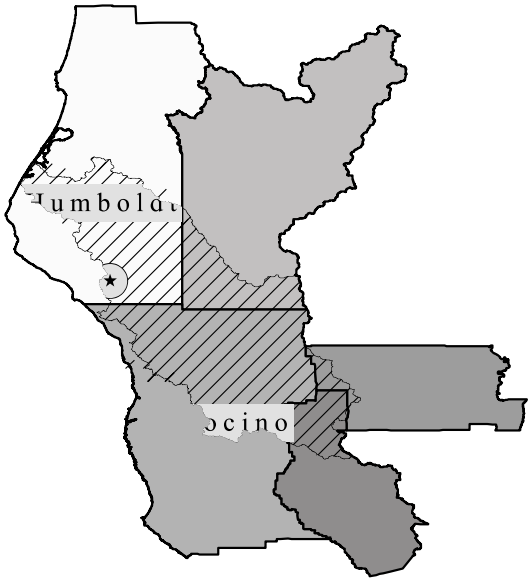
- Funding Resources
- Government Data on Streamflow, Rainfall, and Water Temperature
- Flow Monitoring Methods
- Survey Questionnaire Methodology
- Water Rights Information
- Water Conservation, Efficiency, Permaculture, and Store Information and More
- Emergency Tank Storage Registration Information

[25] This Addendum does not contain the supplementary materials that will be included in the printer-friendly PDF version of the guide. A summary list of materials and resources that can be found in the printer-friendly version is included on this page.

APPENDIX A

Map: *The Five Counties of the Eel River Watershed*

Source: Jerry Dinzes, Environmental Management and Protection, Humboldt State University, 2014



enn

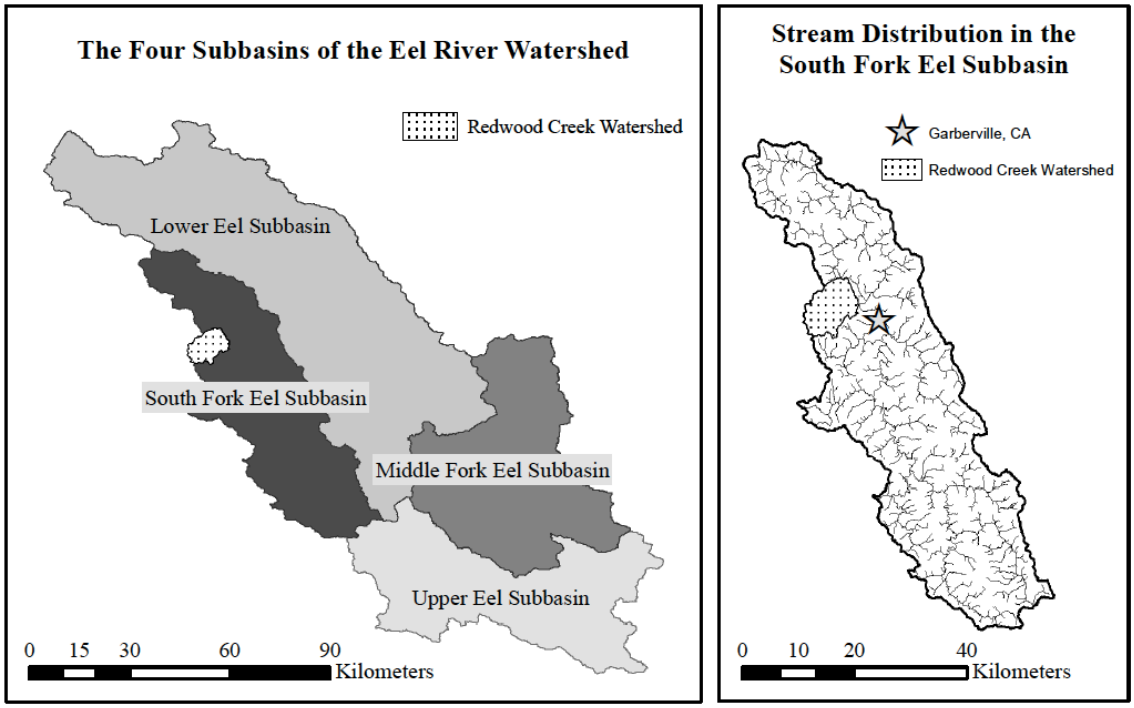
Percent Distribution of County by Watershed:

46% - Mendicino
33% - Humboldt
22% - Lake
15% - Trinity
6% - Glenn

APPENDIX B

Map: *The Four Subbasins of the Eel River Watershed*

Source: Jerry Dinzes, Environmental Management and Protection, Humboldt State University, 2014

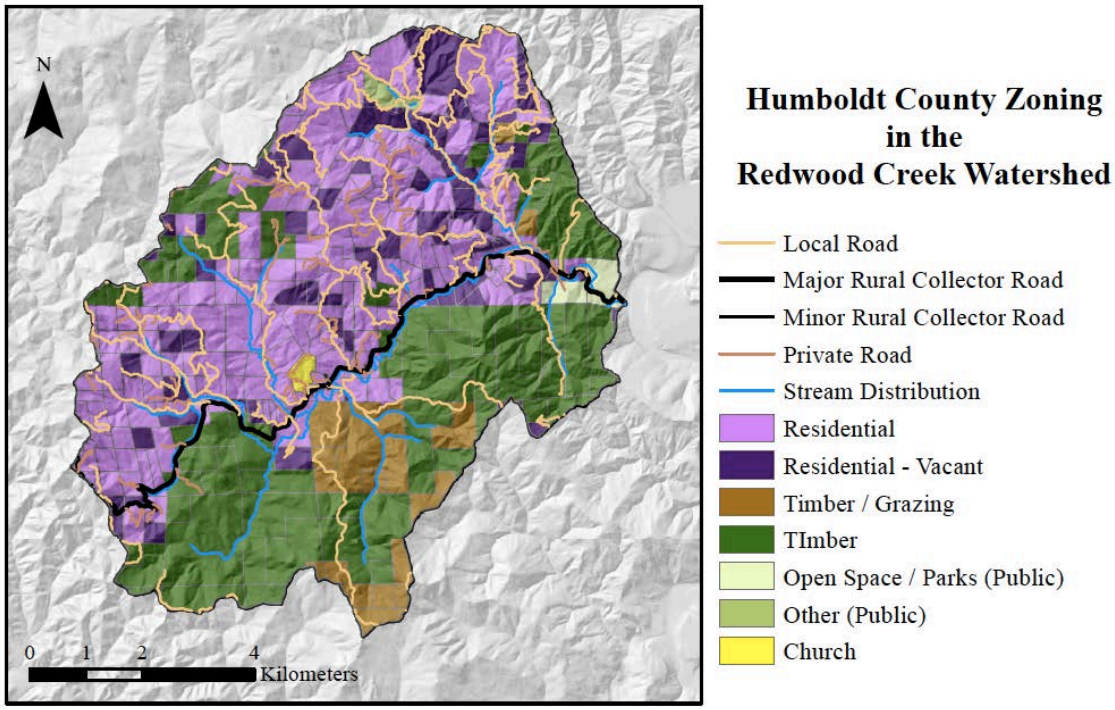


Coordinate System: North America 1983 - UTM Zone 10
Data Source: UC Berkeley - National Center for Airborne Laser Mapping

APPENDIX C

Map: *Humboldt County Zoning in the Redwood Creek Watershed*

Source: Jerry Dinzes, Environmental Management and Protection, Humboldt State University, 2014



Coordinate System: North America 1983 - UTM Zone 10
Data Source: UC Berkeley - National Center for Airborne Laser Mapping / Humboldt County GIS Portal

APPENDIX D

Survey Cover Letter

Source: Sara Schremmer, Humboldt State University, 2013

December 27, 2012

Dear Redwood Creek Area Resident,

I am a graduate student at Humboldt State University, and in collaboration with Sanctuary Forest and Salmonid Restoration Federation, we are writing to ask for your help in understanding residential water use patterns in the Redwood Creek area. Your voluntary response will help us determine the feasibility of transferring the Mattole headwaters voluntary water storage and forbearance program to Redwood Creek.

Redwood Creek provides important habitat for coho salmon and supplies many Southern Humboldt residents with fresh water for drinking and irrigation. In recent years, there has been a notable decrease in water flows during the low flow season in several Redwood Creek drainages, jeopardizing the water supply for both people and fish. Understanding residential water use patterns is the first step in determining if voluntary water storage and forbearance is an appropriate and desirable solution to the low flow problem on Redwood Creek. This study will also examine the length of the dry season, land use patterns and forest cover conditions as they relate to water flows on Redwood Creek.

You will receive one survey questionnaire in the mail for every parcel of land that you own in the Redwood Creek area. Please complete and return one survey for each parcel that you own that has a residence or business located on the property. The survey can be completed by the landowner, a tenant, or any other adult (18 years or older) with knowledge of how water is used and stored on your parcel. For each survey that you complete, please use the postage-paid envelope that we have provided and mail it back to the Salmonid Restoration Federation office: PO Box 784, Redway, CA 95560.

The questionnaire should only take 5-10 minutes to complete. Your responses are voluntary and will be kept confidential. Your names are not on our mailing list, and your answers will never be associated with your mailing address. If you have any questions about this survey of Redwood Creek area residents, please call the researcher, Sara Camp Schremmer, at (xxx) xxx - xxxx or e-mail xxx@humboldt.edu.

By taking a few minutes to share how your household uses water, you will be directly contributing to important restoration work in the Redwood Creek area and your participation is greatly appreciated by the local organizations that are leading those efforts.

I hope you enjoy completing the survey and I look forward to receiving your response.

Many thanks,

Sara Camp Schremmer, Sociology Graduate Student, Humboldt State University

APPENDIX E

Redwood Creek Community Perceptions & Residential Water Use Survey

Source: Sara Schremmer, Humboldt State University, 2013

Redwood Creek Community Perceptions & Residential Water Use Survey

Please complete this anonymous survey and mail it to the Salmonid Restoration Federation office: PO Box 784, Redway, CA 95560.

1. Please tell us what you value about Redwood Creek by marking each scale provided below. If there is something that you value about Redwood Creek that is not included in this list, please write in your response on the line provided.

I value Redwood Creek for its…

Fresh drinking water:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Water for irrigation:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Habitat for salmon:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Aesthetic beauty:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Other: _____

2. Please tell us about any changes you have observed over the years in Redwood Creek and the surrounding area that you think may be contributing to low summertime flows. Mark each scale provided below, and please use the additional space to write in any other observations or comments.

In Redwood Creek or the surrounding areas, I have noticed…

Fewer pools and/or pools that are less deep in the creek:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Changes in the amount or type of forest cover (for example: less meadow/grassland or increases in certain species of trees):

Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Changes in the length of the dry season (or changes in the timing of the first rains of the year:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Fewer logs in the creek:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

More gullies, landslides or roads that could be draining the groundwater:
Strongly Agree [ ] [ ] [ ] [ ] [ ] Strongly Disagree

Other Observations or Comments:
_____
_____
_____
_____
_____

3. How frequently or infrequently do you talk to other people in your community about the health of Redwood Creek?

[ ] Very Frequently
[ ] Frequently
[ ] Occasionally
[ ] Infrequently
[ ] Very Infrequently

4. How interested or uninterested are you in participating in voluntary water flow restoration efforts in Redwood Creek?

[ ] Very Interested
[ ] Interested
[ ] Neither Interested or Uninterested
[ ] Uninterested
[ ] Very Uninterested

5. How many years have you been a resident in the Redwood Creek area? _____

6. How many people live in your household? _____

7. What is the total estimated square footage of the irrigated lawn(s), shrubbery, orchard(s), and/or garden(s) on your parcel of land? Please only include irrigated areas in your estimate.

[ ] 10 ft x 10 ft (100 sq. feet)
[ ] 16 ft x 24 ft (384 sq. feet = the size of a one car garage)
[ ] 22 ft x 26 ft (572 sq. feet = the size of a two car garage)
[ ] 30 ft x 50 ft (1500 sq. feet = the size of a two bedroom house)
[ ] 60 ft x 60 ft (3,600 sq. feet = the size of a little league baseball diamond)
[ ] 160 ft x 360 ft (57,600 sq. feet = the size of a football field)
[ ] I don't have any irrigated areas on my parcel of land.

[ ] Other: _____

8. What is the approximate length of your irrigation season?

[ ] May – October (6 months)
[ ] June – September (4 months)
[ ] Not Applicable
[ ] Other: _____

9. What is your water source for household use?

[ ] Redwood Creek tributary
[ ] Spring
[ ] Well
[ ] Other: _____

10. What is your water source for irrigation?

[ ] Redwood Creek tributary
[ ] Spring
[ ] Well
[ ] Other: _____

11. Does your household use one or more water storage tanks?

[ ] Yes
If yes, please tell us how much total storage capacity you have in your water tank(s):
_____ gallons

[ ] No

If no, please describe your household water system and then skip to Question 13:
_____
_____

12. If your household does use one or more water storage tanks, do you have any mechanisms in place to prevent tank overflows?

[ ] Yes
If yes, please tell us how your household prevents tank overflows (example: tank shut off valves):
_____
[ ] No
If no, please tell us why your household does not use mechanisms to prevent tank overflows (example: concern about economic costs):
_____
_____

13. How often does your household perform maintenance to fix all water leaks in your water system and household plumbing?

[ ] More than once per year
[ ] Once per year
[ ] Less than once per year
[ ] Never
[ ] Not sure

14. Please let us know if you would be interested in joining us for any upcoming water conservation and restoration gatherings in the Redwood Creek area.

As part of this study, two voluntary house meetings and one free conservation workshop will be hosted by SRF and Sanctuary Forest in your area to provide a forum where neighbors can discuss potential solutions to the low flow problem on Redwood Creek and learn more about this project.

If you are interested in attending a voluntary house meeting and/or the free water conservation workshop, please check one (or more) of the boxes below. This information will be used for planning purposes only.

[ ] House meeting #1: Thursday, January 10, 2013 at the [redacted] residence at [redacted] Miller Creek Road in Briceland from 5-7pm.

[ ] House meeting #2: Thursday, January 31, 2013 at the home of [redacted], at [redacted] Briceland Thorn Road in Redway from 5-7pm.

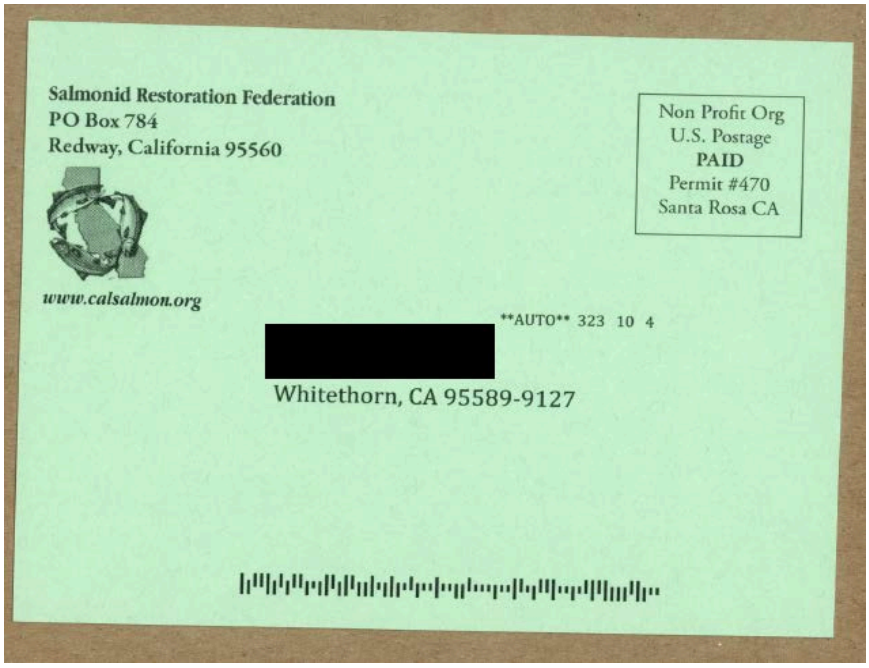
[ ] Workshop: Saturday, February 2, 2013 at Beginnings Octagon in Briceland.

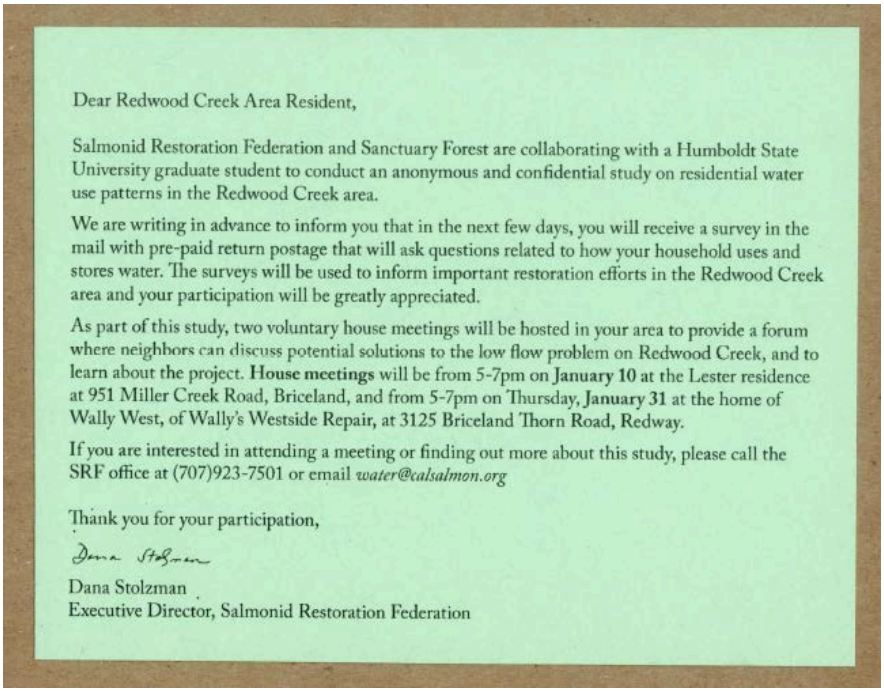
If you would like to know more about the upcoming house meetings or have any other questions or concerns related water flow restoration efforts in Redwood Creek, please call the Salmonid Restoration Federation office at (707) 923-7501 or e-mail water@calsalmon.org.

APPENDIX F

Survey Pre-Notice Postcard

Source: Salmonid Restoration Federation, 2013





Dear Redwood Creek Area Resident,

Salmonid Restoration Federation and Sanctuary Forest are collaborating with a Humboldt State University graduate student to conduct an anonymous and confidential study on residential water use patterns in the Redwood Creek area.

We are writing in advance to inform you that in the next few days, you will receive a survey in the mail with pre-paid return postage that will ask questions related to how your household uses and stores water. The surveys will be used to inform important restoration efforts in the Redwood Creek area and your participation will be greatly appreciated.

As part of this study, two voluntary house meetings will be hosted in your area to provide a forum where neighbors can discuss potential solutions to the low flow problem on Redwood Creek, and to learn about the project. **House meetings** will be from 5-7pm on **January 10** at the Lester residence at 951 Miller Creek Road, Briceland, and from 5-7pm on Thursday, **January 31** at the home of Wally West, of Wally's Westside Repair, at 3125 Briceland Thorn Road, Redway.

If you are interested in attending a meeting or finding out more about this study, please call the SRF office at (707)923-7501 or email *water@calsalmon.org*

Thank you for your participation,

Dana Stolzman

Dana Stolzman
Executive Director, Salmonid Restoration Federation

APPENDIX G

Redwood Creek Water Conservation Project Workshop Poster

Source: Salmonid Restoration Federation, 2013

Redwood Creek Water Conservation Project

Redwood Creek is a 26-mile watershed that flows into the South Fork of the Eel River. The five tributaries of Redwood Creek have historically supported strong runs of Chinook, coho salmon, and steelhead. Salmonid Restoration Federation, Sanctuary Forest, and a HSU sociology graduate student are researching the feasibility of instituting a water conservation project modeled after the Mattole headwaters successful water storage and forbearance program. Water usage surveys were mailed to all landowners in Redwood Creek. If you are a landowner or resident, please take a moment to fill out and return these anonymous surveys. If you are Redwood Creek resident and did not receive a survey, you can download one at *www.calsalmon.org.*

Thank you for your valued participation in this exciting effort.

Community House Parties

January 10, [redacted] Miller Creek Road, Briceland

January 31, [redacted] Briceland Thorn Road, Redway

Water Conservation Workshop & Tour

Saturday, February 2, 10am - 4pm Beginnings Octagon

Speakers Include:

Tasha McKee, *Executive Director*, Sanctuary Forest
Hezekiah Allen, *Executive Director*, Mattole Restoration Council
Sungnome Madrone, *Executive Director*, Mattole Salmon Group
Sara Camp Shremmer, *HSU Sociology Graduate Student conducting the Redwood Creek Feasibility Study*
Kyle Keegan, *Permaculture Advocate*

Afternoon tour of water conservation projects. This workshop & tour is free.

For more information, please contact SRF at *water@calsalmon.org* or (707)923-7501 *www.calsalmon.org*
Check-out the Redwood Creek pages of our website for a project overview, the water surveys, and FAQs

APPENDIX H

Save the Date! Workshop and Community House Meeting Announcement

Source: Salmonid Restoration Federation, 2013

Salmonid Restoration Federation
PO Box 784
Redway, California 95560

Non Profit Org
U.S. Postage
PAID
Permit #470
Santa Rosa CA

229 10 4

San Francisco, CA 94112-4362

www.calsalmon.org

Save the Date!

Please join a community-led effort to understand water flow patterns on Redwood Creek by taking a moment to fill out the enclosed anonymous survey. Your participation is greatly appreciated and will help inform ongoing conservation and restoration efforts in the Redwood Creek area.

Mateel & Eel River Water Conservation Workshop

February 2, Beginnings Octagon, Briceland, CA

SRF and Sanctuary Forest will host a water conservation workshop to share water conservation techniques for rural residents in the Mattole and Eel river watersheds. This workshop will explore the feasibility of transferring the Mattole headwaters water storage and forbearance program to Redwood Creek, a tributary of the South Fork Eel river watershed. We will explore causes and solutions to low flows and visit sites that demonstrate water storage, conservation gardening and groundwater recharge. Please join us to share knowledge and restore healthy flows for people and fish.

Community House Parties

As part of this study, two voluntary house meetings will be hosted in your area to provide a forum where neighbors can discuss potential solutions to the low flow problem on Redwood Creek, and to learn about the project. **House meetings** will be from 5-7pm on **January 10** at the Lester residence at 951 Miller Creek Road, Briceland, and from 5-7pm on Thursday, **January 31** at the home of Wally West, of Wally's Westside Repair, at 3125 Briceland Thorn Road, Redway.

APPENDIX I

Brochure: The Redwood Creek Water Conservation Project

Source: Salmonid Restoration Federation, 2013

and be easier to install than one 10,000 gallon steel tank, and will last longer than a bladder tank (making it a better investment for your money).

Before You Purchase Water Storage Tanks, We Recommend That You:

Receive a technical consultation. It is important to speak with a professional before purchasing water tanks, to make sure that your water storage will be sited and installed properly based on the unique geological properties of your land.

Find out about permitting. Permitting needs vary depending on the tank style, capacity, and the county that you live in. We recommend that you contact your county building department to determine permit requirements for your location, and there may be organizations in your area who can assist you with the permitting process.

Calculate your water storage needs. It is recommended that every household store enough water to last for a dry season lasting 3½ months, or 105 days. The State Water Resources Control Board suggests calculating your water storage needs based on the following:

- Household water use: 55 gallons per day (gpd) per person
- Garden water use: 18.5 gpd per 100 square feet of garden
- Fire protection water reserve: 2,500 gallons

Local Resources

Consult Sanctuary Forest's Water Storage Guide for additional information on fish-friendly water pumping, calculating your storage capacity needs, and permitting. If you need a copy of the guide, contact Sanctuary Forest at (707) 986-1087 or *sanctuary@sanctuaryforest.org*.

If you live in Humboldt County and need a contractor or technical consultation, contact:

RainCatcher Installers, Rod Silva & Mark Hilosvsky, (707) 986-7241

We Dig It, Shanon Taliaferro, (707) 223-0494

Plants for the People, Mikal Jakubal, (707) 923-5063

Whitethorn Construction, (707) 986-7416

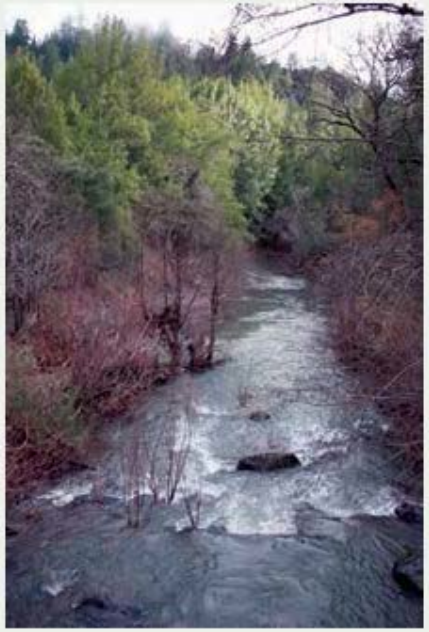
To speak with a water tank supplier, local contractors recommend:

Scott's Tanks
376 N Main St
Willits, CA 95490
(707) 459-6677

Dazey's Supply
3082 Redwood Drive,
Redway, CA
(707) 923-3002

For more information about the Redwood Creek Water Conservation project:
www.calsalmon.org
water@calsalmon.org
(707) 923-7501

Redwood Creek Water Conservation Project



Thank you for your interest in fish-friendly winter water storage. If you are a rural landowner who relies on a spring, tributary or creek for your household or irrigation water supply, you have an exciting opportunity to participate in a collective solution to the problem of low instream flows—an issue that is affecting watersheds throughout California, to the detriment of both people and fish.

(Front)

Redwood Creek and its tributaries provide important habitat for coho, Chinook, and steelhead in the South Fork Eel River watershed. For decades, residents had ample water, but in recent years many long-term residents have witnessed decreases in water during the dry months when salmon are most vulnerable to low flows and high water temperatures.

The purpose of this brochure is to outline basic information for rural landowners who are interested in purchasing additional tanks for winter water storage. Adding winter water storage capacity to your property for use during the low flow season (also known as water storage and forbearance) is one water conservation method that research has shown to be both cost effective and beneficial in restoring healthy flows for vulnerable salmon species.

Different Storage Options

The three types of storage tanks outlined below are commonly purchased in humboldt county, but some are more appropriate and cost effective for fish-friendly winter water storage than others:

Bladder Tanks can be easily transported to very remote areas and can offer large storage capacity at a low upfront cost, but they are susceptible to damage from outside elements such as rodents, bears, and falling tree branches, which means that they may only last for one or two seasons before needing to be replaced. Bladder tanks are not typically recommended for winter water storage, simply because they are not a cost-effective or long-term investment for your property.

Polyethylene Tanks are very popular, and with good reason. They are light and easy to move, fairly inexpensive and very durable. They range in size from 100 gallons to 15,000 gallons and can be used for potable water. Because poly tanks are relatively inexpensive, durable (lasting 20+ years) and can be easily installed (depending on the size), poly tanks may be the best option for rural landowners looking to make an investment in winter water storage capacity. Local contractors recommend purchasing multiple tanks at 2,500 gallons each. This option will enable to you install tanks easily and incrementally for a lower upfront cost. Tanks that are 5,000 gallons or more become difficult to install without additional equipment.

Rainwater catchment is a great way to collect water especially if you live at the top of a ridge and don't have gravity flow.

Steel Tanks tend to be the largest tanks available and can range in size from 2,500 gallons to millions of gallons. They are extremely durable and are considered to be an excellent investment for your property, but are more expensive per gallon than poly tanks. There are many types of steel tanks, and a popular choice for many rural landowners is the RainCatcher. RainCatcher tanks can harvest both rainwater and snow, and can last between 20-25 years. While these tanks are generally used for large-scale agriculture and for fire protection, they can also provide potable drinking water. The high upfront cost and the more difficult installation requirements mean that steel tanks may not be a convenient or suitable option for some landowners.

RainCatchment tanks harvest both rain and snow and can last for 25 years.

Economic Incentives for Winter Water Storage

Many local residents and contractors have indicated that their investment in water storage typically pays itself off within five years when compared to the cost of getting 1,000-2,500 gallons of water trucked in per week. While the upfront cost of purchasing water storage for your property may seem daunting at first, the economic investment is worthwhile and will likely end up saving you money in the long run.

If you are interested in installing additional water storage incrementally and for a relatively low cost, local contractors recommend 2,500 gallon polyethylene tanks. For example, purchasing and installing five poly tanks (for a total of 10,000 gallons of storage) will cost less per gallon

(Back)

APPENDIX J

Brochure: The Redwood Creek Water Conservation Project: Frequently Asked Questions

Source: Salmonid Restoration Federation, 2013

Federation office a (707)923-7501 to request a survey if you haven't received one already.

Why did I receive more than one survey in the mail? In order to gain a more thorough understanding of residential water use patterns and community perceptions of Redwood Creek, the organizers of this feasibility study are hoping to obtain one survey for every parcel of land in the area. If you own more than one parcel of land, you were mailed more than one survey and we would greatly appreciate your willingness to complete and mail-in each survey that you receive.

I live in Redwood Creek but I'm not a landowner. Can I still fill out a survey? The survey can be completed by the landowner, a tenant, or any other adult (18 years or older) with knowledge of how water is used and stored on a parcel of land. Please note that we only need one survey per household.

How do I know that my privacy will be protected if I complete this survey? The surveys were carefully constructed in order to ensure complete anonymity and confidentiality. We don't ask for your name, your address, or any other identifying personal information that might potentially connect your response to your parcel of land.

Why did you include a return envelope with a postage stamp? For the data from the surveys to be useful, we need as many people to complete them and mail them in as possible. By providing a postage-paid envelope with the survey, we are hoping to encourage your participation by making the process as easy as possible.

Is there anything else that I can do to support this project? This feasibility study will rely heavily upon word-of-mouth, because many residents in the Redwood Creek area live in places that are difficult to reach. If you know of neighbors who may not have heard of the project, who haven't received the survey, or who haven't heard of the house meetings or conservation workshop, please have them write to *water@calsalmon.org* or call the Salmonid Restoration Office at (707) 923-7501.

Thank you for your valued participation in this exciting effort.

Water Conservation Workshop & Tour

Saturday, February 2, 10am - 4pm

Beginnings Octogon

Speakers include:

Tasha McKee, *Executive Director,* Sanctuary Forest

Hezekiah Allen, *Executive Director,* Mattole Restoration Council

Sungnome Madrone, *Executive Director,* Mattole Salmon Group

Sara Camp Shremmer, *HSU Sociology Graduate Student conducting the Redwood Creek Feasibility Study*

Kyle Keegan, *Permaculture Advocate*

The Water Conservation workshop and tour will highlight water conservation techniques, opportunities, and changes in the forest and hydrology, and tour some local water conservation projects.

Redwood Creek Water Conservation Project

Frequently Asked Questions (FAQs)

Redwood Creek is a 26-mile watershed that flows into the South Fork of the Eel River. The 5 tributaries of Redwood Creek have historically supported strong runs of Chinook, coho salmon, and steelhead. Salmonid Restoration Federation, Sanctuary Forest and a HSU sociology graduate student are researching the feasibility of instituting a water conservation project modeled after the Mattole headwaters successful water storage and forbearance program. Water usage surveys were mailed to all landowners in Redwood Creek. If you are a landowner or resident, please take a moment to fill out and return these anonymous surveys. As part of this project we will have house parties and a Water Conservation workshop. If you are Redwood Creek resident and did not receive a survey, you can download one at *www.calsalmon.org*.

(Front)

Basic Definitions

What is water storage and forbearance? As it relates to this project, water storage typically refers to above ground tanks that can be used to store water from a river or tributary during the high flow season. Forbearance refers to the practice of using stored water from an above ground tank during the low flow season, as opposed to diverting water directly from a river or tributary.

What is technology transfer? Technology transfer generally refers to the transfer of information, knowledge or technology from one entity or geographic location to another. For this project, technology transfer is being used to describe the process of transferring Sanctuary Forest's water storage and forbearance program from the Mattole headwaters to a tributary of the South Fork of the Eel River in Humboldt County.

The Feasibility Study

What is the overall vision of this feasibility study? To foster a productive, solutions-oriented dialogue in Redwood Creek and surrounding areas about environmental stewardship and water conservation, and—if data shows that the flows are indeed low—to contribute to the eventual restoration of healthy water flows on Redwood Creek for the benefit of both people and fish through the establishment of a voluntary water storage and forbearance program and/or other water conservation methods.

Why was this feasibility study initiated in the first place? Late in 2012, this feasibility study was initiated to determine if Sanctuary Forest's successful Water Storage and Forbearance Program on the Mattole should be transferred to Redwood Creek, a tributary of the South Fork of the Eel River that some local residents have identified as having a low flow problem.

Who is organizing this feasibility study? This feasibility study was initiated by Tasha McKee, Executive Director of Sanctuary Forest, and is being organized with the help of Dana Stolzman, Executive Director of Salmonid Restoration Federation, and Sara Camp Schremmer, a Humboldt State University sociology graduate student.

Which organizations support this feasibility study? While this project is only in its beginning stages, it is already seeing growing support in Redwood Creek and other communities throughout Humboldt County. To date, Sanctuary Forest, Salmonid Restoration Federation, the Briceland Volunteer Fire Department, Eel River Recovery Project and Friends of the Eel River have all endorsed this project.

What are the goals of the feasibility study? The goals of this feasibility are to a) Gather generalizable and anonymous data from willing landowners and residents to determine if human water diversions are impacting flows on Redwood Creek; b) Examine the length of the dry season, land use patterns and forest cover conditions as they relate to flows on Redwood Creek; c) Provide several public forums where landowners in the Redwood Creek and surrounding areas can share their knowledge, observations and concerns about water flows on Redwood Creek; and d) Gather landowner and resident feedback on potential solutions—including but not limited to voluntary water storage and forbearance—that can foster community-wide water conservation practices.

What are the components of this feasibility study? This feasibility has an ecological component and a sociological component. The ecological component will determine whether Redwood Creek has a low flow problem and whether human water diversions are a contributing factor. If so, the study will explore water storage and forbearance and other methods of water conservation as potential solutions. The sociological component will explore whether landowners and residents in the Redwood Creek watershed are interested and willing to actively participate in water conservation for the purposes of restoring healthy flows on Redwood Creek.

Who is eligible to participate in this feasibility study? While this particular study is mainly focused on landowners and residents living in the Redwood Creek watershed, we welcome the active participation of any individual or group who has suggestions, questions, concerns, or an interest in potentially bringing a similar study to their tributary or river.

What is the timeline? The sociological component of the feasibility study is expected to run through the Spring of 2013, with a low flow study initiated by Salmonid Restoration Federation beginning in the Summer of 2013.

Are there any risks associated with participating in this feasibility study? No We understand that landowners and residents want to protect their privacy and property rights, and this study was specifically designed with participant protection as the highest priority.

Mail-In Surveys

Why are surveys necessary? In order to determine whether water storage and forbearance would be ecologically and socially feasible, general baseline data needs to be gathered about residential water use patterns and community perceptions of Redwood Creek. The most effective way to gather data on a large scale while protecting landowner privacy is through anonymous and confidential mail-in surveys.

I'm a landowner in Redwood Creek and I haven't received a survey yet. What should I do? Please write to *water@calsalmon.org* or call the Salmonid Restoration

(Back)

APPENDIX K

Community House Meeting Agenda

Source: Salmonid Restoration Federation, 2013

Time	**Agenda Item**	**Who/How**	**Desired Outcomes**
5pm	Introductions: Name, tributary, reason for attending	Roundtable: Give each person a turn to speak without cross-talk	Get acquainted, Learn what is of concern to rural landowners
5:20pm	Introduce the project	Sara Schremmer explains need for data	Emphasize the need for landowner participation
5:30pm	Explain SRF's role in the project	Dana Stolzman, SRF ED	Explain the trajectory of the project
5:40pm	Background on Sanctuary Forest's program	Tony Fair, Sanctuary Forest	Answer questions about the program for landowners
5:50pm	Introduce value of community engagement	Hezekiah Allen, ED Mattole Restoration Council	Create constructive environment for discussing options
6pm	Discussion of potential solutions	Group brainstorm	Learn about community ideas
6:45pm	Next steps	Dana / Sara	Identify volunteers

APPENDIX L

Table: 2014 Comparison of Steel 50,000 gallon tanks, water bags, poly tanks, and underground poly tanks

Source: Sanctuary Forest, 2014

	Steel 50,000 gallon tanks	**Water Bags 15,000 gallon (Aqua Dam)**	**Poly 5,000 gallon tanks**	**Underground poly**
Sources				
	Whitethorn Construction 986 7416	Aquadam, ATL	Multiple local Whitethorn Construction, Dazey's Wycoff's	Contech Duramax system: Contech Engineered Solutions LLC 415-897-8587 tel ckruger@conteches.com
	Mark Hilosky 986 7241		National tank	
			American Tank	
	National tank			
	American tank			
Durability and longevity				
Warranty	10 years	N/A	3 years	
Life expectancy	30 years	New product hasn't been around long enough to determine lifespan, but after four years bags have held up fine, so far.	10-15 years if shaded	10-15 +
Fireproof	Medium resistance	Low-no resistance	Low-no resistance	High resistance
Earthquake	Medium strength	Hi strength	Hi strength	Hi strength
Snow loading	Low strength	Hi strength	Hi strength	Hi strength
Sun- UV	Hi resistance because liner is enclosed and protected	Low resistance- tanks will eventually break down if exposed directly to sun. But does contain UV inhibitors that should delay this process.	Low resistance- tanks will break down if exposed directly to sun	Hi resistance

Damage from falling trees	Medium -low strength	Not stronger but unlikely that multiple tanks would be damaged if several were installed in series	Not stronger but unlikely that multiple tanks would be damaged if several were installed in series.	Unlikely due to earth cover
Vermin resistance	Medium (sand and geo tech fabric help protect the liner; however it is possible that vermin could chew their way through- so far no instances reported in Humboldt and Mendocino Counties)	Medium (Hard for vermin to chew through if full, and very easy to patch)	High (It would be more difficult for vermin to chew their way through the tank wall or bottom)	High
Water quality				
Drinking water safe	Yes -AS/NZS 4020-2002 approved	Yes -NSF approved, but patching process compromises approval rating	Yes -NSF approved	Nsf 61 material
Water temperature	Colder because of large volume =better water quality	Warmer because of smaller volumes= lower water quality	Warmer still because of small volumes= lower water quality	Colder=better
Volume to surface ratio	Higher volume to surface ratio- could result in lower pick up (leaching) from surface materials	Lower volume to surface ratio - could result in higher pick-up (leaching) from surface material	Lower volume to surface ratio - could result in higher pick- up (leaching) from surface material	Higher volume to surface ratio- depending on design
Water Security	Medium high security with a goof ladder and proper operation of valves. Significant water loss would only occur if: 1) the goof ladder was destroyed; 2) a leak occurred between the goof ladder and the tank; 3) the tank itself developed a leak	Low security with one unit, but security increases if there are multiple bags installed with only one open at any time, thus limiting potential loss to the capacity of one unit.	High security with proper operation of valves: If there were several tanks, and only one tank was open at any time, the maximum loss would be the capacity of the one tank.	High security with proper operation of valves: If there were several tanks, and only one tank was open at any time, the maximum loss would be the capacity of the one tank.

Permit Requirements				
Building permit	Required for greater than 5,000 gals; approved for AOB application only	Not required	Not required	Not required but untested with county
Grading permit	Required for excavation greater than 50 yards	Required for excavation greater than 50 yards	Required for excavation greater than 50 yards	Required for excavation greater than 50 yards
SWRCB permit	Required for storage longer than 30 days	Required for storage longer than 30 days	Required for storage longer than 30 days	Required for storage longer than 30 days

APPENDIX M

Focus Group Guide

Source: Sara Schremmer, Humboldt State University, 2014

General Categories

- Opening
- Transitional
- Key Questions
- Closing

1. What do you value about Redwood Creek?
    a. Probe: aesthetic beauty, habitat for salmon and other species, water for drinking or irrigation
2. What kind of changes have you observed in the Creek over the years?
    a. Probe: fewer pools, lower than average flows, changes in the length of the dry season
3. How do these changes make you feel?
4. Community-based restoration generally requires strong grassroots support and participation from the community. Do you think that the folks in your community will be supportive of a restoration project like the one being explored for Redwood Creek? Why or why not?
5. What sort of solutions do you think will be necessary to keep water flows at a healthy level through the dry season? Do you think landowners in the area will be supportive of those solutions?
6. What do you think are some of the barriers that are keeping youth from participating in the project? How do you think we could overcome those barriers?

APPENDIX N

Focus Group Letter of Informed Consent

Source: Sara Schremmer, Humboldt State University, 2014

Focus Group for the Redwood Creek Water Conservation Project

Overview. The purpose of this focus group is to explore community perceptions about water flows and discuss restoration options on Redwood Creek. This is part of a larger study examining the feasibility of transferring the Mattole headwaters successful and voluntary water storage and forbearance program to Redwood Creek. This study was developed by Sara Camp Schremmer, a graduate student at Humboldt State University, in collaboration with Sanctuary Forest and Salmonid Restoration Federation. I may contact the researcher at [redacted] or by cell at [redacted].

Participant Role. My part in this study involves participating in a one hour recorded focus group at a residential home in the Redwood Creek watershed. During the focus group, I will have an opportunity to discuss issues related to water flows and conservation practices on Redwood Creek. I will be asked to talk about my concerns and perceptions of Redwood Creek as a resource, and how I feel about water storage and forbearance as a possible solution to the low flow problem.

Risks and Benefits. There are no risks associated with my participation in this project; instead, I may find that the process will offer the benefit of focused time to reflect on the topic.

Voluntary Participation. I understand that the interviewer will answer at any time any questions I may have concerning the study or the procedures. I also understand that my participation in this study is entirely voluntary. I may decline to enter this study or decline to answer particular questions for any reason. I may also withdraw from the study at any time without jeopardy. I also understand that the researcher may end our interview or my participation in this study at any time.

Confidentiality. My individual privacy will be maintained in all written materials resulting from this study. All references to my real name, as well as any other real names captured in the interview recording, will be assigned pseudonyms in any transcriptions and other written materials generated from those recordings. Recordings will be destroyed within 30 days os transcription. Records linking pseudonyms with real names will be kept in a secure location. This consent form will be kept for 5 years after study completion in a designated and locked file drawer controlled by the Department of Sociology.

Concerns. If I have questions regarding my rights as a participant, any concerns regarding this project, or any dissatisfaction with any part of this study, I may report them—confidentially, if I wish—to the Dean for Research & Sponsored Programs, Dr. Rhea Williamson at [redacted] or [redacted]. Likewise, I may also contact Dr. Elizabeth Watson, Professor of Sociology, Humboldt State University at [redacted] or [redacted].

I understand the above and in signing below provide my consent to participate.

_____ _____

Signature of Participant Date

APPENDIX O

The Redwood Creek Water Conservation Project, South Fork Eel: Report & Updates

Source: Sara Schremmer, Humboldt State University, 2013

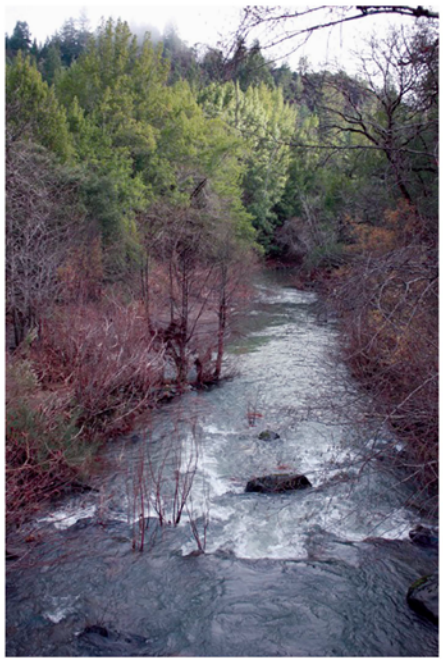
The Redwood Creek Water Conservation Project, South Fork Eel River: *Report & Updates*

A Project of Salmonid Restoration Federation

Early in 2013, Salmonid Restoration Federation in collaboration with a Humboldt State University sociology graduate student, Sara Camp Schremmer, initiated a study to determine the feasibility of conducting a "technology transfer" of Sanctuary Forest's successful Mattole headwaters water storage and forbearance program to Redwood Creek on the South Fork Eel River.

The Redwood Creek watershed spans 26 square miles and has historically supported strong runs of coho, Chinook and steelhead. Juveniles of these species are routinely found throughout the watershed in spring and early summer, with Coho and steelhead rearing in the watershed until migrating to the ocean the following spring. Today, the watersheds, tributaries, and drainages of the South Fork Eel River basin are suffering from the legacy impacts of industrial timber management, extensive road networks and rural sub-divisions. Residential water diversions appear to be compounding the problem. Native salmon populations are now endangered and rural communities have virtually no baseline information or data about historic flows in the small creeks which many local residents depend upon.

To address these concerns, the Redwood Creek Water Conservation Project was designed in order to gather baseline data about human water use and low flows in the watershed, to gauge community interest in establishing a voluntary water conservation program, and to understand the type of water conservation program that might be appropriate for the Redwood Creek watershed and its rural residents. The project is based on the methods employed in Sanctuary Forest's innovative Mattole headwaters water storage and forbearance program, where during the period from 2007-2012, sixteen participating landowners signed a legal agreement with Sanctuary Forest to store water from the Mattole River during high flows, and to use stored water from their tanks during the low flow season. The program has successfully engaged the community in water conservation efforts and has increased flows in that one-mile reach of the Mattole by 40%, according to data monitored by the CA Department of Fish and Wildlife.



Surveys & Data Analysis

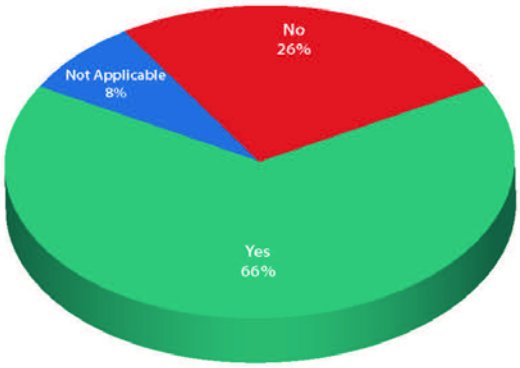
In the first phase of the feasibility study, an anonymous survey was mailed to the approximately 400 owners of parcels in the Redwood Creek watershed. In order to gather baseline data and obtain a clear understanding of human water use patterns in the watershed, the survey contained questions related to water source(s), withdrawal rates and current on-site storage capacity. Questions on community perceptions and values regarding Redwood Creek were also included, in order to gauge the level of interest that residents have in participating in a voluntary water conservation program.

As of May 2013, 70 people completed and sent in a survey questionnaire, resulting in a 17.5% response rate. Intensive outreach efforts were made through local media outlets, phone banking, and word-of-mouth to ensure the highest response rate possible, and while the feasibility study coordinators are pleased with the results, we have also done an assessment of the factors that may have kept more residents from participating in the survey.

For our mailing list, we could only obtain the names and addresses of the owners of parcels in the watershed. Owners who did not live on their parcel and/or had a primary tenant and caretaker living on their land may not have completed the survey; in other instances, residents may not have received the survey if they lived on a sub-divided parcel and were not technically an owner. Also, many Southern Humboldt residents travel during the winter and may have missed the survey as a result. Other residents may not have felt that the survey applied to them if they identified as resident of a smaller drainage (ex: "I'm a Miller Creek resident, not a Redwood Creek resident"). And lastly, we recognize that water is a sensitive issue for the rural residents of Humboldt County, and some people may have opted not to participate in the survey if they were distrustful of how the information would be used.

Tables 1 and 2 summarize the results of the first two questions on the Redwood Creek Community Perceptions & Residential Water Use Survey, where respondents were asked to rank what they

Figure 1: Do you have any mechanisms in place to prevent tank overflows?



value about Redwood Creek and to share any observations of changes that they have observed in the watershed that may be contributing to low summertime flows.

An interesting finding surfaced when we analyzed the results in Table 1. There is a significant relationship between a respondent valuing the aesthetic beauty of the creek and valuing the creek for habitat for salmon when compared to the respondent's level of interest in volunteering in flow restoration efforts. Values concerning fresh drinking water and water for irrigation did not have a significant impact on levels of interest in volunteering. From this information, we could conclude that the emphasis of community outreach efforts for the Redwood Creek Water Conservation Project should be on restoring and preserving the natural beauty of the creek and the vital habitat for salmon that it provides.

Figure 1 shows a breakdown of the percentage of survey respondents who have mechanisms in place to prevent tank overflows. While 66% reported that that they do have mechanisms in place to prevent overflows, 26% reported that they do not, and 8% indicated that the question was not applicable to them. With over one-quarter of respondents indicating that they do not have mechanisms in place to prevent tank overflows, the Redwood Creek Water Conservation Project should work to ensure that information is available to all residents about the affordable and accessible options that can help prevent water loss, including the installation of automatic shut-off valves and installing an overflow pipe back to the water source.

Figure 2 illustrates a comparison between two questions: How frequently or infrequently do you talk to other people in your community about the health of Redwood Creek? and How interested or uninterested are you in participating in voluntary flow restoration efforts in Redwood Creek? We found that there is a significant correlation between how often respondents talk about the health of the creek and how interested they are in volunteering in restoration efforts. One interpretation of this finding suggests that future efforts to increase levels of volunteer engagement in the community would more likely be successful if we were to provide additional forums for public dialogue among residents of the watershed.

Lastly, Figure 3 describes respondents' water source(s) for irrigation and household use. Just over half of the respondents reported that they obtain their water for irrigation from springs, and nearly 70% use springs for their water for household use. This information will help inform the low flow study that will be happening in the summer of 2013.

If you are interested in learning more about the survey results, or if you have any questions about the data analysis in this report, please contact Sara Schremmer at *sara@calsalmon.org.*

Community Outreach

In the second phase of the feasibility study, two house meetings were hosted in Miller Creek and Seely Creek to provide a forum where Redwood Creek residents could participate in the decision-making process regarding the scope and trajectory of the Redwood Creek Water Conservation Project. At each meeting, presentations were given by local restoration experts, highlighting the concerns about the watershed from a resource system perspective. Additionally, feedback was gathered from residents on their interest in participating in water storage and forbearance versus other forms of water conservation.

At the Miller Creek house meeting, 40 people were in attendance with a roughly equal distribution of men and women. The Seely Creek house meeting was attended by 11 men and 6 women. Both meetings were comprised mostly of residents who appeared to be in their mid- to late-forties or older. The meetings were designed to provide a welcoming space for

Table 1: Please tell us what you value about Redwood Creek by marking each scale provided below.

	% Agree*	% Neutral	% Disagree*	Mean**	Number of Responses***
Aesthetic Beauty	92.8	2.9	1.4	1.26	68
Habitat for Salmon	88.5	10.0	1.5	1.33	70
Fresh Drinking Water	57.1	15.7	24.2	2.37	68
Water for Irrigation	50.0	15.7	32.8	2.68	69

community engagement in the design of a water conservation project, and additional efforts will be made in the future to ensure that younger residents are invited to attend and participate.

Below is a summary of some of the points that were discussed at both meetings:

- The factors that made the Mattole Flow Program successful, including the development of a feasibility study very similar to the one being implemented in Redwood Creek.
- What a low flow study in the Redwood Creek watershed might look like, beginning in the summer of 2013.
- Suggestions for water conservation methods (such as installing float valves) that can be implemented right away by residents.
- Options for incentivizing water storage, such as initiating a revolving low-interest loan fund for storage tanks.
- Increasing community awareness during the low flow season. Specific suggestions included "Water Conservation Corners" at local hardware stores and low-flow road signs for Seely, Dinner, China and Miller Creek.
- The pros and cons of different storage tank options. For example, 5,000 gallon polyethylene tanks are relatively easy to install and do not require a permit.

From the house meetings, we learned that a couple of obstacles currently stand in the way for rural residents who want to add winter water storage to their properties. In addition to the initial expense of purchasing a new tank, the current policy in Humboldt County is to increase a landowner's property taxes when additional water storage is installed, resulting in a financial disincentive. To address this problem, a few non-profits in the region are working together to explore the options for passing an ordinance or new tax policy that would provide a financial incentive for Humboldt County residents who want to install winter water storage.

Additionally, the issue of water rights presents a significant hurdle for residents who want to legally add water storage to their properties. According to the New California Water Atlas, only two residents have established water rights in the Redwood Creek watershed, yet hundreds of families in the region currently divert water for domestic and agricultural purposes. A recent "enforcement sweep" initiated by The State Water Resources Control Board Division of Water Rights has left many residents confused about their water rights and concerned about state agencies coming onto their land. Several non-profits in the area, including SRF, have responded by putting together a public forum where residents can learn about their water rights and how to come into compliance with state water law so that they can legally divert and store water without fear of legal repercussion.

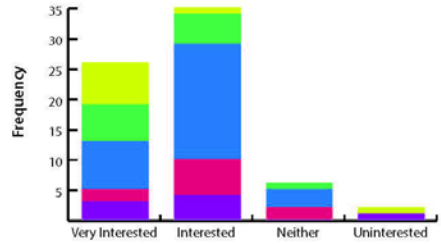
Table 2: Please tell us about changes you have observed over the years in Redwood Creek and the surrounding area that you think may be contributing to low summertime flows.

	% Agree*	% Neutral	% Disagree*	Mean**	Number of Responses***
Fewer pools	57.1	27.1	7.1	2.14	64
Changes in length of dry season	44.3	40.0	8.6	2.32	65
More gullies, landslides, or roads	37.2	34.3	15.7	2.56	61
Changes in forest cover	40.0	31.4	20.7	2.57	63
Fewer logs in the creek	14.3	52.9	22.8	3.13	63

** = Respondents who selected Strongly Agree or Agree were included in the % Agree column. Respondents who selected Disagree or Strongly Disagree were included in the % Disagree column. Missing responses were included in the percentage totals.*
*** = The mean was calculated based on a scale of 1 (Strongly Agree) through 5 (Strongly Disagree).*
**** = Total number of survey responses was 70.*

Landowner Surveys Indicate Strong Stewardship Ethic

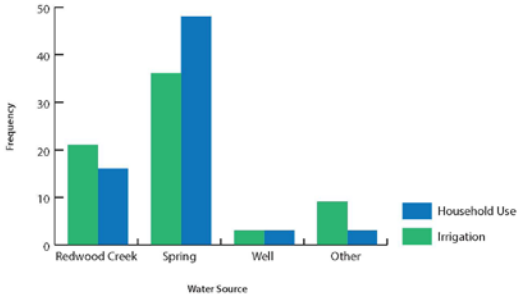
Figure 2: Interest in volunteering in restoration efforts compared to how frequently the respondent talks to their neighbors about the health of the watershed.



	Very Interested	Interested	Neither	Uninterested
Very Frequently	7	1	0	1
Frequently	6	5	1	0
Occasionally	8	19	3	0
Infrequently	2	6	2	0
Very Infrequently	3	4	0	1

** = Example: Out of the 27 respondents who indicated that they are Very Interested in participating in voluntary efforts to restore flows in Redwood Creek, 7 also talk Very Frequently with others in their community about the health of Redwood Creek.*

Figure 3: Water Source for Irrigation & Household Use



Water Conservation Workshop and Field Tour

The water usage surveys and house meetings culminated in a free water conservation workshop with presentations by staff from Sanctuary Forest, Salmonid Restoration Federation, the Mattole Restoration Council and the Mattole Salmon Group. Presentations were followed by a three-hour field tour in Briceland in order to teach landowners hands-on water conservation techniques that could be applied to their own homestead. Stops during the field tour included appropriately designed and constructed lined ponds, groundwater recharge ponds, rainwater catchment tanks, and poly-tank farms, all for the purposes of increasing resident knowledge about options for winter water storage.

Next Steps

Analysis from the surveys and house meetings revealed which tributaries of Redwood Creek have landowners and residents living along them that would be amenable to the implementation of a voluntary water conservation program; however, measuring the social acceptance is just one key component to the project. In order to determine where water storage and forbearance would have the greatest ecological impact in restoring flows, a low flow study will be initiated on Redwood Creek in the summer of 2013.

The low flow study will provide baseline flow data that will illuminate to what extent water diversions are impacting flows on Redwood Creek, as well as which locations in the Redwood Creek watershed are most critical for salmonid population recovery. Salmonid Restoration Federation's low flow study on Redwood Creek will be guided by Bill Eastwood, a local geologist and restoration practitioner with expert knowledge of the watershed as a resource system.

Participants toured a recharge pond as part of the Water Conservation workshop that SRF hosted in the winter, 2013. All photos: Dana Stolzman

SRF Redwood Creek Project Coordinator, Sara Schremmer, trained with Sanctuary Forest's monitoring team to learn low-flow study techniques that will be employed in the low-flow study in Redwood Creek this summer.

SRF will continue to work with multiple agency and organizational partners, including Sanctuary Forest, the Mattole Restoration Council, Eel River Salmon Restoration Project, the Department of Fish and Wildlife, Humboldt Area Foundation, Trees Foundation, Eel River Watershed Improvement Group, NRCS, and the Briceland Volunteer Fire Department, to harness the momentum and excitement around flow restoration that has already been generated by this project. With the active input and continual engagement from the residents of the Redwood Creek watershed, SRF is working to develop and implement a community-led residential water conservation program in the near future that will suit the needs of both people and fish for generations to come.

Saving coho salmon in South Fork Eel River is critical for the recovery of coho salmon in the North Coast region of California. The tributaries of Redwood Creek have all historically supported coho and provided valuable spawning habitat. Coho salmon are now on the brink of extinction due to lack of habitat and instream flows. Our water conservation efforts can make a difference.

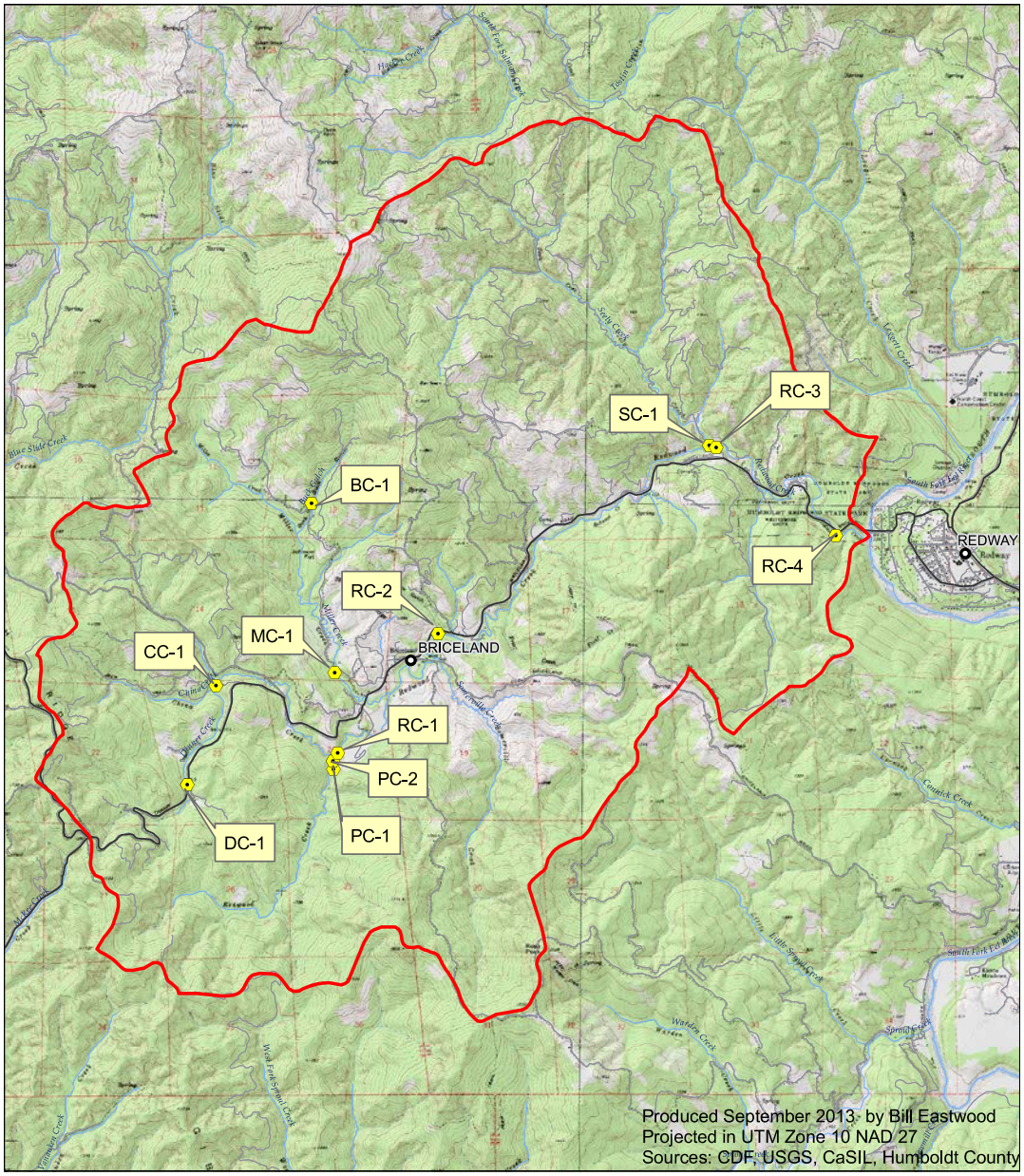
For additional information about The Redwood Creek Water Conservation Project or any questions related to the feasibility study discussed in this report, please contact the Project Coordinator at *water@calsalmon.org* or call (707) 923-7501.

Information is also available on the Salmonid Restoration Federation website at *www.calsalmon.org*

APPENDIX P

Map: Redwood Creek Low Flow Study Monitoring Stations

Source: Bill Eastwood, Eel River Salmon Restoration Project, 2013


SC-1
RC-3
BC-1
RC-4
REDWAY
RC-2
MC-1
CC-1
BRICELAND
RC-1
PC-2
PC-1
DC-1
Produced September 2013 by Bill Eastwood
Projected in UTM Zone 10 NAD 27
Sources: CDF, USGS, CaSIL, Humboldt County

N

0 1 Miles

APPENDIX Q

Recommended Resources

Source: Tasha McKee, Sanctuary Forest; Sara Schremmer, Humboldt State University, 2014

Funding Resources

- The Natural Resource Conservation Service: http://tinyurl.com/l54loyw
- California State Water Resources Control Board Division of Financial Assistance: http://www.swrcb.ca.gov/water_issues/programs/grants_loans/
- California Department of Water Resources Integrated Regional Water Management (IRWM) Grants: http://www.water.ca.gov/irwm/grants/index.cfm
- EPA Watershed Funding: http://water.epa.gov/grants_funding/shedfund/watershedfunding.cfm
- EPA Catalog of Federal Funding Sources for Watershed Protection: https://ofmpub.epa.gov/apex/watershedfunding/f?p=fedfund:1

Government Data on Streamflow, Rainfall, and Water Temperature

- USGS Water Data for the Nation: http://waterdata.usgs.gov/nwis
- USGS Water Data Discovery: http://water.usgs.gov/data/
- NOAA's National Weather Service Precipitation Data Frequency Server: http://dipper.nws.noaa.gov/hdsc/pfds/

Flow Monitoring Methods

- State Water Resources Control Board Alternative Monitoring Methods: http://www.waterboards.ca.gov/waterrights/water_issues/programs/diversion_use/wm_alt_mthds.shtml
- Sanctuary Forest QAPP: Waiting for it to be put online
- Railsback, Steven F., John Kadvany and William J. Trush. *Demonstration Flow Assessment Procedures*: http://205.225.207.106/waterrights/water_issues/programs/hearings/cachuma/comments_rdeir/williams/h_railsback_undated.pdf
- Sanctuary Forest Quality Assurance Project Plan (QAPP): http://www.sanctuaryforest.org

Survey Methodology

- Dillman, Don A., Jolene D. Smyth and Leah Christian. (2009). *Internet, Mail, and Mixed-Mode Surveys: The Tailored Design Method*. Hoboken, NJ: John Wiley & Sons, Inc.

Water Rights Information

- Sawyers, Gary W. (2010). *A Primer on California Water Rights*: http://aic.ucdavis.edu/events/outlook05/Sawyer_primer.pdf
- New California Water Atlas: http://ca.statewater.org/
- Sanctuary Forest. (2004). *Options and Obstacles: Living with Low Water Flows in the Mattole River Headwaters*.

Water Conservation, Efficiency, Permaculture and Storage Information and More

- Sanctuary Forest. 2008. *Water Storage Guide: Storing water to benefit streamflows and fish in North Coast Creeks and Rivers*. Produced with support from the California Department of Fish and Wildlife's Fisheries Restoration Grant Program.
- Hemenway, Toby. 2009. *Gaia's Garden: A Guide to Home-Scale Permaculture*. Chelsea Green Publishing Company.
- Lancaster, Brad. *Rainwater Harvesting for Dry Lands and Beyond*. Volumes One, Two and Three: http://www.harvestingrainwater.com/
- Water efficiency educational materials and literature for residential and commercial properties from the California Department of Water Resources: http://www.water.ca.gov/wateruseefficiency/landscapeordinance/technical.cfm
- High Tide Permaculture Design. 2014. Water Through a Permaculture Lens (Brochure): http://tinyurl.com/mar-water

Emergency Tank Storage Registration Information

- SWRCB Registration for Small Domestic Use Appropriation (FORM): http://www.waterboards.ca.gov/waterrights/publications_forms/forms/docs/sdu_registration.pdf
- SWRCB Water Rights Registration Program Flow Chart: http://www.waterboards.ca.gov/waterrights/board_info/docs/regprocess_sdulsu_overview.pdf
- Emergency Tank Storage Registration Process Guide: http://eelriver.org/wpcms/wp-content/uploads/2014/03/Process-Guide-for-Registration-for-SDU-Appropriation.pdf

APPENDIX R

Brochure: Know Your Water Rights

Source: Salmonid Restoration Federation, Friends of the Eel River, 2013

Helpful Definitions

Water Rights: A water right is a granted permission to withdraw water from a river, stream, or groundwater source for a "reasonable" and "beneficial" use. Water rights vary from very small domestic use water rights to very large state and federal projects to provide water for irrigation districts, hydropower, and cities. Generally speaking, the diversion of surface water, including diversion of water from subterranean streams flowing in known and definite channels, requires a valid basis of right. California recognizes many types of water rights, including riparian (streamside) and appropriative water rights.

Riparian Rights: Land that touches a stream—or a parcel that kept water rights when it was split from a larger parcel that touches a stream—has the right to divert and use the natural flow of surface water for domestic, agricultural, and other beneficial uses as long as other riparian diverters and public trust resources like fisheries are not impaired. A riparian right can only be used to divert the natural flow of surface water. Water may not be diverted during wetter years or months and stored for use during drier years or months.

Appropriative Rights: Someone who takes water for use on non-riparian land or who uses water that would not be there under natural conditions on riparian land appropriates water. Water right certificates, permits and licenses issued by the State Water Board and its predecessors are examples of appropriative water rights.

Beneficial Uses: The beneficial uses of water, pertaining to water rights, are defined in the California Code of Regulations (CCR), title 23, §659-672 and include, but are not necessarily limited to: domestic; irrigation; power; municipal; mining; industrial; fish and wildlife preservation and enhancement; aquaculture; recreational; stockwatering; water quality; frost protection; and heat control.

Public Trust Resources: The State Water Board is responsible for the protection of resources, such as fisheries, wildlife, aesthetics, and navigation, which are held in trust for the public. The State Water Board must consider these responsibilities when planning and allocating water resources, and protect public trust uses whenever feasible. The State Water Board must consider these public trust values in the balancing of all beneficial uses of water in accordance with the Water Rights Mission Statement and Water Code §1253.

Water Rights Resources

For more information about water rights and other requirements related to the diversion and use of water, the following public agencies and organizations can help:

For information on **Water Rights**:

- Mark Matranga, State Water Resources Control Board, Division of Water Rights, (916) 327-3112, *mark.matranga@waterboards.ca.gov*
- Matt McCarthy, State Water Resources Control Board, Division of Water Rights, (916) 341-5310; *Matthew.McCarthy@waterboards.ca.gov*
- Visit: *www.waterboards.ca.gov/waterrights*

For information on **Water Quality**:

- Bryan McFadin, North Coast Regional Water Quality Control Board, (707) 576-2751, *bryan.mcfadin@waterboards.ca.gov*

For questions about permits to install diversion facilities or other structures in the stream:

California Department of Fish & Wildlife

- Jane Arnold, Staff Environmental Scientist (Eureka), (707) 441-5671; *jane.arnold@wildlife.ca.gov*
- For information about filing a Lake or Streambed Alteration Agreement with the Department of Fish & Wildlife, visit: *www.dfg.ca.gov/habcon/1600*

To view a map of all claimed or authorized water diversions in California, go to the **New California Water Atlas:** www.*ca.statewater.org*

State Water Board Electronic Water Rights Information Management System (eWRIMS) Database: *www.waterboards.ca.gov/ewrims*

Water Rights and Storage Frequently Asked Questions: *www.waterboards.ca.gov/waterrights/board_info/faqs.shtml#toc178761088*

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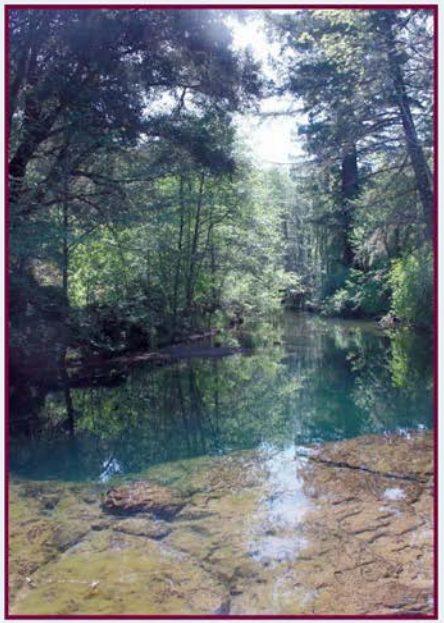
Know Your Water Rights



Water is a Shared Resource and Public Trust Value

If you're diverting water from a spring or stream, you need to be informed about your water rights and responsibilities.

The State Water Resources Control Board, Division of Water Rights has notified landowners that diverting water without complying with State water rights law could lead to enforcement action and fines of up to $1,000 plus $500 a day.

Compliance with State water law requires filing forms and acquiring permits when needed. The benefits are ensuring your homestead's water security and your land's value, while protecting our region's vital fisheries and wildlife.

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Step 1: File a Statement of Diversion & Use

State water rights law requires all people diverting surface waters (springs, streams, and rivers), including diversion of water from subterranean streams flowing in known and definite channels, to file a basic statement that includes the following information related to the diversion: amount, location, method, and basis of water right.

How to File:

Download the Statement of Water Diversion and Use form, available here: *www.waterboards.ca.gov/waterrights/water_issues/programs/diversion_use/docs/intl_stmnt_form_2013.pdf*

The form is an initial filing. You will be notified every three years to file a supplemental Statement. There is **no fee** to file.

Helpful Tips:

If you can't determine the latitude and longitude, you may indicate on a topographic map the location of your diversion and include this as an attachment. When indicating the rate of your diversion, a rough calculation will suffice, but don't be afraid to get to know your water meter!

What if I Don't File a Statement?

If you received a legal notice and you fail to respond after 30 days, you may be subject to fines of up to $1,000, plus $500 for every additional day of diversion where a Statement of Diversion has not been filed. If you do not have a valid basis of water right, your diversion could be subject to removal, particularly if your diversion is likely to contribute to significant and/or cumulative harms to public trust resources like fisheries.

Who is Exempt From Filing a Statement of Diversion & Use?

A Statement is not necessary if your diversion (1) has a valid basis of ***appropriative*** right, such as a certificate, permit, or license, (2) if a Watermaster files a report that includes the diversion, or (3) if you are diverting from a spring that does not otherwise flow off your property and your combined diversions do not exceed 25 acre-feet per year.

Step 2: Determine If You Need an Appropriative Right

If you cannot divert water under a riparian right, you will need to establish an appropriative water right through the State Water Resources Control Board's Registrations Program.

Register Your Water Storage

Riparian water users have the right to divert water for beneficial use (i.e. domestic or agricultural) on their parcel as long as it doesn't impair other riparian users and other beneficial uses of water including fish and wildlife. If you store winter water for use in the summer, you will need to establish a storage right.

How to Register

To learn more about appropriative rights &/or to download the appropriate form go to: *www.waterboards.ca.gov/waterrights/water_issues/programs/registrations/index.shtml*

Domestic Water Storage Rights

A relatively simple way to secure an appropriative right is to file a Registration of Small Domestic Use, which allows storage of three million gallons. Whether or not you need an appropriative right, it is important for all of us to do our part to protect fish and wildlife. Developing water storage minimizes taking water out of our creeks in the summer. Winter water storage ensures both landowners and fish have enough water in the dry season. The cost is $250 for a five year registration. The Department of Fish and Wildlife may conduct a site visit to provide protective terms for fish and wildlife resources based on site conditions. Here is the link to the small domestic use registration form and instructions. *www.waterboards.ca.gov/waterrights/publications_forms/forms/docs/sdu_registration.pdf*

What if I Don't Register My Water Storage?

You may be asked to remove your water storage system and subsequently draw unwanted attention from state agencies to your neighborhood.

A lake or streambed alteration agreement may also be required by CDFW, this is determined by on the environmental conditions and the project itself. The information and form are here: *www.dfg.ca.gov/habcon/1600/*

Step 3: Fish and Wildlife Protection

Your diversion of water or other alteration of streams (construction or modification of culverts, etc.) may require special notification to the California Department of Fish and Wildlife, which has the job of managing California's fish and wildlife resources and their habitats for their ecological value and enjoyment by the public. DFW issues Lake and Streambed Alteration permits ('1600 agreements') that may put limits on your diversion to ensure that public trust resources, including fish, are protected. From the DFW website:

Notification is required by any person, business, state, or local government agency, or public utility that proposes an activity that will:

- substantially divert or obstruct the natural flow of any river, stream or lake;
- substantially change or use any material from the bed, channel, or bank of, any river, stream, or lake; or
- deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake.

If your diversion matches any of these criteria, you may need a 1600 agreement. Contact DFW for information on fees (which vary depending on the project) and how to get started:

CA Dept. of Fish & Wildlife
Eureka Office, 619 Second Street, Eureka, CA 95501,
(707) 445-6493

Additional information about filing for a 1600 permit can be found here: *www.dfg.ca.gov/habcon/1600/Forms.html*

What if I Don't File for a 1600 Agreement?

If you don't file for a 1600 agreement and your diversion or other alteration is found to substantially modify a river, stream or lake, you may be subject to a financial penalty and/or the removal of any diversion facilities that are not covered. Additionally, you run the risk of substantial liability for harms to public trust resources, especially fish listed under the state and federal Endangered Species Act.

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