Rain Tanks, Springs, and Broken Pipes As Emerging Water Commons Along Salmon Creek, CA, USA

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Abstract

Large waterworks helped to produce California's cities, agricultural bounty, and attendant discourses of progress, private property, and human control over riverine ecosystems (Woelfle-Erskine, 2007). However, over the past two decades, water governance has been decentralized and some infrastructure diversified with rain tank retrofits, creating new local waterscapes in the interstices of California's 'hydraulic society' (California Department of Water Resources, 2005; Worster, 1992). These local waterscapes emerge entangled with alternate discourses of human-ecological collaboration and water as a public trust or commons, which in turn generate new cultural practices and governance strategies (Woelfle-Erskine, in press). I develop a field interview approach to investigate how installing rain tanks initiates shifts in water practices and environmental imaginaries along Salmon Creek (Sonoma County). There, a collaborative citizen-agency project has to date installed rain tanks with a total capacity of two million litres, aiming to improve water security for rural residents and increase late-summer streamflow to benefit endangered salmon. Residents who participate in monitoring salmon populations, water quality, and their own springs and rain tanks report that these activities have increased their sense of interdependence with other human and nonhuman neighbours who rely on the watershed's limited water sources. Drawing on Barad's

(2007) concepts of apparatus and intra-action, I argue that the notion of water as an interspecies commons is co-evolving with rainwater harvesting and that collective choice frameworks that embrace both management practices and environmental imaginaries represent a coherent alternative both to state and market frameworks of water governance and to traditional adaptive management methods and discourses.

Introduction

In California (USA) and elsewhere in the industrialized world, the material and socio-political characteristics of large waterworks have removed any clear-cut connection between local watersheds and urban water supply (Sofoulis, 2005). Large waterworks helped to produce California's cities, agricultural bounty, and attendant discourses of progress, private property, and human control over riverine ecosystems (Woelfle-Erskine, 2007). However, over the past two decades, water governance has been decentralized and some infrastructure diversified, creating new local waterscapes in the interstices of California's 'hydraulic society' (California Department of Water Resources, 2005; Worster, 1992). These local waterscapes emerge entangled with alternate discourses of human-ecological collaboration and water as a public trust or commons, which in turn generate new cultural practices and governance strategies (Woelfle-Erskine, in press). How can we make sense of new waterscapes in places where concern for riverine ecosystems motivates household water conservation, and climate change undermines supply-driven managerial approaches? Methodology is not well established to research how changes in household-scale water and wastewater infrastructures affect water practices and how people conceive of water sources. Several recent studies investigate perceptions and use of greywater systems (e.g., Mahmoud, 2008; Naylor *et al*., 2012; Pinto and Maheshwari, 2010) and the effects of rainwater harvesting or greywater reuse on household water use (Jones and Hunt, 2010; Muthukumaran *et al*., 2011). However, to date research largely focuses on social and infrastructural factors in isolation (for an exception see Domènech and Saurí, 2010). 'Scaling down' research to the household scale can reveal strategies that people use to track and regulate water use, and describe values that inflect their conservation efforts.

To address this gap, I developed a field interview approach to investigate how rural water use practices may shift in response to new knowledge about how human water use threatens salmon with extinction. Working as part of a collaborative of citizens and scientists, I asked research participants living near salmon in Salmon Creek, Sonoma County, California, to bring me into the field, where together we examined springs, well, rain tanks, and the homemade devices they used to track water levels and spring flows. Studying down to the household level in this way, I also traced local knowledge networks that residents use to share rainfall and well level data, and found that discourses of groundwater and salmon as commons are co-evolving along with rain tank programs and new watershed governance institutions. My attention to the co-evolution of decentralized

infrastructures, cultural practices, and conceptions of water's role (as public good, as private good, as commons) differs from the managerial move that has been the decentralization literature's central focus (e.g., Larson and Soto, 2008; Wiek and Larson, 2012; Plummer *et al*., 2013). Moreover, the beliefs, perceptions, and actions that emerge in these early interviews do not map onto Ostrom's (1990) design principles for common property resource governance. Instead, new environmental imaginaries (cf. Peet and Watts, 1996) emerge as understandings of salmon hydro-ecology travel from agency and private sector scientists – some of whom are also watershed residents – through existing monitoring and data sharing networks. In these new imaginaries, subsurface water connects humans to streams and to other species in lively and reciprocal relationships, and people describe an ethical responsibility for regulating their own water use so that other species can also thrive.

This case is a microcosm of issues debated across California and the western U.S. as drought deepens and climate change promises even scarcer and more erratic precipitation. As I began my study on Salmon Creek, new scientific understandings of groundwater-stream interconnection were challenging regulatory orthodoxies that arbitrarily separate ground and surface waters (Naiman *et al*., 2010). Residents sought ways to procure water without drying up streams and killing juvenile salmon. Arguing that harvesting rain in tanks could offset groundwater pumping, but only if residents changed watering practices and carefully monitored water use, local agencies designed a large-scale rain tank subsidy program that won federal salmon recovery funds (Gold Ridge RCD, n.d.). Understanding sociotechnical change in this context requires an approach that integrates salmon ecology, existing water infrastructures and practices, and social norms that regulate water use. In this paper, I present one such approach, articulating a relationship between a feminist theoretical approach and a commensurate method for studying emerging cultural waterscapes empirically.

Context: decentralising turns in water infrastructure and governance

California instituted decentralized water governance in 2002 through the Integrated Regional Water Management process, which funded multi-stakeholder groups to develop new water management plans. (Conrad, 2012; Hanak *et al*., 2011). Who participates in these groups, what infrastructural changes they consider, and what ethical frameworks they adhere to influences how the resulting plans negotiate competing claims for water, both amongst different human users and between human consumption and other species' needs for flowing streams. Rainwater harvesting has gained currency in recent years for its potential to alleviate pressure on rivers and improve conditions for juvenile salmon on the brink of extinction by restoring natural flow regimes (DeBusk *et al*., 2010; Poff *et al*., 1997). Northern California communities are increasingly examining rain tanks and shallow aquifer recharge as ways to protect aquifers and increase late-summer

groundwater flow to streams. Whether this potential is realized depends on a mix of social, economic, and hydrological factors.

Rain tanks can improve water security and water quality for well-dependent residents. However, state laws prohibit residents from using rainwater for drinking, cooking, washing, or flushing toilets, thereby limiting conservation potential. Moreover, rainwater systems are beyond many residents' means unless subsidies offset costs (Sofoulis, 2014; WATER Institute *et al*., 2011). Whether residents decide to adopt and maintain these systems, and whether the systems reduce water consumption overall, depends on how people use water in their homes and gardens. Understanding this decentralizing turn thus requires a parallel research turn away from dominant technical approaches – a turn that is charted in this special issue. By investigating how people use water in their homes and gardens, and why they do what they do, this research turn challenges conceptions of water as an abstract fluid best regulated by technical bodies. Linton (2010) and other hydrosocial theorists focus on how hydraulic engineering and state water agencies rendered water into 'purified' H2O in order to abstract (in the sense of extract) water from streams via dams and aqueducts. In contrast to the hydrological approach, I join other practice theorists (e.g., Shove *et al*., 2009; Sofoulis, 2005; Strengers and Maller, 2012) in focusing on everyday water practices as a window into local and ad-hoc water governance regimes that persist in the interstices of large technical waterworks, and in examining how water users monitor and understand local water sources and cycles.

As noted earlier, my research site is Salmon Creek, Bodega County, California, where two charismatic and economically important salmonid fishes – coho salmon (*Oncorynchus kisutch*) and steelhead (*Oncorynchus mykiss*) – spend their early lives in local streams but have declined in response to habitat degradation . Earlier collaborative research by citizen scientists and resource conservation agencies demonstrated that pumping by the Bodega Water Company and local ranchers accelerates stream drying, thereby jeopardizing salmonid recovery (Hammack *et al*., 2006). Their watershed assessment provided the scientific rationale for a pilot project that installed large rain tanks (ranging from 34,000 to 148,000 litres) at nine residences and two large systems at local ranches. The total installed capacity as of December 2014 was approximately two million litres.

My study of this rain tank project yielded a novel finding. By working to recover salmon – either as watershed monitors or by installing rain tanks to reduce their pumping from streams – all participants reconsidered how their water source connected with other aquifers and the stream, and a small minority argued that groundwater and salmon should be understood and governed as commons. In this paper, I briefly outline how the theoretical framework I used contributed to the field interview method I developed. I then offer some preliminary findings on how household water practices are co-constituted with infrastructures, local water sources, and ecosystems. In tying theory, method, and findings together in this

way, I offer readers the outlines of a new approach to conceptualising water use and governance practices that may co-evolve with a shift to rain tanks as supplemental water sources, and argue that this approach is well-suited for new governance and institutional water contexts.

The paper unfolds as follows. I first use Karen Barad's (2007) concepts of apparatus and intra-action to investigate whether participating in watershed monitoring and living with rain tanks constitute intra-actions that increase residents' sense of interdependence with riverine species. I then locate sites where the concept of water as a commons is co-evolving with rain tank installation and salmon recovery efforts. I argue that concepts of streams as inter-species commons, born of citizen entanglements with their neighbours, their water, and its fish, can support new institutional arrangements of collective governance. The paper concludes by discussing the research method's participatory and reflexive potential in other water governance contexts.

Entanglements: infrastructures, knowledges, social networks

Karen Barad develops her theory of agential realism from quantum physics. An observer viewing atoms through a scanning tunneling microscope influences the atoms she observes; this influence is intrinsic to the measurement process, so that separating the phenomenon of measurement into constituent parts is impossible (Barad, 2007). In Barad's view all matter is entangled with meaning in a similar way, through relationships she terms "intra-actions" between humans, their measurement tools, and nonhuman agents, including other species and human constructs. Extending Fernandes' (1997) analysis of mechanic agency in a Calcutta jute mill, Barad argues that when a loom breaks down, the crisis creates a cascade of conflicts, between weaver and mechanic, workers and union, etc. Barad conceptualizes these conflicts as intra-actions between humans, machines, cotton, and cloth. In her agential realist frame, the looms are not passive hunks of wood and metal, but active agents that collaborate with humans to create social arrangements within the factory. Workers, machines, factories, cotton plants, and unions all co-constitute the apparatus of cloth production that stretches out into the regional and local economy, and comes to matter (she plays deliberately on the multiple valences of the word "matter") by their engagements with each other. Challenging Cartesian cuts between humans and nature that produce a mediated, representational view of the world, Barad's theory de-centers the human and re-figures phenomena as lively and entangled relationships. Barad's attention to measurement practices is important to my task because measurement figures prominently in the household water systems that Salmon Creek residents monitor and maintain themselves.

White's (1996) figure of the Columbia River as organic machine could easily serve as another example for Barad because, like Fernandes' jute mill, White's river possesses a lively agency that emerges from its constituent elements. For White, the Columbia is a 'mixture' of its dams, fish, fishers and other workers who

"knew the river through the work the river demanded of them" (White, 1996, 4). In arguing that "there is no easy way to disentangle the natural and the cultural [on the Columbia]," White challenges human-nature binaries that have led people to treat nature as "a machine that can be disassembled and redesigned largely at will, as if its various parts can be assigned different functions with only a technical relation to other parts and functions" (1996, 111). The organic machine is lively, beyond human control. White's water body is a kind of cyborg body in which the machinic pieces cannot be separated from the living ones: "What is real is the mixture" (White, 1996, 111). My project resonates with White's in that I examine how people come to know a stream and its waters through laboring to maintain springs, measure water quality, and count salmon. Reading Barad's entanglements in relation to White's, I account more fully for affective connections that residents develop with salmon, which they watch return from extinction to swim again in local streams. These residents come to see the stream as something possessing an animacy that circulates through all of the watershed's channels and bodies.

In extending agential realism to think about water policy, I see an opportunity for a radical shift in perspective that may reveal new ways to reconcile human and ecosystem needs for water. Hydrosocial thinking highlights the need for this shift: theorists see waterworks as hybrid apparatuses that variously determine, constrain, and enable people's social relationships with water (e.g., Bakker, 2003; Linton and Budds, 2013; Swyngedouw, 2009). The hydrosocial approach studies down from institutions to social practices, making water a tool for tracing power through political landscapes. These thinkers all acknowledge water's materiality and the sometimes unruly agency that drives hydrosocial cycles. Barad's concept of entanglement develops a more sophisticated ontology of entities like like fish and dams than the hydrosocial approach achieves. In an agential realist view, the natural and the social are not just connected: they only come to matter in relation to one another. The co-constituents do not precede their becoming and thus have no chance of disentangling their shared futures. An agential realist approach helps explain why practicing frequent spring monitoring and maintenance might lead a resident to describe their water systems as containing human, manufactured, plant, animal, mineral, and atmospheric elements. Adopting Barad's ontological stance regarding apparatus – that measurement, measurer, and object are co-constituted through lively entanglements – inspired me to develop a research method that connects how people measure, track, ration, use, and share water in the home to whether they decide to share scarce water with riverine ecosystems.

Research setting: scarcity, regulation, and watershed imaginaries

I began my inquiry with an empirical question: How does a lived experience of scarcity tangle with particular forms of infrastructure? In Salmon Creek, variable rainfall and local geology mean that water has always been scarce locally, influencing both plant and animal species' adaptations and human settlement patterns. Ninety-five percent of the watershed is privately owned, and only nine

landowners have permits to divert water from the stream; most residents rely on wells or springs that dry up or drop to a trickle in the late summer. In the absence of central monitoring and regulation, residents track rainfall, spring flow, and aquifer levels using hand-made instruments, and know in a general sense that their groundwater use affects local streams. This knowledge is spatially incomplete, in that there is no central repository for data, nor standardized collection and reporting methods, and often relative, in that people compare the current year's rainfall and streamflow with past years. Residents use this local knowledge to police others' water use through informal social networks ("Someone should tell her not to water her lawn," one respondent told me), and they curtail irrigation when sources seem to be drying up.

The Bodega Water Company (BWC) has just 39 connections, two gallery supply wells that tap shallow groundwater, and no storage reservoir; as a result, customers face frequent service interruptions and pay high water rates. They are 'strong-armed' by their neighbors into serving on the water board, where they experience firsthand the difficulties of maintaining a small water system. Residents without a BWC connection must maintain their own spring or well. All residents historically coped with water scarcity on an individual basis, by attempting to drill more wells, buying water from tanker trucks, limiting summer water use, or installing rain tanks or greywater irrigation systems. The idea to diversify water supply infrastructure at the municipal scale by installing rain tanks throughout the town of Bodega emerged in response to twin prerogatives: increasing reliability for BWC customers and ranchers, and augmenting flows for near-extinct salmon.

Beginning in the 1990s, scientific evidence that BWC pumping dried up salmon habitat downstream began to circulate. At watershed council meetings and through informal networks, residents' understandings of local water expanded to include a sense of salmonids' dependency on flowing streams. Two environmental imaginaries emerged: the notion of the watershed and the idea of water and salmon as commons. Although these imaginaries may seem unrelated to the problem of household water provision, they surface again and again in residents' descriptions of their water use.

The field interview as window into watery entanglements

Through scoping interviews with local residents, I articulated three specific research questions as windows into entanglements between scarcity, water infrastructure, and water practices. Does local knowledge inform scientific goals and understandings of water scarcity and salmon decline, and if so, via what processes? How do different residents understand local streams and aquifers: as private, public, commons, or something else? Are design principles for collective governance (Ostrom, 1990) emerging along with the idea of the commons?

In the U.S., and particularly in the water-scarce western states, gaining access to private well and spring data poses a challenge for household water researchers

because few public repositories exist and landowners are reluctant to release data that could reveal that their water supply is unreliable. I developed a field interview approach to gain a ground-level view of the landscape (geology, topography, land use, and settlement patterns) while discussing household water use practices with residents. I conducted 21 field interviews with residents who relied on some combination of wells, springs, rain tanks, and municipal systems for household water. My four years of participant observation in the local watershed council and regional scientific meetings facilitated follow-up conversations with 12 participants.

I met with residents at their homes, individually or in self-selected groups of neighbors. Conversations typically began inside homes in a somewhat formal context, with me asking questions about the water source, water use patterns, and conservation measures. Next, I asked to see the local sources that supplied household water – the well, spring, and, in some houseolds, rainwater tank. This part of the interview was less formal, and respondents often took the lead in explaining how their system worked. At the time, I lived nearby with a small spring for my water source, and often discussed my experiences of leaks and frozen pipes; this shared experience gave the field interviews a more conversational tone. On visits to springs – often located several hundred meters from dwellings – I asked about soil characteristics, runoff patterns, and seasonal variations in flow; participants responded with comments on local history and ecology. The first resident I interviewed demonstrated how he measured flow from a spring with his watch and a mayonnaise jar and showed me a log book containing 30 years of monthly measurements. I subsequently asked others if they measured spring flow or kept records of well depth or rainfall. Nearly all did. I also asked whether they compared their records with rainfall data collected by weather bureaus or neighbors. Most could recall exactly how much rain several of their neighbors had measured during the last rainfall; four long-time residents discussed systematic differences between their measurements and a local weather station.

At the end of the interview, typically after returning from the water source, I asked two questions designed to elicit responses about groundwater regulation and watershed governance: Who should decide who can withdraw water from Salmon Creek and its source aquifers?; and, Who should decide how much water must stay in Salmon Creek?

Findings: Linking water apparatus to common waters

Residents use their own measurements to decide when to curtail water use and to interrogate state-supplied rainfall and groundwater data. They are blending their own and neighbors' experiences with information gained from agency scientists to explain why wells and springs dry up. Some residents believe water should be shared among humans and also with nonhuman animals (cows, salmon, otters, and raccoons were all mentioned). All respondents thought that water should be allocated fairly or equitably, but few thought that the government could

effectively regulate water use, and only one desired additional government regulation of residential water use.

The analysis of field interview revealed an unexpected finding: that people extend their own experience of scarcity to nonhumans and their human neighbors. They can relate to the hassle and uncertainty of running out of water, and this allows them to consider scarcity's effect on others, including nonhuman others. Often, residents' responses to the question "Who do you think should decide how much water must stay in Salmon Creek?" indicated that they consider the water they drink, wash, and garden with to be interdependent with a multiplicity of living and nonliving things. For example, one resident who recently installed a rain tank said the following:

What is the benefit of those creeks to those people who live here, and do the other animals that live here have any rights at all? Who's going to provide a habitat for the fish and the animals – the bobcats and the deer and the coyotes and the raccoons and all of those other animals that go down to the creek to drink? You can hear them down there. Do they have a right to clean water?

How should we interpret this shift in focus – that in response to a question about regulating water withdrawals, a resident responds that animals who drink from the stream have a right to clean water? Extending Barad's concept of apparatus to household water infrastructure offers one explanation: Salmon Creek residents understand their water supply as complex entanglements of infrastructures and agents. This shift in ethics – to considering other species as residents with rights to water – is not typically considered in decentralizing projects, but should be considered as plans to scale up rain tanks and greywater irrigation proceed.

My attention to the co-evolution of infrastructures, practices, and understandings of water differs from managerial approaches to decentralization (e.g., Daigger, 2009; Pahl-Wostl, 2007). Seeing infrastructures, practices, and water users' ecological ethics as bound together lends credence to residents' claims that if given a certain amount of autonomy they will regulate their own use. Several residents voiced this perspective, including this BWC customer with a rain tank:

I happen to think that we all live here together as a living network. . .The creek should be preserved for the benefit of all living people [he corrects himself] all living beings, as well as for humans… If that means a regulation of consumption, then maybe we need to self regulate in some regards.

That is not to say that formal regulation should be abandoned; California's 2014 regulations have increased interest in rain tanks and large rain-fed ponds among residents and ranchers (John Green, personal communication). What my findings imply is that practices of monitoring and maintaining rain tanks are also practices of cultivating a sustainability ethic and should be encouraged, not minimized as managerial approaches often advocate. In places like Salmon Creek,

where commoners initiate water conservation action on behalf of another species, rain tank installation projects have the potential to be more contextually situated if they incorporate practical knowledge (cf. Scott, 1998) residents have gained through monitoring their other household water systems.

At this early stage, it would be premature to draw conclusions about the state or structure of common pool resources or common property regimes along Salmon Creek. However, it seems like the beliefs, perceptions, and actions that emerge in these interviews are only distant kin to Ostrom's design principles. I found evidence of only two of her eight principles at work in the watershed in an informal manner. Those are, to match rules governing use of common goods to local needs and conditions, and to develop a system, carried out by community members, for monitoring resource use. The other six principles – to clearly define group boundaries, to ensure that people affected by the rules can participate in modifying them, to ensure outside authorities respect community members' rule-making rights, to use graduated sanctions against rule violators, to provide accessible, low-cost dispute resolution forums, and to build responsibility for governing the common resource in nested tiers from the lowest level up – are not evident in the material my method generated.

Institutions for managing ground and surface water may instead be emerging through a process of institutional bricolage, "the patching together of institutional arrangements from the cultural resources available to people in response to changing conditions" (Chase Smith *et al*., 2001, 42, cited in Cleaver and Franks, 2005, 4). Like bricoleurs, Salmon Creek residents already participate in some self-regulation in response to social pressure and a lived experience of scarcity; however, it is unclear whether residents would accept more regulation by peers via some form of collective governance. Groundwater is clearly seen as a common pool resource, but strategies to govern groundwater withdrawals are contested.

The monitoring and data sharing networks I found are seeds of commons governance institutions. The common resource at stake is not just a non-living fluid, but rather an animate substance that connects humans to other species. Governing this commons will need to consider all of these actors. Although not explicitly on the table, a collective governance structure could improve water reliability and ecological flows compared with the status quo (which lacks clear rules and procedures for monitoring and enforcing use) or government regulation (which is unwelcome politically, and unlikely given government funding shortfalls). Key questions remain – who would serve as the rulekeeper and which constitutional and distributional rules would need to be in place? – but it seems plausible that the small, close-knit community that lives in the watershed could grapple with them.

Conclusion: Field interviews as a method in water policy

Open-ended interviews with landowners and residents open a window onto understandings of local hydrology, daily water interactions, social norms that regulate use, and attitudes towards regulators. Together, the sit-down and field interviews can reveal residents' perceptions of *de facto* water governance regimes – whether water is considered a private good, common property resource, or public good – and identify consensus and dissent about which regime is in effect. Putting this approach into practice should probably involve assessment by an interviewer who is perceived as having no stake in local politics, as residents are unlikely to disclose rule-bending to regulators, and might tell funding agencies what they think they want to hear. Familiarity with local water practices is also important: knowing something about local aquifers and rainfall patterns, or knowing how to clean out a sediment trap on a rain tank system, can elicit rich details about local hydrology and people's daily interactions with water. More than mere observer, the well-informed researcher serves as a conduit for information between residents, scientists, and regulators who may never meet face-to-face, and may be asked to arbitrate between contested scientific and local ways of knowing.

What if living with scarce resources and some autonomy over use creates qualitatively different water use practices, compared to living with reliable Big Water supplies? Rain tanks provide the ability to adapt to fluctuations in municipal or borewell supply. In Salmon Creek, scarcity and proximity lead to greater interest in the source of household water, awareness of its interdependence with climate, ecological, and human factors, and concern for its continued integrity as both human resources and ecological habitat. One couple who recently retired in the watershed mobilized this awareness to argue that water and salmon should be managed in common, as follows:

Female householder: I do consider it a commons, but I don't think I'm in the majority in this community. People in this community respond more to a specific argument, like "The fish need it, we want the fish, we're going to go get them and eat them." I consider it a commons, don't you?

Woelfle-Erskine: I do

Male partner: I think there are two resources that need to be managed like that, and one of them is air quality, and the other one is water. Everything else – the mineral contents, the gold they find on your property – that seems to be built into our political system that it's yours. But . . .we're all using the same water and the same air. There has to be consensus and agreement on how to use them most effectively. People can't get greedy.

These and similar responses are evidence of an incipient discourse of water as a commons that is akin to Ostrom's (1990, 38) insight that "[t]he key fact of life for coappropriators is that they are tied together in a lattice of interdependence so long as they continue to share a single [common-pool resource]".. My interviews

uncovered several status-quo rules that govern *de facto* governance of groundwater and groundwater-fed streams, suggesting that collective governance in Salmon Creek is at an incipient stage: when people begin to consider scarce groundwater as a commons that should be managed collectively to sustain another common-pool resource, salmonid fishes. Residents' accounts of extreme scarcity and uncertainty in rainfall and water supply suggest that the watershed is akin to Ostrom's (1990, 59) cases in that "the harshness of these environments [functions] as a stimulus toward improvement…". Understanding local water supplies as commons shared by many species may increase residents' willingness to change their water practices and to intervene in others' wasteful use.

Decentralizing water governance and infrastructure involves more than a change in water management. The literature on decentralized water systems has underplayed these complexities to date. But unless people's relationships to their water sources change, a mere shift in infrastructure – be it rain tanks, greywater systems, or groundwater recharge schemes – is unlikely to conserve sufficient water to restore ecological flows. Further exploring the ways in which particular decentralization strategies shift social relationships around water should become an integral part of decentralized infrastructure planning, because new water relationships spur behavioural changes, and often motivate broader political engagement in water issues (Woelfle-Erskine, in press). In combination, decentralized infrastructure, heightened water awareness, new social water use norms, and political action could succeed in recovering salmon by creating new governance strategies that embody interspecies ethics of reciprocity and care.

The method I presented for investigating household water practices pair field interviews with theoretical frameworks of entanglement and intra-action. The method reveals social adaptations to scarcity and uncertain supply that arise in response to local climatic conditions and are conditioned by cultural preferences around washing and watering. These practices are not fixed (as water managers often assume), but shift in response to new knowledge about local water sources and changing perspectives on other species. In rural areas where people manage their own springs, wells, and rain tanks, autonomous water governance regimes regulated through social pressures may represent a sustainable alternative to state or local governmental regulation. Sofoulis (2014) argues in an Australian suburban context that this anarchic character of rain tanks governance increases their sustainability potential. Faced with mandatory water restrictions, many residents with rain tanks enthusiastically adopted other alternative infrastructures like greywater systems as a way to maintain gardens and to do their part for drought response (Sofoulis, 2014, 9-10). However, in several Australian cities water managers derided and discouraged these enthusiasms because they perceived residents' drought innovations as economically irrational (Sofoulis, 2014, 13-14). In contrast, the local Resource Conservation District that has funded and implemented Salmon Creek area rain tanks engaged personally with residents and ranchers in the rain tank pilot project and incorporated residents' design ideas into

second-phase tank installations. Neither the District nor the Bodega Water Company owns or maintain the tanks, and indeed required tank recipients to sign maintenance contracts. Rain tank owners connected to the BWC supply felt no responsibility for maintaining that system, but complete responsibility for their rain water supply.

Research that scales up from household water practices complements top-down hydrosocial analysis of water supply. It responds to Cleaver and Franks' (2005, 17) call for research that attends to "how people understand the relationship between themselves and the natural world, the socially embedded principles of decision-making on which they draw to manage their natural resources, and the effect of such processes on inclusion and access". The Baradian approach I have outlined here is useful because it brings entanglements of matter and meaning in household water practices to light, revealing differences between household water practices that are co-constituted by particular people, plants, animals, pumps, storms and streams.

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