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Contexts and Complexities

A Case Study in Evolving Participatory Watershed Stewardship

Victoria Chanse

ABSTRACT The actions of organizations and individuals shaped an evolving practice of participatory watershed stewardship of Contra Costa County, California, between 1980 and 2006. This study applies Stokols's (2006) transdisciplinary action research (TDAR) framework to examine how various organizational and volunteer dimensions of watershed stewardship emerged to shape watershed stewardship within the county. Cast from a TDAR perspective and based on participatory research, site visits, interviews, observations, and local watershed documents, this study demonstrates how organizations and individual volunteer practices evolved to manage watershed stewardship across multiple scales. Transdisciplinarity when applied to participatory watershed stewardship involves the generation of knowledge through four primary approaches: (1) participation, (2) collaboration, (3) management, and (4) physical signs of care and ownership. The physical results are the creation of riparian habitat landscapes shaped by local volunteers and watershed groups. Both governmental and nongovernmental organizations (NGOs) have developed multidimensional and transdisciplinary approaches to watershed stewardship by incorporating the ecological, physical, and social components across geographic scale.

KEYWORDS watershed planning, stormwater management, stewardship, volunteerism, urban creeks

INTRODUCTION

With roughly 4,000 small nongovernmental organizations (NGOs, for example, Friends of the Creek organizations) involved nationally in watershed management, stewardship efforts in urban watersheds have expanded from a few demonstration sites to thousands of local organizations (Schueler 2005). Between 1988 and 2003, water monitoring program organizations increased from 44 groups in 24 states to 832 groups in all 50 states (EPA 2003, cited in Schueler 2005; Riley 1998).

Concern for habitat fragmentation, stormwater management, water quality, and rapid development of urban environments continues to shape water management policies and stewardship practices in the United States in the 21st century (Booth 2005; Thorud et al. 2000). The dimensions of watershed stewardship are inherently complex because they include overlapping political and geographic boundaries, community involvement, planning, management, volunteerism, and diverse technical issues. Understanding how these

factors combine to shape watershed stewardship is useful in clarifying how stewardship evolved in the face of this increased complexity. This research applies Stokols's (2006) transdisciplinary action research (TDAR) framework to assess how these integrated factors together shape watershed stewardship in Contra Costa County, California, over a 26-year span.

The name *Contra Costa* means "opposite coast" in Spanish and refers to Contra Costa County's physical relationship to the city of San Francisco. Established in 1850, Contra Costa County is one of the original counties of California. Located east of San Francisco, Contra Costa County and Alameda County constitute the East Bay of the nine-county San Francisco Bay Area. Alameda County serves as Contra Costa County's western and southern border, and San Joaquin County bounds Contra Costa to the east. Suisun Bay and San Pablo Bay serve as the county's northern border. Approximately 950,000 people live in the county's 43 municipalities and towns. Of the 802 square miles in Contra Costa County, 25 percent are water. Most of the county's 31 watersheds run from the East Bay Hills, which contain East Bay Municipal Utility District lands, ranchlands, and East Bay Regional Park lands, to the San Francisco Bay, though some watersheds drain to the Suisun and San Pablo Bays. The watersheds vary in size from 1,322 to 405,120 acres (Figure 1).

This case study of the emergence of participatory watershed stewardship in Contra Costa County examines how the concurrent influences of governmental agencies, nonprofit organizations, and volunteerism altered the process of watershed stewardship. Volunteer efforts to care for individual urban creeks, NGO efforts to steward watersheds, and the effects of changing relationships among the activities of individuals, groups, and governmental agencies have all reshaped watershed management in the county. This paper presents, in four sections, a TDAR framework addressing watershed stewardship, case study design, case study findings, and the implications for research and practice.

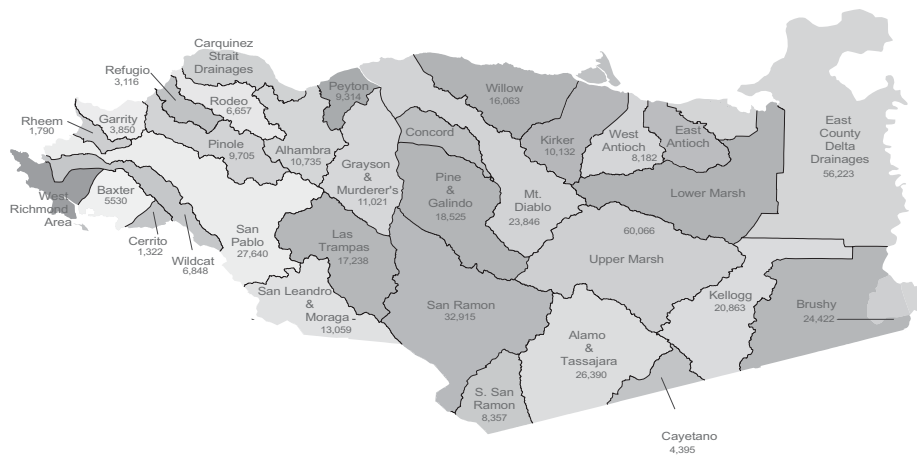
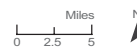


Figure 1. Costa Watershed Forum watershed map. (Courtesy Ryan Yonce, derived from Contra Costa County watershed map).



STEWARDSHIP COMPONENTS WITHIN A TRANSDISCIPLINARY ACTION RESEARCH FRAMEWORK

An examination of the literature related to the changing approaches and concepts of watershed stewardship establishes the components of participatory watershed stewardship. The review then examines Stokols's (2006) conceptualization of transdisciplinary action research. A discussion of the organizational scope of the TDAR framework considers the behavioral motivations and perceptions of individuals, groups, and agencies of volunteerism and stewardship management. Consideration of the TDAR concept of analytic scope includes discussion about the relationships of the biophysical dimensions of aquatic habitat restoration and watershed stewardship. A discussion of geographic scale considers the issues of stewardship across watershed and political boundaries.

Concepts of Stewardship

Stewardship may imply land conservation (Luccarelli 1995; Ndubisi 2002; Steiner, Young, and Zube 1988) activities related to watershed management (Hall 1996; Riley 1998), the management of private working landscapes for sustained yields (Scarfo 1988; Wunderlich 2004), urban greening projects, a land ethic (Leopold 1968), and restoration (Berger 1990; Riley 1998). The multivalence of its implications reflects the three meanings of *stewardship*:

1. An ethic that stresses healthy natural resources (Leopold 1968; Scarfo 1988; Selman 2004; Wunderlich 2004)

2. An approach to restoring and protecting land through design, planning, and involvement (Van der Ryn and Cowan 1996)

3. An outcome in terms of ecological health, wildlife habitat, and sustained yields (Berger 1990; Scarfo 1988; Selman 2004; Spirn 1984; Wunderlich 2004).

The practice of stewardship is closely associated with the third definition, that of stewardship resulting in a particular outcome in the landscape. Yet outcomes of stewardship in urbanized areas are difficult to scientifically assess given that many volunteer projects lack the capacity, in terms of volunteer hours, to document a scientific baseline of conditions for vegetation, habitat, and water quality before the implementation of stewardship projects. Qualitatively, outcomes of stewardship may be assessed through an examination of project types, activities, and changes in the built environment.

In urban areas, however, stewardship approaches are easier to characterize than outcomes. Contemporary urban stream restoration efforts are comparable to various urban neighborhoods' efforts to plant trees in inner cities in the 1970s and 1980s (Riley 1998). Such site-based stewardship is growing in popularity, providing local opportunities to involve residents in caretaking, which until recently existed only in nonurban areas (Chanse and Hester 2003; Chanse and Yang 2005; Mazingo 2005). In urban areas, *stewardship* is frequently used to describe efforts to rehabilitate and manage urban nature, including city creeks, naturalized open spaces, pocket parks, waterfronts, and greenways.

Growth of volunteer-driven stewardship. The shift from private land stewardship to volunteer-driven restoration programs highlights the expanded role of NGOs in watershed stewardship and a shift in organizational approach to stewardship. This approach works with, and to some extent manages, volunteers in stewardship practices. In urbanized areas, growing citizen involvement in a participatory model promoted by NGOs now characterizes the practice of stewardship. The management of large-scale areas, such as parks and waterfronts, is beyond the scope of the city staff, so volunteers play an important role in restoration and management. Volunteers remove exotic plants, install native plants, collect seeds, and propagate beneficial species. These volunteer activities reconnect participants with the ecology of a place while enhancing its wildlife habitats. The NGOs and the governmental organizations tend to shape stewardship by organizing stewardship activities and by providing technical support for local creek groups.

With the growing urbanization of watersheds and newer approaches of bioregional thinking and watershed planning, agencies adapting stewardship strategies now drive the practice of watershed management (Riley 1998; Wunderlich 2004). Communities have begun to develop new watershed restoration and alternative land management approaches to combat the challenges of issues from stormwater runoff to non-point source pollution (Schueler 2005; Selman 2004). Urban environmental stewardship blends management approaches with the goals of governmental agencies, the private sector, and civil society (Svendsen and Campbell 2008). The development of collaborations allowing participants to engage with local projects and shape their own goals tends to complement the quest for technical solutions in managing urbanized watershed issues (Shandas and Messer 2008).

Motivation for individual stewardship. In addition to agency involvement, individual participation is important to effective watershed stewardship. Research on volunteerism and watershed collaboration has

identified motivational factors contributing to stakeholder engagement. Earlier research on environmental stewardship focused on the motivation of volunteers to attach psychologically to place, on the organizational aspects of stewardship programs (Donald 1997; Grese et al. 2000; Nassauer 1993, 1995), and on improving nearby nature (Grese et al. 2000; Ryan, Kaplan, and Grese 2001). Research also suggests that reconnecting with the land and nature (Kaplan, Kaplan, and Ryan 1998; Nassauer 1993, 1995; Selman 2004), fighting environmental anomie, and doing something physical in response to current environmental problems (Gobster, Stewart, and Bengston 2004; Hester 2006; Ryan, Kaplan, and Grese 2001) are important motivators for initial engagement. Long-term volunteerism, however, must be sustained by opportunities to pursue specific activities (for example, hands-on involvement in planting riparian habitat) (Grese, et al. 2000; Ryan, Kaplan, and Grese 2001). What remains unknown is how initial stakeholder engagement motivation and the long-term benefits of volunteer engagement affect the development of watershed stewardship approaches.

Applying TDAR to Watershed Stewardship Research

Transdisciplinary action research (TDAR) is useful to the study of watershed stewardship for several reasons. TDAR suggests a research approach that places equal emphases on the complementary agenda of community enhancement and research objectives (Christens and Perkins 2008; Stokols 2006). Action research tends to create exchanges of information between participants and researchers that are beneficial to practice (Christens and Perkins 2008, 223; Thering 2009). This type of research approach encourages mutual learning (Saeger 1993, cited in Christens and Perkins 2008, 224; Stokols 2006), part of which occurs through knowledge dissemination among stakeholders (Stokols 2006). Within the context of watershed stewardship, an applied TDAR framework provides a way to understand the role of the various motivations of organizations cultivating volunteerism in the context of activities with a heritage of being run by volunteers. Previous research on watershed

stewardship has focused on particular facets—organization, motivations, activities, and values (Donald 1997; Grese et al. 2000; Nassauer 1993, 1995; Ryan, Kaplan, and Grese 2001)—rather than on comprehensive, transdisciplinary studies that elucidate the evolution of watershed stewardship as ethic, practice, and physical outcome in the landscape.

The determination of how the combination of individual watershed stewardship approaches, collaborations, and planning efforts shaped stewardship practices in Contra Costa County was challenged by the broad array of involved stakeholders, watersheds, sites and planning approaches. TDAR overcomes this challenge by offering a framework for examining the multiple dimensions of organizational scope (for example, the varying volunteerism interests/motivations of individuals, groups, and government agencies), working across geographic scale (the spatial distribution of organizations and management responsibility across watersheds), and examining multiple analytic scopes (the biophysical dimensions of aquatic habitat restoration) as a part of watershed stewardship.

RESEARCH DESIGN AND METHODS

Scale and Case Study Selection

Friends of the Creek NGOs often drive urban watershed stewardship activities. Assessing the emergence of urban watershed stewardship in Contra Costa County, however, required looking across several different geographic scales. Watershed stewardship occurs not only across various scales but also across various sectors and components of organizational scope. What happens at one organizational level or geographic scale affects projects, physical landscapes, and watersheds at other scales and organizational scopes. The particular scales addressed in this study are, from smallest to largest: project/site, creek (immediate in-stream and riparian), watershed, county, and San Francisco Bay.

The scale of municipalities in Contra Costa County renders them too small a geographic unit for examining

watershed stewardship organizational schema; many creeks in the East Bay area run through several incorporated and unincorporated areas. The scale of individual creek reach is also too small given the emergence of watershed stewardship. The county is an appropriate scale of analysis for four reasons:

1. The Contra Costa County Watershed Forum coordinates Friends of the Creek watershed stewardship activities across diverse scales and watersheds.
2. More geographic data are available at the scale of the county.
3. The Contra Costa County Flood Control District and the County Community Development Department maintain geographic information and water quality data for each of the 31 watersheds in the county.
4. Innovative aspects of Contra Costa County's Watershed Forum¹ approaches to coordinating efforts and knowledge dissemination among the various local Friends of the Creek groups within the county.

Case Study Methods

Examining the development of watershed stewardship in Contra Costa County required an exploratory case study approach to assess outcomes and their effects on watershed stewardship (Flyvbjerg 2001, 2006; Francis 2001; Schneider and Cheslock 2003; Yin 2003). The case study approach is particularly appropriate for studying the context-sensitive and practical knowledge that is often the subject of research in the planning and design fields (Flyvbjerg 2001).

This exploratory case study involved several phases of research. The initial phase of the case study included: (a) developing a conceptual framework of stewardship; (b) understanding the context of watershed and creek-based stewardship including funding, structure and approaches; and (c) gaining entrée to the watershed stewardship context in Contra Costa County. Primary research methods used in gathering data for analysis

Table 1. Chronology of Watershed Organizational Development

Time period	Type of organization			Total groups
	Regional Creek nonprofit advocacy and technical groups	Friends of the Creek groups	Watershed forum	
1980–1984	1	0	0	1
1985–1989	1	0	0	2
1990–1994	0	2	0	4
1995–1999	1	4	0	9
2000–2006	0	8	1	18
TOTAL	3	14	1	18

Note: The number of Friends of the Creek Groups (14) is not equivalent to the number of creeks physically adopted (18) as represented in Table 2 because some of these groups adopted more than one creek.

included: (a) conducting semi-structured interviews with volunteers, staffpersons, and other stakeholders; (b) visiting sites across the county's watersheds; (c) attending meetings of the Contra Costa County Watershed Forum (CCC-WF), San Francisco Bay Joint Venture Creeks Committee, regional watershed conferences and local creek planning charrettes; (d) volunteering with different local creek groups; (e) analyzing local creek watershed planning documents and memoranda; and (f) compiling and analyzing geographic data. Secondary source documents include newspaper and magazine articles as well as local watershed stewardship reports.

FINDINGS

Watershed stewardship in Contra Costa County emerged in several distinct stages, which have become increasingly more complex in terms of approach and scale. The composition of stakeholders involved in watershed stewardship of Contra Costa County has also become more diverse. Watershed stewardship approaches now include activities of regional nonprofit advocacy and technical organizations, individual volunteer groups, and countywide integrated and cohesive approaches. Watershed stewardship organizations working in conjunction with volunteer involvement shaped participatory landscapes² and created an effective ability to work across county, city, regional, and local watershed scales. The remainder of this section discusses four sets of findings:

1. The chronology of watershed stewardship organization development (Tables 1 and 2)
2. Stages of evolution of organizations as watershed stewards (Table 3)

3. Approaches and activities occurring in each evolutionary stage (Table 3)

4. Physical outcomes in the landscape (Table 3)

Chronology of Stewardship Organization Development

Tables 1 and 2 document the chronology of organizational development and approaches to watershed stewardship in the county. Between 1980 and 2006, changes in the total number of watershed organizations occurred in one period of small growth and two periods of larger growth. Between 1980 and 1994, the total number of watershed groups increased from one to four. In contrast, during the period from 1995 and 1999, six new groups were established, and between 2000 and 2006, nine new groups came into existence.

Based on scale, approaches, and funding, the identity of the groups fell into three basic categories:

1. Regional creek nonprofit advocacy and technical groups
2. Local volunteer watershed groups that are associated with specific creeks
3. Governmental agencies created to coordinate activity among the various groups (Table 1)³

Between 1980 and 2006, a total of 14 Friends of the Creek organizations adopted 21 watersheds in Contra Costa County. Over the 26-year period, watershed stewardship organizations in Contra Costa County increased in number and complexity. Watershed stewardship organizations have increased in number from 1 regional creek nonprofit advocacy and technical group in the early 1980s to 18 in 2000, and they now include 3

Table 2. Evolution of Local Friends of the Creek Groups in Contra Costa County

Year established	Name of group	Adopted Watershed(s)
1991	Friends of Alhambra Creek	Alhambra Creek
1994	Friends of the Creeks	Walnut Creek and smaller tributaries
1995	Friends of San Leandro Creek	San Leandro Creek
1996	Friends of Five Creeks	Codornices Creek Cerrito Creek Blackberry Creek Marin Creek Village Creek Schoolhouse Creek
1997	Friends of Baxter Creek	Baxter Creek Steger Creek
1999	Friends of Lafayette Creeks	City scale: Watersheds within the city of Lafayette
2000	San Pablo Watershed Neighbors Education and Restoration Society	San Pablo Creek
2001	Friends of Garrity Creek	Garrity Creek
2001	Friends of Kirker Creek	Kirker Creek
2001	Friends of Pinole Creek Watershed	Pinole Creek
2002	Refugio and Rodeo Watersheds Group	Refugio Creek Rodeo Creek
2003	Friends of Pleasant Hill Creeks	City scale: Watersheds within the city of Pleasant Hill
2004	Friends of Marsh Creek	Marsh Creek
2004	Friends of Mount Diablo Creek	Mount Diablo Creek

Note: The number of Friends of the Creek Groups (14) is not equivalent to the number of creeks and watersheds physically adopted (21) represented in Table 2 because some of these groups adopted more than one creek. Other Friends of the Creek groups may have also formed after 2006.

nonprofit groups, 14 Friends of the Creek groups, and a countywide forum.

A subtle shift in the geographic pattern of watershed adoption by Friends of the Creek groups occurred from 1990 to 2000. Between 1980 and 1994, Friends of the Creek groups adopted watersheds in the developed and urbanized areas (for example, Alhambra Creek in Martinez, the affluent area of Walnut Creek). Between 2000 and 2006, these groups adopted watersheds in the more rural, less densely populated areas of the county.

Evolution of Organizations as Watershed Stewards

Based on scale, approach, and funding, the groups fell into three basic categories:

1. Regional nonprofit groups
2. Local volunteer watershed groups associated with specific creeks
3. Governmental agencies (Table 1)

Two of the three technical watershed nonprofits groups came into existence before the establishment of

any of the local Friends of the Creek groups in the 1980s. The largest growth period was during the years 2000–2006, when eight Friends of the Creek groups were established in Contra Costa County, as is observed in the Timeline of Local Creek Groups (Table 2).

Table 3 suggests that in addition to a magnitude of change in the number of watershed organizations between 1980 and 2006, the types of organizations, approaches, and physical outcomes in the landscape have become increasingly more complex. During the 1980s and 1990s, the regional creek nonprofit advocacy and technical group efforts focused attention on alternative flood control measures and some community organizing against traditional flood control measures (Mozingo 2005; Riley 1998; Schwartz 2000). Annual creek clean-ups, with increased involvement from regional groups, were prominent in the mid-1990s. County-level coordination enabled local Friends of the Creek groups to work with the Contra Costa County Department of Conservation and Development (CCC–CDD) and Flood Control District to map the local creeks. Local watershed plans began to develop in the late 1990s.

Table 3. Approaches, landscape outcomes, and scale of watershed stewardship organizational stages

Time period	Stage	Approaches	Nonprofit/Volunteer/ Governmental landscape outcomes	Scale(s)
1982–2006	Regional creek nonprofit advocacy and technical groups	Alternative flood control measures Environmental justice Creek education Habitat site stewardship	Implementation of watershed management structures to control floods Provide public access and create civic space Improved creek visibility Stenciling of water-quality implications onto storm drains	Creeks in the City of Richmond, then expanded to East Bay creeks
1990–2006	Local Friends of the Creek groups	Local watershed organizations adopted nomenclature of Friends of the Creek about 2001. Site stewardship Watershed planning efforts	Improved physical creek accessibility through removal of invasive plant species and trash Establishment of riparian plantings Creation and restoration of habitat sites Maintenance of riparian sites	Local watershed
2000–2006	County-level administration	Countywide awareness Contra Costa County watershed calendar Volunteer-organized mapping of county creeks Volunteer-organized water quality testing Production of county watershed atlas Generation of GIS and water quality data Continuing bi-monthly meetings of local watershed groups organized by the county government	Watershed signage across the county Creation of gateway projects to connect civic space with the creeks	Integration of efforts of local watershed groups across the county Shared knowledge/technology across the creek groups in the county

Note: Whereas the time periods presented in Table 1 illustrate the chronology of the organization of watershed stewardship groups, the time periods presented in this table illustrate the evolution of stewardship approaches in Contra Costa County.

Evolving Approaches and Activities

Table 3 also suggests that the approaches and activities to stewardship pursued by each stage of watershed organization were, in many respects, more similar to than different from one another. They did vary in the geographic scale of their interests. During the first phase, the technical nonprofits focused on particular creeks, such as the emphasis of the Urban Creeks Council of California (UCCC) on Wildcat Creek in the 1980s, in addressing environmental injustice and developing alternative flood control measures. During the second phase,

Friends of the Creek organizations adopted entire watersheds. Various Friends of the Creek groups adopted 21 creeks. A larger number of creeks received attention through site-level stewardship approaches (removing invasive plants, restoring riparian habitat sites, and creek cleanups). Many of the local Friends of the Creek groups shaped the site scale programs for creating non-structural approaches to wildlife and riparian habitat enhancement projects. The third period witnessed the evolution of county-level coordination of knowledge and events within a formal organizational structure to



Figure 2. Volunteer riparian plantings along Cerrito Creek (Courtesy the author).

integrate the specific foci of individual nonprofit and Friends organizations.

Physical Outcomes in the Landscape

Stewardship activities produced various physical outcomes in the landscape. These outcomes occurred in two phases. The first phase of stewardship approaches involved removing trash from the creeks, fighting traditional flood control measures on Wildcat Creek, daylighting Strawberry Creek⁴ in 1984, and stenciling the words “Don’t dump, drains to bay” near storm drains (Mozingo 2005; Riley 1998; Schwartz 2000). The second phase of physical outcomes emphasized distinct watersheds as the Friends of the Creeks groups emerged. In Contra Costa County, the emerging phenomenon of watershed identity took on a new form with the appearance of watershed signage for the various watersheds. Individual watershed organizations often developed their own systems of signage. Driving the second phase were greater involvement and funding from the Contra Costa County Resources Conservation District (CCD-

RCD), the National Heritage Institute (NHI), and The Watershed Project (TWP). Between 2000 and 2005, each of these groups (CCD-RCD, NHI, and TWP) had one staff member involved in planning meetings and activities for Friends of the Watershed groups. Such groups adopted eight watersheds between 2000 and 2006. Many were able during this period to work with a designated staff member from the CCD-RCD, NHI, or TWP.

From the late 1990s, local watershed groups and other organizations created a sense of stewardship through volunteer activities, with volunteers playing a growing role in site stewardship for enhancing riparian habitats and creating volunteer landscapes. Through implementation of site-based initiatives, the habitat projects increased the knowledge of local volunteers and increased visible access to the creeks by creating cues to care (Nassauer 1997) and signs of ownership (Rose 1994). Established and adopted by volunteers, the landscapes (see plantings established by volunteers in Figure 2 and path defined by native California plantings in Figure 3) were primarily nonstructural projects. Creation of these volunteer landscapes involved riparian restoration efforts to increase native habitat, remove ivy and overgrown invasive plants, and establish paths to provide visible and physical access to creeks.

Physical changes in the landscape enhanced the awareness of watershed identity. With the advent of Friends of the Creek groups, the activities of local creek volunteers—the posting of “drains to bay” signs on storm drains and the mapping of watersheds—has enhanced overall watershed awareness and created a more distinct identity for each creek. Furthermore, the sense of scale has become more complex in that the projects began to address water quality at several different scales. Signs (Figure 4) emphasize connections between the local watershed and ecology and the San Francisco Bay and proclaim shared ownership of the waters and watersheds by stating, “Ours to Protect.” As of 2006, more than 300 watershed signs exist across the county.

Figure 3. Path and plantings along Alhambra Creek created by volunteers (Courtesy the author).



Thematically, stewardship approaches produced six categories of landscape outcomes between 2000 and 2006:

1. Paths to enhance public access
2. Environmental education sites to inform watershed residents and enhance watershed identity
3. Removal of invasive plants and/or trash
4. Riparian habitat creation and enhancement
5. Posted signs to enhance watershed identity and visibility at the county scale
6. Creek-oriented civic spaces symbolizing signs of shared ownership and care within the various watersheds

Among the various projects creating these outcomes, 67 percent involved habitat restoration or enhancement, 31 percent involved construction of paths, and 2 percent involved land acquisition (Contra Costa County 2003; site visits).⁵ Watershed stewardship projects in Contra Costa County now focus more on land acquisition. As evidenced by visible downtown projects along Alhambra Creek in downtown Martinez and the El Cerrito del Norte Bay Area Rapid Transit Station for the Baxter Creek Gateway Project, many of these have integrated the provision of watershed stewardship infrastructure with the creation of civic space.

IMPLICATIONS FOR THEORY AND PRACTICE

Transdisciplinary action research must use various levels of analysis to consider various contexts of a phenomenon. It must be sensitive to the context of change over time and the multidisciplinary dimensions involved (Christens and Perkins (2008). The analytical framework for watershed stewardship presented here addresses a gap in the methods for analysis of complex transdisciplinary, multiscale, landscape projects and informs practice across hierarchically nested geographic scales. Understanding how watershed stewardship approaches develop over time and how they generate new knowledge and new processes to produce a succession of diverse physical outcomes in the landscapes requires application of a TDAR methodology to integrate evolving phenomena, contexts, and scales.

Watershed stewardship in Contra Costa County evolved in ways that addressed the inter- and intrascale approaches to knowledge dissemination among the local creek groups via the watershed forum, riparian habitat restoration and care, and creation of watershed identity. These approaches to watershed stewardship also grew increasingly sophisticated as Friends of the Creek organizations developed the skill levels of their volunteers. What began as trash cleanup and removal of invasive plant species blocking physical and visual creek accessibility developed into water quality testing,



Figure 4. Alhambra watershed sign
(Courtesy the author).

the planting of riparian plants along the creek banks, and the mapping of creeks (Table 3). Use of the TDAR framework created a more comprehensive understanding of the development and dissemination of shared knowledge among the 18 organizations. Applying the transdisciplinary action framework to watershed stewardship helped answer the question of which factors together shaped watershed stewardship—and how.

As watershed organizations and the volunteer practices managed by these organizations continue to shape increasingly sophisticated approaches across scales, the county-level approach to watershed forums may prove a model for disseminating volunteer practices across Friends of the Creek organizations in other areas. Establishing the replicability of these findings in regard to the role of watershed stewardship context and approaches to producing and disseminating knowledge, establishing similar levels of watershed identity, and creating similar types of physical projects in the landscape, however will require additional research. Ideally, such research will occur in other areas with large watershed bodies managed by multiple governmental jurisdictions in concert with volunteer creek groups and technical nonprofit organizations.

NOTES

1. During the time of this research, the CCC-WF was well established (founded 2000). In early 2006, a similar effort, the

Alameda County Watershed Forum, was conducted in an adjacent county of the East Bay.

2. The author defines participatory volunteer landscapes as the landscapes created and cared for by volunteers. In the context of this study, participatory volunteer landscapes were created through the removal of invasive plants, the clearing of trash, and the planting of riparian vegetation along the banks of the creeks.
3. This chronology does not include governmental institutions such as the Contra Costa County Resource Conservation District (RCD) and municipalities such as the City of El Cerrito involved in watershed management because they were not originally created for the purposes of watershed stewardship or because they were created outside the time frame of this research. Although not included in the chronology, RCD and the municipalities play a key role in working with the other organizations to manage watershed stewardship.
4. Strawberry Creek is located in Alameda, not Contra Costa County, but it is included here to characterize the earlier approaches to creeks in the East Bay.
5. These percentages do not include the 300-odd signs put up in the county.

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