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Cerrito Creek step-pools: An opportunity for restoration and education at Blake Garden

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Cerrito Creek Step-Pools: An Opportunity for Restoration and Education at Blake Garden

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Abstract

The focus of this proposal is to examine relevant creek restoration research and existing restoration projects and to apply the resulting knowledge to the specific conditions at Blake Garden to develop a conceptual model for the restoration of this section of Cerrito Creek. This proposal builds on goals and data that were compiled as part of a prior student restoration proposal. A literature review, case studies, interviews and a site survey provide data about the restoration of similar creeks, future visions for Cerrito Creek and existing creek conditions. Based on the compiled data, a system of step pools is recommended to restore channel stability in this reach of the creek. Channel geometry is based on a restoration model with similar characteristics, Baxter Creek in Pointsett Park. Step pool geometry is determined using a ratio between step height, length and channel slope. Channel visibility and physical access are revealed as important aesthetic concerns. Recommendations are summarized in a conceptual design proposal that integrates the restoration objectives with the existing site conditions.

Introduction

The reach of Cerrito Creek in Blake Garden presents a unique opportunity for creek restoration in an urban context. Unlike most stretches of creeks in the East Bay, this reach of Cerrito Creek is above ground and largely unconstrained by nearby structures. Additionally, because of its location on property owned by the University of California it has potential to serve as an amenity for the general public, local schools groups and university students. Until recently, the creek has been largely obscured and inaccessible due to overgrowth of invasive Himalayan blackberry. The subsequent vegetation removal has revealed incised banks that are unprotected and subject to erosion (Ludy and Podalak 2007). The focus of this proposal is to examine relevant creek restoration research and existing restoration projects and to apply the resulting knowledge to the specific conditions at Blake Garden to develop a conceptual model for the restoration of this section of Cerrito Creek.

This proposal was based directly on a 2007 study by Jessica Ludy and Kristen Podalak. They identified incision and bank erosion as primary concerns for this reach of Cerrito creek and stated upstream urbanization and removal of bankside vegetation as probable causes. Additionally, their report identified creek accessibility and visibility as important restoration considerations. Their goal of integrating bank stabilization with enhanced creek aesthetics, visitor experience and educational opportunities became the overarching framework for my proposal. Finally, my proposal drew on the data that they collected, particularly their survey information.

Background Information

Cerrito Creek, located in Contra Costa and Alameda Counties, drains a 2200 acre catchment flowing west from its origins the East Bay Hills approximately 2.5 miles to its mouth in San Francisco Bay (Figure 1). The Blake Garden reach is located in the steep, bedrock controlled headwaters of the catchment (Ludy and Podalak 2007). Single-family residential housing is the dominant land use in the watershed and the estimated percent of impervious surface is 65% (Contra Costa County 2004).

Blake Garden is a ten-acre garden that was deeded to the University of California for use as an educational resource by the Blake family in 1962. It is operated by the department of Landscape Architecture and Environmental Planning and it has served teaching resource since 1957 (Blake Garden: A History of Landscape Change. 2006). It is open to the public during weekdays.

Methods

<u>Literature Review:</u> I conducted a brief review of the literature concerning the restoration of steep stream reaches and the use of drop structures in step-pool systems. I reviewed a 2008 paper by Anne Chin and others, *Linking Theory and Practice for Restoration of Step-Pool Streams*, a 2006 paper by Anne Chin and Jonothan Phillips, *The Self-Organization of Step-Pools in Mountain Streams* and a 2002 paper by Mario Aristide Lenzi, *Stream Bed Stabilization Using Boulder Check Dams that Mimic Step-Pool Morphology Features in Northern Italy*.

Case Studies: I investigated three existing restoration projects in the San Francisco Bay Region that utilized drop structures or step-pools: Strawberry Creek on the University of California, Berkeley campus, East Alamo Creek at the Windemere subdivision in San Ramon, CA and Baxter Creek in Pointsett Park in El Cerrito, CA. My research included reviews of plan documents, reviews of post project appraisals and informal site investigations to assess the social and aesthetic function of the projects.

Because of its close proximity to Cerrito Creek, I studied Baxter Creek more thoroughly. I based comparisons of the respective catchments on analysis of topography maps and information compiled by Contra Costa County. I also studied channel geometry by reviewing restoration reports and by comparing cross sections and long profiles.

Interviews: In order to further my understanding of the history, future goals and mission of Blake Garden I conducted interviews with the garden director, Linda Jewell and the garden manager, Lauri Twitchell.

Site Survey and Mapping: The survey methods that I used built directly on those established by Ludy and Podalak. I surveyed the long profile and three cross sections using a manual level, stadia rod and two 300' tapes. I used a benchmark elevation at the upstream edge of the road culvert as a starting point and to register with the 2007 Ludy and Podalak survey. Stable monuments were mapped to locate cross sections for future surveys. In addition, I measured the planform of the creek channel and the locations of adjacent trees.

Results

Literature Review: The 2008 paper by Anne Chin stated that step pools are becoming an increasingly common method for restoring steep stream reaches but that there needs to be more monitoring of restoration results. Lenzi cited potential improvements to habitat and aesthetics as reasons for the popularity of step pools. The 2008 Chin paper revealed that a relationship between channel slope and step pool frequency and height is largely accepted within the stream restoration community. This is expressed as the ratio of the step height to the step length to the channel slope. This ratio of (H/L)/S is generally between one and two.

Strawberry Creek Case Study: The restoration of Strawberry Creek has continued incrementally since 1987 and has goals of restoring ecological integrity and promoting research and teaching (Charbonneau and Resh 1992). During the course of my studies at UC Berkeley I have observed that the creek is central to outdoor life on campus. People routinely engage the creek via built elements including bridges, shallow banks, amphitheaters, benches, seat walls and stepping-stones.

East Alamo Creek Case Study: This restoration project was carried out in 2001 includes a sequence of step pools on one of the steeper reaches to prevent channel erosion (Adair and Perraso 2006). The dimensions of the design follows the formula (H/L)/S=2 and were built larger than required in order to compensate for future urbanization (Chin and others 2008). During my site visit, I observed healthy riparian vegetation and a relatively complex channel.

Baxter Creek Case Study: A reach of Baxter Creek located in Pointsett Park was daylighted in 1996. The original step pool geometry proved to be unstable, and reorganized itself naturally after several storms. The resulting channel appears to be stable and it now follows the ratio of (H/L)/S=1.1 (Chin and others 2008). During my site visits, I observed dense riparian vegetation and a moderately complex channel. The density of the vegetation largely obscures creek visibility and prevents physical access.

Baxter Creek and Cerrito Creel have similar catchment areas, 2465 acres and 2245 acres respectively (Figure 2). They are located within two miles of each other in the East Bay Hills and both drain land that is predominantly covered with single family residential housing (Contra Costa County 2004). Of the two reaches under study, Baxter Creek in Pointsett park is likely to have flows with higher energy as it drains a 25% larger catchment and it flows at an 8% slope versus the 6% of Cerrito Creek. However, cross sections reveal that the Cerrito Creek channel is more deeply incised (Figure 3).

Interviews: Linda Jewell and Lauri Twitchell both discussed plans to redevelop the area of the garden along the creek. They expressed a desire to build a path along the creek that would serve as the main pedestrian entrance into the garden. Additionally, Lauri Twitchell discussed long-term plans to relocate the storage sheds that are currently adjacent to the creek (north of the green house). Linda Jewell stressed the educational importance of the creek specifically mentioning opportunities to monitor the creek and post results of projects or storm impacts.

Mapping and Surveys: Long profile measurements determined the length of the restoration reach to be 220 feet with a vertical drop of 12.8 feet and an average slope of 0.058 (Figure 4). Cross sections and planform measurements were used to create a compilation map to quantify the spatial relationships among the various site features (Figures 5,6).

Because of vegetation clearing efforts, the creek is readily visible from the pedestrian entrance and the cut flower garden. Near the road its view is obscured by the storage sheds. There are no existing landscape features that encourage engagement with the creek. Due to steep, incised banks, it is very challenging for an able bodied person to access the water. There is an existing footbridge across the creek, however its deteriorated condition prevents visitors from using it.

An additional unanticipated condition was observed and recorded. As a result of unknown causes, a significant portion of the creek flow has routed into a channel that passes into the neighboring property before re-entering the main channel north of the greenhouse (Figure 6). Due to the heavy cover of Himalayan blackberry, it was not possible to determine this channel's exact configuration.

Conclusions

<u>Channel Stability:</u> Because much of Cerrito Creek is channelized, it is unlikely that it will support extensive aquatic habitat in the near future. Thus, the primary reasons for establishing a system of step pools in Blake Garden are aesthetic and educational considerations. Because of the educational mission of Blake Garden, there is significant opportunity for ongoing monitoring of this project and to increase knowledge about a restoration method that is gaining prominence.

The relative stability of the Baxter and Alamo Creek restorations indicate that the step pool ratio as described above ($1<(L/H)/S>2$) is applicable in this region. The comparison of Cerrito Creek with Baxter Creek reveals that the restoration of Baxter Creek in Pointsett Park is an appropriate model for a restoration of Cerrito Creek at Blake Garden.

This proposal is based on the assumption that the present channel migration into the neighboring property is an undesirable condition and it will be corrected when blackberry removal is completed and before any major creek restoration work.

Creek Visibility: Interviews with the garden manager and director revealed that it is desirable to maintain open views to the creek. The Alamo and Baxter Creek case studies are limited models in this regard as they are both heavily vegetated and channel visibility is low. In the case of Baxter Creek, it is likely that the dense vegetation lining the channel plays a significant role in maintaining that channel's stability. Thus, a model for Cerrito Creek in Blake Garden will need to balance the channel stability provided by vegetation with the desire for open views.

Physical Access: Interviews with the garden manager and director indicated a desire to integrate the creek into the educational and aesthetic missions of Blake Garden. Implicit in this is a desire for increased physical access to the creek. A pedestrian path and relocation of the storage sheds were cited as opportunities to achieve this. The Strawberry Creek case study provided additional insight about how design features can facilitate physical proximity to a creek in an educational setting.

Recommendations

Channel Stability: Due to ongoing channel incision and bank erosion I recommend to regrade the creek banks. The proposed grading is designed to accommodate flows with a widened channel (Figures 7,8,9). Channel dimensions of six feet wide by one foot deep were based on the Baxter Creek precedent. A system of step pools is proposed based on an average slope of 0.055 and the step-pool ratio from Baxter Creek where $(H/L)/S=1.1$. The resulting series of pools are approximately one foot in height and are spaced approximately 16 feet apart (Figures 7,9).

Creek Visibility: In order to maintain the creek's visibility I propose to limit dense riparian vegetation to the section of the creek upstream of the redwood trees and to the left bank. In other areas I propose planting widely spaced trees and recommend that their trunks are kept clear of foliage that would obscure views of the creek (Figure 10).

Physical Access: I propose a path along the creek connecting the interior of the garden to the pedestrian entrance. To accommodate the topography, I recommend grading a wheelchair accessible path that is integrated into the geometry of the cut flower garden and a stairway that leads directly to the creekside path. I propose a pedestrian bridge to join the two sides of the creek. I envision this feature as a connection to the formal geometry of the garden and as the focal point of the view from the pedestrian gate. As a terminus to the path that the bridge serves, I propose a bankside seating area under the mature redwood trees. In order allow access to the water, I propose to grade one of the banks at twelve percent and to install stone paving and stepping-stones to minimize erosion. Finally, I recommend relocating the two storage sheds to enhance of creek access and to enlarge the existing creative area under the large coast live oak trees (Figures 10, 11).

Future Study: I recommend a thorough study of step pool anchoring and construction prior to commencing any restoration efforts. Such a study should include a survey of soil and geological conditions, hydrological modeling and calculation of sheer stresses and their affect on the step pool design. I also recommend additional research into appropriate vegetation. This should include a detailed planting design and a program to acquire, propagate and manage plant material. Finally, I recommend further investigation into project funding.

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Figures

Appendix One:

Catchment Comparison Cerrito Creek and Baxter Creek

	Cerrito Creek	Baxter Creek	Source
Area of Catchment	1322 acres*	5530 acres**	atlas
Area of Catchment	2245 acres	2465 acres	USGS map analysis
Area of Catchment		2720 acres	NRRSS PPA
Length of Longest Branch	2.44 miles	2.87 miles	atlas
Highest Elevation in Catchment	996 feet	825 feet	USGS map analysis
Average Annual Rainfall	22in	22in	atlas
Estimated Percent Impervious	65%	65%	atlas

Notes

*The Contra County Watershed Atlas figure for the watershed area of Cerrito Creek is likely low because they measured the area of the watershed only within Contra Costa County. The number from the USGS map analysis reflects the entirety of the catchment, including a substantial portion within Alameda.

** The Contra County Watershed Atlas figure for the watershed area of Baxter Creek is likely high because they took into consideration areas drained by unnamed creeks to the south and north of Baxter Creek. As these areas do not drain into the Baxter Creek channel, they were not considered important to our comparison. Instead the figures from the NRRSS study and the USGS map analysis were considered as a better gauge of watershed conditions.

Restoration Reach Comparison: Cerrito Creek at Blake Garden to Baxter Creek at Pointsett Park

	Cerrito Creek	Baxter Creek	Source
Area of Sub-Catchment	116 acres	147 acres	USGS map analysis
Elevation of Sub-Catchment	996 to 450	700-150	USGS map analysis
Length of Restoration Reach	210 feet	250 feet	Long Profile
Slope of Restoration Reach	0.06%	0.08%	Long Profile

Appendix Two Raw Survey Data all units in feet

LONG PROFILE

Station	FS	BS	HI	Elevation	Water Ht	Water El	Description
	3.76		605.36	601.87			edge of tool shed
	1.28			604.08			garden edge
18.3	**10.82**			**594.54**	**0.03**	**594.57**	**upstream edge of culvert BM***
27.5	10.27			595.09			
39.3	10.09			595.27			
52.8	9.73			595.63			
58	10.06			595.3			rock at point
63.4	9.82			595.54	0.04	595.58	depth stake
68.5	10.72			594.64	1.19	595.83	pool bottom
73.4	9.69			595.67	0.02	595.69	pool top
85.2	9.5			595.86	0.01	595.87	confluence
94.6	9.9			595.46			
105.3	8.52			596.84	0.08	596.92	
112.4	8.52			596.84	0.02	596.86	concrete bag wall one side
123.1	7.38			597.98			concrete bag wall two sides
TP	4.18			601.18			stump
		9.7	610.88	601.18		601.18	
130.1	11.78			599.1	0.02	599.12	
132.3	10.68			600.2			
136.7	11.84			599.04	0.02	599.06	last pool
146.9	10.85			600.03			
157	10.39			600.49	0.03	600.52	
169.7	8.72			602.16			down stream edge of bridge
175.2	8.25			602.63			up stream edge of bridge
179.5	8			602.88			downstream edge of rubble pile
185.7	6.26			604.62			upstream edge of rubble pile
188	7.2			603.68	0.88	604.56	pool bottom
193	4.22			606.66			grade break
205.1	3.84			607.04		0	
215.8	3.92			606.96	0.17	607.13	
233	3.28			607.6			
237	3.57			607.31	0.03		edge of blackberries

*NOTE: bench mark corrsponds with long profile station 70.8 (top culvert) from Ludy and Podalak 2007

Appendix Two Raw Survey Data all units in feet

SECTION1

Station	FS	BS	HI	Elevation	Water Ht	Water El	Description
			610.88				
18							oak
39.9	8.82			602.06			
45	8.56			602.32			
50.8	9.06			601.82			top of bank
53	10.36			600.52			
54.8	11.3			599.58			top of concrete
55.1	13.9			596.98	0.02	599.57	right edge of channel
55.4	14.3			596.58	0.02	599.07	center of channel LP 102.3
55.7	13.9			596.98			left edge of channel-undercut
56.5	11.72			599.16			grade break
58.9	10.3			600.58			
61.6	9.03			601.85			
63.7	7.75			603.13			top of bank
72.4	8.01			602.87			
76.2	8.14			602.74			
91.7							fence

CROSS SECTION2

Station	FS	BS	HI	Elevation	Water Ht	Water El	Description
			610.88				
5	5.19			605.69			oak
11	5.49			605.39			
18	5.76			605.12			
24.3	6.21			604.67			top of bank
26.8	7.78			603.1			
27.9	9.35			601.53			
28.6	10.62			600.26			right edge of channel LP 143.8
29.9	10.86			600.02			center of channel
30.6	10.95			599.93			left edge of channel
32.5	8.59			602.29			
33.3	7.85			603.03			top of bank
35.6	6.09			604.79			
40.2	5.74			605.14			
46.8	4.78			606.1			redwood

Appendix Two Raw Survey Data all units in feet

CROSS SECTION3

Station	FS	BS	HI	Elevation	Water Ht	Water El	Description
			610.88				
2.83	3.4			607.48			buekner hose connect
6	1.68			609.2			
8.4	1.66			609.22			
13.7	1.8			609.08			top of bank
14.7	2.76			608.12			concrete on right
15.2	3.3			607.58			step
15.8	3.85			607.03			right edge of channel
16.7	3.95			606.93			center of channel LP 204.2
18	3.85			607.03			left edge of channel
19.1	3.05			607.83			grade break
22	2.24			608.64			
26	1.59			609.29			
31	0.96			609.92			
34.4	0.52			610.36			redwood