An Assessment of a Small Urban Stream Restoration Project in Northern California

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Abstract

Stream restoration projects have become increasingly common, and the need for systematic post-project evaluation, particularly for small-scale projects, is evident. This study describes how a 70-m restored reach of a small urban stream, Baxter Creek (in Poinsett Park, El Cerrito, California), was quickly and inexpensively evaluated using habitat, biological, and resident-attitude assessments. The restoration involved opening a previously culverted channel, planting riparian vegetation, and adding in-stream step-pool sequences and sinuosity. Replicated benthic macroinvertebrate samples from the restored site and an upstream unrestored site were compared using several metrics, including taxa richness and a biotic index. Both biological and habitat quality improved in the restored compared with the unrestored section. However, when compared with a creek restored 12 years before, habitat condition was of lower quality in the recently restored creek. A survey of the neighborhood residents indicated that, overall, they were pleased with the restored creek site. The approach used in this demonstration project may be applicable to other small-scale evaluations of urban stream restorations.

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Introduction

Habitat restoration is currently a major focus in the field of environmental science and generally refers to the reestablishment of processes and functions of biological, chemical, and physical linkages between aquatic, riparian, and associated terrestrial ecosystems (Kauffman et al. 1997). Stream restorations in urban areas have increased because of heightened awareness for recreational, aesthetic, and public involvement benefits and of increased availability of funding.

Although stream restorations are increasingly common, consistent monitoring of their success is still rare (Kondolf & Micheli 1995). Reasons include poor planning and lack of allocated funding. Without adequate evaluation of restorations, lessons cannot be learned from successes and failures, and the field of stream restoration will not advance (Kondolf 1995). This is especially true for small-scale projects, which virtually never have a detailed post-restoration assessment plan included.

The social aspects of stream restoration are important to determine the perceived success of a restoration, yet they are rarely included in evaluations. Surveys of residents and others involved in a project can be used to determine social attitudes, values, and perceptions regarding the manner in which the restoration was conducted (FISCRWG 1998). Although the scientific goals and social perceptions of a restoration project are often disjunct, considerations of both result in a comprehensive overview of the achievements and failures of a restoration project. Also, evaluation of social attitudes can aid future urban stream restoration projects in terms of public support. The local politics of stream restoration are pertinent in urban areas because residents are often particularly concerned about the impact the restoration project may have on their property values and quality of life.

This post-restoration case study of Baxter Creek in Poinsett Park, El Cerrito, California was designed as a demonstration of how to conduct a rapid and inexpensive evaluation of a small-scale urban creek restoration project. These evaluations included a habitat, a biological, and a social component and can serve as a model of studies that could be conducted by university undergraduates, volunteer monitoring groups, or neighborhood associations.

The Restoration

In 1992 the El Cerrito City Council determined that it was more economically feasible to open and restore a 70-m section of underground culvert in the east end of Poinsett Park than to repair and maintain the culvert over time. The goal of the restoration was to re-create pre-culvert conditions by restoring sinuosity and riparian vegetation to the newly opened channel (Fig. 1). However, they concluded that no reference conditions upstream of the restoration site existed for developing design criteria. Upstream areas were either culverted, channelized, or highly degraded. The design channel cross-sectional area, width, and depth were determined using regional hydraulic geometry relationships between channel sizes and drainage areas (Riley 2000, personal communication). Channel lengths were computed based on regional relationships of channel widths and lengths. The channel sinuosity and slope were matched to a steep 10% valley slope. A design width of 2 m and a depth of 30 cm were selected.

Step pools (designed to be <30 cm high to avoid undercutting) were created with salvaged rocks from the excavation. Soil from the excavated channel was donated to a community garden; this made the project less costly by eliminating expensive soil-removal charges. Bank and riparian modifications included "soil bioengineering" approaches: fascines (bundles of willows) and willow posts (1 m long, 10–15 cm wide). (See Riley [1998] and Owens-Viani [1999] for illustrations of these techniques). In the 3 years since the restoration was completed the number of step pools in the restored section have increased through natural processes. The restoration design clearly provided slope stability while storm discharges over time fine tuned the step-pool features.

Description of Study Sites

The study sites are located in the East Bay of the San Francisco Bay Area, a region with a Mediterranean climate (wet cool winters, dry warm summers) and an annual water deficit (Gasith & Resh 1999). Baxter Creek, the location of the restoration, originates in the El Cerrito Hills (Contra Costa County, California) and flows through Richmond and into the San Francisco Bay (for detailed maps of this area see *www.creativedifferences.com/baxtercreek/Map.html*). The stream chosen as the "best attainable condition," Strawberry Creek, runs through the University of California, Berkeley campus, the city of Berkeley (Alameda County, California), and then empties into the San Francisco Bay (for map see *www.ehs.berkeley.edu/pubs/pubs.html*). Strawberry Creek has been the subject of detailed biological evaluation of stream restoration techniques (Charbonneau & Resh 1992).

The restored segment of Baxter Creek (Fig. 1) is located at the east end of Poinsett Park in El Cerrito, California (37°56′N, 122°18′W) and is approximately 70 m in length. In the 1940s, like many urban creeks in the San Francisco Bay Area, this segment of Baxter Creek was culverted to address flooding and sanitation concerns (Dury 1995). Poinsett Park was constructed some years later over the culvert, and the land was converted to a grassy lawn. Today, the formerly culverted creek (Fig. 1) emerges at the tip of a triangular park and flows west before it goes back underground beneath a playground, maintenance building, and large cemented court at the west end of the park. Streets border all sides of the park. Three sampling areas (A, B, and C) in the restored site were chosen approximately 10 m apart.

To evaluate the relative conditions at the restored site in Poinsett Park, two comparison sites were selected. The first was an unrestored site, located on Baxter Creek approximately 300 m upstream from the restored site (37°56′N, 122°18′W), near the stream's source. Studies on this reach provided insight into the stream's conditions in its pre-culverted unrestored state. Three sampling areas were selected within this site (D, E, and F). One sampling area (F) was approximately 30 m below the source, had ivy-lined banks, and was shaded by a house deck most of the day. There was very sparse overhanging vegetation compared with the restored site. The other sampling areas within the unrestored site (D and E) were 10 m apart and separated from the sampling area F by a road. This section was in a semi-channeled area with a rock wall and limited riparian vegetation, consisting mostly of non-native species.

The second reference site was a reach of the south fork of Strawberry Creek located on the University of California, Berkeley campus (37°52′N, 122°15′W). This site underwent extensive ecological restoration between 1987 and 1989 (Charbonneau & Resh 1992) and is considered a success story in stream restoration (Owens-Viani 1999). Because of its proximity (<10 km distance) and geomorphic similarity, it is used in this study as baseline data for the "best attainable conditions" for an urban stream in this region. The three sampling areas in Strawberry Creek (G, H, and I) were selected to be comparable (i.e., slope, depth, substrate composition, and density of riparian vegetation) with the sampling areas in the two sites examined in Baxter Creek and were also approximately 10 m apart.

Methods

To fulfill the study objectives the evaluation of Baxter Creek included (1) a visually based habitat assessment; (2) an assessment of water quality using biological indicators; and (3) a survey of the neighborhood residents living near the creek to gauge their perceptions about how the restoration process was conducted and about the final product.

Habitat Assessment

The assessment of habitat quality is a critical part of stream monitoring because aquatic fauna often have

Figure 1. Photographs of the site during restoration in 1996 (top) and after restoration in 1998 (bottom). (Photographs by Lisa Owens-Viani.)

distinct habitat requirements that are independent of water quality (Barbour et al. 1996). A visually based habitat assessment of the entire reach of each site was conducted based on a qualitative analysis of bank covering (riparian vegetation), bank stability, and in-stream habitat diversity. Two areas were assessed (D–E and F) and averaged at the unrestored site because a road separated them. Each habitat assessment was conducted using the U.S. Environmental Protection Agency's Rapid Bioassessment Protocols (*www.epa.gov/owowwtr1/monitoring/rbp/app_a.html*). This approach is the standard method for habitat assessments across the United States (Hannaford et al. 1997). The habitat parameters evaluated were epifaunal substrate, substrate embeddedness, velocity/depth, sediment deposition, channel flow status, channel alteration, frequency of riffles, bank stability, vegetative protection, and width of riparian vegetative zone. Each habitat parameter was rated on a scale of 0 to 20 (poor to optimal). The sum of the parameters gave an overall score for each site.

Consistency of visual assessments was ensured because the same individuals conducted each assessment. Habitat assessments conducted in 1999 were compared with those made in 1997 by others. Studies show that equal levels of training and experience reduce variability of habitat assessments conducted by different individuals (Hannaford et al. 1997); therefore, because both 1997 and 1999 assessments were done with equivalent levels of training by the same instructor, we believe that the scores are comparable.

Biological Assessment

There has been a shift in North America toward the use of freshwater organisms to assess water quality, in contrast to complete reliance on chemical and physical measurements (Resh et al. 1996). The organisms most frequently used in a biological approach to water quality monitoring are benthic macroinvertebrates. Members of this diverse and ecologically important group occur in practically every stream environment and are sensitive to chemical and physical perturbations.

For the biological investigations all sampling areas (three per site) were selected according to the following criteria: (1) shady areas with highest water flow (only riffle or run water habitats were sampled, which maximized macroinvertebrate taxa richness); (2) presence of riparian vegetation; and (3) similar depth, width, and substrate size. Concrete-lined channels were avoided.

A biological assessment of the benthic macroinvertebrate assemblage was conducted by collecting a sample at each of the nine sampling areas in the three study sites in July 1999. A D-frame net was placed downstream from the sampling area; all large and medium-sized stones ($>$10 cm diameter) within an area of approximately 1 m^2 were scrubbed to remove any organisms that might be attached to them and put aside to clear the area. With the D-frame net still in place, a 1-minute interval of vigorous kicking was used to loosen the substrate and collect dislodged organisms in the net. The material collected in the net was drained and then placed into a plastic bag filled with 70% ethanol to preserve the organisms.

In the laboratory each sample was separated into two subsamples according to substrate size, using a 4-mm and a 0.4-mm sieve. The benthic macroinvertebrates were then carefully identified (e.g., Merrit & Cummins 1996). The sites were compared based on measures of family richness (number of families), taxa richness (number of species), the number of taxa of EPT (the largely pollution sensitive orders Ephemeroptera, Plecoptera, and Trichoptera), the proportion of the macroinvertebrate community that are EPT, and the calculation of a family biotic index. These metrics are all widely used approaches in biological monitoring of streams (Resh & Jackson 1993). The family biotic index is calculated by assigning a pollution tolerance value to each species of macroinvertebrate, multiplying this value by the number of individuals of that species collected, and dividing the sum of these products by the total number of individuals collected (Resh et al. 1996). A high value indicates an assemblage with mostly pollution tolerant species, whereas a low value indicates the presence of many pollution sensitive species. Finally, a Jaccard index (Resh & Jackson 1993) was also used to assess similarity between sites. The closer the Jaccard index value is to 1, the more similar the sites.

The biological monitoring techniques described above, which are also appropriate for volunteer, school, and neighborhood groups, are described in detail by Resh et al. (1996). Various websites (search under biomonitoring) can provide additional details and sometimes regional identification keys.

Survey of Attitudes

A survey was used to obtain information on residents' opinions and perceptions of the creek restoration project at Poinsett Park. Questions were designed to determine how residents perceived they were informed by the city about the restoration and to establish their perceptions, in general, on the topic of stream restoration. The survey was conducted door to door in the area surrounding the park. If residents were not at home, a written form was left in their mailbox and collected later. The pre-established sample population included all houses directly adjacent to the park in addition to houses within one block of the park (70 households total; of these, 45 surveys were completed). Some 49% (22) of the residents surveyed were located directly adjacent to the park, whereas the other 51% (23) were within one block of the park.

In addition, several City of El Cerrito personnel involved in the restoration were interviewed and asked questions pertaining specifically to their role in the restoration; no uniform survey was conducted. The information compiled from these interviews was an important additional component to this study because it gave insight and details regarding the planning and implementation of the restoration.

Results

Habitat Assessment

In a comparison of the physical habitat assessments conducted at each site (Table 1), the unrestored Baxter Creek site had the lowest score (79). The restored site in Baxter Creek scored higher (119) than the unrestored site but was lower than the site defined as the best attainable conditions, Strawberry Creek, which had a score of 144.

The restored site scored higher than the unrestored site in all parameters examined, except channel alteration, which was rated the same for both sites (Table 1). Strawberry Creek scored higher than the restored Baxter Creek site in all parameters except velocity/depth regime and frequency of riffles.

Biological Assessment

Macroinvertebrate taxa richness at all sampling sites overlapped considerably (Table 2), as did the faunal composition (Tables 3 and 4). Taxa richness ranged from 18 to 31 and 16 to 28 per sampling area at the restored site and the unrestored site, respectively. The mean number of taxa at the restored site (22.7) was slightly higher than that of the unrestored site (22). Family richness ranged from 15 to 26 and 12 to 22 at the restored and unrestored sites, respectively. Strawberry Creek samples had from 18 to 27 taxa, 15 to 24 families, and in total 32 taxa and 28 families. The species composition at the restored and unrestored sites of Baxter Creek was more similar to each other (0.64, Jaccard Index) than when either site was compared with Strawberry Creek (0.48 and 0.51, respectively).

The sites differed in numbers of individuals collected (Table 2). The unrestored site had the most individuals (4,831 in total), although most of those were pollution-tolerant Oligochaeta (worms).

When the mean values of family biotic index calculated for each site are compared (Table 2), a higher value (which indicates a higher mean pollution tolerance of the macroinvertebrate assemblage) was found at the unrestored site (7.6) than at either the restored site (6.9) or at Strawberry Creek (6.6).

A widely used approach in biological assessments is to use the richness and proportion of the community that is in three largely pollution-sensitive orders of aquatic insects—mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) (Resh et al. 1996). EPT richness averaged 1 at the restored site, 0.7 at the unrestored site, and 3.3 at the best attainable conditions site (Strawberry Creek). In terms of proportion of faunal composition, the percentage of EPT ranged from 0.1 to 0.3% at the restored site, 0 to 0.3% at the unrestored site, and 0.2 to 0.9% at Strawberry Creek.

In December 1997 (1 year after restoration and during the rainy season) only 7 families of macroinvertebrates were collected at the restored site, whereas 11 families were collected at the unrestored site (Nowicki & Shah 1997, unpublished data). The family biotic index scores then were 6.6 and 6.4, respectively. No EPT taxa were found in the 1997 study. By 1999 additional recolonization of the restored site had occurred and taxa numbers were similar, and the biotic index of the restored site in-

Table 1. Comparison of habitat assesent scores for the three study sites (a higher score indicates better habitat).

Habitat Parameter	*Restored Site, Baxter Creek*	*Unrestored Site, Baxter Creek*	*Best Attainable Conditions, Strawberry Creek*
Epifaunal substrate/available cover	13	8	14
Embeddedness	13	12	15
Velocity/depth regime	16	9	15
Sediment deposition	9	7	14
Channel flow status	12	7	16
Channel alteration	10	10	14
Frequency of riffles (or bends)	18	14	15
Bank stability	11	6	17
Vegetative protection	11	4	17
Width of riparian vegetative zone	6	2	7
Total Score	**119**	**79**	**144**

Qualitative score of 0–20 (poor to optimal). The unrestored site values are an average of two areas done separately.

dicated an assemblage with a more pollution-sensitive composition.

Survey of Attitudes

The demographics of the 45 respondents to the survey indicated that most respondents were women between the ages of 40 and 65 and had moved there in the last 20 years (Fig. 2). Eight questions were used to deduce perceptions and reactions to the creek restoration in their neighborhood park (Table 5). Most residents believed they were adequately informed before the restoration (64%), and most enjoyed living near the newly uncovered creek (84%). Their responses also show no correlation between frequency of park visits and how much residents liked the creek ($p > 0.05$).

When asked what their perceptions were about stream restoration in general, the responses varied widely. The most common responses given for restoration to occur were to rejuvenate native biology/landscape (42%), improve aesthetics of the neighborhood (20%), and improve water quality and storm drain control (15%). Most responded that the restored Baxter Creek would increase property value (58%). When asked, "Did this restoration live up to your expectations?" an overwhelming 82% responded "Yes."

However, negative views and concerns about the restoration emerged from additional interviews with residents. One resident, against the restoration, maintained that the waterway was "not a creek" but a storm drain fed only by street run-off. The main concerns among those surveyed were the size and density of the newly added trees and safety and health issues. The willows planted in the riparian zone have grown considerably since they were planted in 1996. Before the restoration the neighbors were able to see other houses directly across the street. The trees now reduce the visibility of the area and the residents are split on their opinions of this aspect. Some respondents remarked that they loved the aesthetics of the trees and the increased privacy, whereas others disliked the trees because they created a place for burglars to hide and they could not "watch out" for their neighbors with the trees in the way. The irony in this is that the creation or expansion of riparian zones is one of the major elements in urban stream res-

Table 2. Mean and range for biological measures evaluated at each of the three sites in 1999.

	Restored Site, Baxter Creek	*Unrestored Site, Baxter Creek*	*Best Attainable Conditions, Strawberry Creek*
Taxa richness	22.7 (18–31)	22.0 (16–28)	22.3 (18–27)
Family richness	19.3 (15–26)	16.7 (12–22)	19.3 (15–24)
Total number of individuals	713.0 (606–1,187)	1,610.3 (781–2,799)	910.0 (319–1,681)
Family biotic index	6.9 (6.4–7.3)	7.6 (7.3–7.8)	6.6 (5.8–7.4)
EPT richness	1 (1)	0.7 (0–2)	3.3 (3–4)
Percentage of EPT individuals	0.2 (0.1–0.3)	0.1 (0–0.3)	0.5 (0.2–0.9)

EPT = Species or individuals within the orders Ephemoroptera, Plecoptera, or Trichoptera. Values are means, with ranges in parentheses.

Table 3. Biological assessment mean and range in parentheses for taxa of insects collected at each of the three study sites.

Insect Order	Family (no. of taxa)	Restored Site, Baxter Creek		Unrestored Site, Baxter Creek		Best Attainable Conditions, Strawberry Creek	
		Taxa	Ind	Taxa	Ind	Taxa	Ind
Odonata	Coenagrionidae (1) (damselflies)	1 (1)	106 (85–130)	1 (1)	59.3 (40–73)	1 (1)	24 (18–28)
Collembola (springtails)	Hypogastruridae (1)	—	—	—	—	0.7 (0–1)	1.3 (0–3)
	Entomobryidae (2)	0.7 (0–1)	0.7 (0–1)	0.7 (0–2)	1 (0–3)	0.3 (0–1)	0.3 (0–1)
Ephemeroptera (mayflies)	Baetidae (1)	—	—	0.3 (0–1)	0.3 (0–1)	—	—
Plecoptera (stoneflies)	Nemouridae (1)	—	—	—	—	1 (1)	5.3 (1–12)
Trichoptera (caddisflies)	Hydropsychidae (1)	—	—	—	—	0.7 (0–1)	0.7 (0–1)
	Hydroptilidae (1)	1 (1)	4.3 (1–11)	0.3 (0–1)	0.3 (0–1)	—	—
	Lepidostomatidae (1)	—	—	—	—	1 (1)	18.3 (1–32)
	Limnephilidae (1)	—	—	—	—	0.3 (0–1)	0.3 (0–1)
	Rhyacophilidae (1)	—	—	—	—	0.7 (0–1)	0.7 (0–1)
Megaloptera	Sialidae (1) (alderflies)	—	—	—	—	1 (1)	2 (1–3)
Diptera (true flies)	Chironomidae (4)	3 (3)	290.7 (137–537)	2.7 (2–3)	73 (19–114)	2.3 (2–3)	1,532 (95–512)
	Simuliidae (1)	1 (1)	14 (1–36)	1 (1)	5.7 (3–8)	1 (1)	91.7 (12–213)
	Tipulidae (4)	2 (2)	4.7 (2–8)	2.7 (2–4)	6.7 (4–9)	0.3 (0–1)	1 (0–3)
	Empididae (2)	1 (0–2)	9 (0–26)	1 (0–2)	2 (0–5)	1.3 (1–2)	40 (7–91)
	Psychodidae (2)	—	—	0.7 (0–2)	3 (0–9)	—	—
	Stratiomyidae (1)	0.7 (0–1)	2 (0–5)	—	—	—	—
	Pelecorhynchidae (1)	—	—	0.7 (0–1)	0.7 (0–1)	0.7 (0–1)	1.3 (0–3)
Coleoptera (beetles)	Dystiscidae (1)	—	—	—	—	0.7 (0–1)	2 (0–5)
	Dryopidae (1)	0.3 (0–1)	0.3 (0–1)	—	—	0.3 (0–1)	0.3 (0–1)
	Hydrophilidae (1)	0.7 (0–1)	1 (0–2)	—	—	—	—
	Elmididae (1)	—	—	0.3 (0–1)	0.3 (0–1)	—	—

"Taxa" refers to number of taxa collected and "Ind" refers to the number of individuals collected. A dash indicates no individuals were found in that sample.

toration that consistently results in improved stream biological conditions.

Several respondents in the interviews expressed concern over public health aspects of the restored creek. They were sure that mosquitoes and other pests that could potentially spread disease would breed in the creek; no mosquito larvae or adults were found in the sampling. Some even thought that the very idea of running water above ground was "unclean" and that the creek should be fenced off to prevent children and pets from being exposed to water-borne pathogens. These fears could have been addressed before the restoration through educational presentations by local agencies and conservation organizations.

Local Politics Interviews

To better understand the story behind the restoration and the controversies and perspectives involved, interviews were conducted with persons involved in various facets of the restoration. The El Cerrito City Engineer, More Struve, indicated that when the city was prioritizing sites for storm drain repair, he saw Poinsett Park as an opportunity to restore the creek, which would be less costly than repairing the culvert. Initial resistance from a few neighbors centered around lowered property values from the presence of an unsightly creek. Struve worked with residents and engineers to come up with a design that was acceptable. When asked if the project was successful, he replied, "There have been no complaints recently, so I would call that a successful project!" This comment underscores the point that some city planners may equate a lack of negative feedback with success.

Discussion

The stream restoration project in Poinsett Park was chosen for evaluation for two reasons. First, it can be con-

Table 4. Biological assessment mean and ranges (in parentheses) for non-insect taxa of macroinvertebrates collected at each of the three study sites.

Phylum, Class, or Order	Family (no. of taxa)	Restored Site, Baxter Creek		Unrestored Site, Baxter Creek		Best Attainable Conditions, Strawberry Creek	
		Taxa	Ind	Taxa	Ind	Taxa	Ind
Amphipoda (scuds)	Gammaridae (1)	0.3 (0–1)	0.3 (0–1)	0.7 (0–1)	1.3 (0–2)	1 (1)	10.3 (1–24)
Ostracoda (1) (seed shrimp)		1 (1)	13 (2–26)	0.3 (0–1)	11 (0–33)	1 (1)	50.7 (29–79)
Isopoda (1) (pill bugs)		0.3 (0–1)	0.3 (0–1)	0.3 (0–1)	0.3 (0–1)	0.7 (0–1)	0.7 (0–1)
Gastropoda (snails)	Physidae (1)	1 (1)	29 (13–43)	1 (1)	18.7 (2–38)	1 (1)	32.3 (9–48)
	Viviparidae (1)	1 (1)	33.3 (6–60)	1 (1)	521 (300–892)	1 (1)	11 (9–13)
	Lymnaeidae (1)	1 (1)	89.7 (28–182)	0.7 (0–1)	75.3 (0–120)	1 (1)	40 (12–26)
	Planorbidae (1)	0.7 (0–1)	1.3 (0–3)	—	—	—	—
Bivalvia (1) (clams)	Schaeridae	1 (1)	1.7 (1–3)	1 (1)	327 (129–511)	1 (1)	5.3 (1–13)
Oligochaeta (2) (worms)		1 (1)	72.7 (36–108)	1.7 (1–2)	473.7 (167–1,027)	1.3 (1–2)	22.7 (16–31)
Turbellaria (flatworms)	Platyhelminthidae (1)	1 (1)	22 (3–60)	1 (1)	20 (9–36)	0.7 (0–1)	29 (0–63)
Acarina (7) (water mites)	sp. 1	0.7 (0–1)	4.7 (0–8)	0.3 (0–1)	2.3 (0–7)	0.3 (0–1)	0.3 (0–1)
	sp. 2	0.3 (0–1)	1 (0–3)	0.7 (0–1)	0.7 (0–1)	0.3 (0–1)	1.7 (0–5)
	sp. 3	0.7 (0–1)	2.3 (0–6)	0.3 (0–1)	5 (0–15)	—	—
	sp. 4	0.7 (0–1)	3 (0–3)	—	—	—	—
	sp. 5	0.3 (0–1)	0.3 (0–1)	0.3 (0–1)	0.3 (0–1)	0.3 (0–1)	6.3 (0–19)
	sp. 6	—	—	0.3 (0–1)	0.3 (0–1)	—	—
	sp. 7	0.3 (0–1)	0.3 (0–1)	—	—	—	—
Hirudinea (leeches)	Bdellidae (1)	0.7 (0–1)	5.3 (0–12)	0.7 (0–1)	1 (0–2)	—	—

"Taxa" refers to number of taxa collected and "Ind" refers to the number of individuals collected. A dash indicates no individuals were found in that sample.

sidered a true restoration rather than a rehabilitation project. Restoration of this study site involved changing a covered creek to an open one, not solely improving chemical water quality and the vegetation of the riparian zone. In actuality, many projects that improve channel conditions are referred to as "restorations," when they are more accurately described by the term "rehabilitation," defined by Kauffman et al. (1997) as the process of reinstating the use of a land area after natural or anthropogenic disturbances. Second, this restoration project is a classic example of small-scale urban creek restoration; in fact, it was used in before/after photographs on the cover of Ann Riley's book, "Restoring Streams in Cities" (Riley 1998).

A difficulty in restoring Mediterranean-type streams such as Baxter Creek is that they tend to be intermittent during the dry summer season, with large seasonal fluctuations in the composition of the biota reflecting the sequential flooding–drying pattern (Gasith & Resh 1999). Baxter Creek, however, was once intermittent but it is now perennial because watering of a nearby golf course at the headwaters of the creek recharges the water table and allows the creek to run year-round.

A comparison of overall habitat assessment scores for each site indicates that the restored site habitat has improved relative to the unrestored site. However, it has still not reached the level of the best attainable conditions site.

The macroinvertebrate assemblage found in 1997 (1 year after restoration) compared with 1999 (3 years post-restoration) indicated that recolonization from the upstream site has now occurred at the restored site, and macroinvertebrate richness of Baxter Creek is similar to that found in Strawberry Creek. However, there have been other potential macroinvertebrate recolonizers that have not become established in Baxter Creek. Resh (unpublished data) used light traps to collect adult stages of aquatic insects (compared with the sampling techniques in the present study that collected the immature stages) at a site between the unrestored and restored sites on Baxter Creek. This study found that 12 species of Trichoptera (caddisflies) flew to the creek (but appar-

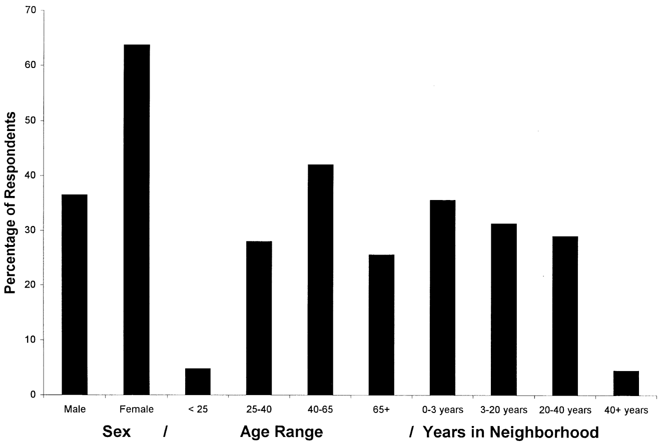

Figure 2. Demographic characteristics of Poinsett Park area residents who participated in the survey (n = 45).

ently did not live there in their immature aquatic stages) between 1984 and 1988. The results of this study show that only one of these species actually lives in the creek today. We do not know whether habitat or water quality conditions have prevented the other 11 species of caddisflies present in the area from becoming established in Baxter Creek or whether they are there but in numbers too low to detect.

In terms of evaluating the success of the restoration using the benthic macroinvertebrate community, the fact that the restored stream segment is only 70 m long and that it is culverted at both ends (as is the majority of the stream located above and below the restored site), affects expected faunal composition and richness. Consequently, the 12 species of Trichoptera described above, which are potential colonizers from other sites, have relatively little area to select appropriate egg-laying sites or have adequate habitat for larval survival and population establishment or have insufficient resources to support a more diverse insect assemblage.

The macroinvertebrate results from this study have implications for the design of other urban stream restoration evaluations. Although the trend found in using the EPT metrics follows that shown for other measures used, these EPT richness and proportional values are almost an order of magnitude lower than those found in

Table 5. Results of resident survey.

Questions	*Responses*	
1. **Were you informed** of the project before it began?	Yes: 64% (29/45)	No: 9% (4/45) Cannot remember: 26% (12/45)
If so, **how** were you informed?	City flyers: 75% (21/28) Neighbors: 21% (6/28)	Media: 4% (1/28) N/A: 4% (1/28)
2. Do you **enjoy** living near a creek?	Yes: 84% (38/45)	No: 16% (7/45)
Why?	Aesthetics: 42% (18/38) Natural setting: 35% (15/38)	Recreational use: 9.5% (4/38)
Why **not**?	Preferred grass: 9.5% (4/6) Flood concern: 2% (1/6)	Didn't notice a difference: 2% (1/6)
3. How **often do you visit the park?**	A few times per week: 56% (25/45) Once a month: 4% (2/45)	Less than once a month: 40% (18/45)
4. Were you **involved** in the restoration?	Yes: 42% (19/45)	No: 56% (25/45) N/A: 2% (1/45)
How were you involved?	Attended Meetings: 37% (7/19) Planting/Maintenance: 47% (9/19)	Other: 16% (3/19)
5. Were you **updated on the progress** during the restoration?	Yes: 58% (19/33)	No: 42% (14/33)
6. In general, what do you think is the **primary goal of any creek restoration** (not just the one in Poinsett Park)?	Rejuvenate native biology/ landscape: 42% (17/40) Improve aesthetics: 20% (8/40)	Improve water quality: 15% (6/40) Spend taxpayers' money: 8% (3/40) No goals: 5% (2/40)
7. How do you think the recently uncovered creek will **affect your property value?**	Increase: 58% (26/45) Decrease: 2% (1/45)	Remain the same: 20% (9/45) Don't know: 20% (9/45)
8. Did this restoration **live up to your expectations?**	Yes: 82% (32/39)	No: 18% (7/39)

non-urban streams of coastal California (Resh, unpublished data). Therefore, evaluation of restoration success in urban waterways may have to involve choice and analysis of different metrics than those used in non-urban settings.

The perceptions of the Poinsett Park residents indicate that most residents surveyed liked living near the newly uncovered creek. Most believed they were well informed by the city or neighbors but expressed skepticism about the project before it began. A 1997 survey found that a year after completion of the Poinsett Park restoration, residents were mostly unsatisfied with its appearance (Owens-Viani 1997). Yet, now that the vegetation has grown, residents like it much more. The improved resident reaction in the 1999 survey can be correlated with improved aesthetics and increased riparian vegetation.

Conclusions

Based on the biological and habitat assessment results, the restoration project at Baxter Creek improved habitat and biological conditions compared with those at the unrestored site. From the social perspective, despite the concerns voiced by some neighbors, the vast majority were pleased that the creek was restored. Certainly, involving the residents in the planning process had both positive and negative results. The positive results were that the neighborhood took "ownership" of the project and felt an investment in what was being done to their park. The restoration brought residents together to discuss their needs and desires. After the restoration project several residents worked toward refurbishing the playground downslope from the creek. They held fund-raisers over a 2-year period to raise money for the new structures. The negatives of public involvement were that city planners had to field many complaints and meet the needs of a diverse group of people, which delayed and increased the cost of the project.

In the attitudinal survey the most common response of residents about the primary goal of any creek restoration was to rejuvenate native biology/landscape. Thus, the quantitative assessments of habitat and biological condition are appropriate evaluations of at least part of the residents' goals for a project.

This post-restoration survey of habitat, biology, and resident attitudes was conducted by two university undergraduates and was completed in a 2-month period at a cost of $4,000. Costs could have been reduced by 75% if university credit was substituted for salary or a work-learn/internship agreement was used. Such an approach could enable more small-scale projects to be evaluated and could provide a database to indicate which restoration techniques actually improve habitat and biological quality. Finally, it could show which planning approaches make residents more involved with, satisfied about, and committed to maintaining the project.

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