Watershed Field Study: Garden Club Canyon Creek

Study area
Our study area is a small watershed in the Martin Griffin Preserve of Audubon Canyon Ranch. The site is located in one of the four canyons in this preserve called the Garden Club Canyon, adjacent to Bolinas Lagoon. Audubon Canyon Ranch was formerly a dairy ranch that was purchased in the 1960s and converted into a preserve, the function the land serves to this day. The main tree cover at the site consists of coast redwood and California bay laurel, while chaparral and marsh habitat are found in the canyon floors. Our group characterized two segments of the stream channel that run through Garden Club Canyon; one that is situated higher up the canyon with a step-pool morphology and redwood cover (LP1), and another located closer to the Highway 1 in an alluvial fan with chaparral cover (LP2).

Figure 1: Study Site – Location of the Garden Club Canyon Creek (blue) within the Bolinas Lagoon Watershed, West Marin California.
Stakeholders

- Audubon Canyon Ranch - and more specifically Gwen Heistand, the Resident Biologist for the Martin Griffin Preserve - are the primary stakeholders for this watershed. Gwen oversees the operations at the ranch, where the main mission is to preserve this landscape, while keeping it available to the public for both educational and scientific endeavors.

- Caltrans is involved because it must periodically clear the culvert and repair CA Highway 1 after flooding events. Additionally, because the creek floods a major passageway in this area, the creek’s flooding impacts local residents.

- There are several organizations that are concerned with the movement of sediment into the Bolinas Lagoon, which may be partially fed from creeks such as Garden Club Canyon Creek. The Marin County Open Space District and the Bolinas Lagoon Foundation are only two of these organizations, and both are working on a restoration project for the lagoon. Our watershed in Garden Club Canyon plays only a minor role in their concerns, but is still significant.

Problem statement

Garden Club Canyon Creek experiences a number of issues, many of which are specifically tied to storm events:

- The culvert under Highway 1 that the creek runs through to the Bolinas Lagoon frequently fills with sediment and must be cleared by Caltrans.

- Winter storm events have caused the creek to flood Highway 1.

- A debris dam exists just upstream of the creek’s alluvial fan. This dam was created during a storm on New Years Eve, 2005. The creek split into two channels during this event.

- The creek now flows on/alongside a fire road (when there is water in the channel), and is eroding the road.

- The former creek channel has been buried close to Highway 1.

The potential causes of problematic flooding events of this creek coupled with the aggradational issues through the alluvial fan must be established and characterized in order to inform any future restoration projects on this creek to alleviate flooding and allow for more natural channel behavior. Our group has characterized sediment and water quality, as well as channel geometry and grade of two unique segments of the creek to provide baseline data that can be used to develop an approach for restoration.
Results and Discussion

*Vertical and horizontal controls*

Refer to Excel file ‘Garden Club Canyon Creek’, tabs “End points XS 1 and 2” “End points XS 3 and 4” for full photo documentation of controls. For LP1 (step-pool), we established a benchmark at the Northwest corner of a bench near the channel reach studied (Figure 2). This benchmark was also used as the benchmark for both cross sections along this reach. For LP2 (alluvial fan), we established a benchmark at a small stone monument at the end of an extruding pipe (Figure 2). The stone monument was used as the benchmark for both cross sections along this reach.

![Figure 2: Benchmarks](image)

A – Benchmark for LP1
B – Benchmark for LP2

*Longitudinal profile*

Two distinct reaches of Garden Club Canyon Creek were characterized in order to effectively develop a baseline understanding of the watershed and possible sediment sources. Two longitudinal profiles (LP) were conducted; one in the upper reaches of the creek which is characterized by step-pool habitat and redwood vegetation (A), the other in the lower reaches of the creek which is characterized by an alluvial fan formation where the gradient of the creek levels out (B) (Figure 3). Each LP covered an approximately 30 meter reach. Elevation and related readings were taken at 0.5 – 1 m intervals with a digital level and stadia rod. At every elevation reading water depth was similarly observed.
LP 1 survey was started at the fallen log across the stream (see the excel spreadsheet for exact details). This fallen tree marked the 0 m point on the tape measure which was pulled out upstream to 32 m. The LP 1 graph depicts a series of step pools and riffles typical of a high gradient creek. The upper reach (LP1) was steeper and more characteristic of a Rosgen “A” type stream. The longitudinal profile showed a slope of .075. The lower LP2 reach was started at the branches of a fallen tree which had fallen directly into the stream. The tape measure was placed at the tip of the branches to mark the 0 m point and pulled downstream along the dry creek to the 32 m on the tape (see the excel spreadsheet for exact details and images). The LP 2 graph shows that the creek runs at a very slight gradient along this reach. It seems to be comprised of pools and riffles but due to lack of water this is less obvious. The LP2 the longitudinal profile showed a slope of .033 and the lower reach (LP2) more closely resembles a Rosgen “C” type stream. For both LP charts see Appendix 1 at the end of the report. For full documentation of longitudinal profile data and charts, refer to “LP1 (data)” “LP2 (data)” “LP1 (chart)” and “LP2 (chart)”.

Cross section
Cross sections are useful in showing the overall channel conditions and how they change with time. A series of cross section observations over a number of years will be able to provide information on erosion and deposition rates, and change in bed and bank materials. Four cross section surveys were conducted in this study, and as no prior stream characterization has been
completed for this creek these cross sections will form the baseline data for future studies. At each longitudinal profile two cross section surveys were conducted; one at the beginning of each LP reach, the other at the end of each LP reach. Elevation and related readings were taken every 0.5 m with a digital level and stadia rod. On LP 1 two cross sections were established at 7.9 m and 21.1 m along the LP survey tape (see the excel spreadsheet for exact placement), and along LP 2 the two cross sections were established at 6.1 m and 31.9 m mark on LP tape. No rebar was installed at the endpoints of all cross sections but pink flagging tape was used instead.

For cross section charts see Appendix 1 at the end of the report. See excel file tabs “LP1 XS1”, “LP1 XS2”, “LP2 XS1” and “LP2 XS2” for further documentation and graphs of cross section profiles.

**Pebble-count transects**
As stream behavior is dependent on stream composition the type of sediment that streams are comprised of will influence channel form and hydraulics, erosion rates and sediment supply (Harrelson *et al* 1994). Streams in steeper regions that are predominantly comprised of boulders and cobbles will act differently than low gradient streams comprised of sand and silt (Harrelson *et al* 1994). To help determine the source of the sediment that aggregates at the base of the creek after heavy flow events, pebble-counts along both LPs were conducted. Methods according to ‘The River Field Book, Representative Pebble Count Procedure’ page 240 were followed. We selected ten pebbles at random and measured their median particle. Additionally, pebble-counts were sampled in the various bedform types (riffles, pools). The number of riffles and pools sampled was proportional to the presence of either bedform along the sampled reach.

We found a general trend within LP1 indicating that the majority of sediment consisted of medium to very coarse gravel within riffles; within pools the majority of sediments were silts clays. Within LP2, we found for riffles the majority of sediments were coarse to very coarse gravel, while for pools the majority of sediments were coarse to very coarse gravels and small cobbles. Due to the lack of water in this reach, these results are not conclusive. For pebble count charts see Appendix 1 at the end of the report. Refer to pebble count tab of excel file for detailed documentation of the sediment study.

**Water quality monitoring**
Water quality parameters pH, temperature and specific conductance were measured at three sites along the first longitudinal profile in the step pool reach. Dissolved oxygen was not measured
due to incorrect installation of the DO sensor. The first set of measurements were taken in the first pool at the beginning of the longitudinal profile, the second set of measurements were taken in a pool midway upstream just after a down log and the last set of measurements were taken in the final pool upstream at the end of the longitudinal profile (see the excel spreadsheet for map where water quality was measured along LP1). All measured parameters indicated that the general water quality of the step pool reach was good. Water temperature was cool at 12°C, pH was in range between pH7-8 and specific conductance measured low (0.373 mS/cm) which is to be expected in freshwater streams (See table 1). California newts (Taricha torosa) were frequently observed in the pools and riffles along the step pool reach which could be a further indication of good water quality. As there was no water flow in the lower lying parts of the creek no water quality measurements were taken at the second longitudinal profile.

<table>
<thead>
<tr>
<th>Region of LP</th>
<th>Pool</th>
<th>pH</th>
<th>Temp (°C)</th>
<th>Specific Conductance (mS/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning of LP1</td>
<td>First pool</td>
<td>7.43</td>
<td>12.5</td>
<td>0.374</td>
</tr>
<tr>
<td>Midway of LP1</td>
<td>First pool after second down tree just at the gully on west bank of creek</td>
<td>7.65</td>
<td>12.2</td>
<td>0.374</td>
</tr>
<tr>
<td>End of LP1 last pool</td>
<td>Last pool</td>
<td>7.73</td>
<td>12.1</td>
<td>0.373</td>
</tr>
</tbody>
</table>

Table 1: Documenting water quality along the step pool longitudinal section

**Conclusion**

Our study established baseline data for two reaches of Garden Club Canyon Creek, establishing benchmarks and longitudinal profiles, as well as cross sections. We also characterized water quality parameters and sediment qualities of each reach in order to compare the varied morphologies of Garden Club Canyon Creek. This baseline data can be used for further characterization studies of the creek in order to observe creek evolution over time. Subsequent surveys covering the same areas surveyed in this study will provide useful information to inform any future restoration projects to alleviate flooding and allow for more natural channel behavior.
Further Recommendations

Subsequent studies are necessary to develop greater insight into the functioning of this creek and to effectively identify sediment sources in times of heavy rainfall events. The group confers that the use of pink flagging tape to establish cross section endpoints is likely not an effective, long-term technique to mark the cross section surveys. It is highly recommended to install rebar for future studies. Prior permission from the landowners Audobon Canyon Ranch must be secured when installing rebars.

References


Chart 1: Longitudinal profiles of step pools (top) and alluvial fan (bottom). No water flow was apparent in alluvial fan region of creek.
Chart 2: Cross sections on LP1 at 7.9 m (XS1) and 21.1m (XS2) on LP tape measure. Blue level denotes presence of water in the channel.
Chart 3: Cross sections on LP2 at 6.1 m (XS1) and 31.9 m (XS2). Blue level denotes potential water course in wet season. At time of survey no water flow was apparent in this section of the creek.
Chart 4: Pebble count for LP 1 step pools reach, riffles versus pools.
Chart 5: Pebble count for LP 2 alluvial fan. Riffles versus pools.