Soberanes Creek Status Report
Monitoring the 2016 Soberanes Creek Fire Disturbance

By
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Introduction

This creek monitoring status report was prepared by me with the assistance of the CSUMB Aquatic Ecology class on behalf of the Central Coast Regional Water Quality Control Board. The goal of this study is to assess the biological integrity and to detect the ecological changes in respond to the recent fire disturbance impacts on the Soberanes Creek stream. Researchers used bioassessment sampling method and statistical analysis of benthic macroinvertebrates (BMI) collected to achieve this goal. The bioassessment sampling method was conducted a year after the fire to accurately assess the impacts the fire disturbances had on the stream.

Background

Our study site is the Soberanes Creek, located on the northern end of the Big Sur coast, three miles south of Point Lobos State Reserve. Soberanes Creek is a small first order stream in Garrapata State Park (36°27′17.00″N 121°55′20.62″W) and drains into the Pacific Ocean. Dominant plant species include California sagebrush (Artemisia californica), poison oak (Toxicodendron diversilobum), wild cucumber (Marah cucurbits), and multiple fern species. Soberanes Creek has been considered a reference site since 2010, although the site did experience a major wildfire last year in 2016. Recently in 2016, the Big Sur coast in the Los Padres National Forest, Ventana Wilderness, and adjacent private and public land in Monterey County, California was impacted by wildlife that burned 132,127 acres or 53,470 ha. Soberanes Creek was selected because of its geology, surrounding ecosystems, stream size, aspect, and recent fire disturbance.

Objective

Our objective was to conduct a bioassessment a standardized way of collecting data to assessing and the biological stream’s conditions, chemistry, and physical habitat after the recent fire disturbance to point out the implications of the results to stakeholders.

Methodology

Field Sampling

Field sampling followed the standard protocols described in the California Stream Bioassessment Procedure (SWAMP, 2007). The upstream portion of the study area's potential hazards (bridges/culverts/water treatment plants) and wetted width were recorded to determine survey location and length. We used the conventional methodology (SWAMP) for when the wetted width is 10m, and then the length of the surveyed reach should be approximately 150 meters (11 systematic transects at 15m length). Dissolved oxygen, temperature, salinity, conductivity, and
pH were recorded using an YSI multipara meter at the most downstream section of the survey area. At each transect, water depth, cobble embeddedness, riparian vegetation, and stream width were also recorded. Crews split into teams and sampled two or three transects per group, there was a total of eleven transects, at each transect, where benthic samples were collected, several local habitat parameters were assessed including substrate composition, percent canopy, average stream velocity, average water depth and rifle gradient. Using the closest riffle upstream of the transect following SWAMP protocol. A D-net with a 500- mesh was held by one team member while the other disturbed and brushed off organic material (OM) from the cobbles in the one-foot area in front of the D-net. The sediment under the cobbles was then disturbed up to 10cm deep for 30 seconds to free any invertebrates into the water column. After waiting for the water to filter through the D-net, it was then removed and used again at the next transects. After the transects had been surveyed, all the contents of the net were placed into a 500- sieve to remove any large organic material and rocks after inspecting for invertebrates. The remaining material in the sieve was then placed in jars of ethanol to be taken back to the lab for inspection and identification of the invertebrates. For a more detailed description of the field, sampling refers to SWAMP protocol.

Laboratory methods

The samples were placed into bottles of ethanol in the field to preserve the specimens and taken back to the lab. Each sample was rinsed in a standard no. 35 sieve (0.5mm) and transferred to a tray with twenty, four in.2 (25 cm2) grids for subsampling. Subsampling into a large pan and divided into 16 equal sections. The sections were then selected and each sample was placed under a dissecting microscope in a petri dish. Forceps were used to move debris and find invertebrate species. Once an invertebrate was found, it was classified by order and placed into the respective bottle for that order. Using the macroinvertebrate key from An Introduction to the Aquatic Insects of North America (Merritt, et al.), the samples were key out to identified down to family, genus, or species. This information was then used to conduct data analyses and to assess the abundance, diversity, and species composition of Soberanes Creek.

Results

Several metric indexes and models were conducting for each of the species from Soberanes Creek using both data analysis software ArcGIS and Microsoft Excel. The first sets of results are the three model metrics (O/E, MMI, and CSCI) which were used to determine whether or not the site is disturbed or reference. The second sets of results are the Shannon- Weiner index, Shannon index (H0), and the Simpson index were used to determine the overall species composition of the stream such as diversity, evenness, and richness of the BMI sampled. The third sets of results are the EPTC, and FFG used to find the abundance of sensitive stream order within the creek to determine if there any environmental stressors negatively impacting the BMI population. Lastly,
water quality testing was conducted to assess the concentration of nutrients and chemicals are presented in the creek’s water.

*The three model metrics (O/E, MMI, and CSCI)*

The observed over expected (O/E) model output was 0.589 with a percentile of 0.020. The multi-metric index (MMI) model output was 1.120 with a percentile of 0.75. Both the MMI and O/E were combined to produce one single score called the California Stream Classification Index (CSCI). The CSCI model output was 0.85 with a percentile of 0.18 (Table 1). These three metrics are standardizing models used throughout California to determine whether or not a stream site is disturbed or reference.

### Table 1: The three stream health model metrics (O/E, MMI, and CSCI)

<table>
<thead>
<tr>
<th>Stream ID</th>
<th>Count</th>
<th>O/E</th>
<th>O/E Percentile</th>
<th>MMI</th>
<th>MMI Percentile</th>
<th>CSCI</th>
<th>CSCI Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soberanes Creekes</td>
<td>42</td>
<td>0.589</td>
<td>0.020</td>
<td>1.120</td>
<td>0.750</td>
<td>0.854</td>
<td>0.180</td>
</tr>
</tbody>
</table>

*The Shannon-Weiner, Shannon index (H₀), and Simpson indexes*

The Shannon-Weiner Index (H) and the Simpson’s Index of Diversity was calculated to determine the abundance of species diversity. In order to calculate the Shannon-Weiner Index, these three elements (Pi, ln[Pi], and Pi*ln[Pi]) were included in an excel table for each site. The proportion (Pi) was calculated by dividing the number of individual species counted at the representative stream by the total number of macroinvertebrates counted at each site. The second step was to take the natural log (ln[Pi]) by converting the value of Pi to its natural logarithm form. The last step was to multiply the proportion (Pi) and natural log of the proportion (ln[Pi]) together to find their final product. The Shannon-Weiner Index was calculated by the summation of all the Pi*ln(Pi) at their representative site(s).

Evenness was calculated by dividing the number of total benthic macroinvertebrates (BMI) found at the site by the species richness for that site. This quantitative measure was then multiplied by the natural log of the new proportion (calculated in the preceding steps) for each of the distinct species observed at the site. For each of the species their own Pi*ln(Pi) was summed with the other species Pi*ln(Pi) at the site to obtain the maximum Shannon-Weiner Index (Hmax). The closer H is to Hmax, the more diverse the site is. The true H was divided by the Hmax to get the Species Evenness (E) for that site. The species evenness is a measure of biodiversity, which quantitatively shows how the species in a particular habitat area are distributed within the sampling site. Evenness is a ratio, thus as the value approaches 1, the distribution of species becomes more equal.

Simpson’s Index of Diversity is also calculated based on the proportion (Pi), however, unlike the Shannon-Wiener index, the next step is to square the value of Pi and the summation of that column is equal to D. The sum is subtracted from 1 to find Simpson’s Index of Diversity. The closer this number is
to 1, the less diverse the site is. The Simpson Diversity indices describe the probability of choosing any one individual from the same species twice, as such; the maximum value is 1 which states that the probability of picking two of the same species is higher than would otherwise be expected. The results gathered from our samples found that there was no significant difference between the two sites (burned and unburned) as far as Shannon-Weiner diversity index, evenness, Simpson, and Simpson’s index of diversity with a significance level of 0.05 (Table 2). The Shannon-Weiner incorporates richness and evenness into one usable number. The weakness is that it cannot capture the difference between populations with highly difference richness values (Figure 2).

Table 2: The Shannon-Weiner, Shannon index ($H_0$), and Simpson indexes calculations

<table>
<thead>
<tr>
<th>Indices</th>
<th>Var.</th>
<th>Soberanes Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shannon-Weiner</td>
<td>H</td>
<td>1.498</td>
</tr>
<tr>
<td>Max Shannon-Weiner</td>
<td>Hmax</td>
<td>2.079</td>
</tr>
<tr>
<td>Richness</td>
<td>R</td>
<td>8</td>
</tr>
<tr>
<td>Evenness</td>
<td>E</td>
<td>0.720</td>
</tr>
<tr>
<td>Simpson</td>
<td>D</td>
<td>0.302</td>
</tr>
<tr>
<td>Simpson’s index of diversity</td>
<td>1-D</td>
<td>0.698</td>
</tr>
</tbody>
</table>

Figure 1: Pie chart showing the percentage of each order of benthic macroinvertebrate’s order found at Soberanes Creek.

*The EPTC and (FFG)*

EPTC is a metric which uses known sensitive species abundance as indicators to determine the severity of the disturbance (Townsend 1989). The proportions of EPTC in the samples taken from Soberanes Creeks Creek were found to be the most abundant. Ephemeroptera had a total percentage of 45.24%, Plecoptera had a total percentage of 9.52%, Trichoptera had a total percentage of 28.57%, and Coleoptera of 3.38% (Table 2).

Functional feeding groups (FFG) are classifications of species in each family that are classified in different feeding group. FFGs are a useful metric to use when looking at stream conditions (Figure 1). The proportions of FFGs in the samples taken from Soberanes Creek were collector gatherers had a total
percentage of 45.2%, predators had a total percentage of 19 %, scrapers had a total percentage of 11 %, and shredders had a total percentage of 9.5 %.

Table 3: Stream health metrics

<table>
<thead>
<tr>
<th>% EPTC</th>
<th>SOB</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>45.24%</td>
</tr>
<tr>
<td>P</td>
<td>9.52%</td>
</tr>
<tr>
<td>T</td>
<td>28.57%</td>
</tr>
<tr>
<td>C</td>
<td>2.38%</td>
</tr>
</tbody>
</table>

Figure 2. Pie chart showing the percentage of each order functional groups found at Soberanes Creek.

Water Quality

Prevalent nutrients found in the Soberanes stream were phosphate with a concentration of 0.46, nitrate with a concentration of 0.07 (Table 4).

Table 4: Nutrients found within the stream

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>Phosphate</th>
<th>Nitrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soberanes</td>
<td>7.3</td>
<td>0.46</td>
<td>0.07</td>
</tr>
</tbody>
</table>
Discussion

Researchers used macroinvertebrate benthic (BMI) data to assess and report the changes in communities and physical habitat compiled into four sets of results. Lastly, researchers evaluated the biological stream’s conditions, chemistry, and physical habitat after the recent fire to determine what any possible environmental stressors are negatively affecting the BMI population of the creek for future remediation efforts.

The three model metrics (O/E, MMI, and CSCI)

The multi-metric model (MMI) measures ecological structure and function. The observed-to-expected (O/E) model measures taxonomic completeness. The O/E and MMI models are sum together and take the average to provide an output of indication about the condition of a stream called the CSCI score. The CSCI is a statewide standardize model used to translate complex data about individual benthic macroinvertebrates (BMIs) living in a stream into an overall measure of stream health, whether or not it is disturbed or reference site. According to the CSCI metric, Soberanes Creek has a score of 0.85 indicating the stream is a reference site (Table 1).

The Shannon–Weiner, Shannon index (H₀), and Simpson indexes

The Shannon–Weiner index, Shannon index (H₀), and Simpson indexes were calculated to determine the diversity, evenness, and richness of the BMI found. These stream health metrics were used to evaluate the health of the Soberanes Creek, indicating there is a high abundance, richness, and diversity of the macroinvertebrate benthic (Table 2).

The EPTC and FFG

Ephemeroptera, Plecoptera, Coleoptera, and Trichoptera are known stream species orders that are sensitive to disturbances. These species orders have been compiled into a standardize metric called EPTC. The EPTC uses known sensitive stream species order abundance as indicators to determine the severity of the disturbance (Townsend 1989). The Plecoptera, Coleoptera, Ephemeroptera and Trichoptera showed a significant high abundance at the Soberanes Creek (Table 3).

Functional feeding groups (FFG) expand beyond the limits of EPTC. Taxa were assigned a functional feeding group category (predator, shredder, grazer, filterer, and collector) and tolerance value (TV), which represents the relative sensitivity to perturbation and/or stressors. Shredders are most sensitive to disturbance out of all the functional feeding groups. Soberanes Creek had a relatively low abundance of shredders at 9.2%. This indicates that although Soberanes Creek is a reference site with an EPTC metric showing a high abundance of sensitive stream order species based on the FFG results, the Soberanes Creek is being effectively by current environmental stressors (Figure 2).
Physical habitat including water quality

Stream conditions (stressors) such as wildfires act like filters on the stream and will filter out certain species by adding more stress onto the environment (Poff 1997). Human activities led to the Soberanes fire being started, human induced wildfires can dramatically alter terrestrial and aquatic ecosystems. When there is a fire disturbance, trees become broken causing the soil to become loose collecting into water’s stream. This creates a significant amount of suspending sediment negatively impacting the biological organisms of the creek. Ash from terrestrial burnt remains can accumulate in the creek’s water. Also, vegetation can become lost causing stream bank to become unstable. As a result of the fire disturbance, researchers were expecting to see altered flow regimes and increased amount of suspended sediment in the stream.

However, this was not the case at Soberanes Creeks. Samples were collected in early February, when there was a high flow of rainfall with a strong magnitude and fast velocity from increased seasonal annually rainfall. There were also a low amount of suspended sediment in the water, plenty of canopy cover, and a noticeable decline in bank stability. There was a low amount of sediment due to either a large amount of seasonal rainfall causing high flows with a substantial magnitude and fast velocity capable of washing out all the sediment, primary consumers, woody debris, and nutrients in the stream (Table 4). Or a possible blockage further upstream prevents the sediment traveling down into the creek. It is important to know if there a blockage further upstream preventing the sediment coming down, this could cause potential problems to the Creek over time. Based on these results, it is not certain that fire disturbance is acting as an environmental stressor on the creek. Further monitoring and assessment need to be conducted to determine what environmental stressors are negatively affecting the Soberanes Creek.

Conclusion

Human activities, in particular starting wildfires, can drastically change the environmental conditions and resources availability within a stream. Results proved that the Soberanes Creek is still a reference site despite the fire disturbance that transpires last year. It is recommended that stricter camping restrictions should be implemented to prevent future wildfires. Although, results were inconclusive in determining which environmental stressors are causing a decline of shredders in the Soberanes Creek. The possible error could be according to the SWAMP protocol samples collected size should be 500; however this report was based on a small sample size of 42 so results may be inconclusive. Further monitoring and assessment need to be conducted in order produce more conclusive results to determine the stream health and environmental stressors of the Soberanes Creek.
References


