Lab 8

Stream Ecology Using ANOVA

April 10, 2002

Group 5
Abstract
Stream ecology was analyzed in this lab because it indicates the effects of pollutants on organisms in the environment. Lab 8 compared the mouth and base of Huron Creek, which has been affected by paved-over wetlands and road salts to Coles Creek, which is virtually untouched by construction. The Total Dissolved Solids (TDS), temperature, and amount and type of organisms in the two streams were measured as indicators of the health of the stream. The conductivity, a measure of TDS, and temperature were collected using a computer program “Test 12 Total Dissolved Solids”. The amount and types of macroinvertebrates were determined by collecting 10 rocks from the stream. The organisms on the rocks were then counted and identified on each rock. This technique was used as a biological indicator of the health of the two creeks. Cole’s Creek was found to be ecologically healthier than Huron Creek through analyses of aquatic organisms present and of the conductivity of the water. Additionally, ANOVAs performed on the data showed Cole’s Creek to be statistically different from Huron Creek in temperature, conductivity, and organism diversity. Good. Some more specific results would be appropriate (e.g., The conductivity at Coles Creek (65 μS) was low and unaffected by road salts in comparison to the conductivities measured in Huron Creek (112, 490 μS). Both the number of individuals (avg. 35 per rock) and the variety of types (18 organism types identified) found in Coles Creek were much higher than those found in Huron Creek (5 and 7 per rock, 5-7 organism types).

Introduction
One aspect of Environmental Engineering deals with measuring pollution concentrations and controlling pollution in the environment. The reason for doing this is to protect the organisms present within those environments. Some species of organisms are more susceptible to pollution than others. Those species indicate the health of the ecosystem. Organisms play important roles in their ecosystem; therefore, it is critical to monitor their status to safeguard the health of the environment.

The objective of the lab was to observe the effects of paved over wetlands, and road salt on stream ecology. By measuring the temperature, conductivity, and the macroinvertebrates in an unhealthy stream compared to a healthy stream, one can see the effects of pollutants on stream ecology. A large area and large number of organisms were sampled. Therefore, ANOVAs were used to assess if any of the data was/were/ statistically different from one site to the next site.

The areas sampled were from the mouth and the base of Huron Creek and from Cole’s Creek. Huron Creek starts from behind Wal-Mart and goes to the waterfront park on the Portage Canal. The paving of wetlands there has altered the stream’s original course and there is less flow upstream than compared to/use either “than at” or “compared to”/ the mouth. Cole’s Creek is virtually untouched by human impacts, and is fast flowing compared to Huron Creek.

Methods
Each Lab section sampled either Huron Creek or Cole’s Creek. Each group collected 30 TDS measurements, 30 temperature measurements, and collected ten rocks from the respective streams. The rocks where then placed in plastic bags and taken to the lab for counting and identifying of organisms. Both the conductivity and temperature measurements were taken using the Mac laptop computers to collect the data. Since conductivity depends on the total number of ions present in the water, conductivity and TDS are linearly related. So, from the conductivity measurements, TDS concentrations were determined. The steps outlined in Lab 8 handout (Urban 2002) were followed. However, conductivity and temperature measurements were taken at three different locations on Huron Creek instead of two different locations.

**Results**

Table 1 below illustrates the TDS levels, measured by conductivity, for the four different test sites. Huron Creek at Wal-mart exhibited the highest TDS concentrations of 492.04 (Significant digits 490) mg/L while Cole’s Creek had the lowest TDS concentrations of 66.87 mg/L. The data suggested that TDS concentrations increased in Huron Creek as it passed by Wal-mart and then slowly decreased as the Creek drained to the Portage Canal. Road salt and other dissolved ions associated with the chemicals surrounding Wal-mart have been the major factor in this phenomenon.

<table>
<thead>
<tr>
<th></th>
<th>Cole’s Creek</th>
<th>Huron Creek Mouth</th>
<th>Huron Creek Walmart</th>
<th>Huron Creek Walmart before</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>66.87</td>
<td>346.0</td>
<td>492.04</td>
<td>112.68</td>
</tr>
<tr>
<td><strong>St Dev</strong></td>
<td>1.40</td>
<td>164.6</td>
<td>12.05</td>
<td>1.99</td>
</tr>
<tr>
<td><strong>COV</strong></td>
<td>0.02</td>
<td>0.48</td>
<td>0.02</td>
<td>0.02</td>
</tr>
</tbody>
</table>

**Significant digits**
Table 2 shows the average number of macroinvertebrates per rock for each test site. Cole’s Creek contained the highest number of organisms per rock. Huron Creek had a relatively low number of organisms at both locations. The category named “Other” summed all of the individual organisms not bolded. Tables 3, 4, and 5 below show the results of the ANOVA for temperature, conductivity, and number of organisms for each of the four sites. The F value was larger than the F-critical value for all three cases. This meant that all four sites are statistically different from one another in all three cases. The ANOVA results indicate that not all four sites are similar, but it does not indicate whether one is different from the others, whether two are different from another two, or whether each one is different from the others.

There are not all the observations being read; therefore, the values are slightly off.
Discussion
Figures 1, 2, and 3 show the distribution of aquatic macroinvertebrates in Cole’s and Huron Creek. Midges were most predominating/predominant/ in all three sites. Cole’s Creek displayed a wider variety in/of/ organisms than did either test site on Huron Creek, which displayed a lower variety of organisms at higher population levels percentage-wise. Huron Creek also had a larger percentage of group 2 and 3 taxa organisms, which are more pollution tolerant, than did Cole’s Creek. Cole’s Creek contained more group 1 taxa organisms, which can only be found in good quality water. This indicated poorer water quality in Huron Creek than in Cole’s Creek. This difference may have been due to Huron Creek flowing through more industrialized areas and encountering more pollutants than Cole’s Creek.

Figure 1: Huron Creek at Walmart Macroinvertebrate Pie Chart

How could the reader tell what is the percentage of each type of organism from the figure?

Figure 2: Cole's Creek Macroinvertebrate Pie Chart
Huron Creek Mouth Macroinvertebrates

Figure 3: Huron Creek at Mouth Macroinvertebrate Pie Chart

Temperature also may have played a role in the number of organisms per rock. The data indicated that higher temperatures correlated with an increased variety of organisms. Cole’s Creek had an average temperature of 2.6 °C and had a wide variety of organisms. On the other hand, Huron Creek at Walmart had an average temperature of 0.57 °C and had a low variety of organisms.

Conductivity, as a measure of TDS concentrations, also may have played a role in the number of organisms per rock. As shown in Table 1, Cole’s Creek had a much lower average conductivity level at 66.87 mg/L than did any of the points on Huron Creek, which ranged from 112.68 mg/L to 346.0 mg/L. It was not determined exactly how much of the conductivity levels were due to saline runoff from streets but it can be assumed that road salt accounted for a large part of the high conductivity concentrations seen in Huron Creek.

All three ANOVAs performed on temperature, conductivity, and number of organisms showed statistical differences between the four test sites. This was justified in that the averages of temperature, conductivity, and number of organisms for each site were noticeably different from one another. The ANOVAs confirmed this through statistical analysis. Therefore, not only was Cole’s Creek different from Huron Creek in all three categories, but Huron Creek displayed different characteristics within the stream itself at the three different points that were measured.

Conclusion

In conclusion, Cole’s Creek appeared to be of higher water quality than Huron Creek according to conductivity concentrations and macroinvertebrate diversity. The ANOVAs that were performed in this lab also showed that Cole’s Creek is statistically different in all three measured categories from Huron Creek. In addition, Huron Creek displayed statistical differences in all three measured categories at different points within itself due to the areas it flows past and the alteration of its original pathway. This lab
confirmed that the virtually pristine Cole’s Creek was of better water quality than Huron’s Creek, which has been subjected to the construction associated with Wal-mart and pollution sources from Houghton’s urban areas. Good
Sample Calculations

1. Mean- \( X = \frac{\sum_{i=1}^{n} X_i}{N} \)
   
   sample: \((13.9+13.2+13.7)/3=13.6\)

2. Standard Deviation- \( \sigma = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{N-1}} \)
   
   sample: \(((13.9-13.6)^2+(13.2-13.6)^2+(13.7-13.6)^2/(3-1))^{(1/2)} = 0.4\)

3. Coefficient of Variance - \( COV = \frac{\sigma}{\bar{X}} \)
   
   Sample: \( \frac{185.7}{945.6} = 0.196 \) \( \frac{185.7}{945.6} = 0.196 \)

4. ANOVA-

   \( S_b^2 = \frac{\sum_{j=1}^{k} n_j (\bar{Y}_j - \bar{Y})^2}{k-1} \)

   \( S_j^2 = \frac{\sum_{i=1}^{n} (X_{ij} - \bar{X}_j)^2}{n_j - 1} \)

   \( S_w^2 = \frac{\sum_{j=1}^{k} (n_j - 1) S_j^2}{\sum_{j=1}^{k} (n_j - 1)} \)

   \( F = \frac{S_b^2}{S_w^2} \)

   \( F_{crit} \) is found in Table 8.2 in *Statistical Procedures for Analysis of Environmental Monitoring Data and Risk Assessment*
WORKS CITED


CE3502
Laboratory Report Evaluation Sheet

I. Title Section  3/3
   1) Title  1) Date  1) Authors

II. Abstract  6/7  Needs more specific results
   2) Objective / Purpose  1) Methods  2) Key results  2) Significance

III. Introduction
   a) Concern with this topic (background)  4/4
   b) Objectives  4/4

IV. Apparatus and Procedure  4/4
   1) Reference lab handout  1) Changes made to lab

V. Results  12/15
   5/5) Text along with results. Significant digits

VI. Discussion  14/17
    Overall, the discussion is quite good. The ANOVA results are over-interpreted and no t-tests were performed to identify the specific differences.

VII. Conclusion and Recommendations  9/9
    2) Answer the objectives  3) Main Results  2) Sources of Errors  2) Assumptions

VIII. Tables, Figures, Appendices  8/10
    2/2) Label Appendices A, B, etc.  2/2) Number and Title Tables  2/2) Number and Title Figures  2/2) Units  0/2) Label Axis

IX. Composition  17/20
    1/2) Spelling  4/5) Grammar  2/2) Separate paragraphs / single sentence paragraphs  2/2) Sample Calculation  4/5) Meaning behind writing  4) Not concise writing

X. Overall Appearance, Organization  8/8
    2) Ease of finding data (including summary tables)  2) Neatness of tables / figures  2) Neatness of sample calculation  2) Neatness of report format
Name of Student: ______________________________

Total Points for Report (100 Maximum): **89/90**

Comments:  *A very nice report except for lacking t-tests.*