The report on the influence of watershed on the water quality in fullerton

Environment, Nature

Introduction

Watersheds

A watershed is a geographical location that drains into a river system by one outlet (Musacchia, B. & Madden, B., 2014). Watersheds are segregated by vantage points such as mountains and hills, used to maintain water sources and are primary spots for organism growth and revolved around by food webs which are intricately made with multiple organisms. In Orange County, California, there are over 10 watersheds. Watersheds are important because they help guide water into larger bodies of water preventing flooding and other damages. Though watersheds provide many ecosystems with flowing fresh water, this water is sometimes tainted as it travels through urban cities, such as Fullerton. Many common pollutants include pesticides, fertilizers, and animal wastes (Musacchia, B. & Madden, B., 2014). These pollutants strongly affect the biological aspects of environment; many creatures and plants cannot live with intensely affected waters.

Figure 1: Location of Observational Creek Study, Acacia Creek Park

Water Quality

Environmental changes that arise because of increased pollution and degradation have negative impacts on local watersheds and life in those ecosystems. It is important to observe and collect data on the water quality of a body of water because it highlights potential issues that may arise in the future; it provides a precautionary insight. Many experiments have proven to many that influences can create fatal effects (Morris, Kristy 2014). Some of these experiments include measuring pH levels, fecal coliform bacteria count, and nitrate levels. By testing the waters of the Acacia Park Creek, the experiment can determine whether or not the local community or other sources are generating negative impacts. By testing for biological diversity and water chemistry, the experiment can also determine when to take action. How much pollution and degradation is too much for the environment to handle?

Water chemistry. Water chemistry is the analytical study of how chemical compounds can affect life water quality at the immediate level as well as the molecular level. Water chemistry includes different studies such as pH tests and nitrate level examinations. This test can help determine whether or not the water is suitable for life. For instance, this study can help determine whether or not water is too acidic or basic to sustain normal life. Most, if not all, methods of analyzing the water chemistry of particular watershed include using pH indicators, nitrate concentration indicators, and phosphate concentration indicators (Musacchia, B. & Madden, B., 2014). The collection of several observations and data can accumulate and formulate a Water Quality Index (Musacchia, B. & Madden, B., 2014) that is a uniform unit that can be used to estimate water quality status and compare to other watersheds. Two very important aspects we need to analyze include the phosphate and nitrate concentration of the water. These data values can help determine whether an algal bloom will occur and how detrimental it may be. One reason that there may be an increase in these chemical compounds is excess runoff that carries fertilizers and pesticides.

Biological assessment. Biological assessment is the analysis of the number of living organisms in a particular are and how they work along amongst each other. It is important to analyze the different populations in a particular area as the data can show the relationships between organisms; for instance, if a particular species is excessively growing, an analysis can be made to see whether or not this larger species is degrading the other smaller species (Morris, Kristy 2014). Processes of achieving information is by taking samples of random water and sediment of the watershed and taking counts of how many organisms there are in a particular sample count. These population counts are amalgamated with other species counts and formulated into a Biological Index which is an uniform unit that allows for comparison amongst watersheds and evaluation of a certain watershed. Some indicators that can and will be used include the biological index; this indicator takes into account the number of species in the whole area and calculates whether or not there is a healthy biological diversity.

This study. The Acacia Park Creek in Fullerton, California will be the test site of this particular study. Water quality and water chemistry will be heavily tested. Several water samples will be taken in addition to population counts on several species. Water chemistry will test for nitrate levels, phosphate levels, and many more parameters (Musacchia, B. & Madden, B., 2014). Biological assessment also helps guide the study to show relationships in the particular area.

Research Questions:

1. Is the nitrate level in the Acacia Creek, which is located in the heart of a suburban neighborhood, excessively high?
2. Is the phosphate level in the Acacia Creek, which is located in the heart of a suburban neighborhood, excessively high?
3. Does the location of the watershed and its surrounding environment affect the water quality?

Hypotheses:

When the water chemistry of the Acacia Park Creek is analyzed, the Water Quality Index will indicate that the water quality is fair.

When the biological diversity is assessed, the water quality of Acacia Park Creek will be given the Biological Index that represents good.

The phosphate levels will be higher than normal because the use of pesticides and herbicides carried by runoff in a suburban neighborhood will increase the phosphate content in the creek (Musacchia, B. & Madden, B., 2014). The nitrate levels will be higher because the use of fertilizers is higher; runoff from suburban neighborhood runoff will carry excess nitrates into the watershed, hence increasing the nitrogen content in the creek (Musacchia, B. & Madden, B., 2014).

Materials and Methods

Study Area

The location of the study site will be located in Fullerton, California at the Acacia Park Creek in a suburban, residential neighborhood. The climate during this study is significantly warmer than that of any other part of the year; September and October are some of the hottest parts of the year (The Weather Channel 2014) in Southern California. In addition, precipitation was extremely low at this time; therefore there may have been a potential decrease in water in addition to chemicals and organisms. The observational study was conducted on October 2nd and 3rd of 2014. On these two days, the cloud cover was minimal to none and the wind was minimal to none. The study was established into three parts, each carried out by a different team. The observation team went down to the creek to take two samples of water. The first sample will be stored and saved for a couple of days so that it can be used to do a fecal coliform test. The second sample will be used right away to test for parameters such as water oxygen saturation. Physical assessments were made on the site to observe how the area appears; analyses based on wildlife, vegetation, or geography will be made. Observations have shown that the stream bottom and bottom cover is fairly rocky; the stream bank is very bare, full of plenty of human activity signified by trash and trails with limited vegetation. The trash assessment will measure the amount of pollution that influences the biological diversity and water chemistry. The trash assessment has shown that the amount of trash left and collected at the Acacia Creek is extremely high; most of the litter is caught by reeds and other forms of aquatic vegetation. Trash is collected, categorized, and accounted for. The flow of the water will also help show how fast certain pollutants spread in the creek and how its flow affects biological diversity. The flow is tested in a designated site where a bobber is placed in the water, allowed to flow for 10 meters while being timed during that duration; 10 meters divided by recorded time is equivalent to the average rate of the water flow.

Data Analysis

Chemical analysis. The chemical analysis of this study occurred both at the creek and back inside the classroom; data collection occurred on October 2nd and 3rd while other experiments were done on October 4th and 5th to observe other parameters such as fecal coliform. All of these events occurred between the times of 10: 30 A. M. and 12: 20 P. M. Each parameter has a particular Q-value that corresponds to the determined actual value. The Q-value is then multiplied by a particular weighting factor. Then, the sum of all the products of the parameters forms a value called the WQI or Water Quality Index (Musacchia, B. & Madden, B., 2014). This value allows for the comparison and evaluation of a particular watershed.

This chemical analysis will help determine whether or not the creek is chemically safe and healthy, there are values that can be used to help gauge health. Q-values were collected from a classroom study. Each of these Q-values are then multiplied by a weighting factor which will be incorporated into the sum of all parameters; this sum will be the Water Quality Index value. This value will be analyzed on a scale that will gauge the water quality rating.

Biological assessment. The biological assessment was conducted on October 4, 2014 at around 10: 30 a. m. to 12: 20 p. m. In order to collect the information properly, there is a procedure that must be followed. Using hands and pitchers, the researchers must collect a generous amount of sediment from the creek; make sure to collect water separately to help separate animals later. Use a sifter or sieve to separate the water and sediment. Fill an ice cube tray and the sediment with creek water. Then start collecting and separating the individual creatures into groups; each ice cube section is sectioned for a particular species. Make sure to use tweezers and pipets to aid in classification. If there is a difficulty in deciphering the creatures, use a guide and magnifying glass. After all possible creatures are collected and categorized, count the number animals in each of the species and record their numbers.

After collecting and categorizing the animals in the collected sediment and water, an analysis must be made. To properly find the gauge value, Biological Index of Water organisms, the number of organisms must be determined. After this determination, a percentage of each species amongst all collected is made; this percentage is also known as an Abundance Category. This percentage will also help determine an S value, an Index Score, by using a particular table, the Table of Index scores. By adding all the S-values together, the sum can be used to determine the Biological Index of Water Quality. This sum will be used to find a rating with the Water Quality Rating Scale.

The method in which the Biological Index of Water Quality (Musacchia, B. & Madden, B., 2014) was determined is facilitated by counting organisms and assigning a total percent of a particular species in a sample. The abundance category is also used to adjust and account for the different proportions of the Acacia Creek. Finally, a “ S” value is used to find the sum score in 3 different categories, the sensitive, intermediate, and tolerant category. Adding the “ S” values create what is called the Biological Index of Water Quality. This index will generate a unit that can be used for comparison and evaluation of a particular body of water.

Data Collection

Chemical Analysis. The data of the water quality is states as October 2, 2014 during 11: 20 to 12: 20. All instruments were conducted with the directions of the manufacturer labels.

Figure 1: Parameter with corresponding Measuring Device and Unit

Parameter Measuring Device Unit

Temperature Thermometer Celcius (*C)

Dissolved Oxygen Colorimetric/ Chem Mets Grams per mL

Acidity/Basicness Probe pH

Fecal Coliform Cell Growth Plate Colonies 100 mL

Biological Oxygen Demand Colorimetric/ ChemMets Grams per mL

Nitrate Concentration Colorimetric/ LaMotte Parts per Million or mg/L

Phosphate COncentration Colorimetric/ LaMotte Parts per Million or mg/L

Conductivity Probe Micro Siemens

Turbidity Secchi Tube Centimeters

Biological Assessment. The biological assessment was conducted on October 4, 2014 from 11: 20 to 12: 20. Hands and pitchers were used to gather sediment, which was later put in a sieve in which the sediment was analyzed. The contents in the sieve were separated by general physical characteristics and replaced into ice cube trays filled with stream water to categorize the many organisms. All species and number of organisms in each species were identified and recorded.

Results

General Observations:

The creek that was tested is located in the Acacia Park in the suburban neighborhoods of Fullerton, California. This creek is located between houses and a playground; both locations are connected by a bridge. Heavy human activity in these areas is indicated by trails, trash, and graffiti on the banks of this creek. The clear creek itself is very low in water. It shows signs of previous times in which the water was higher such as salt lines and ridges, but the water at the time of testing and observation was at most half a feet deep. There is vegetation along the hills, but most of the shrubs and trees are tainted by human activity. The smell of the water is near nothing.

The flow of the water is at 1. 1 meters per second. This seemed to be a relatively slow flow rate in the area in which it was tested. In terms of litter and trash, there is plenty of around the creek and it seems to collect around the reeds and bridge. Litter also covers the surrounding environment left by human activity.

Chemical Assessment.

Table 2: Collected Data versus Average Data

Test Average Measurements Observed Measurements

pH

Temperature Change

Fecal Coliform

BOD

Nitrate

Phosphate

TDS (Conductivity)

TSS (Turbidity)

Ammonia

Dissolved Oxygen 7. 836

1. 1 *C

199. 0 colonies per 100 mL

3. 000 mg/L

0. 3333 mg/L

0. 4598 mg/L

1450 microseconds/meter

5. 440 mg/L

0. 0833 mg/L

8. 380 mg/L 10. 12

2. 100 *C

5. 760 colonies/100 mL

6. 600 mg/L

9. 600 mg/L

7. 500 mg/L

5. 600 mg/L

5. 440 mg/L

N/A

Table 2: This table displays the series of tests conducted and the average measurements in conjunction to the observed measurements from the Acacia Creek Park.

Based on the recorded measurements, it is clear that many of the observed values are not near the expected values. In most cases the observed values exceeded the average values. For instance pH, nitrate, and phosphate levels were increasingly high and have no close relation to the average values. On the other hands, some values were significantly lower than that of the average value. For instance, the parameters that have lower values than the average values are TDS (Total Dissolved Solids), TSS (Total Suspended Solids), and Fecal Coliform.

The Water Quality Index (WQI) (Musacchia, B. & Madden, B., 2014) value is 68. 83. This value translated into a Water Quality Rating is Poor Water Quality. All parameters contributed to this aspect because all of the recorded aspects were extremely abnormal whether it is excessive or low, all contributed some form of influence on the Water Quality Index. For example, the Fecal Coliform is expected to be 199. 0 colonies per 100 mL, but the actual value is 5. 760 colonies/ 100 mL The largest influence based on differences comes from TSS (Total Suspended Solids) and Dissolved Oxygen.

Graph 2

The Graph 1 shows the proportion of parameters that affect the Acacia Creek. Based on this pie chart, Dissolved Oxygen is the most contributive parameter in the creek. However, this does not denote a connotation on the high value of dissolved oxygen. This solely shows that dissolved oxygen is a large influence towards the Water Quality Index. It does not show whether dissolved oxygen levels are bad or good.

Bioassessment

There are three categories of biological organisms that were analyzed. The first group is the Sensitive Category which includes mayflies, stoneflies, caddisflies, and hellgrammites. These organisms are the most vulnerable to slight changes in the environment. The second group is the Intermediate Category. This category includes riffle beetles, netspinning caddisflies, alderflies, crane flies, water beetles, flatworms, and other invertebrates. These organisms are fairly resistant to changes in the environment, but extreme changes cannot sustain these organisms. The last category observed is the Tolerant Category. This category includes midges, blackflies, dragon flies, damsel flies, leeches, snails, clams, scuds, and segmented worms. These organisms are the least susceptible to environmental changes and are able to sustain themselves during these changes.

Table 3: Number count of Acacia Creek Biological Survey

Sensitive Intermediate Tolerant

Number Capture Index Score Number Capture Index Score Number Capture Index Score

Mayflies

Stoneflies

Caddisflies

Hellgrammite 3

0

0

0

6

0

0

0 Riffle Beetles

Netspinning

Caddisflies

Alderflies

Craneflies

Water Beetles

Flatworms

Invertebrate 1

2

0

0

0

7

8 2

2

0

0

0

2

2 Midges

Black Flies

Dragon Flies

Damsel

Flies

Leeches

Snails

Clams

Scuds

Segment

Worms 9

0

0

0

2

0

34

209

27 1

0

0

0

1

0

1

0

1

Table 3: This table shows the recorded number of organisms in our Acacia Creek Park samples and the corresponding index score.

Based upon the sample survey and Table 3, there was a significant amount of tolerant organisms, moderate amount of intermediate organisms, and very few sensitive organisms. This is expected because of the differing tolerance levels and the resistance of each type of organism. The total number of groups counted is 10. With all the index scores summed up, the value produced is 19. This gives the water quality a rating of Fair. It would be most favorable if the Biological Assessment Index was higher at around 25 or more, which would give the creek a Biological Assessment Index of Excellent.

Graph 2:

Based on this Graph 2, intermediate organisms have the largest proportion of index scores, sensitive have a moderate amount, and the tolerant have the lowest proportion. In comparison to the table above, even though there was a significant amount of tolerant organisms, its influence on the Biological Index of Water Quality (Musacchia, B. & Madden, B., 2014) is minimal. However, intermediate organisms, with a moderate amount of organism count; it displays the greatest influence in terms of index score.

Water Quality Discussion

Conclusion:

Hypotheses:

When the water chemistry of the Acacia Park Creek is analyzed, the Water Quality Index will indicate that the water quality is fair due to abnormal levels in creek parameters.

When the biological diversity is assessed, the water quality of Acacia Park Creek will be given the Biological Index of Good.

The phosphate levels will be higher than normal because the use of fertilizers carried by runoff in a suburban neighborhood will increase the phosphate content in the creek (Musacchia, B. & Madden, B., 2014). The nitrate levels will be higher because the use of fertilizers is higher; runoff from suburban neighborhood runoff will carry excess nitrates into the watershed, hence increasing the nitrogen content in the creek (Musacchia, B. & Madden, B., 2014).

Post Hypotheses:

The data collected from the study provides a Q-Value of 68. 83 which will reject the hypothesis that the water chemistry of Acacia Park Creek is fair. The Acacia Creek water chemistry is Average. For the water chemistry to be fair, the Q-value must fall under the interval of 26-50. The actual observed Q-Value is 68. 84 which falls into the range of Average water quality.

The data rejects the hypothesized Biological Index of the Acacia Park Creek. It is not Good; it is only Fair. The actual value of the Biological Index of the Acacia Park Creek is 19 which falls into the Fair category whereas Good requires a value between 21 to 25.

The data accepts this hypothesis because both nitrate levels and phosphate levels are significantly higher than the average levels. The average levels of nitrate and phosphates are 0. 3333 mg/L and 0. 4598 mg/L, respectively. However, the actual values were 9. 600 mg/L and 7. 500 mg/L respectively.

Evaluation:

There are multiple potential sources of error that could have occurred during the study. Researchers could have misread the readings on the instruments used. To fix this, the researchers can receive multiple readings to ensure safety and clarity of the research. Another source of error is the miscalculation of Q-values and Biological Indexes. To reduce this error, multiple calculations by multiple researchers must be performed. Lastly, another source of error is taking samples of biased water, water that is collected in places which is not representative of the whole Acacia Park Creek. The best way to reduce this issue is to take multiple samples from multiple places and times.

The procedures of this experiment are properly done in terms of steps for each instrument and sample count. The only issue with this particular set up is the loss of multiple trials. The issues that will be faced are the lack of multiple trials. Multiple trials decreases variability and focus the observed values of the Acacia Park Creek to the actual values. The best way to resolve this issue is to introduce the concept of team research by breaking large classes into several groups and have each group conduct the whole experiment on its own.

Another procedure in this experiment that should be improved is the amount of time provided to conduct these studies. With increased time permission, it will be easier for researchers to get more accurate observations. In addition, more time will also allow for increased amounts of study. More time permits researchers to obtain more information that will reduce biases.