2018 Student Research Symposium Webinar Series

Analyzing GLOBE Data
December 13, 2017

Dr. Richard Wagner
Dept. of Earth and Atmospheric Sciences
Metropolitan State University - Denver

Schedule of Webinars on Facilitating Student Research

Conducting Field Investigations	October 24, 2017
Writing research Questions	November 14, 2017
Analyzing GLOBE Data	December 13, 2017
Writing Conclusions	January 24, 2018
Science Poster Construction	February 13, 2018
Science Poster Presentation	March 5, 2018

www.globe.gov/web/united-states-of-america/home/student-research-symposia

Steps in the Scientific Process

Observe Nature

Pose Questions

Develop Hypothesis

Plan Investigation

Assemble Data

Analyze Data

Document Conclusions

Present Findings

Pose New Questions

Analyze Data

In studying Earth, data analysis often involves comparing data from different times and places and looking for patterns and different types of variations. Averages and extreme values are often useful to consider along with comparisons of how data from two different measurements vary.

- Think about what are the easiest ways to see what you are looking for in the data you have assembled – maps, graphs, tables? If you are looking for spatial patterns, maps are useful. If you are looking for patterns over time for one place, a graph works well.
- Do you need to do any calculations as part of your analysis? Remember you can use spreadsheet programs if you have access to them. They can make it easier to do calculations on large amounts of data and generally provide the ability to graph data and results.
- Analyze your data and create tables, graphs, and charts to illustrate and summarize your discoveries. Analysis should be focused on using the data to answer your stated research question(s).
- Can you answer your research questions from your data? Is your hypothesis confirmed or disproved? Remember that either result is valuable. Can you clearly state your reasoning and explain it to someone else? If you can't answer your question(s) with the data you have collected and the analysis you have performed, can you collect more data, do a different type of analysis, or revise your original questions? This is a point in your research project where talking to your teacher or mentor can help.

2017 U.S. GLOBE Regional Student Research Symposium
Rubric for Project Review

Research Question
- Clear and focused objective
- Answerable through scientific research appropriate to the scope of the project
- Addresses why project has scientific relevance and interest

Research Methods
- **Obvious use of GLOBE protocols and/or data**
- **Clearly defined variables**
- Well designed plan and data collection methods

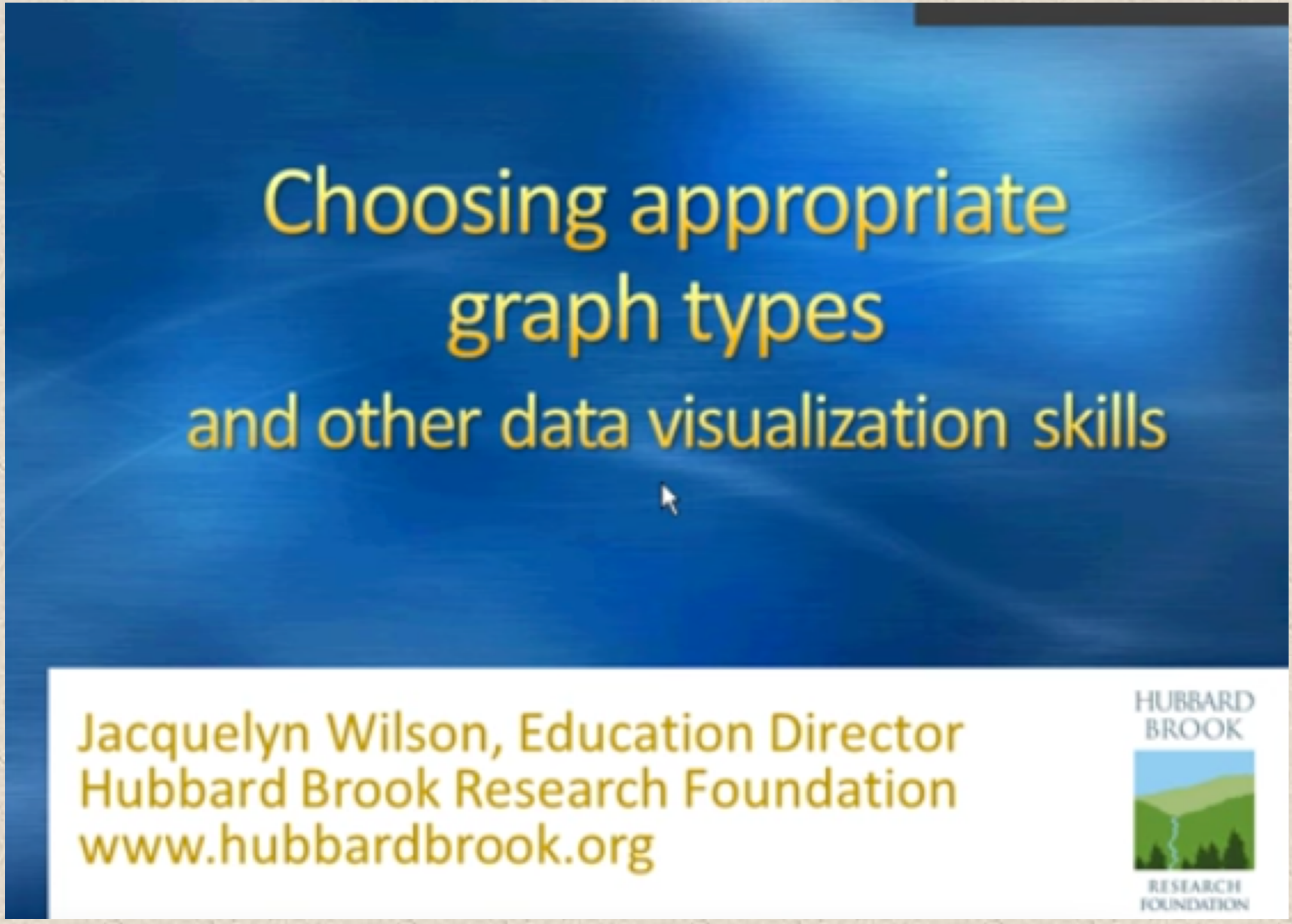
Results
- Reproducibility of results
- **Appropriate application of mathematical and statistical methods**
- **Sufficient data collected to support interpretations**

Discussion/Conclusion
- **Data interpretation with possible sources of error identified**
- Conclusion puts findings in context, stating why they are important or relevant
- Describes future research possibilities
- Materials and scientific literature correctly cited

Poster
- Logical organization of material
- **Graphics and legends clear**
- Written content reflects the student's understanding of the research

Presentation Interview
- Clear, thoughtful responses to questions
- Understanding of basic science relevant to project
- Understanding of interpretation and limitations of results and conclusions

Recorded Webinar from 2016: This part starts at 24 minute mark.



Why graph?

- To tell a story, bring meaning
  - detect patterns
  - notice variability
  - identify questions

Necessary graph components

- Appropriate graph type used
- Axes labeled correctly, with units
- Title accurately describes what is being represented
- Data plotted correctly
- Contains ONLY what's necessary to the story
- *Possibly*: line of best fit

Graph Choice Chart

What question would you like to explore? Write your question as a complete sentence.

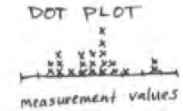
Does your question ask about the **variability** of a group of data points?

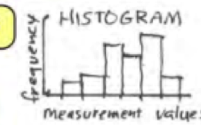
(i.e. the range of the data, the shape of the distribution, or what the center of the data is)

— YES —

Examples:
1. Do all high tides rise to the same height?
2. How variable are windspeeds here?
3. What is the range and distribution of incomes in the United States?

— make a → FREQUENCY PLOT — either — DOT PLOT / HISTOGRAM / BOX PLOT





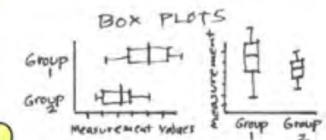
Does your question **compare two or more groups** to decide if the groups are the same or different?

— YES —

Do you want to compare the **variability of all data points** in each group to decide if any difference between the groups is *meaningful?*

Examples:
1. Which of the two car designs is most consistently the fastest?
2. Is there a meaningful difference in the heights of fertilized and unfertilized bean plants?

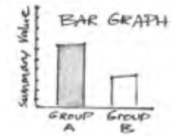
For each group make a → FREQUENCY PLOT



Are you comparing **single numbers** that summarize a group? (such as mean, median, or total...)

Examples:
1. Was the total snowfall greater this winter than last winter?
2. Do cats and dogs have the same average body temperature ?
3. How do the median incomes for the U.S. and Sweden compare?

— make a → BAR GRAPH



Does it ask if **two numeric factors are correlated** ?

Examples:
Is the temperature inside the house correlated with the temperature outside?

How did electricity used by the kitchen circuit fluctuate during the past week?

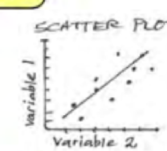
— YES —

Does it ask about how something changes through **linear TIME?**

NO —

Examples:
1. Is the fuel efficiency of a car related to its weight?
2. Are smoking rates correlated with median income?
3. Given a fixed volume, how are temperature and pressure related?

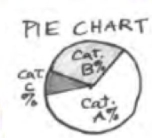
— make a → SCATTER PLOT

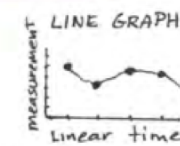


YES —

Examples:
1. Have summer lake water temperatures warmed over the last ten years?
2. How did my weight change over the last 3 months?

— make a → LINE GRAPH



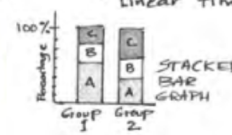


Does your question ask how a **total** is **proportioned** into sub-groups? (Or what proportion a sub-group is of a total?)

— YES —

Examples:
1. Which circuit accounts for the largest proportion of the electricity use by our household?
2. What proportion of U.S. energy comes from wind?
3. What proportion of U.S. residents take public transportation to work?

— make either → PIE CHART / STACKED BAR CHART



The Maine Data Literacy Project -- Graph Choice Chart

Graphing tips

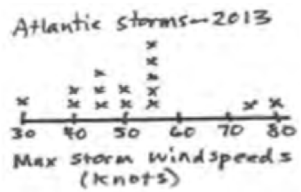
Variability questions: **Frequency plot** (3 kinds)

Kind of data:

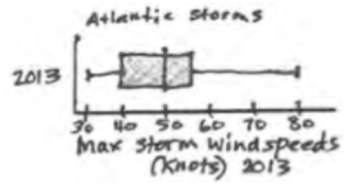
One categorical group and
One numeric variable (one axis)

Frequency plots show how variable the group is. Describe variability by range, measure of center (mean, median, or mode), and the shape of the distribution.

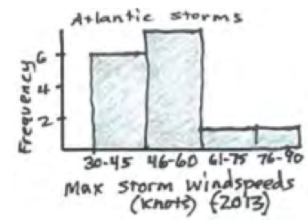
Dot plot



Box & whisker plot



Histogram

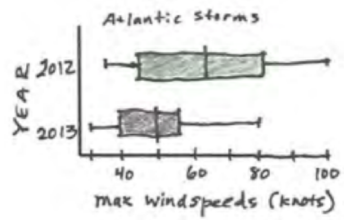


Comparing groups questions: **Frequency plots** OR **Bar graph**

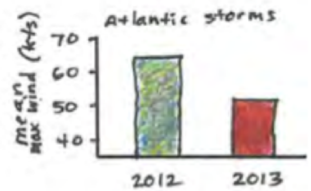
Kind of data:

Two or more categorical groups &
One numeric variable

***Frequency plots** allow you to compare how variable the groups are. **Bar graphs** only show a single number (ie. sum, average, percent or count) for each group.*



(To compare two groups of values)



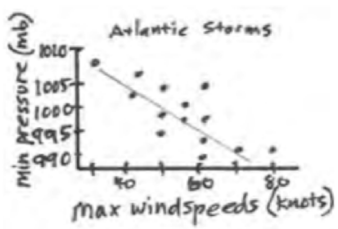
(To compare two summary values)

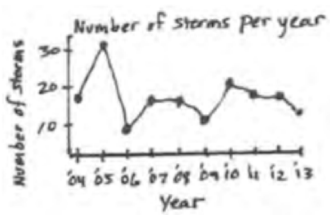
Correlation questions: **Scatter plot** OR **Line graph** (for time series)

Kind of data:

Two numeric variables

Both variables must be continuously numeric. Connect dots only if one variable is linear time (i.e. days, years…) Put time on the X-axis.
Show correlation with a 'line of best fit'.



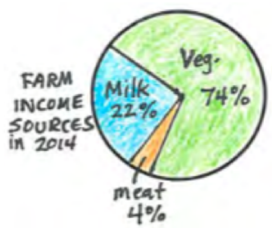


Proportion (percentage) questions: **Pie chart** OR **Stacked bar graph**

Kind of data:

Size of a subgroup as a **percentage** of the whole group (Total of sub-groups must = 100%)

In pie charts and stacked bar graphs, all sub-group percentages must total 100%.



Criteria for an informative graph:

___ Graph type fits the question
___ Axes are drawn & scaled correctly
___ Axes are labeled clearly, correctly
___ Units are given
___ Data are plotted accurately
___ Legend is present, if needed
___ Graph is overall neat & legible
___ Title and/or caption present
___ Trend line shown (scatter plot or line graph only)

___ Graph helps answer the question

(There are other kinds of questions and other kinds of graphs, and often more than one graph type is useful for a given question. Learn to graph data for these basic kinds of questions first.)

Use of Data at Southwest Regional Student Research Symposium

Selected Comments from Scientist Reviewers

Data type

"Relationship between temp. and dissolved oxygen could have been shown more visually in a line graph."

"pH should be presented as dots, not bars."

"Could have used more visuals (e.g. scatterplot)"

Available Data

"Not enough repeat samples to identify error."

"Would benefit from more data."

"Could use more data over a longer period of time."

Use of Data at Southwest Regional Student Research Symposium

Selected Comments from Scientist Reviewers

Number of Graphs

"Relationship between temp. and dissolved oxygen could have been shown more visually in a line graph."

"I would have loved to see more graphs instead of some of the pictures. "

"Nice text/visual ratio"

Appearance of Graphs

"Some of the best graphs. Each graph had a descriptive title and was big."

"Graphics needed more legible type. "

"Legends are hard to read."

"I wonder about the significance and number of decimals reported on graphs."

Macro-invertebrates And Water Chemistry

Abstract:

This science project was done to learn more about the macroinvertebrates in the Boulder Creek, and how the numbers and species fluctuate according to alkalinity, temperature, dissolved oxygen (D.O.) and pH. Before collecting data, we hypothesized that the warmer the water got, the more pollution tolerant species would be present. This is because if the water was warmer, it would mean that the atmosphere outside was warmer, which would lead to snow melt. The snow would pick up the dirt and debris it passes on its way to the creek, therefore, polluting the water. Almost every Monday, we went down to the creek and collected macroinvertebrates using the kick and pick protocol. Our conclusions were that since the stream's water chemistry stayed healthy and balanced, there was little change in the macroinvertebrates numbers and species. The only change was between the spike in stoneflies and drop in the mayflies during the fall.

Title Page: How do the species of macroinvertebrates in the Boulder Creek compare with the water chemistry of the stream?

Table of Contents:

Lindsey Bartoletta and Breck Dunbar , Alexander Dawson School, Mr. Meyers, September 19 2016 (beginning of the school year)

Question:

How do the species of macroinvertebrate in Boulder Creek compare or relate with the water chemistry? How do the number of pollution sensitive, intermediate and tolerant macro-invertebrates relate to the water chemistry as well?

What prompted the research?

At the beginning of the school year, when we were taking water samples, we decided to collect macroinvertebrates as a fun activity. We had a lot of fun doing this and wanted to do it again. When we found out about the Globe science project we thought it would be a great idea to involve the macroinvertebrates with the water chemistry to learn more about the subject.

The importance of the research:

This project could be used in many useful ways, like being able to get a good sense of the water chemistry of a creek by only looking at macroinvertebrate. It may be hard for some people to test the health of a local stream without having all of the many tools used to find out the water chemistry. Instead they can get a good sense of the creek's health just by looking at the macroinvertebrate population, making it easier and less expensive. This could also help scientists to better understand increases and decreases in population. If there were threatening changes in the macroinvertebrate population, scientists would have a better idea of what caused them, and it would be easier to improve the health of the creek.

Information from literature review:

We used a chart that was separated in categories of sensitivity to pollution. They were split into three groups, pollution sensitive, pollution intermediate, and pollution tolerant. This chart described each macroinvertebrate, helping us to identify each one. This also allowed us to compare and contrast the different macroinvertebrates in their category.

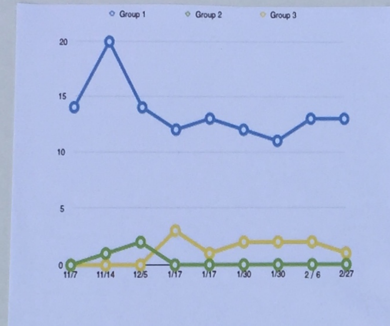
<u>Materials and Methods:</u>

Materials:

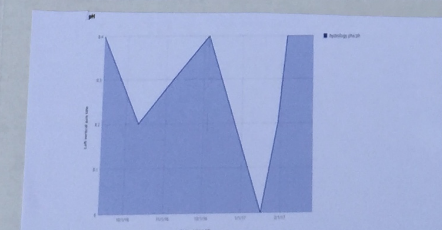
- Kick net
- Tweezers
- Ice cube tray
- Boots
- Macro Invertebrate Classification paper
- Water chemistry kit

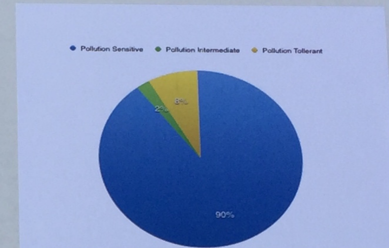
Method:

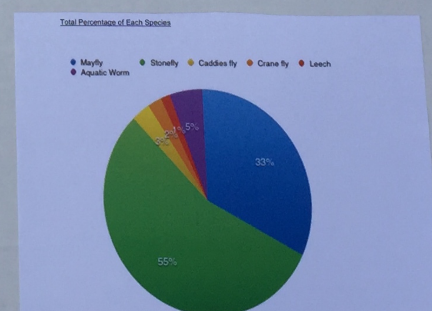
We followed the Globe Protocol for Water chemistry but we did not for collecting macroinvertebrates. Instead we used the kick and pick protocol. We collected data on two things, the water chemistry and the macroinvertebrates. We went down to the creek almost every week on Monday. We held a kick net in a spot with shallow water, then walked in a 2 meter area upstream of the net, kicking rocks for a total of 3 minutes. Then we randomly picked out macroinvertebrates and put them into two ice-cube trays. We used the macro invertebrate classification paper to identify the species of each and then recorded the species we found into a data table and stopped once we got to about 15 organisms. We also recorded the diversity of the macroinvertebrates.

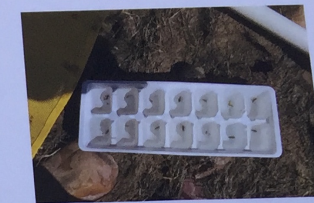


*Group 1 is pollution sensitive, group 2 is pollution intermediate, and group 3 is pollution tolerant









Analysis and Results:

An experimental error that took place when we collected our data was that there were so many macroinvertebrates that we just had to randomly select them. Also, when randomly selecting macroinvertebrates from the net, we were more likely to select the bigger ones that were easier to find than the smaller, more camouflaged ones, which likely impacted our data. Therefore, we could have possibly gotten very different data if we had collected information from all of the macroinvertebrates on the net. An uncertainty could be why the mayflies dropped so suddenly and why the stoneflies increased. We don't know if something happened to the mayflies that didn't happen annually, such as the decrease in temperature effecting them. The water chemistry stays balanced for most of the year, so that would not be a reason for change in macroinvertebrate species and numbers. When the pH was at its lowest, that was when there were the most pollution tolerant macroinvertebrates. However, the number of pollution sensitive stayed consistent so there was no solid evidence that the lower pH was harmful to the environment. The mayflies were more prominent in the beginning of the year, which might mean that they thrive better in warmer water. When the mayflies began to decrease, the stonefly nymphs increased. This could mean that they thrive better in colder water or that they thrive better without mayflies, as they could be competition to the stoneflies for food and shelter.

Conclusions:

Based off of the results of our experiment, we can conclude that the water chemistry and species of macroinvertebrates at Boulder Creek were healthy. By examining the water data, we were able to find the the measurements of the water were healthy and would not negatively affect life in the creek. When we examined the D.O and temperature, we found that they were both healthy and able to preserve life. The D.O in the water consistently stayed above five mg/L, meaning there was sufficient D.O for all of the macroinvertebrates in the water to live. When examining overhead photos of the creek we found that there were man-made structures upstream from our study site used to add D.O to the water. The pH and alkalinity of the water were also very healthy, staying more or less consistent throughout the year. A pH range from 6.8 to 8.5 is healthy, and the pH of the Boulder Creek stayed right in that area. When comparing these results to the macroinvertebrates, we found that because of the healthy water condition, the macroinvertebrates are healthy as well. There was a good balance of all three groups. The creek was made up of mostly pollution sensitive macroinvertebrates, which is good, because these would not be able to survive in polluted water. Although there was a small number of pollution tolerant organisms, this is not necessarily a bad thing. Even though they are tolerant to pollution, there is no reason to assume that they live better in polluted environments. Also, it is good to have a balance of organisms, because in case the water does become polluted, it is good to have organisms that can survive the pollution.

Discussion:

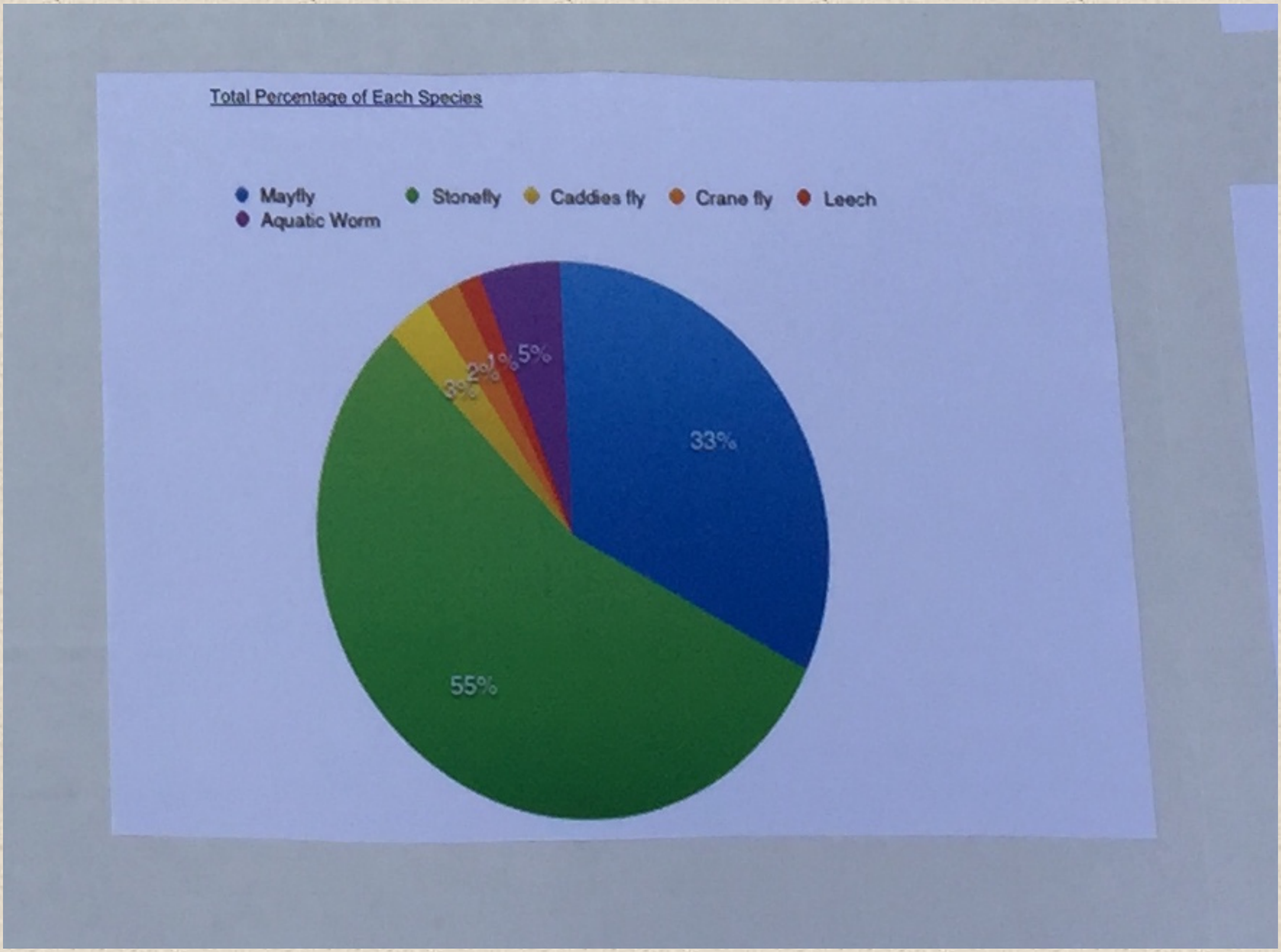
An improvement that could be made in this project would be going to two different streams; a healthy one, such as the stream near Alexander Dawson, and a stream that may not be as healthy. It would be good to compare a healthy stream and a non-healthy steam to see if this changes the numbers or species of the macroinvertebrates in the stream. This project could be used in many useful ways, like being able to get a good sense of the water chemistry of a creek by only looking at macroinvertebrate. It may be hard for some people to test the health of a local stream without having all of the many tools used to find out the water chemistry. Instead they can get a good sense of the creek's health just by looking at the macroinvertebrates, making it easier and less expensive. This could also help scientists to better understand increases and decreases in population. If there were threatening changes in the macroinvertebrate population, scientists would have a better idea of what caused them, and it would be easier to improve the health of the creek. To understand the relationship between the macroinvertebrates and the water chemistry better, we would want to take another year of data to see if the mayfly population increases and to see if they decrease again in the fall because of the drop of temperature.

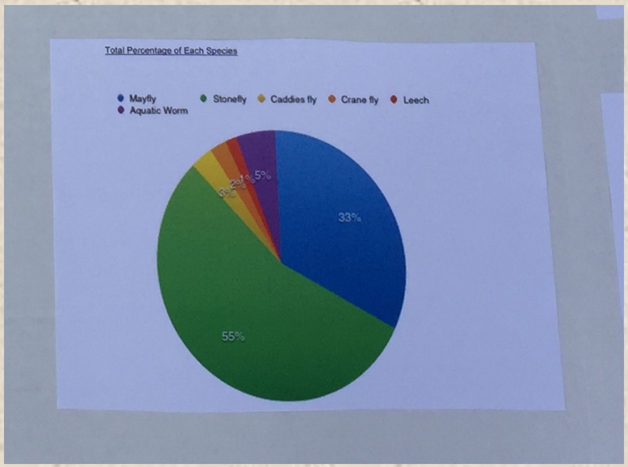
Acknowledgements:

The river watch program, Mr. Meyers, Globe program, Boulder County Open Space, and Alexander Dawson School helped make this research possible. Thank you!

References/Bibliography

- Division of Natural Areas and Preserves- Macroinvertebrate Identification Guide
- Colorado Division of Wildlife- Fall 1995- River Watch Network


Total Percentage of Each Species
Mayfly
Stonefly
Caddies fly
Crane fly
Leech
Aquatic Worm
33%
55%
3%
2%
1%
5%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33%
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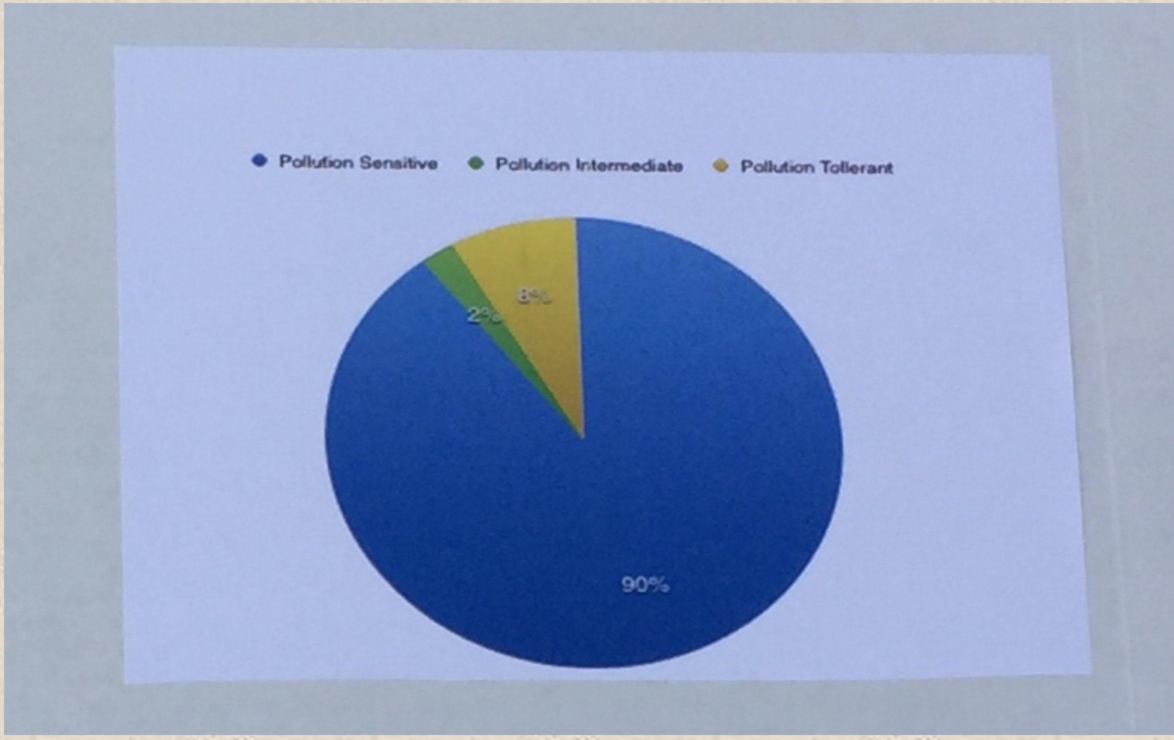
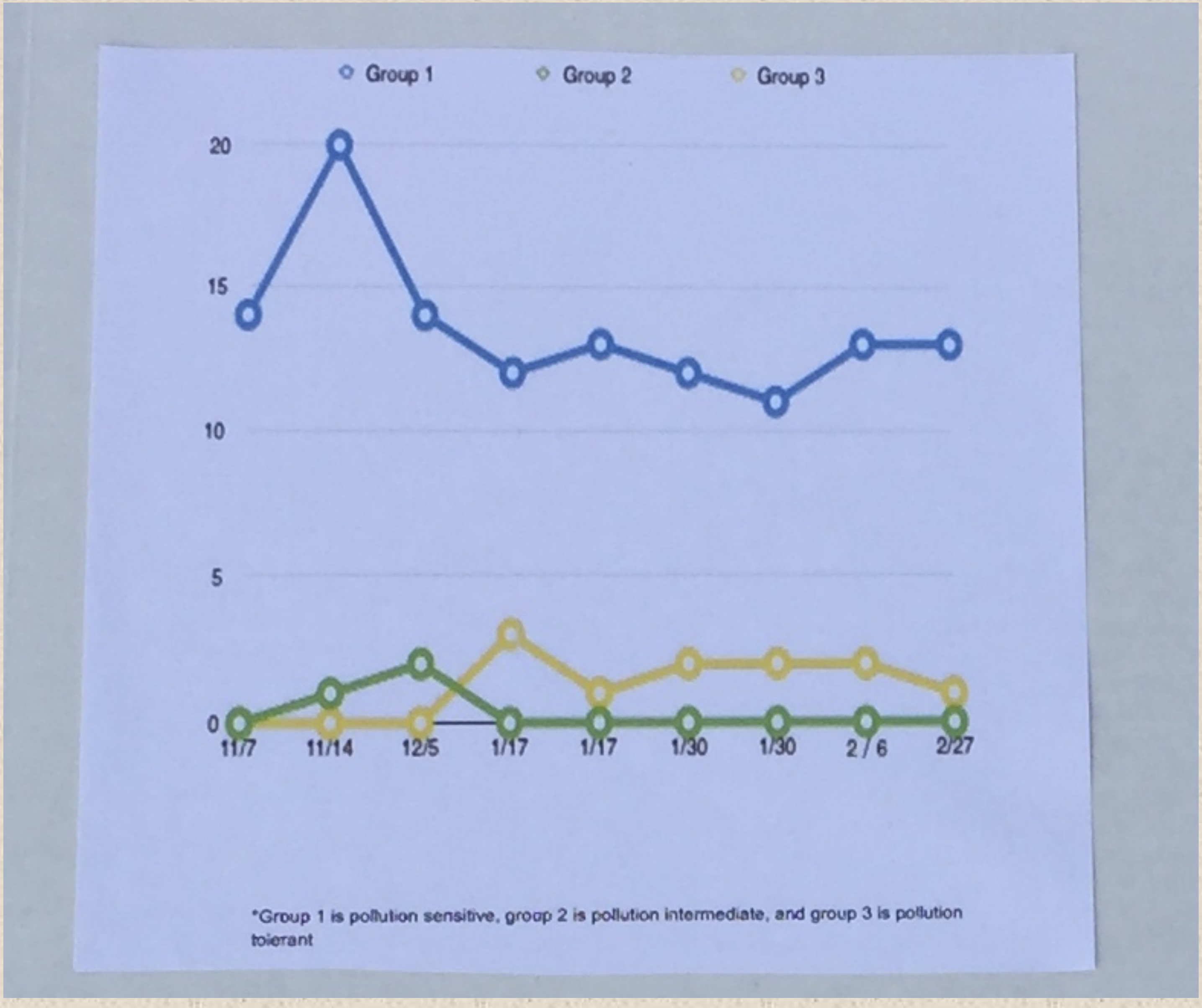
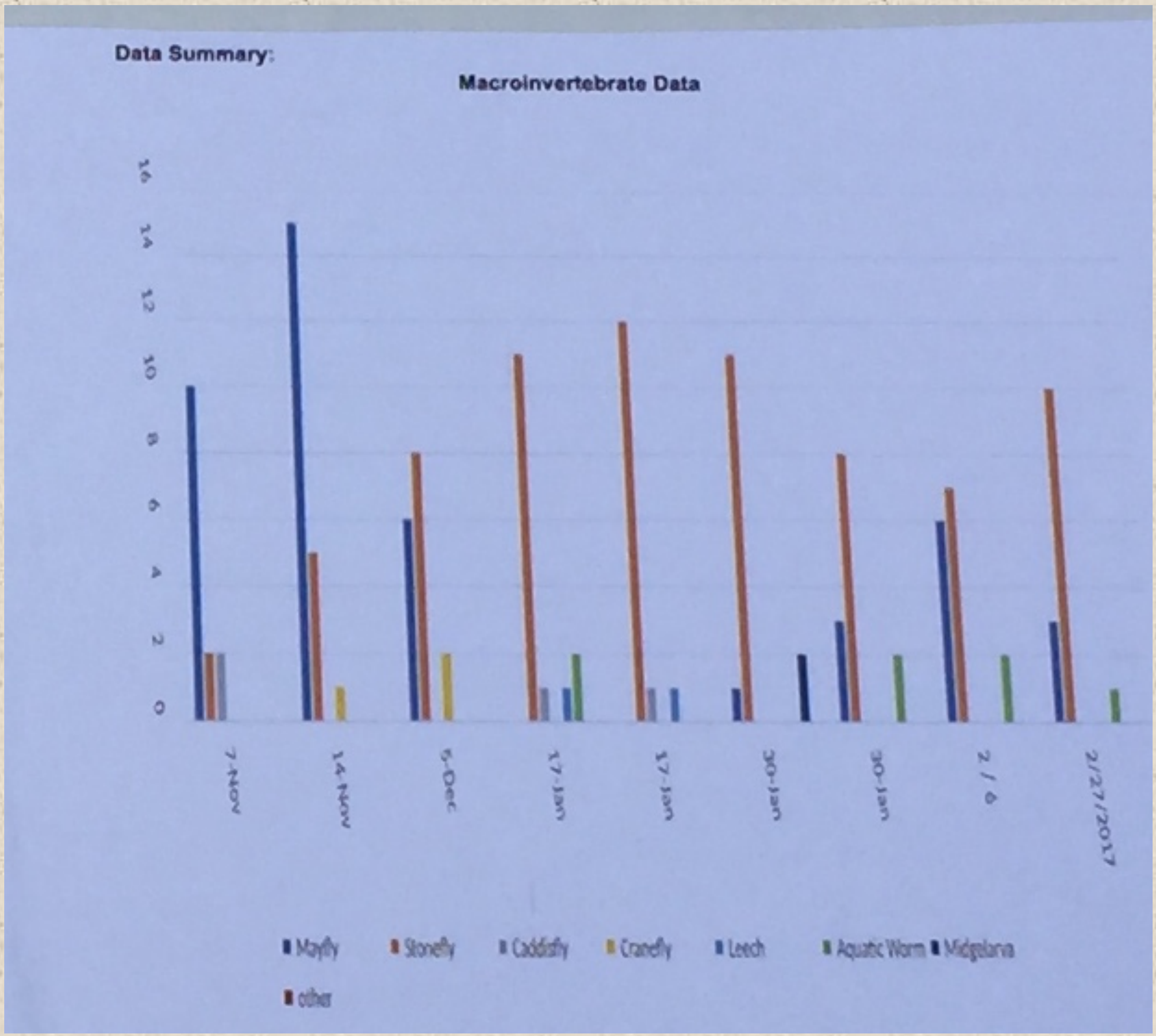
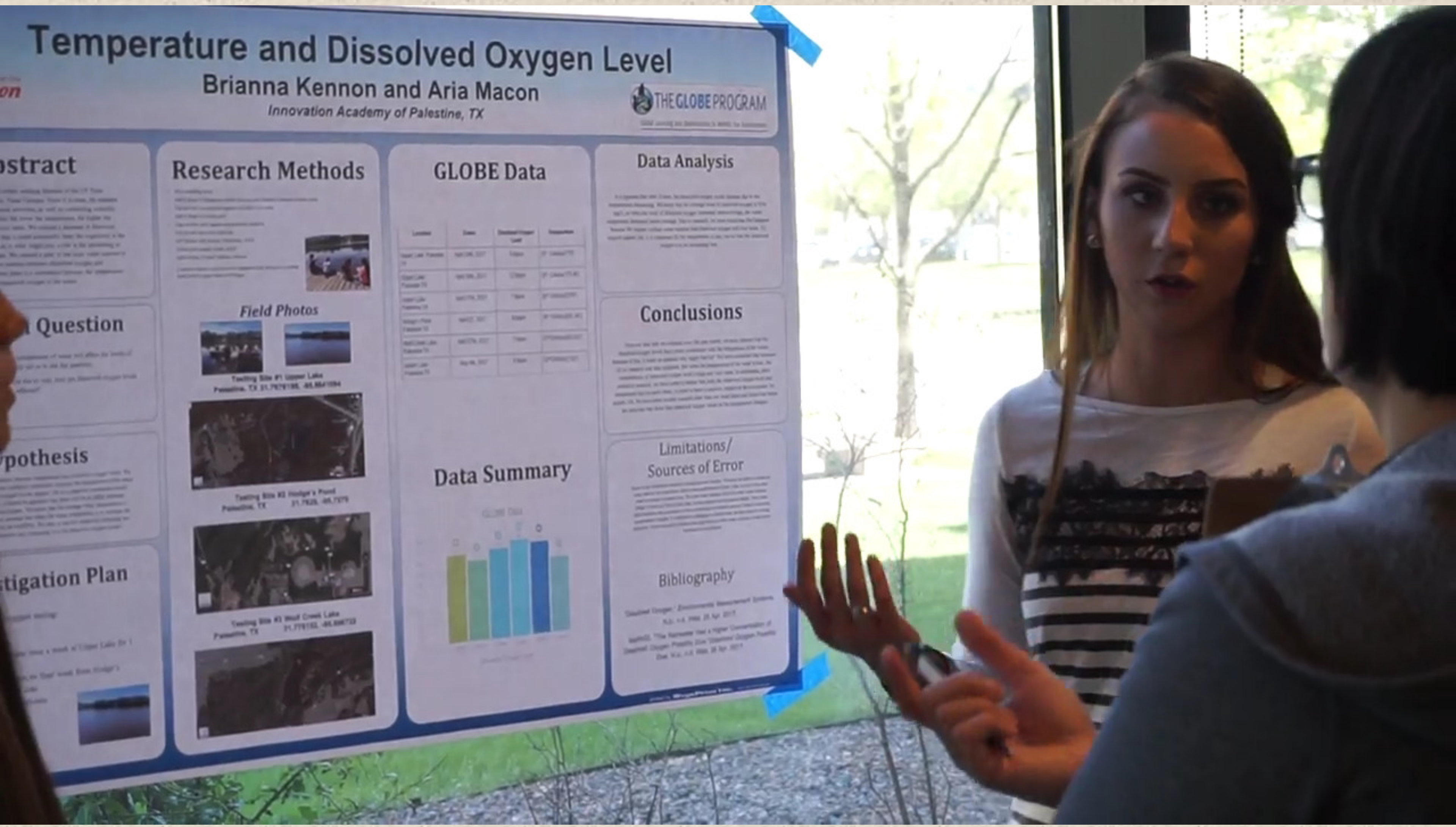
5%


Pollution Sensitive
Pollution Intermediate
Pollution Tollerant
8%
2%
90%


Group 1
Group 2
Group 3
20
15
10
5
0
11/7
11/14
12/5
1/17
1/17
1/30
1/30
2 / 6
2/27
*Group 1 is pollution sensitive, group 2 is pollution intermediate, and group 3 is pollution tolerant


Data Summary:
Macroinvertebrate Data
16
14
12
10
8
6
4
2
0
7-Nov
14-Nov
5-Dec
17-Jan
17-Jan
30-Jan
30-Jan
2 / 6
2/27/2017
Mayfly
Stonefly
Caddisfly
Cranefly
Leech
Aquatic Worm
Midgelarva
other


Soil and Moisture Retention
Kennie Adams, Kasey Newsome and Baker Wynne
UT Tyler Innovation Academy
innovation Academy
THE GLOBE PROGRAM
Abstract
Research Methods
GLOBE Data
Data Analysis
Research Question
For what length of time are different soils able to retain moisture and does mulch effect the moisture retention of different types of soil under pseudo natural circumstances? Does the pH change when we add mulch?
Hypothesis
Investigation Plan
Location
pH Level
Data Summary
Figure #1 and #2
Field Photos
GLOBE BADGES
Conclusions
Limitations
Sources of Erro


Temperature and Dissolved Oxygen Level
Brianna Kennon and Aria Macon
Innovation Academy of Palestine, TX
THE GLOBE PROGRAM
Research Methods
GLOBE Data
Data Analysis
Field Photos
Conclusions
Limitations/
Sources of Error
Data Summary
Bibliography


Abstract
Research Methods
GLOBE Data
Data Analysis
Research Question
Conclusions
Field Photos
Pictures from Rose Rudman Park
GLOBE BADGES
Hypothesis
Data Summary
Figures #1 and #2
Investigation Plan

Passive Solar Still Phase II

Bruno Gallegos, Victoria Gomez, Paola Rubi

Jayme Margolin-Sneider, Monica Martinez

Westview Middle School, Longmont Colorado

WESTVIEW MIDDLE SCHOOL
SCIENCE • TECHNOLOGY • ENGINEERING • MATH

THE GLOBE PROGRAM
Global Learning and Observations to Benefit the Environment

Abstract

Our continuation project for GLOBE was a passive solar still that purifies water made out of accessible and low cost materials found in Tanzania. We believed that if we did enough research, we could design a prototype that would purify water for those who need it, but can't afford it in Tanzania (https://thewaterproject.org/water-crisis/water-in-crisis-tanzania) . Our questions consisted of, what can we use to make a water purifier (Figure 8)? What design will be best for this specific product, and how will it affect those in Tanzania? Can this product be made easily, be extremely effective and be affordable? Throughout working on this project, our objectives were to find a design that would purify water and to find materials for it to made out of. We explored making a clay-mud mixture and using different kinds of leaves to build our prototype. By the end of our project, we can make the conclusion that if you follow the design we have created, you can purify a small amount of water in an affordable manner. Moving forward, we would love to be able to get this project out to others, possibly a company or organization that can get our product out to citizens of third world countries who need it.

Research Question

The need for clean water in third world countries is very important. The minimum amount of water that an average human needs to survive is around 3.7 liters per day, 44% of people in Tanzania can not get this amount of clean water. Many in Tanzania can end up dying because of the extreme heat and lack of wter (Popoular Science Volum 2, 2017).The average salary a day for people in Tanzania is around $1.50 (http://www.wageindicator.org/main/salary/minimum-wage/tanzania) , and an average purifier costs around $35. People in Tanzania can't afford their own water purifier, sometimes relying on any collected rain water. The water sources in Tanzania are also drying up do to agricultural irrigation as stated in Popular Science Volume 2, 2017. As members of a first world country, the idea of not having clean water was very terrifying. Therefore we decided that this topic needed to be addressed. We had originally started this project last year and decided it was best to carry it on because the problem is so pertinent. The purpose of the prototype we created last year was to find a design that would solely purify water. The materials that were used are items that can not be found or are accessible in Tanzania.The objective of our study this year was to create a water purifier made out of accessible materials in Tanzania (Figure 8). The reason we chose Tanzania as our area of interest was because of the high level of inadequate water was very troubling for us as students. Our teacher, Jayme Sneider, also visited Tanzania a year ago through GLOBE, and she had sparked our interests in this location (Figure 9).

Hypothesis

If we use accessible and low cost materials found in Tanzania to make a passive solar still, then we can purify water using energy from the sun to be available for use in third world countries.

Investigation Plan

The first step we took was to find out how we were going to make the solar still out of accessible materials that have little to no cost and are found in Tanzania (Figure 8). We believe that if they can make the purifier themselves, then the amount of people that don't have access to clean water will decrease (Popular Science Volume 2, 2017). Therefore, we decided to test our local lake water (surrounded by farms) that we normally would not drink, to see if we could purify it (see Figure 1). Over the course of the research, we had learned that Tanzania also has a pollution/trash problem; meaning that it could be common to see plastic bags and bottles laying around open fields. These plastic item, or specifically the bags, would be used as the lining and the top of the still as well (Figure 3). Our next step in the research process was to find the materials for the base. We learned that clay is very common at our chosen location, similar to what soil is here. Because it is very malleable, it would be easy for us to make a base out of it. We started to make the base of the solar still out of terracotta clay and measured to about 10 inches by 6 inches. The process of creating it was simply making five flat, thick chunks of clay that were all relatively the same size. As seen in Figure 4, the pieces were then molded together by bringing all the pieces in and using access clay to "stick" them together. After we made the base of the still we collected plastic bags and lined the inside of the solar still, and then we added two little tubs of tupperware (Figure 8). Then, the tests began. The first step we took when we set up the solar still to be tested was to collect and measure the pH of different water sources. We used a sensor called SparkVue and PASCO (Scientific Advanced Water Quality Sensor), that took data from our water samples as seen in Figure 6. We would record our findings, and then place that water into a plastic tupperware. The second step was to bring the clay box outside and place the tupperware that had the unpurified water on one side of the still, and an empty one on the other side. The third step was then placing the plastic bag over the top of the still and tying string around the base so that the bag would stay in place. Lastly, we placed rocks on the side of the still that did not have any water as a means to allow the condensation to drip down into a collection container. We then placed it outside (facing the southern sky) until the test was over. After 5-6 hours, we would bring the still inside to test the water quality of the water that condensed and was then collected.

Research Methods

All of our tests were tested in a dry but developed area. For all of the tests we ran them for about 6 hours near our school were the sun rays were hitting the solar still (Figure 8). When tests were finished running we used a PASCO Sensor (Figure 5). From this sensor we were able to find the initial and end temperature of the water, the pH, and the amount of DO_2 in the water. On a few testing days, there wasn't a lot of sun and mostly clouds, but these did not affect the water quality tests that we ran.

Field Photos


Figure 1. Collecting water samples from Lake McIntosh, Longmont, CO


Figure 2. Collecting water samples from local streams in Tanzania

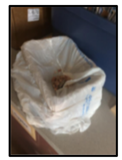


Figure 3. Passive solar still design all set to go outside


Figure 4. Final interior design of still with healthy leaves

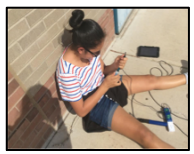


Figure 5. Testing water quality after water collection using PASCO sensor

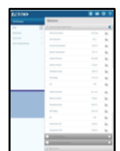


Figure 6. Data collected from PASCO sensor

Additional Research Information

GLOBE BADGES

- **Collaboration** In our group, we began with identifying which role each and everyone of us was going to take. We decided that it was best to have a main leader with writing and research, a leader with the hands on experiment and a leader with the supplies. Paola took the role of the leader, Bruno took the more hands on area and Victoria helped with the supplies.
- **Community Impact** We had first observed this issue when the flood of 2013 came through Colorado. Because of different debris left after the storm, citizens water sources were contaminated. Our research then began because we wanted to find a way for these citizens water issues to be solved. We interviewed local farmers about their water supply & spoke to residents that have family in third world countries.
- **Connection to Scientist** Before we started our project, we had learned valuable information about the chemistry of water from a hydro meteorologist, Matt Kelsch, at NCAR, Boulder, CO. We learned about the properties of water and what it takes to really purify water. The evaporation of water was very important to purify and he taught us about the boiling point (Figure 8).
- **Interscholastic Connection** As a group, we decided that our focal point was going to be Tanzania, for two reasons. We knew that the problem over there is very serious (Popular Science Volume 2, 2017), and we had connections to the area because of our teacher. We used the GLOBE data to compare our beginning pH and our end results as well. Because we had compared results, we were able to improve our still and make the experiment more realistic.
- **Engineering Solution** The goal of our project was to create something that would provide people with clean water and be accessible to all. Individually we had the passion to have a product that would save people's lives. When we designed the solution, we had to think about what materials will be effective and what is easily found and affordable in Tanzania.

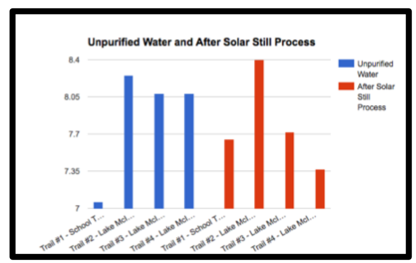
GLOBE Data

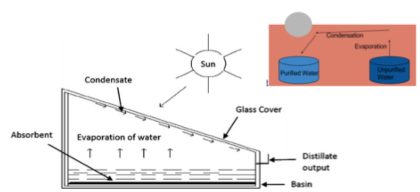
Figure 7. Comparing water quality (pH) on Mount Kilimanjaro, Tanzania, Africa and lake water in Longmont, Colorado, as well as one sample from the school tap water in Colorado.

The data we studied from GLOBE was from the 2015 Mount Kilimanjaro trip. The data shows that the water near the mountain was clean enough to drink. Therefore the product would not be needed in that area because it is so close to the source (snowpack/glaciers). However, we were hoping to analyze data from the rivers that run through towns, because there is a higher chance of pollutants getting in the water and that is most accessible, as well. These can include sanitary needs, trash, fracking, and burning of pollutants. Compared to our data, the solar still did a fairly good job based on the results of the data collected in Tanzania (Figure 2). As seen in the graph, the pH was mostly around the regulations for drinking water.

Data Summary

Results





Data Analysis

Overall, the data that we collected was very acceptable for what we wanted to achieve. Our main goal was to make the pH of the water better than what it started, and most importantly make it to a drinkable pH. pH stands for the potential hydrogen in the water, or how acidic it is. The pH of the water that is usually used for drinking purposes is 7.0, and this is considered neutral. The data we collected exceeded our expectations. The original tests that we had run had not gone the way we wanted to, as to the pH of the water typically went up or higher than the original pH was, which was the opposite of the initial goal. The pH of the water in an average home with a water filter is around 7.5, but health regulations insist that water must be between 6.5 and 8.5 (https://www.watersystemscouncil.org), as mandated by the Environmental Protection Council (EPA). So, with these statistics, our end goal of the water was to be around these numbers, but more or less closer to 7.5. As in most scientific experiments, there is some uncertainty or possibly human error. The beginning pH always increased instead of decreased, which is our uncertainty. However, for a few of the tests that were run, there were problems with the still itself that actually affected the pH, such as the lining of the still, whether that was plastic or leaves, had contaminated the water and the clay base would also do the same.

Conclusions

Overall, we were able to successfully make a water purifier out of accessible materials found in Tanzania. Using the design process, we began with identifying the problem of the millions of people in Tanzania that don't have access to clean water. The population of Tanzania is 53 million, and the amount of people in Tanzania that don't have access to clean water is 23 million (https://www.cia.gov/library/publications/the-world-factbook/geos/tz.html) . That's over 43%.Our next step involved research that lead us to our prototype that purifies water using heat from the sun. The tests we ran are evidence that if you follow our design, the pH of water can decreased to a drinkable level. In the future, we would include more research of expanding the project to big bodies of water, and a more affective size for the still. We would also document more, whether that be data or picture of the field. Overall, we finished our experiment with an accurate hypothesis and an invention that can purify water for those who need it.

Limitations/ Sources of Error

When conducting science experiments there are always limitations, especially when dealing with designing a prototype. An example of a limitation that we had ran into was learning how to use a completely new sensor to test our water, the PASCO scientific advanced water quality sensor(Figure 5). Learning and being able to use a sensor can be very difficult, especially when the type of sensor is fairly new. The data we had received from GLOBE was not where we wanted the data to be collected. We wanted more data from water sources to the cities where people use the water more. In these areas, there is more of a chance of pollutants in the water such as chlorine, arsenic, and hydrogen sulfide that can be deadly to the human body, and purified water is more important (Popular SCience, Volume 2, 2017 page 57). We also ran into the problem of having the sensor cleaned. To make sure that the sensors are completely clean, the sensor must be soaked in distilled water. As we started seeing deficiencies in the data we were observing, we realized that the water itself wasn't clean, it was the sensor. However, in that moment in time, we did not have distilled water available to us, so we used activated charcoal and filtered the water to double check our results. But, if it weren't for these errors, we wouldn't have been able to improve our solar still and our data sets.


Figure 9 Our teacher, Jayme Sneider, taking data in Tanzania. This was in the rainforest at the base of Mount Kilimanjaro.

Field Photos

Figure 1. Collecting water samples from Lake McIntosh, Longmont, CO

Figure 2. Collecting water samples from local streams in Tanzania

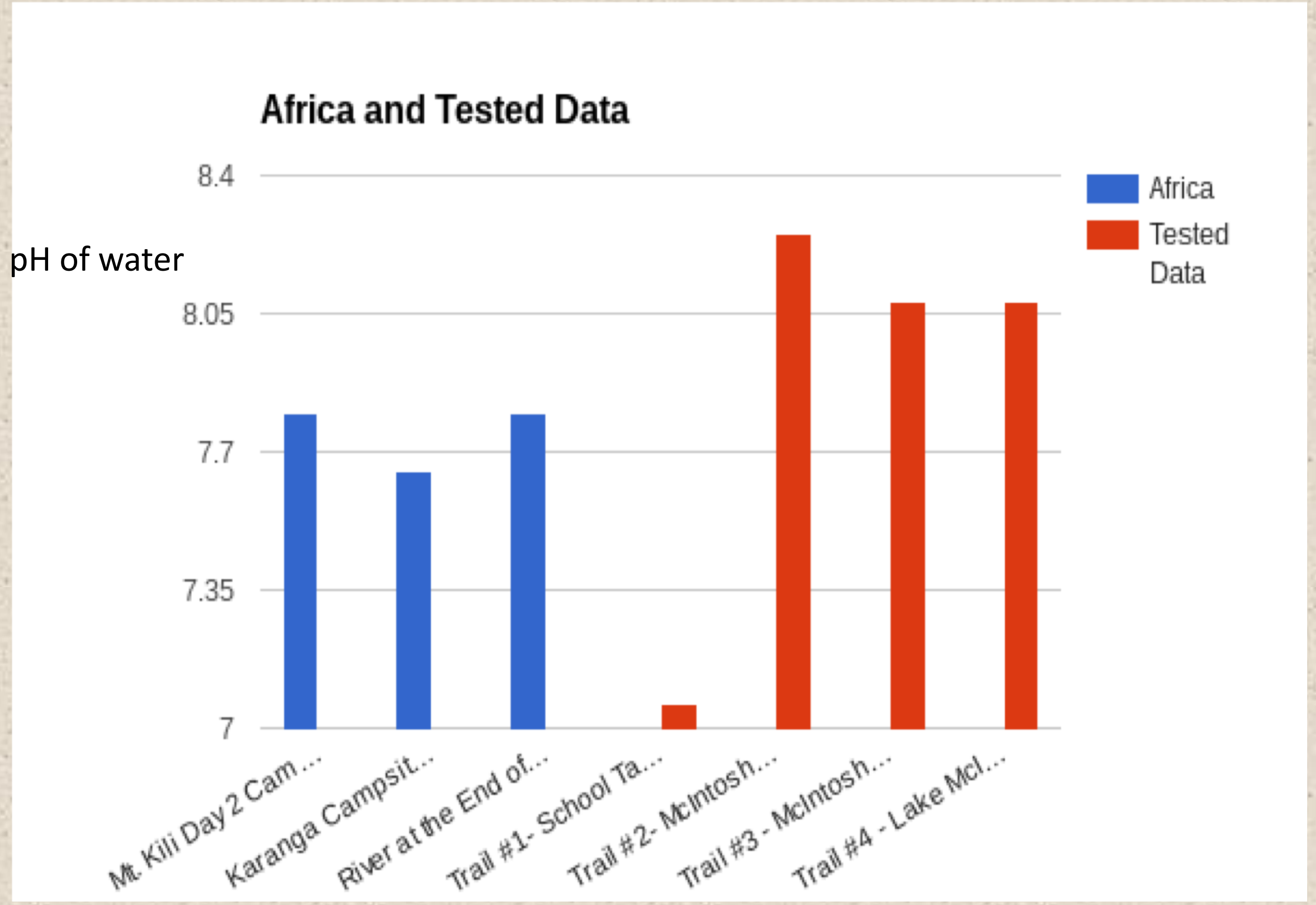
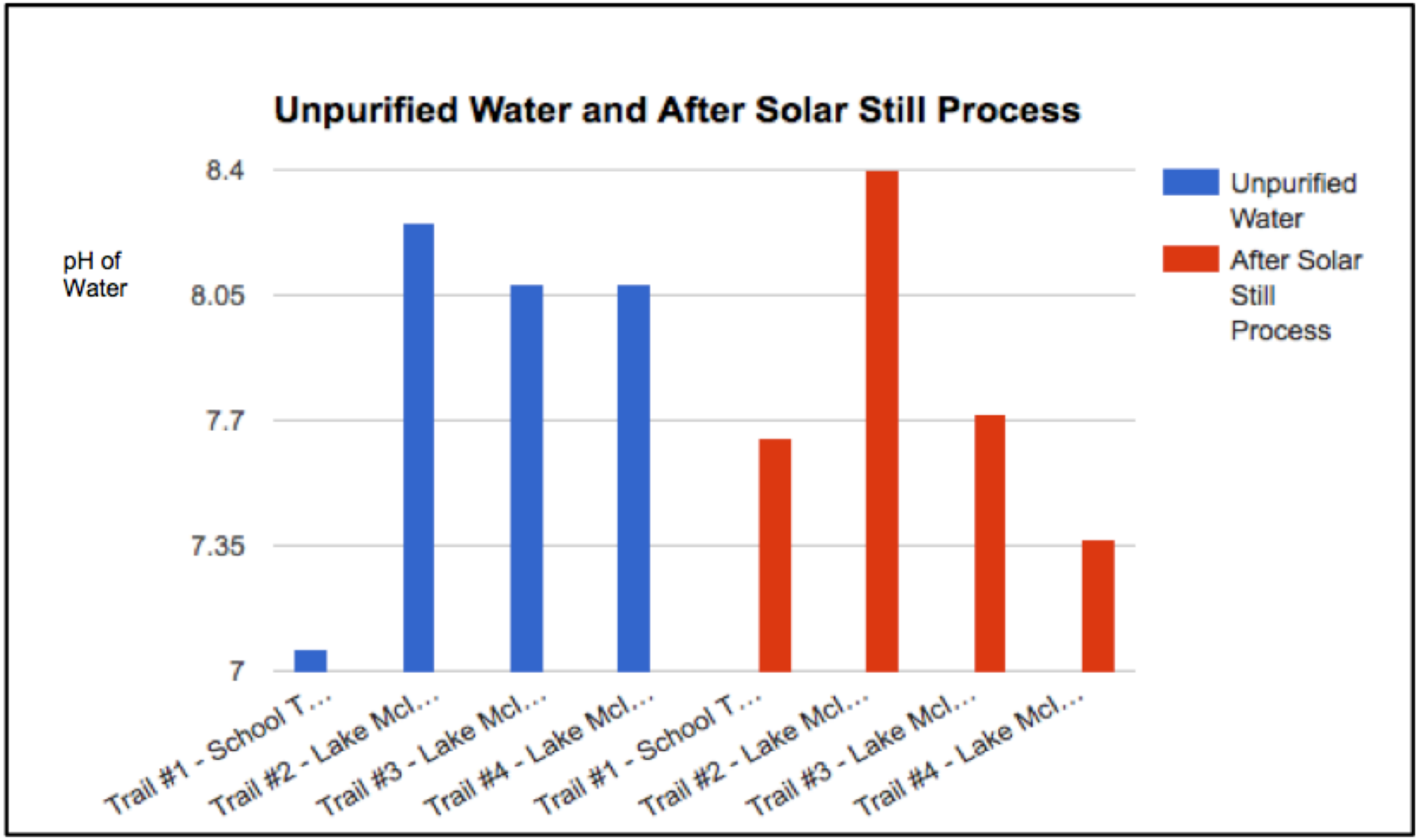


Figure 7. Comparing water quality (pH) on Mount Kilimanjaro, Tanzania, Africa and lake water in Longmont, Colorado, as well as one sample from the school tap water in Colorado.


Unpurified Water and After Solar Still Process
pH of Water
8.4
8.05
7.7
7.35
7
Unpurified Water
After Solar Still Process
Trail #1 - School T...
Trail #2 - Lake Mcl...
Trail #3 - Lake Mcl...
Trail #4 - Lake Mcl...
Trail #1 - School T...
Trail #2 - Lake Mcl...
Trail #3 - Lake Mcl...
Trail #4 - Lake Mcl...

Hawkins High School TOXIC Water Research Project

Triston Dodson, Brady Stone, and Dalton Wages

Hawkins Independent School District Hawkins, Texas

Abstract.

Hawkins High School has gathered a number of GLOBE measurements from 2010 to the present. We began working on a project involving soil contaminants that quickly evolved into a much larger endeavor. Because water will reveal more about pollution in our natural environment, we shifted our topic of investigation over to the health of local water bodies. By 2013, we were communicating with India and Croatia over their concerns of water quality. We began testing four nearby water sources-- Lake Hawkins, the Sabine River, and 2 sites at Lone Star Lake --and obtained information to be shared across the globe.

Using GLOBE hydrology protocols on conductivity, dissolved oxygen, nitrates, pH, turbidity, water temperature, and macroinvertebrates, our GLOBE Club investigated local water quality and submitted data to the GLOBE database. All results from the Hawkins sample sites showed very low pollution levels; however, Lone Star Lake tested positive for coliform and had low levels of dissolved oxygen.

Research Questions.

Through our research, we would like to investigate macroinvertebrates and the water quality of multiple water sampling sites. From our studies, we understand that some macroinvertebrates are more pollution sensitive than others. Therefore, if pollution-sensitive organisms inhabit a watershed area, a pollution problem is not likely.

What conditions are best for sensitive macroinvertebrates? Have environmental regulations enforced at Lone Star Lake improved water quality? How do our nearby aquatic environments compare to those of Lone Star Lake?

By observing and testing three surrounding aquatic sites, we can learn about our impact, either through agricultural, chemical, or industrial expansion, on our environment.

Hypothesis.

Our hypothesis states that if a watershed area is lacking pollution-sensitive macroinvertebrates, a pollution problem is likely. We believe our surrounding watershed areas are fairly unpolluted but would like to test our ideas, as upon investigation, we found evidence of pollutants.

We would like to compare our results with results from Lone Star Lake, as it is located next to a large steel mill that had been shipped products that were found to be toxic in the 1980s. We would also like to see how/if this water has improved since its contamination 30 years ago.

Investigation Plan.

We began by researching watershed areas, water pollution, and specific vocabulary involved in hydrology. By correctly following GLOBE hydrology protocols for dissolved oxygen, nitrates, pH, turbidity, water temperature, and macroinvertebrates, we gathered information needed to identify our watershed sites as "polluted" or "unpolluted."

Upon further investigation we found that there are fish consumption bans at Lone Star Lake, as largemouth bass from this site indicated the presence of mercury "at levels that may pose a threat to human health if consumed." Mercury was also found in the tissue of various other fish.

In this specific research project, we collected data from nearby recreational water sources and from Lone Star Lake and compared them with one another as well as with data shared with us from India and Croatia. Each of our schools had their own questions or concerns about the local watershed environment, but also wished to compare data with other countries with similar inquiries.

Research Method.

The first question asked what conditions are best for pollution-sensitive organisms. This question could be easily answered through a short research of macroinvertebrates. Audra Edwards, GLOBE environmental teacher, taught us more about macroinvertebrates, what types would be expected in our watershed areas, and what this could mean about the water quality.

The second question became more specific in asking what types of macroinvertebrates are located in the selected sampling sites. We used the "Define Your Site," dissolved oxygen, nitrate, pH, turbidity, water temperature, and macroinvertebrate protocols to examine what types of macroinvertebrates could possibly inhabit the four test sites.

Our final question required us to reach out to other schools in order to compare data. Students from a school in Croatia and another in India had begun to build up hydrology projects in water sources of concern by collecting and testing water samples. We communicated with both schools and compared our results.

Data.

Students from Hawkins High School collected data from Lake Hawkins, Lone Star Lake, the Sabine river, and a stagnant tributary to Lone Star Lake, all of which were fresh water. This data was collected over multiple days at varying times throughout each day.

Many experiments show major differences in the water sites, but this can be attributed to the fact that we investigated freshwater habitats and Croatia inspected brackish water channels. Overall, both of the tested watershed sites do not greatly deviate from the standard for healthy bodies of water. The water tested in India and the Lone Star Lake sites, however, seemed to be experiencing some disruption.

Discussion of Measurement Limitations.

Like all experiments and investigations, there is room for error in both precision and accuracy. In this aquatic investigation, the same student or student group did not gather all data collected from the sampling sites, and the experiments conducted on said water may not have been uniform. Therefore, data submitted may have some miscalculations. Also, the kits and instruments used have different producers and will have small deviations in veracity. The collection of data includes, as always, human error and limits the meticulousness of the investigation as a whole.

Conclusion.

Through our research, we learned sensitive macroinvertebrates we would find in our local watershed areas enjoy shallow water with a fair amount of dissolved oxygen and neutral pH. Since oxygen is more easily dissolved in cooler water, a temperature of about 15 degrees Celsius is a healthy temperature.

In our testing sites, the most abundant amount of macroinvertebrates were found in the riffle portion of our pond, where there was plenty of dissolved oxygen and a temperature of approximately 17.5 degrees Celsius. We discovered 27 caddysflies in our small testing area. Caddysflies are fairly sensitive macroinvertebrates. This reveals the health of our streambed, contrary to prior belief that our water was receiving pollution from anthropogenic activities. At Lone Star Lake no macroinvertebrates were present.

Our four sample sites reveal that these surrounding areas are fairly unpolluted. Croatia, though brackish water, is still comparable to our own fresh water and also shows that their previous pollution problem is diminishing and the health of their water channels is rising. Lake Sanjay in India, unfortunately, is experiencing many pollution problems and although people are working to save the lake, there are deviations in the standard measurement for quality water and their collected data. Lone Star Lake, despite the interest in improving its water quality, still faces pollution issues.

Our collaborative research project was started in an effort to not only learn more about our water quality, but also improve where needed. Though this project seems to just be beginning, it is one that will continue on in collaborative investigation.

Citations.

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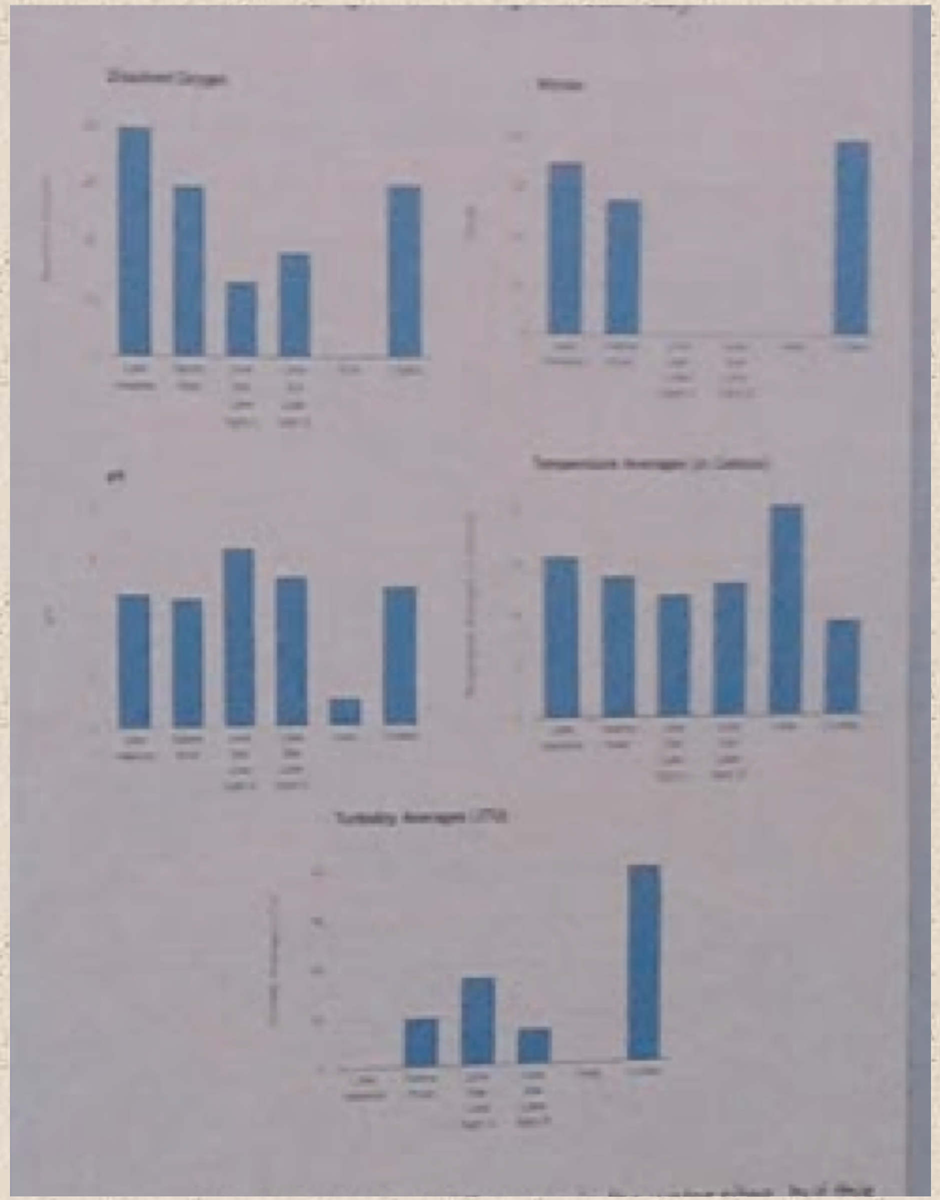
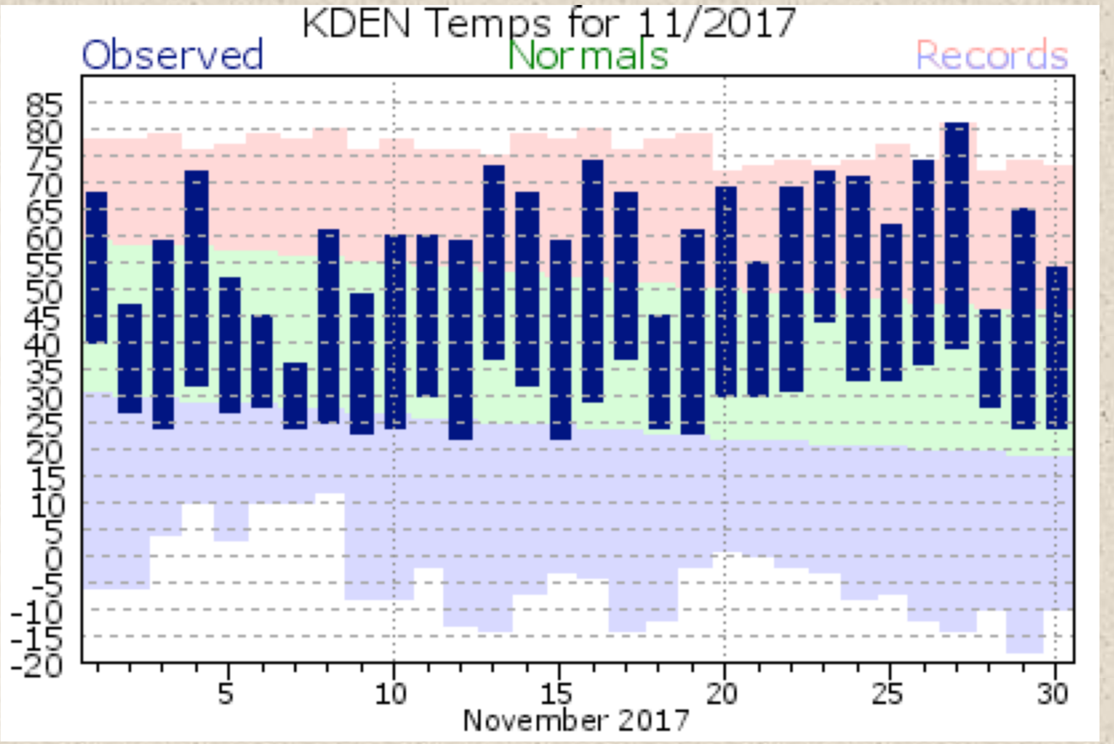
Dr. Wojnowski, David, Lead Professor of Teacher Education and Project WET/Stream Watch Coordinator, "Macroinvertebrates." Personal interview. 23 Jan. 2014.

Chakraborty, Vaibhav, and Mrs. Mamta Agrawal. East Point School, New Delhi, India. Online interview. 3 Mar. 2014.

Medicinska Škola u Rijeci, Croatia. Online interview. 12 Jan. 2014.



Example of Data Shown Using Different Graph Types



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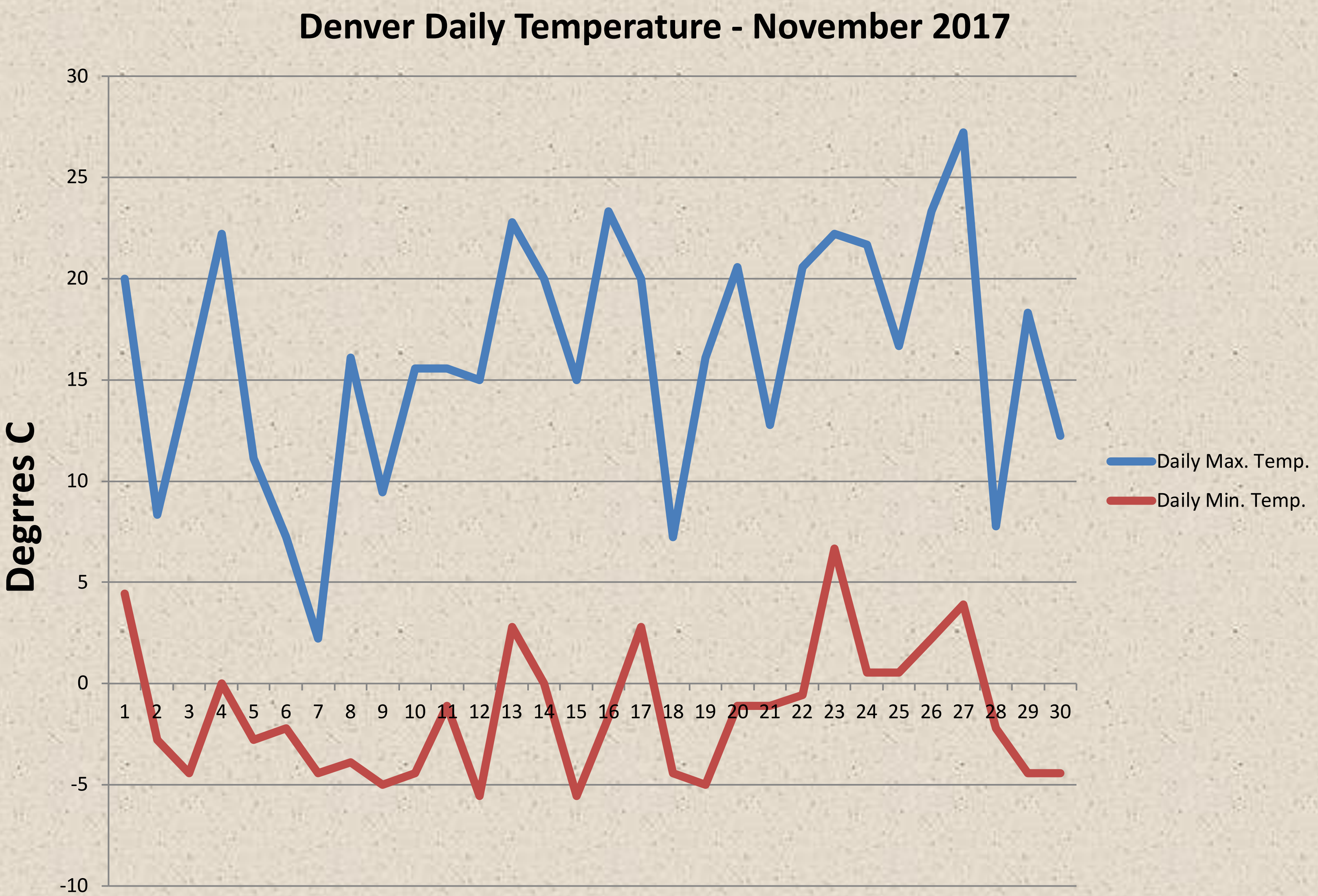

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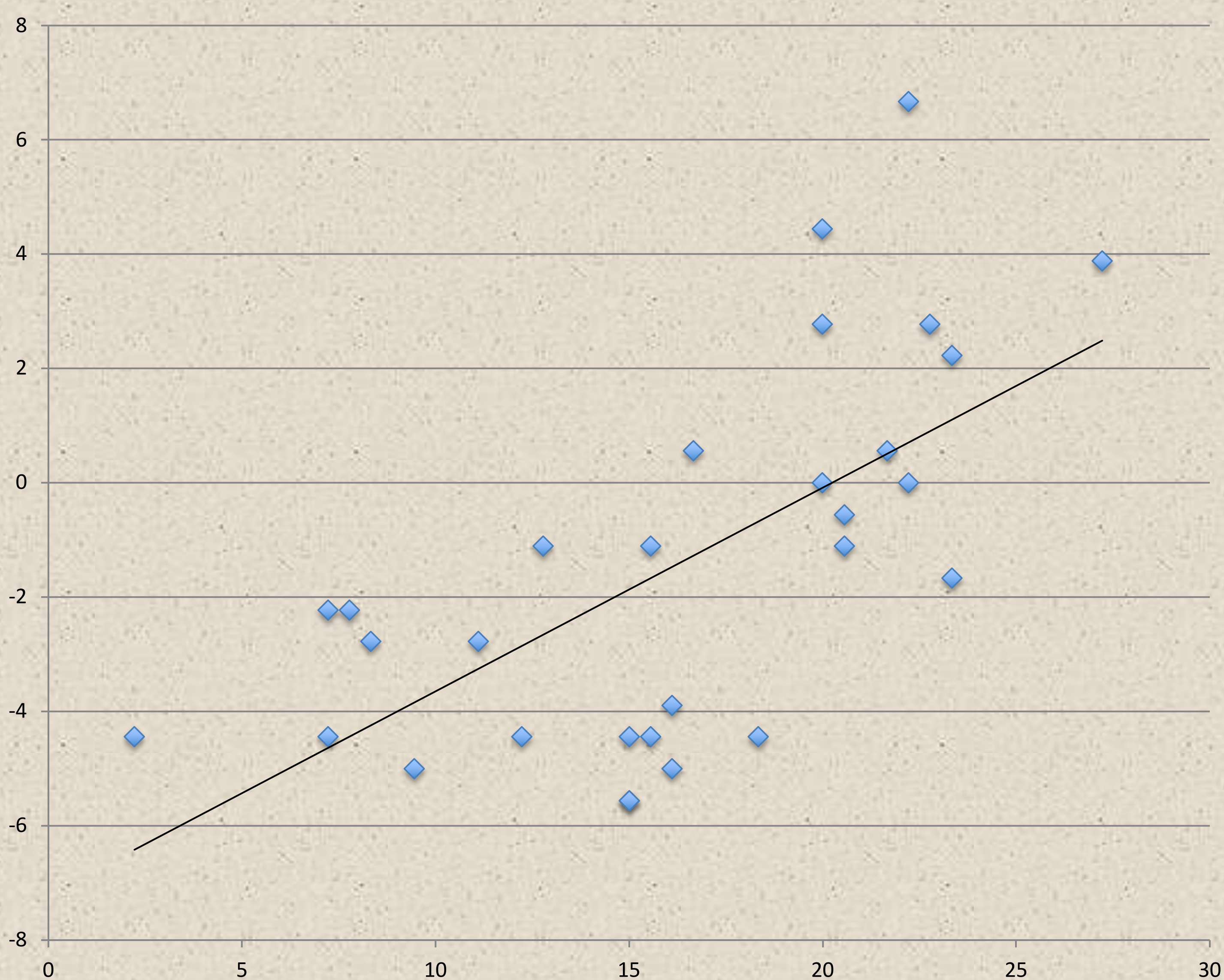

Example of Data Shown Using Different Graph Types