



# HI-MOES 2010 Conference Proceedings





## Table of Contents

<b>Introduction</b> .....	1
<b>A Field Study Comparing Kahalu‘u and Kūki‘o Bays</b> (Hualalai Academy) .....	2
<b>Components of a Watershed</b> (West Hawaii Explorations Academy) .....	15
<b>Species Abundance</b> (Hawai‘i Preparatory Academy) .....	17
<b>Native and Non-Native Percentages</b> (Hawai‘i Preparatory Academy) .....	22
<b>Percent of Categories</b> (Hawai‘i Preparatory Academy) .....	25
<b>Vertical Height</b> (Hawai‘i Preparatory Academy) .....	28
<b>Insect Diversity</b> (Hawai‘i Preparatory Academy) .....	31
<b>HI-MOES Insect Study Project</b> (Hawai‘i Preparatory Academy) .....	33
<b>Insects Found on the Ground Versus Found on Trees</b> (Hawai‘i Preparatory Academy) .....	35
<b>Layer Depth in Different Areas of a Watershed</b> (Hawai‘i Preparatory Academy) .....	38
<b>Soil Structures</b> (Hawai‘i Preparatory Academy) .....	39
<b>Tide Pool Survey Project</b> (West Hawaii Explorations Academy) .....	44
<b>Changes In Types Of Mosses In Increasing Elevations</b> (Waikoloa Middle School) .....	46
<b>Percentage of Ferns in the Different Elevations</b> (Waikoloa Middle School) .....	48
<b>Dissolved Oxygen Changes Over Time</b> (Kealakehe High School) .....	50
<b>Pu‘u Kawaiwai Ecological Study</b> (Innovations Public Charter School) .....	51
<b>Comparing Kahalu‘u Beach Park &amp; Kūki‘o Beach Park</b> (Kealakehe Intermediate School) .....	55
<b>Po‘o Hawai‘i Pond Restoration</b> (Ke Kula ‘o ‘Ehunuikaimalino) .....	59
<b>List of Participating Schools</b> .....	63

## **Introduction**

Hawai'i Island Meaningful Outdoor Experiences for Students (HI-MOES) is a NOAA (National Oceanic and Atmospheric Administration) BWET (Bay Watershed Education and Training) funded science-based outdoor learning program for secondary students that focuses on bay and watershed education in the ahupua'a of the Kona coast and Kohala Mountain. It provides students and their teachers with meaningful outdoor education experiences by supporting research projects in one or more of these selected watersheds.

During the academic year 2009–2010, students learned about their watersheds through classroom presentations and field trips, and identified and implemented a scientific research project to work on throughout the year.

Outdoor Educators from The Kohala Center and Kohala Watershed Partnership have been working with teachers and students closely all year to assist with classroom presentations, research design, site selection, and field trip logistics. Scientists and cultural experts working in these areas have also participated in the program through classroom and field presentations and project support.

Approximately 400 students from ten West Hawai'i Schools have been answering experimental questions about topics/parameters as diverse as moss thickness, soil temperature and composition, and plants in the wet and dry forests of Kohala Mountain, to tide pool species, urchin abundance coral health, and water quality in Kahalu'u Bay and other comparable ocean sites on the west coast.

At the culminating conference in May 2010 students presented their research data. It was an opportunity for students to present their findings to each other. The results of that conference can be found in this publication. Enjoy!

For more details on the conference, and to download student presentations, please see <http://www.kohalacenter.org/himoes/conference.html>.

## **A Field Study Comparing Kahalu‘u and Kūki‘o Bays** **Students of Donna Goodale’s class, Hualalai Academy**

### **Abstract**

Our goal was to answer the questions: 1) Do the nutrient levels found in bay waters reflect human development along the shoreline? 2) Does algae cover change by location and nutrient levels? We searched for two different locations: one with more coastal development, and one with less. With this in mind, we chose to conduct point-transects at Kahalu‘u Bay which appeared more developed, and Kūki‘o Bay which appeared less developed along the shoreline.

At each bay, we set up four 100 ft transects. Four teams of two snorkelers gathered the substrate data. One team took water samples along each transect to analyze water chemistry in the two bays. We found that there was significantly more hard substrate at Kūki‘o and that more of the hard substrate had some type of cover. Kahalu‘u had more sand and bare hard substrate. The mix of the type of cover was also different between the bays. Kūki‘o tended to have more turf algae than Kahalu‘u. The water chemistry data were inconclusive because the instruments used to measure nitrates and phosphates were not sensitive enough to detect existing concentrations.

Our results indicate that there was a difference in the types of cover in the two bays, but it was not associated with nearshore development. However, we may have been incorrect in our assumption that Kahalu‘u was more developed than Kūki‘o. Higher altitude photographs show more development in the overall watershed of Kūki‘o. Future studies with more sensitive instruments may help to answer our questions about nutrients in the two bays.

### **Introduction**

“Do the nutrient levels found in nearshore waters reflect human development along the shoreline?” “Does algae growth and cover change by location and nutrient levels?” These questions will be tested by surveying two beaches, Kahalu‘u and Kūki‘o. Kahalu‘u beach is in a more developed area and Kūki‘o is in a less developed area.

Algae come in many shapes, sizes, and colors; has many uses; and can be found all around the world. Algae exist in most habitats from sub arctic climates to tropical climates like Hawai‘i. Algae vary from simple organisms to complex multicellular organisms and contribute a major amount of oxygen to the world’s atmosphere. There are three different classes of algae: green algae, brown algae, and red algae. These classifications are based on the photosynthetic pigments that give algae their color. Native and alien algae in Hawai‘i come from all three color groups.

Green algae are the most diverse group, with more than 7,000 species growing in a variety of habitats. Like plants, green algae contain two forms of chlorophyll, which are used to capture light energy to fuel the formation of sugars. Unlike plants, green algae are primarily aquatic.

Brown algae have approximately 1,500 species that are very diverse in form and size. They range in size from less than 1 mm long to some species that are among the largest photosynthetic organisms on Earth. Giant kelp can grow to more than 65 meters in length, forming dense underwater forests in nutrient rich cold temperature waters. Brown algae have chlorophyll a and c, as well as carotenes and xanthophylls coloration.

There are over 4,000 species of red algae. Red algae’s pigments include chlorophyll a and the phycobiliproteins, red phycoerythrin and blue phycocyanin, as well as carotenes, lutein, and zeaxanthin. Some red algae have very little phycoerythrin, and may appear green or bluish from the chlorophyll and other pigments present in them.



The Hawaiian Islands are one of the most isolated places in the world. This means that the native species in Hawai‘i are often found nowhere else. About 25% of Hawai‘i’s reef fish, coral, and algae are unique to Hawai‘i.

Coral reefs are one of the most biologically diverse and most endangered ecosystems on Earth. One of the primary threats to coral reefs is human activity. Humans have caused the death of about 10% of the world’s living reefs. One of the most important short-term threats to coral reefs is eutrophication, a form of nutrient pollution caused by over-fertilization and sewage pollution.

Nutrients like nitrate, phosphate, and ammonia naturally occur in the ocean and are necessary in small amounts for a healthy reef. High concentrations of these nutrients can be harmful to the reef. Abnormally high concentrations of nutrients are often due to land run-off from fertilizer and sewage. Algae feed on these nutrients, and when there is too much of the nutrients, the algae population explodes in what is called an algal bloom. Algal blooms block light from the reefs, causing the coral to die. When the algae have used up the nutrients, it dies, leaving nothing to create oxygen for the remaining organisms. The area becomes a dead zone where nothing can live. Other important things that need to be in balance for a healthy reef ecosystem are pH, dissolved oxygen, and salt. Each one of them plays a vital role in helping the reefs thrive.

Nitrate (NO<sub>3</sub>) is a water-soluble molecule made when nitrogen of ammonia combines with oxygenated water. Nitrates in the ocean naturally come from animal waste and decaying plants. Nitrate also enters the water because of run-off from farms, fertilizers being disposed of in the ocean, sewage tanks, sewage treatment systems, human waste, and trash. A certain amount of nitrate is good for the reef because it is a necessary nutrient for marine plants and algae. If there are too many nitrates, algae blooms can occur.

Phosphates, in small quantities, are considered essential for ocean reefs. Phosphate is a primary nutrient source for algae, so in unnatural amounts it can cause an algal bloom. Phosphates can enter the oceans because of run-off from farms and fertilizer, industrial leaks, and human waste.

Ammonia is part of the natural life cycle in the reefs. Decomposing algae and fish wastes are natural ways ammonia enters the ecosystem. Human wastes can cause an unhealthy increase in ammonia levels. Ammonia can bleach coral and harm fish. When algae die, the ammonia levels rise because the algae are not there to remove it and they decompose, releasing more ammonia.

Increased ammonia in the ocean can decrease the dissolved oxygen levels and the pH. If the ocean becomes too acidic, it can cause major problems for the organisms in the reef. Dissolved oxygen is a measure of how much oxygen is dissolved in the water. If there is not enough oxygen, the fish could suffocate. If there is no oxygen, the area becomes a dead zone, where no animals can live.

Salt is very important to sea creatures. Without salt in the ocean water, the fish would not be able to survive. Salt levels between ocean water and fish are evened out through diffusion. If salinity levels are too high, the fish loses more water through osmosis than it can balance in its body. If the salinity levels are too low, the fish gains too much water through osmosis.

The Kahalu‘u area has been populated for many years. During the 18th and 19th centuries Kahalu‘u was an important royal residence. One major feature of Kahalu‘u is “Pa o ka menehune,” which means literally “wall of the ancients.” It is a breakwater constructed in ancient Hawai‘i that might have enclosed the entire bay.

Generations of Hawaiian royalty, from Kamehameha to Kalakaua, considered Kūki‘o a favored place. Kūki‘o appealed not only to royalty, but also to common Hawaiians. Hawaiians followed a traditional lifestyle, which sustained families who lived there.

Kahalu‘u and Kūiki‘o have important cultural significance in Hawai‘i. Native algae are important in the reef ecosystem as well as for native Hawaiian cultural usage. Coral reefs can be threatened by algal blooms. A rise in nutrient levels caused by land run off could cause an algal bloom. This algal bloom could suffocate the reef, and these important places would have lost their natural beauty and some of their cultural significance. Because reefs take many years to regrow, this would be devastating.

**Hypothesis:** Development leads to nutrient run-off in the nearshore water. This results in the increase in algal growth.

### **Experimental Design**

This research project addressed the questions: 1) “Do the nutrient levels found in coastal waters, reflect human development along the shoreline?” and 2) “Does algae growth and cover change by location and nutrient levels?” And, as a class, hypothesized: Development leads to nutrient run-off in the nearshore water. As a result this could cause an increase in algal growth.

In order to test this hypothesis, as a class, we decided to set up similar transects at two sites with comparable substrate that only differ in that, one is much more developed (Kahalu‘u); whereas the other site has less development surrounding the coastal environment (Kūiki‘o). At each site, four transects were plotted parallel to a rocky coastline and were conducted at depths in a narrow range of variation (3.5-7.5 feet).

We then determined we would need a group of people to focus on the chemistry aspect of the project while the others were gathering the data in the water. We split into five groups, one team responsible for conducting chemical tests of nutrient levels, while the other four teams were assigned to gather data from one of the four at each site. Data was collected at each site on two different days to provide replicates.

The data gathered by the chemistry team would consist of everything from nitrogen levels to salinity tests. Meanwhile, the transect teams’ recorded the type of substrate found on the ocean floor of these coastal shores. A 100ft point-transect was used and substrate data collected every 2 feet. The following substrate types were recorded: sand, rock, rubble, coralline algae, turf algae, hard coral, and other.

### **Materials and Methods**

The following pages contain lists of the materials needed and methods used for experimenting with transect lines, making and using GPS, collecting and analyzing water samples, and filming and recording all the action.

#### **Transect Lines**

##### **Materials:**

- Lead Weight
- Measuring tape (over 100 ft)
- Pencil and eraser
- Rope with lead fish weight on the end (drop weight)
- Rubber tube (to connect pencil with slate)
- Slate
- Substrate identification sheet
- Snorkel gear
- Weight



**Method:** The following is a set of step-by-step instructions for this experiment:

1. Pick a place in the water where you want to run your transect line through.
2. Place end of tape measure (with weight attached) in a spot where it will not move.
3. Roll out the tape along your chosen spot, while making sure that it is straight, parallel to shore, and that the end has not moved.
4. Once the tape is laid out in a straight line to the full 100 feet, swim back to the beginning of the line and get out the drop weight and data sheet.
5. One person drops the weight every other foot (starting at 0 and going in 2 foot increments for a total of 51 observations), while the other person records what is directly under the drop weight on their data sheet.
6. Once finished, roll up the tape and head to shore.

**GPS**

**Materials:**

- Buoy
- Global Positioning System
- Pencil and eraser
- Rope
- Slate
- Snorkel Gear
- Tape Measure

**Method:** The following is a set of step-by-step instructions for this experiment:

1. Draw shoreline and label the ocean on a slate.
2. Draw 4 vertical lines for Kūki‘o and 4 horizontal lines for Kahalu‘u, about an inch apart on the slate and label T1 through T4 (Transect 1 is the closest to shore).
3. Put GPS and slate in buoy.
4. Tie rope to the buoy and to any part of your body (make sure it is secure, so it will not float away).
5. Go to the location where your instructor assigned you.
6. After the tape measure is set, find the coordinates for both the beginning point and end point of the transect line.
7. Write down coordinates on a slate and do the same thing for the rest of the transects.
8. Afterwards, finish recording the coordinates, rinse everything off, and wait for further notice.

**GPS Coordinates for Kahalu‘u and Kūki‘o:**

Kahalu‘u Transect GPS Coordinates

South End		North End	
T1: N 19° 34.767	W 155° 58.067	N 19° 34.700	W 155° 58.063
T2: N 19° 34.769	W 155° 58.071	N 19° 34.700	W 155° 58.065
T3: N 19° 34.770	W 155° 58.072	N 19° 34.700	W 155° 58.069
T4: N 19° 34.700	W 155° 58.074	N 19° 34.700	W 155° 58.073

Kūki‘o Transect GPS Coordinates

East End		West End	
T1: N 19° 49.126	W 155° 59.996	N 19° 49.135	W 156° 00.012
T2: N 19° 49.130	W 155° 59.994	N 19° 49.137	W 156° 00.011
T3: N 19° 49.132	W 155° 59.994	N 19° 49.140	W 156° 00.009
T4: N 19° 49.135	W 155° 59.992	N 19° 49.144	W 156° 00.005

## **Ocean Chemistry**

### **Materials:**

- 12 water sample bottles w/caps
- LaMotte chemical ammonia test
- LaMotte chemical nitrate test
- LaMotte chemical phosphate test
- Dissolved oxygen meter
- Pencil
- Permanent marker
- pH meter
- Pipets
- Refractometer (salinity)
- Stopwatch
- Thermometer
- Wash bottles containing tap water
- Water samples from ocean

**Method:** After collecting water samples, make sure to test for temperature first as that will change after being brought out of the water. All other tests can be completed in any order desired.

### **Water Collection:**

1. Use a permanent marker to label 12 sample collection bottles and their lids with transect line numbers (1-4) and A, B, or C for the location on the transect line that each sample will be collected.  
(Note: A=0 ft. B= 50 ft. C= 100 ft. down the transect line.)
2. Keep bottles together in a net bag and swim out to transect line.
3. Swim down to bottom of ocean with the correctly labeled bottle for the location.
4. Open bottle while at bottom of ocean and let fill with water.
5. Recap bottle while still at bottom of ocean.  
(Note: Do not open or close bottle anywhere besides bottom of ocean. Water samples from wrong ocean depth may get in bottle.)
6. Repeat steps 3-5 at all 11 other sample sites.
7. Bring filled bottles back to shore and start testing!

### **Temperature:**

1. Select a water sample.
2. Insert thermometer into water sample.
3. Let sit for approximately one minute or until the scale on the thermometer has finished rising.
4. Record temperature.
5. Repeat steps 1-4 with the other 11 samples.

### **Ammonia Nitrogen:**

1. Select 1 of the 12 water samples.
2. Set up ammonia nitrogen testing kit.
3. Follow instruction booklet inside of kit to receive accurate test results.
4. Record results.
5. Recap water sample bottle and clean up area.  
(Warning: Do not dispose of chemicals in area where they can harm people.)
6. Repeat steps 1-5 with other 11 samples.



**Dissolved Oxygen:**

1. Set up and turn on the dissolved oxygen meter.
2. Select 1 of the 12 water samples and set the dissolved oxygen meter probe into water.
3. Let probe sit and watch the numbers on meter screen drop.
4. Result is the number that shows on the meter screen before the oxygen level readings start going back up.
5. Record results.
6. Pull out probe and recap sample bottle.
7. Rinse end of probe with distilled water.
8. Repeat steps 2-7 with the other 11 water samples.

**pH:**

1. Turn on pH meter.
2. Calibrate it by following instructions on the back of the box.
3. Select 1 of the 12 water samples.
4. Insert pH probe into the water sample.
5. Gently stir the water with probe while watching the meter screen readings.
6. Once meter readings stop increasing, record the largest number reading.
7. Repeat steps 4-6 with the other 11 water samples.

**Phosphate:**

1. Select 1 of the 12 water samples.
2. Set up phosphate testing kit.
3. Follow instruction booklet inside of kit to receive accurate test results.
4. Record results.
5. Recap water sample bottle and clean up area.  
(Warning: Do not dispose of chemicals in area where they can harm people.)
6. Repeat steps 1-5 with other 11 water samples.

**Salinity:**

1. Set up and calibrate refractometer.
2. Calibrate by putting 1 drop of distilled water on the glass surface.
3. Take outside and look through eye lens into the sun.
4. Focus refractometer by turning rubber area around eye lens.
5. Turn knob on top of refractometer until the salinity level measures 0.
6. Dry off glass surface area using glass cleaning cloth.  
(Note: Be careful to not turn top knob on refractometer after it has been calibrated. Doing so will give false results and the refractometer will need to be recalibrated.)
7. Select 1 of the 12 water samples.
8. Use a pipet to put 1 drop of water sample on to glass surface.
9. Take outside and look through lens to see the salinity level measurement.
10. Record results.
11. Clean off glass surface with fresh water and with glass cleaning cloth.
12. Repeat steps 7-11 with other 11 water samples.

## **Filming**

### **Materials:**

- Batteries
- Computer
- DV-R DVDs
- Editing software
- Flip underwater housing
- Flip video HD camcorder
- Snorkel gear
- Underwater digital camera

### **Method:**

1. Gather supplies and put on snorkel gear.
2. Film students entering water.
3. Get into water.
4. Film each group at work.
5. Put camera equipment away.
6. Put snorkel equipment away.
7. Upload all images and clips to computer.
8. Go through all videos/pictures and delete bad ones.
9. Put the clips/pictures you have chosen to use into an imovie presentation.
10. Edit the film.
11. Create an iDVD presentation.
12. Move movie onto DV-R DVDs.
13. Burn presentation onto blank DV-R DVDs.

## **Results**

### *Statistical Analyses*

The transect data were collected as frequency counts, therefore a Chi-square Test of Independence was used to accept or reject the null hypothesis. The null hypothesis was that the categorical variables of substrate type were independent of site. The alternative hypothesis for the Chi-squares is that the ratios of the variables are not independent of site meaning that the location was linked to the coverage type.

The chemical data were collected as measurements, therefore a Student's T-test was used to accept or reject the null hypothesis. The null hypothesis was that the means obtained for the variable from the two sites were not significantly different. The alternative hypothesis, based on a two-tailed test, was that the sites were significantly different for the measured variable.



*Chemistry*

The results of the chemical measurements and analyses are seen in Table 1.

**Table 1. Water Chemistry: Means ± SD**

	Kahalu‘u	Kūki‘o	T-Test
Phosphates (ppm)	<.1	<.1	
Nitrates (ppm)	--	--	
Ammonia (ppm)	0.40 ± .23	0.39 ± .23	NS
Temperature (C)	25.8 ± .7	25.4 ± .2	NS
Salinity (ppt)	34.5 ± .6	34.2 ± .9	NS
pH	8.0 ± .1	7.9 ± .1	NS
Dissolved Oxygen (ppm)	6.2 ± .2	6.8 ± .2	<.01

The attempts to measure Phosphates and Nitrates were unsuccessful. The equipment was not sensitive enough to measure the existing levels. There was no significant difference between the bays for Ammonia, another assay of Nitrogen. There was also no significant difference in temperature, salinity, and pH. There was, however, a significant difference in the average amount of Dissolved Oxygen ( $p < .01$ ). Kūki‘o had, on average, 6.84 ppm DO while Kahalu‘u had 6.19 ppm DO.

*Hard Substrate vs. Sand*

The percent of hard substrate found in transects sampled at Kahalu‘u and Kūki‘o is presented in Table 2. The percentages indicate that Kūki‘o has significantly more hard substrate than Kahalu‘u.

**Table 2. Percent hard substrate vs. sand**

	Kahalu‘u	%	Kūki‘o	%
Hard	272	66.70%	374	91.70%
Sand	136	33.30%	34	8.30%
Total	408	100%	408	100%

*Bare vs. Covered Hard Substrate*

After removing frequencies of Sand, the amount of bare hard substrate was compared with hard substrate that had some type of cover. The percent of bare hard substrate is presented in Table 3 below. This table indicates that Kahalu‘u has more bare hard substrate than Kūki‘o; or conversely, more of the hard substrate at Kūki‘o had some type of cover such as coralline algae, turf algae, etc.

**Table 3. Percent bare substrate vs. covered substrate**

	Kahalu‘u	%	Kūki‘o	%
Bare	164	60.30%	110	29.40%
Covered	108	39.70%	264	70.60%
Total	272	100%	374	100%

*Type of Cover*

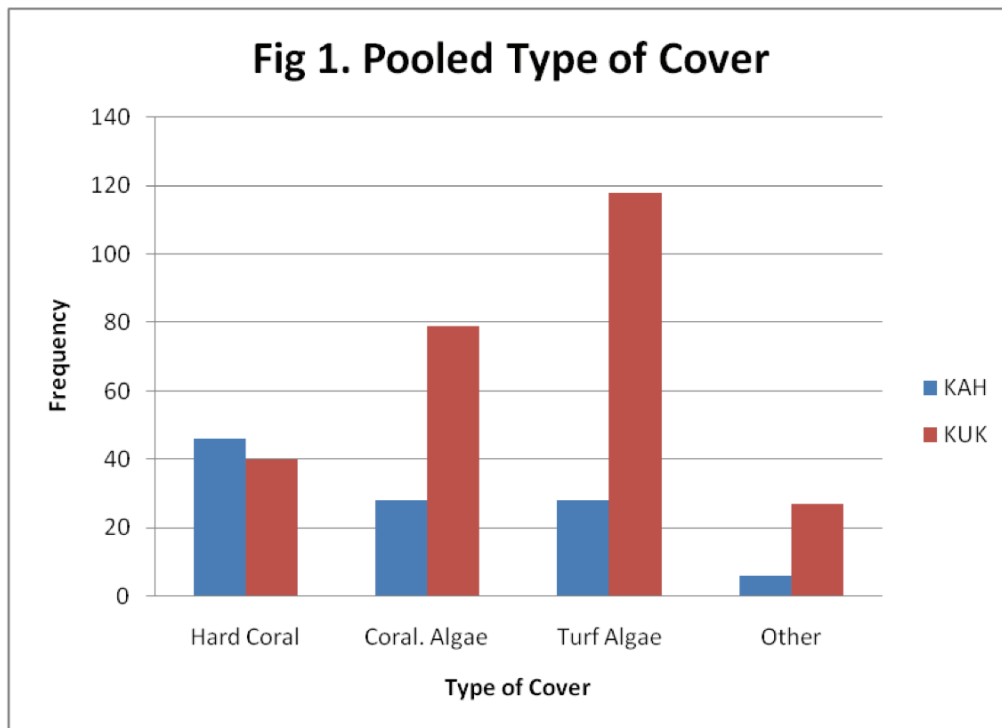
The type of cover on the hard substrate was categorized as *Hard Coral*, *Coralline Algae*, *Turf Algae*, or *Other* at each of the sites. Table 4 shows the pooled frequency of hard substrate coverage over the 4 transects for each of the two bays. Figure 1 graphically depicts this data, while Table 5 shows the Chi-Squared analysis of the data. The statistics show no significant difference in the frequency of *Hard Coral* between the two bays. However, the analysis shows Kūki‘o to have significantly more *Coralline Algae*, *Turf Algae*, and *Other* coverage.

**Table 4. Type of Cover on Hard Substrate at Kahalu‘u and Kūki‘o**

Pooled Transects: Frequency of Cover		
	KAH	KUK
Hard Coral	46	40
Coral. Algae	28	79
Turf Algae	28	118
Other	6	27

**Table 5. Chi-Square Analysis of Type of Cover**

	X <sup>2</sup>	df	p
Hard Coral	2.87	1	NS
Coral. Algae	14.39	1	<.001
Turf Algae	37.77	1	<.001
Other	9.29	1	<.005



*Summary of Findings*

Kūki‘o had more hard substrate and more coverage of that substrate than Kahalu‘u. While there was no difference in the amount of hard coral at the two sites, Kūki‘o had more coralline algae, turf algae, and other types of coverage. The only chemical difference detected between the two bays was a higher dissolved oxygen content at Kūki‘o. Using Google photographs, the nearshore development appears greater at Kahalu‘u, while the upper watershed development appears to be more extensive at Kūki‘o. The use of Kahalu‘u Bay by visitors and residents alike is greater than the use of Kūki‘o Bay because it is a county park with unrestricted access. This information is summarized in Table 6 below.

**Table 6. Summary of Results**

Variables Examined	Kahalu‘u	Kūki‘o
Benthos (Hard Substrate)	Less	More
Benthic Cover	Less	More
Type of Cover:		
Hard Corals	NS	NS
Turf Algae	Less	More
Coralline Algae	Less	More
Other Cover	Less	More
Water Chemistry:		
Ammonia	NS	NS
Dissolved Oxygen	Less	More
Potential Human Impact:		
Shoreline Development	More	Less
Watershed Development	Less	More
Use of Area in Bay	More	Less

**Discussion**

In the analysis, a series of questions was asked to gain as much information as possible about differences between the two bays. The results can be summarized as follows.

1. Kūki‘o has significantly more hard substrate than Kahalu‘u. Kūki‘o has more habitat for recruitment of algae and other cover than Kahalu‘u.
2. Kūki‘o has significantly more cover on the hard substrate than Kahalu‘u. Even though there is more hard substrate at Kuki‘o, more of the hard substrate had some type of cover.
3. There is a tendency for the type of cover to differ between the bays. Kūki‘o tends to have more turf algae and coralline algae.
4. The two bays had the same amount of hard coral.
5. The attempt to associate nutrient levels with the two bays was unsuccessful. No information is available to link nutrient levels with the types of cover on hard substrate in the two bays.

The original hypothesis was that, since Kahalu‘u has more nearshore development (see Appendix 1 and 2), it may show signs of more algae than Kuki‘o. This assumption was based on the possibility that Kahalu‘u would be nutrient enriched by sewage from the nearby development. This nutrient enrichment would favor the growth of algae, especially turf and macro-algae, in Kahalu‘u Bay. First, no information was obtained about nutrients. Second, no macro-algae were found in any samples from either bay. Third, Kūki‘o appears to have more turf algae than



Kahalu‘u. Nearshore development does not appear to be associated with the growth of algae in these two bays.

### Conclusion

The original group hypothesis was that algal growth and cover will be associated with human development along the shore. Nutrient levels in the water were initially believed to be higher at Kahalu‘u due to the high amount of nearshore development. At this point, we are questioning our initial hypothesis about development, Kahalu‘u is more developed near the shore but shows lower amounts of turf algae cover; Kūki‘o is less developed near the shore but shows higher amounts of turf algae cover. The assumption that Kahalu‘u is more developed than Kūki‘o may be incorrect; Kūki‘o shows more overall development in its watershed than Kahalu‘u (Appendix 1 and 2). The instruments used to measure the water chemistry were not sensitive enough to detect the levels present at the two bays. If a follow-up study were to be done, the instruments used to measure water nutrients would need to be more precise. Given the results, perhaps it is more important to look at overall development in a watershed than just the nearshore development.

### Acknowledgements

This study was funded by a grant from The Kohala Center as part of its Hawai‘i Island Meaningful Outdoor Experience (HI-MOES) initiative with NOAA and The Kohala Watershed Partnership. We would like to especially thank Samantha Birch, Field Educator and Program Leader of The Kohala Center, for all of her guidance and assistance. We would also like to thank Mrs. Donna Goodale, our biology instructor, for her guidance and assistance at every stage of the study and in the preparation of this report. This study would not have been possible without her leadership. Finally, Dr. Rick Steger provided guidance for the statistical analyses and interpretations of results.

### References

1. Abbot, Isabella A.; Huisman, John M.; Smith, Celia M. "Hawaiian Reef Plants". *A Publication of the University of Hawaii Sea Grant College Program* pg 31. 2007
2. "Algae." *Atlantic and Gulf Rapid Reef Assessment*. Web. 05 Apr. 2010. [www.agrra.org/background/algaeback.html](http://www.agrra.org/background/algaeback.html).
3. *Coral Reef Aquatics*. Web. 05 Apr. 2010. [www.craquatics.com/phosphates.htm](http://www.craquatics.com/phosphates.htm).
4. "Coral Reef Ecosystem Dynamics, Nutrient Cycling, Effects of Fishing." *The Starving Ocean*. Web. 05 Apr. 2010. [www.fisherycrisis.com/coral3.html](http://www.fisherycrisis.com/coral3.html).
5. "Diffusion." *The Biology Corner*. Web. 05 Apr. 2010. [www.biologycorner.com/bio1/diffusion.html](http://www.biologycorner.com/bio1/diffusion.html).
6. "Introduction to Coastal Pollution". *Oceanography in the 21<sup>st</sup> Century*. [oceanworld.tamu.edu/resources/oceanography-book/introcostalpollution.htm](http://oceanworld.tamu.edu/resources/oceanography-book/introcostalpollution.htm).
7. "Living Corals" [www.marinebiology.org/coralreefs.htm](http://www.marinebiology.org/coralreefs.htm).
8. "Marine Algae of Hawaii" [www.hawaii.edu/reefalgae/natives/sgfieldguide.htm](http://www.hawaii.edu/reefalgae/natives/sgfieldguide.htm).
9. "Nitrate, and Ways to Control It in Saltwater Aquariums." *Saltwater Aquariums, About Saltwater Aquarium Fish, Reef Tanks, Saltwater, Marine Fish, Corals, Invertebrates Marine Saltwater Aquarium Fish*. Web. 05 Apr. 2010. [www.saltaquarium.about.com/od/nitratecontrol/ss/nitratecontrol.htm](http://www.saltaquarium.about.com/od/nitratecontrol/ss/nitratecontrol.htm).
10. "Nutrient Pollution of Coastal Rivers, Bays, and Seas". *Issues in Ecology*. Nov 7 2007. [www.epa.gov/watertrain/pdf/issue7.pdf](http://www.epa.gov/watertrain/pdf/issue7.pdf).

## Appendix 1: Aerial photographs of Kahalu‘u Bay.



Figure 2: Kahalu‘u Bay at low altitude showing nearshore development.

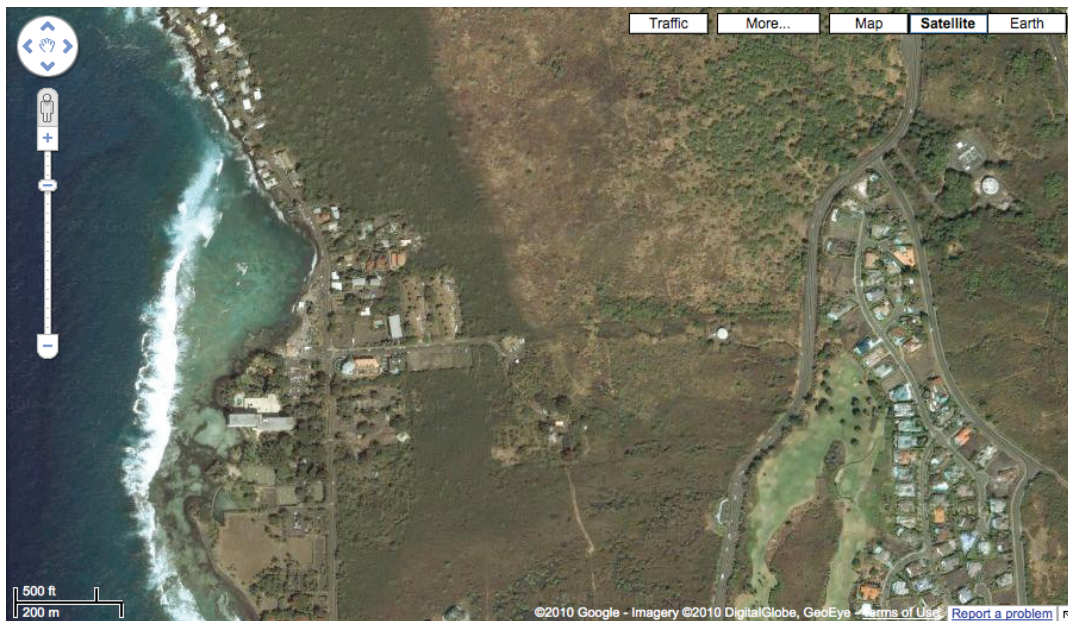


Figure 3: Kahalu‘u Bay at higher altitude showing near high shore development but low upper watershed development.



## Appendix 2: Aerial photographs of Kūki‘o Bay.

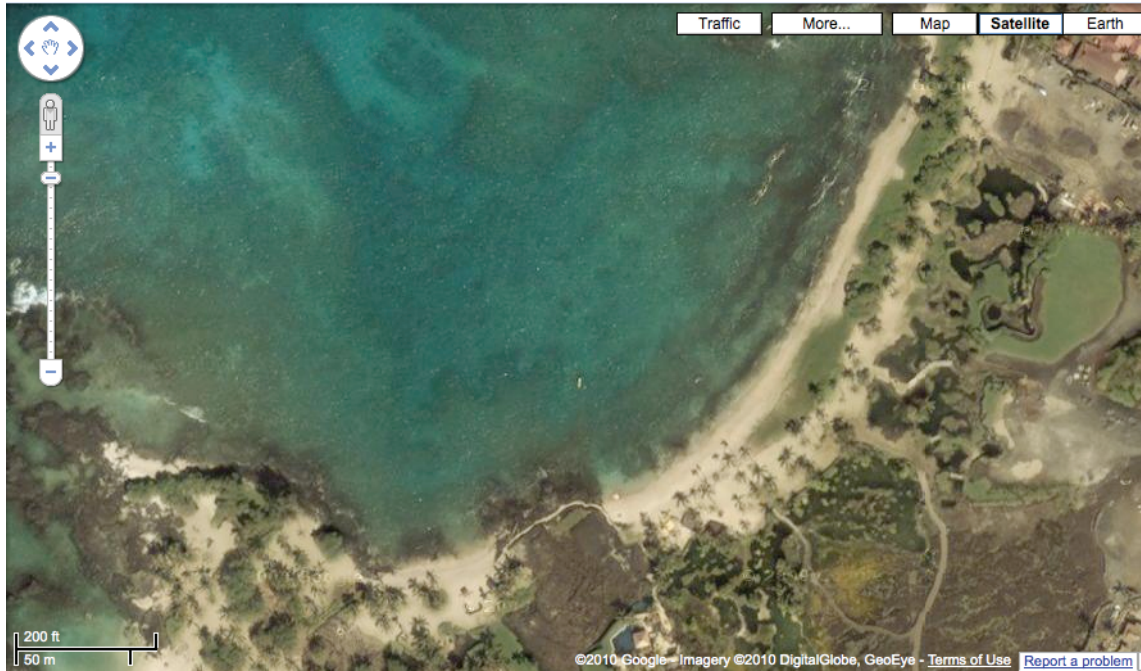


Figure 4: Kūki‘o Bay at low altitude showing low nearshore development.



Figure 5: Kūki‘o Bay at higher altitude showing near low shore development, but high upper watershed development.



## **Components of a Watershed**

**Students of Sylvia Texeira's class, West Hawaii Explorations Academy**

### **Background**

The entire 7th grade class (28 students) participated in the Kohala Watershed Study. The study groups were divided into 4-groups of 7 students each. The groups were: Soil, Water, Animals/Insects, and Plants. The students had a number of ideas to study the watershed, but finally settled with the broad component topics to understand how the biological aspects were being affected by the physical aspects.

Watersheds are made up of soil, water, plants and animals. All of these components must come together to create a watershed, which supports a variety of ecosystems.

### *Plant Team*

**Question:** Will there be more plants growing on the nurse-logs or on the ground next to them?

**Hypothesis:** If we study nurse-logs and the ground next to them then we will find more plants growing on the nurse-logs because they provide more nutrients.

### **Methods and Materials**

The plant team took samples and measurements, identified the plants, and took data on the nurse-log and the areas besides them. They measured plants on the nurse logs and nearby.

### **Conclusion**

They found that everything in the bog was a nurse log.

### *Soil Team*

**Question:** Are there more nutrients in the soil in the higher elevations or the lower elevations?

**Hypothesis:** If we test soil from different elevations then there will be more nutrients in the higher elevations because it is more damp than the lower elevations.

### **Methods and Materials**

The soil team found sample sites, dug a square hole, 1 ft. x 1 ft., took samples from the O and A layer, and did nutrient testing on the soil with the Lamotte soil test kit.

### **Conclusion**

Nutrient levels varied in the Wet forest and in the bog. More samples are needed to support our hypothesis. The dry forest area had low nutrient levels compared to wet forest and bog.

### *Water Team*

**Question:** Does the bog or high stream have more nutrients?

**Hypothesis:** If we test the bog it will have more nutrients than the high stream because the water has more minerals.

**Methods and Materials**

The water team took water samples, tested for chlorides, nitrates and pH and took temperature readings.

**Conclusion**

The high stream had more nutrients than the stream near Pu‘u o ‘Umi. However, the results show that we need more testing to support our hypothesis.

*Animal Team*

**Question:** Are there going to be more animals in the bog, wet forest or dry forest?

**Hypothesis:** We expect to find more diversity of animals in the bog, because there is more water.

**Methods and Materials**

The animal team used a beater tarp to catch insects from the plants and brush and used a sweep net in the grassy areas. They identified the insects with Dr. Peck and preserved the insects in alcohol.

**Conclusion**

There is more diversity in the wet forest than the bog. More surveys should be done to really be sure.

***Thank You to:***

The Kohala Center  
Dr. Robert Peck  
Melora Purell  
Samantha Birch

## **Species Abundance**

### **Students of Laura Jim's class, Hawai'i Preparatory Academy**

#### **Purpose**

How does the number of species in a plot vary from the locations along the Kohala watershed?

**Hypothesis:** There will be more variation at the Pu'u o 'Umi because of how wet it is; however, the more woody trees will be at the Koai'a Reserve because of how woody trees can store water.

#### **Background**

The Kohala Center is a non-profit organization organized by community researchers who want to enjoy and perpetuate Hawai'i's natural landscape. The diversity of Hawai'i's climate and ecosystems is very rare and a wonderful place for research. The Kohala Center began in 2001 with only \$7,600. Now, thanks to donors and gifts, The Kohala Center is growing rapidly.

Pu'u o 'Umi was established in July 9, 1987. The reserve has a wet summit, shrub lands, and grasslands. The reserve extends down slope to the Kohala sea cliffs and coastal dry grassland. Numerous streams run through Pu'u o 'Umi. This area is home to many rare plants and endangered species.

The Koai'a Reserve is named after the Koai'a tree. The Koai'a tree is a strong wooded tree. Even near the cattle pastures they grow proficiently. It is used for tools and long weapons and covers the pasture of the Koai'a Reserve.

#### **Materials**

- Pencil
- Composition book
- Poles
- String

#### **Methods**

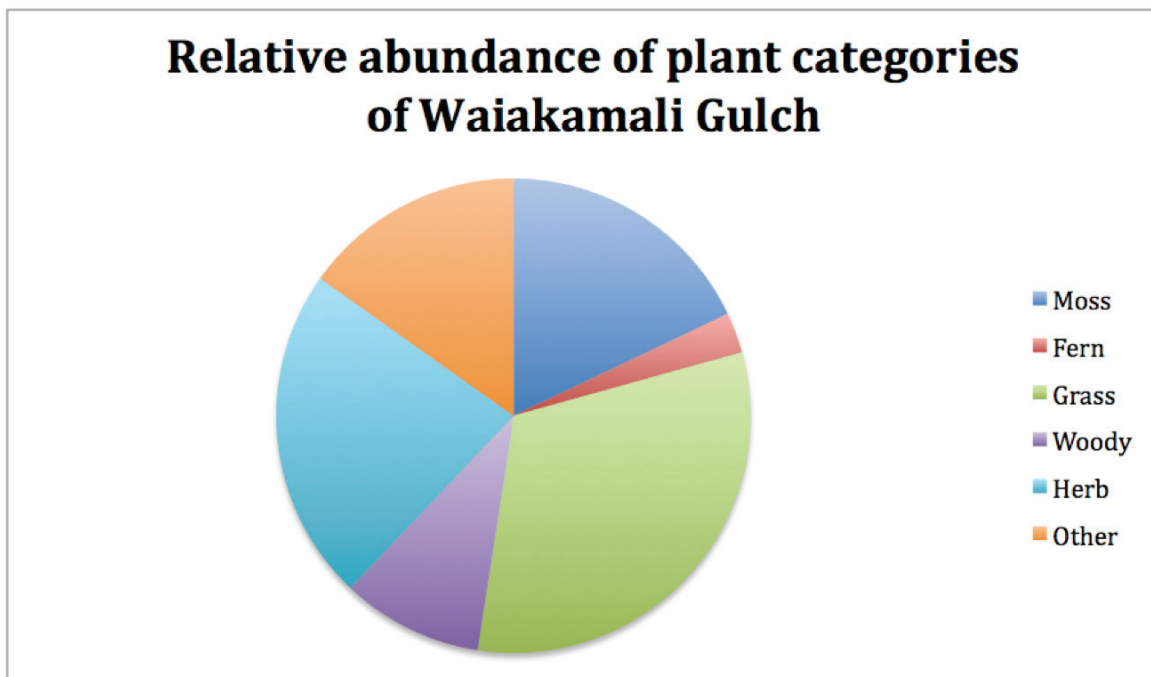
1. Start at Pu'u o 'Umi.
2. Walk 20 steps into the forest.
3. Set down quadrat.
4. Begin counting the number of species present.
5. Record in data table.
6. Take apart quadrat.
7. Repeat this for 20 quadrats.
8. Move to next area.

#### **Data Summary**

The Koai'a Reserve had the least plant diversity. The woody plants and other (rock and dirt) were the most abundant and there were no moss and very little ferns. Pu'u o 'Umi and the Waiakamali Gulch contained representatives of each category with similar quantities of organisms in most of the categories except for herbs, woody plants, and grass.

**Table 1. Number of Species found in plots at the Waiakamali Gulch**

Plots	Moss	Fern	Grass	Woody	Herb	Other
1	3	0	3	0	1	1
2	1	0	3	0	0	1
3	0	1	2	0	2	2
4	2	0	3	1	3	2
5	2	0	3	0	2	1
6	0	0	3	0	3	1
7	2	2	2	1	3	1
8	0	0	2	2	2	1
9	1	1	2	0	0	1
10	0	0	2	0	2	1
11	1	0	0	3	1	2
12	3	0	2	2	1	1
13	2	0	3	0	2	1
14	2	0	3	1	2	2
15	3	0	3	0	3	1
16	2	0	1	0	1	1
17	1	0	3	3	1	1
18	1	0	2	0	1	1
19	0	0	2	1	2	1
20	0	0	2	0	1	1
Total	26	4	46	14	33	22

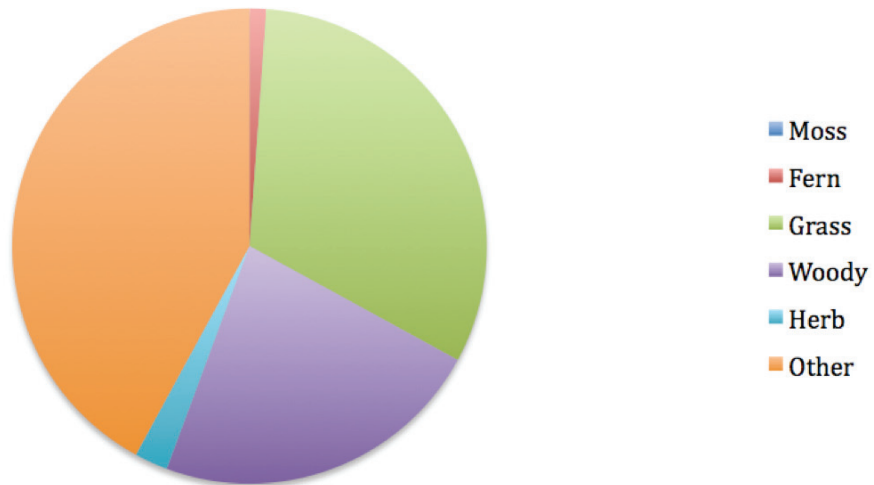




**Table 2. Number of Species found in plots at the Koai'a Reserve**

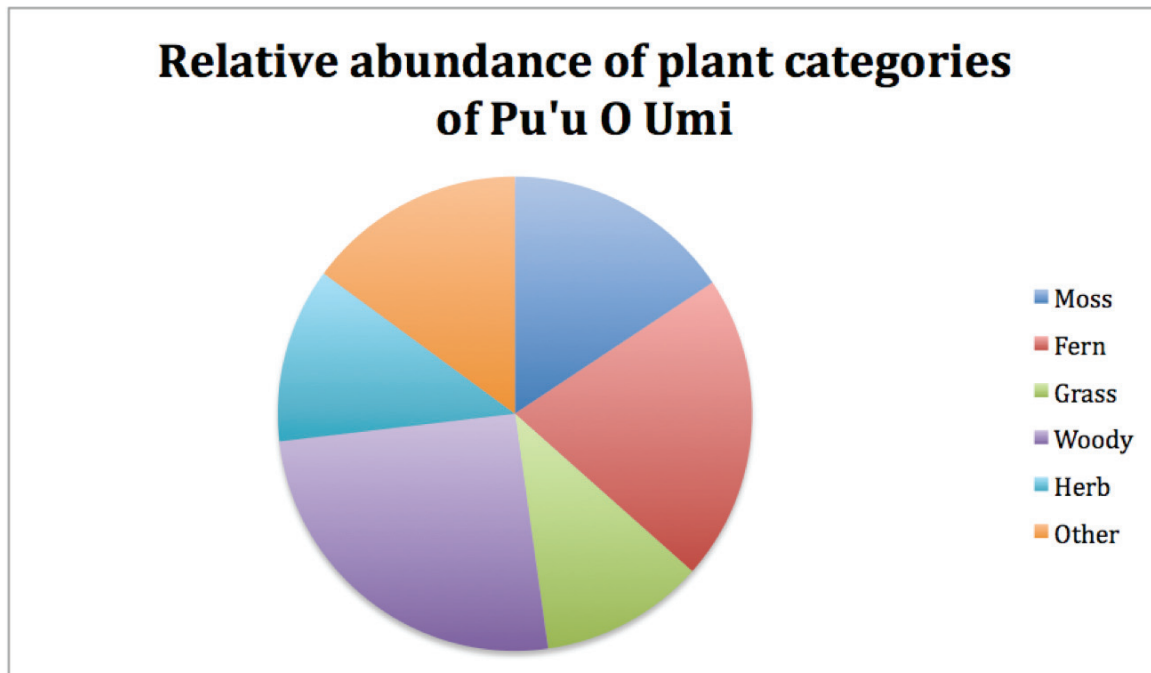
Plots	Moss	Fern	Grass	Woody	Herb	Other
1	0	0	1	2	0	1
2	0	0	1	1	0	2
3	0	0	1	1	0	2
4	0	0	0	1	0	2
5	0	0	0	2	0	2
6	0	0	0	4	0	2
7	0	0	0	3	0	2
8	0	0	0	3	0	2
9	0	0	0	4	0	3
10	0	0	0	5	0	2
11	0	0	2	1	0	2
12	0	0	1	5	0	3
13	0	1	3	0	1	1
14	0	0	3	3	1	2
15	0	0	2	1	0	2
16	0	0	3	1	0	2
17	0	0	4	0	0	1
18	0	0	4	0	0	2
19	0	0	2	2	0	2
20	0	0	1	1	0	2
Total	0	1	28	40	2	37

**Relative abundance of plant categories of Koai'a Reserve**

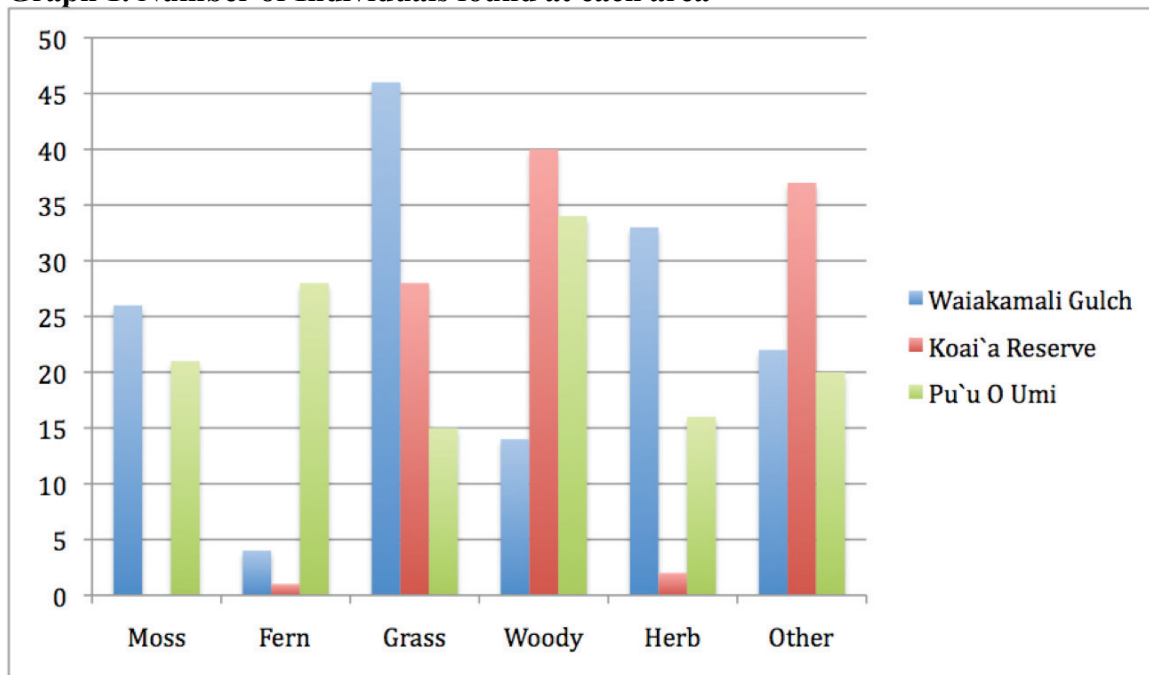


**Table 3. Number of Species found in plots at the Pu‘u o ‘Umi**

Plots	Moss	Fern	Grass	Woody	Herb	Other
1	1	1	1	2	2	1
2	0	0	0	2	1	1
3	1	1	0	2	0	1
4	2	0	0	2	3	1
5	1	2	0	0	0	1
6	1	0	0	1	1	1
7	1	1	1	2	0	1
8	1	3	1	1	1	1
9	2	2	0	2	2	1
10	0	2	3	2	0	1
11	0	2	2	2	1	1
12	1	2	0	1	0	1
13	1	2	0	2	1	1
14	2	1	0	2	0	1
15	1	2	0	1	0	1
16	1	1	1	1	1	1
17	0	2	2	1	1	1
18	3	1	2	4	0	1
19	2	1	2	2	1	1
20	1	2	0	2	1	1
Total	21	28	15	34	16	20



**Graph 1. Number of Individuals found at each area**



**Conclusion**

The numbers of species do change along the Kohala Watershed. Each place had a high number of specific species. For example, the Koai'a Reserve had a lot of grasses and the Waiakamali had a lot of herbs. This could be due to the moisture levels available. Perhaps, herbs, which need large amounts of water, got more water at Pu'u o 'Umi and Waiakamali so were more abundant there. This is true of moss and ferns at Pu'u o 'Umi as well. Which species are more dominant over the other? If so, which area?

We learned that Pu'u o 'Umi had the most species. Perhaps, more plants aren't able to store water very long? We learned that higher elevations get more rainfall, which means more species. It would be good to learn if some species, such as fern, is able to get along better with a specific species that also needs rainfall.

**Works Cited**

Hawai'i Natural Area Reserves

<http://hawaii.gov/dlnr/dofaw/nars/reserves/big-island> (1-26-10)

Species of the Pu'u Loa Koai'a Reserve

<http://www.pacificworlds.com/kawaihae/land/koaia.cfm> (1-26-10)

The Kohala Center

<http://www.kohalacenter.org/> (1-26-10)

## Native and Non-Native Percentages

### Students of Laura Jim’s class, Hawai‘i Preparatory Academy

**Purpose**

What is the percent of native plants verses non-native plants in the Ko‘oia reserve, Waiaka Mali gulch, and Pu‘u o ‘Umi?

**Hypothesis:** We believe that there will be more native plants in the reserves because that is the reason that they were created—to help the native plants to survive. The only non-native plants that are in the reserve were either brought in accidentally or were there originally.

**Background**

Hawaii has a lot of native plants as well as non-native plants. Native plants are plants that have been around before humans introduced other plants. Non-native plants are plants that were brought over from other places by anything that had to do with human interaction.

Plants brought over by the Polynesians are non-native to Hawaii. This is because they were brought over by humans. Any plants brought over naturally are considered native, unless they were brought over recently.

Hawaii has all the climates in the world except for one, which is the arctic tundra, meaning that we have a vast diversity of plants. This shows that a lot of different plants can grow in Hawai‘i, making it even more of a beautiful place. Hawai‘i has all the climates except one because it is close to the equator and has a lot of different elevations.

**Materials**

- Quadrat
- Notebook
- Pencil

**Methods**

1. Place a quadrat on the ground in areas that look very different.
2. Count how many native and non-native plants there are in each quadrat.
3. From the number of native/ non-native, find the percentage and record in notebook.
4. Repeat the process 3-4 times in each of the three reserves.

**Table 1 - Number of Native vs. Non-Native Plants in the Pu‘u o ‘Umi Reserve**

Quadrat #	Native #	Non-Native #
1	3	9
2	16	1
3	73	8
4	19	1
5	7	1
6	58	0
7	50	0
8	22	0
9	18	0
10	4	16



**Table 2 - Number of Native vs. Non-Native Plants in the Koai‘a Reserve**

Quadrat #	Native #	Non-Native #
1	19	5
2	33	0
3	5	30
4	1	33
5	1	15
6	5	0
7	3	0
8	16	5
9	12	3
10	4	16

**Table 3 - Number of Native vs. Non-Native plants in the Waiakamali Gulch**

Quadrat #	Native #	Non-Native #
1	40	13
2	0	40
3	1	44
4	30	30
5	9	34

**Percentages**

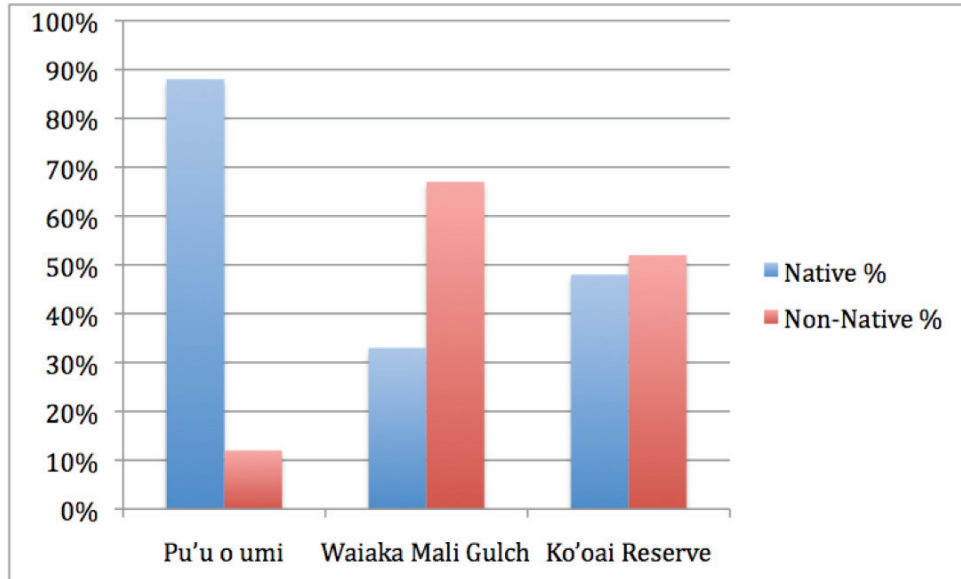
Area	Native %	Non-Native %
Pu‘u O Umi	88	12
Waiakamali Gulch	33	67
Koai‘a Reserve	48	52

**Data Summary**

In the Koai‘a Reserve there were more non-native than native plants but only by 8 plants in the quadrats. There were 99 native plants and 107 non-native plants in total. That means 48% of the plants there were native. In Pu‘u o ‘Umi there were 321 native plants and 27 non-native plants. 88% of the plants in Pu‘u o ‘Umi were native. There were 80 native and a 161 non-native plants in the Waiakamali Gulch. That is 33% native plants.

**Conclusion**

In Pu‘u o ‘Umi there were many more native plants than non-native plants. This shows that this area hasn’t been affected by invasive species as much as the other reserves. Waiakamali gulch was dominated by invasive species. These invasive species were mostly weeds and grass. In the Koai‘a reserve there were just a few more invasive species than native species. All of the invasive plants were grass. The native plants were all trees.



**Works Cited**

What are native plants?

<http://www.for-wild.org/landscap.htm> (Jan.26, 2010)

Regional plant work

[http://www.plantnative.org/reg\\_pl\\_main.htm](http://www.plantnative.org/reg_pl_main.htm) (Jan.26, 2010)

Why are native plants important?

<http://tchester.org/sd/plants/importance.html> (Jan.26, 2010)

## **Percent of Categories**

### **Students of Laura Jim's class, Hawai'i Preparatory Academy**

#### **Purpose**

What are the categories and percents as the elevation grows higher?

**Hypothesis:** We believe that the higher we go in elevation the plants/flora, from the Koai'a Reserve to Pu'u o 'Umi will have more of a variety.

#### **Materials**

- String 2 meters long
- Pencil
- Notebook
- Clipboard

#### **Methods**

1. Reach study site.
2. Set up our materials.
3. Walk and then find a spot and place the string in a circle.
4. Record the percentage of categories.
5. Then we will do this procedure again 10 times and record different data hopefully.

#### **Background**

The difference between moss and lichen is that they look different and grow in different areas and conditions. Moss grows in more wet and moist conditions; it will grow on rocks, trees, dead leaves and plants. Moss is mossy and slimy and slippery. Lichen is mostly found on rocks, trees, and other things. Lichen is mostly found in any moist conditions, but can only grow on other substances.

Ferns are mostly found under closed areas, and they can be found near other plants in squished areas. Woody plants will usually grow in areas together, or also grow by themselves. Most woody plants need lots of water and sun. While some don't, some can live in very hot and dry soil areas. Herbs can vary from a couple inches to a few feet long. As long as they don't have bark then they are an herb, they are also used as medicine.

Pu'u o 'Umi is a reserve that covers the west upper slopes of the Kohala Mountains down to the dry costal sea cliff. Two rare montane bogs are found at Pu'u o 'Umi. The reserve also contains costal dry shrub lands and grasslands. Besides the rare plants in the reserve there are also rare animals, such as the "endangered" Koloa (Hawaiian duck). The reserve is also a very important watershed.

The Koai'a is also called the Koai'a tree. It is a very slow growing hard-wooded tree and it is related to the Koa tree. The Koai'a wood is a strong, hard, fine-grained. It also has a use for weapons such as spears, but it would be a great match for clubs because of its hard wood.

**Table 1 (Averaged Data for Pu'u o 'Umi)**

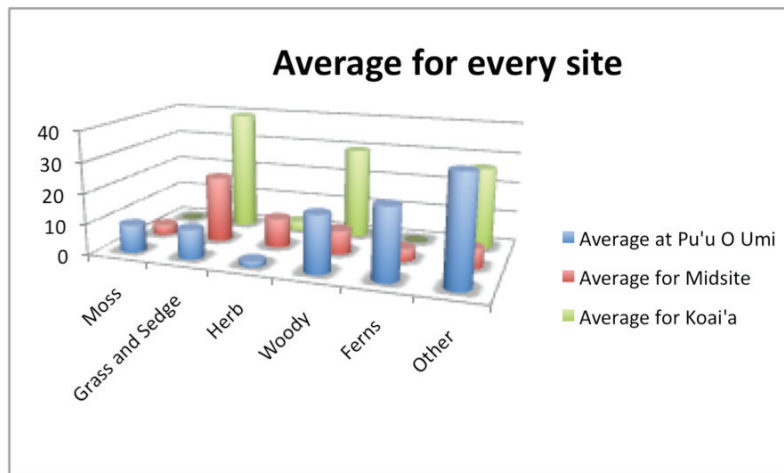
Flora	1	2	3	4	5	6	7	8	9	10	Avg.
Moss	17	20	3	15	10	6	15	5	5	10	<b>9</b>
Grass and Sedge	0	1	1	5	1	2	20	33	33	0	<b>9.6</b>
Herb	0	3	4	1	1	0	5	1	1	1	<b>1.7</b>
Woody	30	20	10	30	5	15	30	18	18	10	<b>18.6</b>
Ferns	25	25	15	3	20	33	15	10	10	75	<b>23.1</b>
Other	28	31	67	46	63	44	25	34	34	4	<b>34.8</b>

**Table 2 (Averaged Data for Mid-site)**

Flora	1	2	3	4	5	6	7	8	9	10	Avg.
Moss	7	1	5	1	5	0	5	5	5	0	<b>3.4</b>
Grass and Sedge	9	10	10	35	35	62	5	40	20	0	<b>21.7</b>
Herb	1	5	20	5	0	25	3	2	35	0	<b>9.6</b>
Woody	0	5	10	9	0	0	2	5	7	20	<b>7.7</b>
Ferns	8	3	25	10	5	0	5	5	0	0	<b>4</b>
Other	75	5	30	40	55	0	80	43	33	50	<b>6.5</b>

**Table 3 (Averaged Data for Koai'a)**

Flora	1	2	3	4	5	6	7	8	9	10	Avg.
Moss	0	0	0	0	0	0	0	0	0	0	<b>0</b>
Grass and Sedge	40	25	50	30	1	0	45	50	90	63	<b>39.4</b>
Herb	5	5	0	0	0	20	0	0	0	0	<b>3</b>
Woody	10	40	45	20	50	30	35	30	10	28	<b>29.8</b>
Ferns	0	0	0	0	0	0	0	0	0	0	<b>0</b>
Other	45	30	5	50	49	50	10	20	0	8	<b>26.7</b>



### **Data Summary**

We noticed that when we took measurements at Pu‘u o ‘Umi, there weren’t really a lot of herbs or grass and sedge. There was more rock/other than anything else. Some ferns were here and there. And some moss was growing on the rocks near moist areas. The ground was really bare and trees were covered in moss. There were also a lot of dead ferns and there was very little grass.

We next went to the Mid-site where there was, again, a lot of (other), which were really boulders and very little rock. There were a lot of ferns growing off the trees and tall trees were over-branching. Some herbs were lying around, and some grass and sedge were also here and there. The moss was growing on the rocks by the stream. There was very little lichen.

At the Koai‘a reserve there were a lot of (other) as well. The grass was really brown and dry, but we counted it, anyway. There were some cactuses and herbs, but in very small amounts. There were also a lot of Koai‘a (the relative of the Koa) for the woody section. No moss was located, but there was a lot of old lichen. We also found that there were no ferns as the ferns usually grow in moist places and this is a really dry place due to its elevation.

### **Conclusion**

During this process we learned that the plants change within the different climates. There is more diversity as you go higher into the climate. Since it was very dry at the Koai‘a reserve, there was less diversity. There was more moss in the forest than at the Mid-site and Koai‘a reserve. There was also a lot of lichen at Koai‘a reserve. It was very interesting to see a different population of plants the higher we went. There was a lot of dead grass at the reserve, but less dead at Pu‘u o ‘Umi. We also learned that there are no moss or ferns when we went down in elevation. We learned that there was actually less grass and sedge at the Mid-site and Pu‘u o ‘Umi. We learned that there is a lot more diversity at Pu‘u o ‘Umi—so much that we couldn’t count everything. I wouldn’t do anything differently, except more time during the visit to the Mid-site.

### **Works cited:**

“The Fern”

<http://en.wikipedia.org/wiki/Fern> (2/10/10)

“Big Island Natural Area Reserves”

<http://hawaii.gov/dlnr/dofaw/nars/reserves/big-island> (2/10/10)

“Herb Research Foundation”

<http://www.herbs.org/> (2/10/10)

“Species of Koai‘a”

<http://www.pacificworlds.com/kawaihae/land/koaiia.cfm> (2/10/10)

“Woody Plant Identification”

<http://utgardens.tennessee.edu/ohld220/> (2/10/10)

“Difference Between Lichen and Moss”

<http://www.wisegeek.com/what-is-the-difference-between-lichen-and-moss.htm> (2/10/10)



## Vertical Height

### Students of Laura Jim’s class, Hawai‘i Preparatory Academy

**Purpose**

Compare and contrast the forest’s vertical structure in three areas with varying elevations.

**Hypothesis:** We think that the higher we go, the higher the trees will grow. There will be lots of ferns and woody plants.

**Background**

The main layers of the forest are the forest floor, the understory, the canopy, and the emergent layer. The forest floor is where most of the moss, shrubs, grasses, and other dead leaves are. The understory is where most of the baby woody and ferns are. The canopy is where the average trees are. The emergent layer is where all the tall trees are including their very tall tree tops. The different layers represent the different heights of the trees and the bushes.

**Materials**

- Notebooks
- Pencils
- Rope

**Methods**

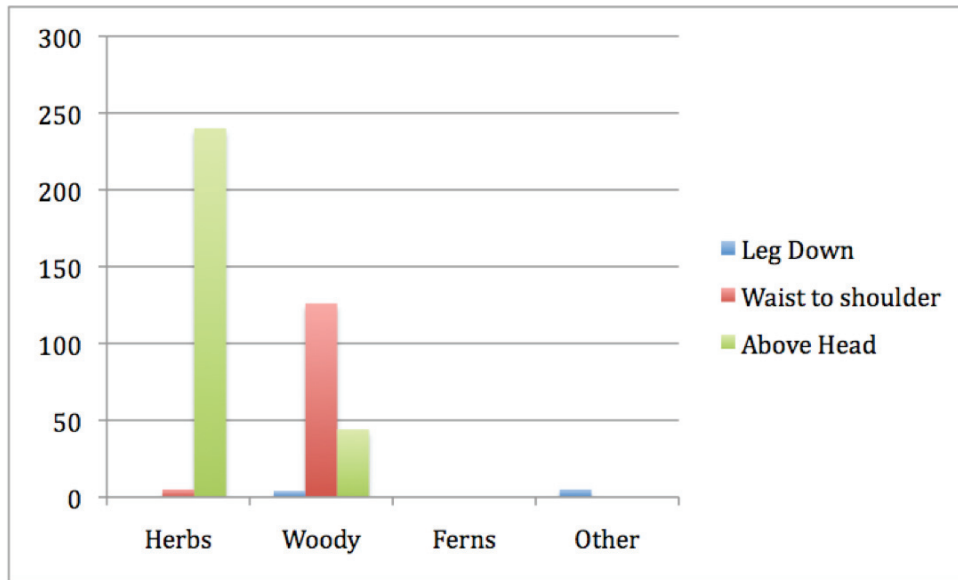
1. Walk 30 feet.
2. Write down the # of plants seen in one area.
3. Categorize the plants in three different groups.

**Data**

**Table 1: Koai‘a Reserve Cumulative Data**

	Herbs	Woody	Ferns	Other
Leg Down	0	4	0	5
Waist to shoulder	5	126	0	0
Above Head	240	44	0	0

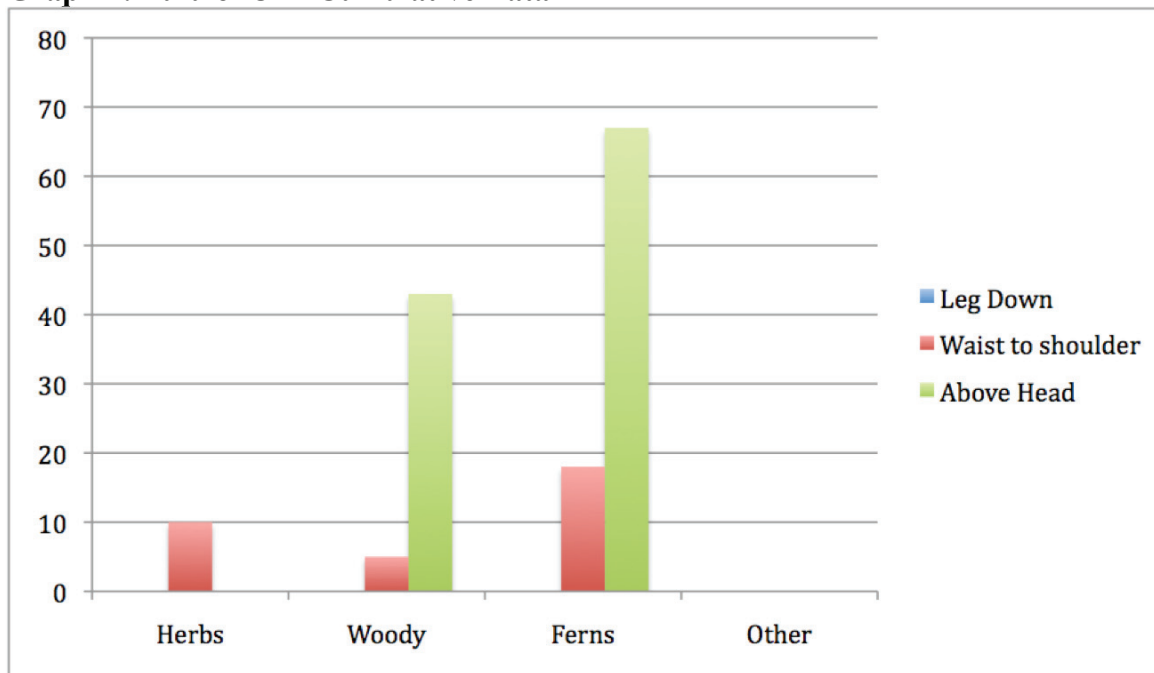
**Graph 1: Koi'a Reserve Cumulative**



**Table 2: Pu'u o 'Umi Cumulative Data**

	Herbs	Woody	Ferns	Other
Leg Down	0	0	0	0
Waist to shoulder	10	5	18	0
Above Head	0	43	67	0

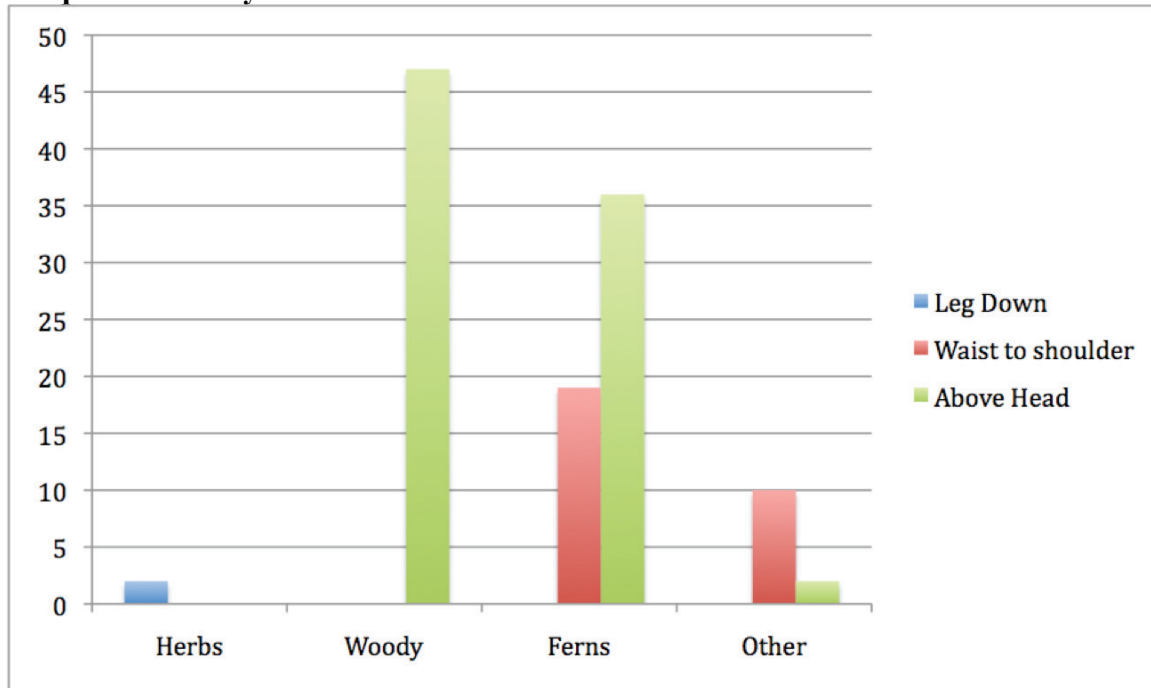
**Graph 2: Pu'u o 'Umi Cumulative Data**



**Table 3: Mid Way Cumulative Data**

	Herbs	Woody	Ferns	Other
Leg Down	2	0	0	0
Waist to shoulder	0	0	19	10
Above Head	0	47	36	2

**Graph 3 Mid Way Cumulative Data**



**Data Summary**

From our data we can conclude that the above head was mostly woody plants and ferns. At waist to shoulder were ferns, woody plants, herbs, and other. The leg down section was herbs and other. Pu‘u o ‘Umi had many tall ferns and tall woody plants which means it gets lots of rain. Mid way had more woody plants and ferns and other categories, and also had really tall weeds. Koai‘a Reserve had both tall woody plants and tall ferns.

**Conclusion**

We thought that the higher we go, the higher the trees would grow. That was wrong because the trees were high the whole time instead of short to tall. We think we should have had a category that was way above our heads. Other than that our project was pretty successful, and the main categories that were above our heads are ferns and woody’s.

**Works Cited**

- <http://www.nationalGeographic.com>(1-27-10)
- Mrs. Jim (1-26-10)
- Melora Purell (1-20-10)

## Insect Diversity

### Students of Laura Jim’s class, Hawai‘i Preparatory Academy

**Purpose**

Which location, Pu‘u o ‘Umi, the Middle area, or the Koai‘a Reserve, has the most insect diversity?

**Hypothesis:** Our hypothesis is that the Middle Area will be the most diverse because it is the best area for the bugs to adapt to. It is not too high in elevation or too low. And the place with the least diversity will be Pu‘u o ‘Umi because of its high elevation, which may make adaptation harder.

**Background**

Pu‘u o ‘Umi is a Natural Reserved Forest that has many native plants. It is located in the Kohala Mountains. This reserve has two rare montane bogs that are surrounded by ‘ōhi‘a forests. The forest has many streams that run through the area. Steep cliffs surround some parts of the forest. One of the other sites that we are going to is the Koai‘a Reserve is a place where the cattle cannot get through which makes the plants there able to survive and thrive. The area is mesic. The middle area is right between Pu‘u o ‘Umi and the Koai‘a Reserve. The middle area is naturally not accessible to cattle as the place is a steep gulch. Insects are a class within the arthropods that have a chitinous exoskeleton a three-part body (head, thorax, and abdomen).

**Materials**

- 3 small beating sheets, and 1 70cmx70cm beating sheet
- 1 Tweezer
- 1 Magnifying Glass
- 2 Plastic Vials
- A Stick

**Methods**

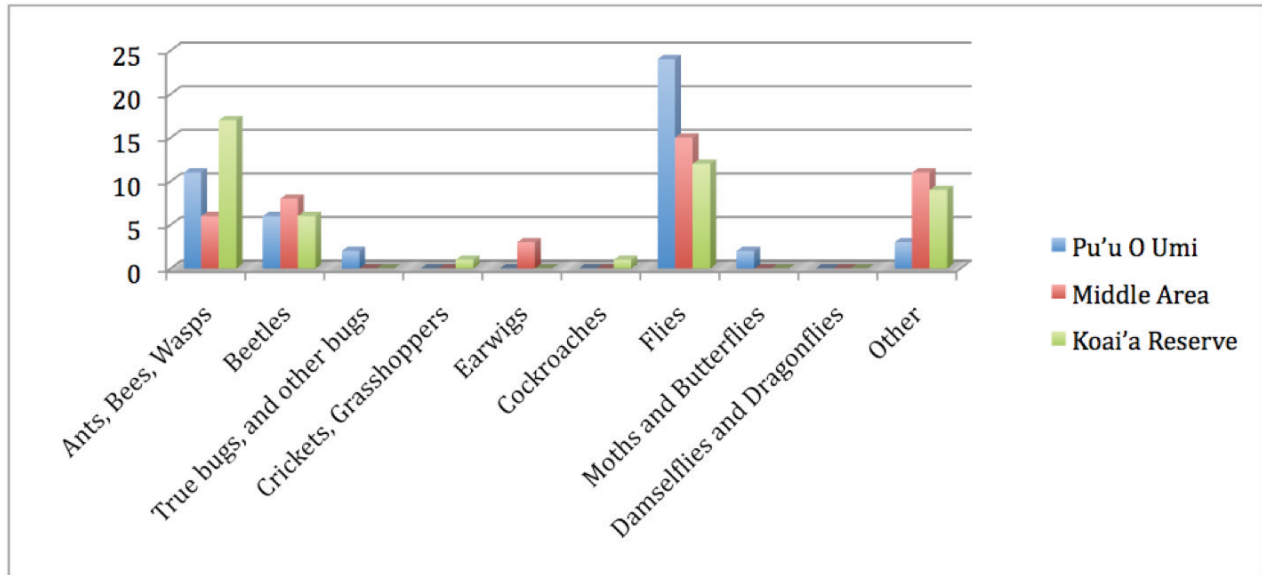
1. Get picked up by the car and drive to Pu‘u o ‘Umi.
2. For Tree: Go to a tree; put beating sheet underneath it; shake or tap tree; look at bugs on the sheet that fall off from the tree; identify them; record in data tables.
3. For the Ground: Get mini sheet; lay sheet on the ground; wait for bugs; identify bugs on sheet; record in data tables.

**Data Tables**

Category	Pu‘u o ‘Umi	Middle Area	Koai‘a Reserve
Ants, Bees, Wasps	11	6	17
Beetles	6	8	6
True bugs, and other bugs	2	0	0
Crickets, Grasshoppers	0	0	1
Earwigs	0	3	0
Cockroaches	0	0	1
Flies	24	15	12
Moths and	2	0	0

Butterflies			
Damselflies and Dragonflies	0	0	0
Other	3	11	9

**Graph of Data**



**Data Summary**

On January 29, we went to do our HI-MOES research project on bugs. Pu‘u o ‘Umi had the most amount of bugs when compared to Koai‘a Reserve and the Middle Area. Pu‘u o ‘Umi also has the most diversity. The Middle area had the least amount of diversity. The Middle area also had the least amount of bugs compared to Pu‘u o ‘Umi and Koai‘a Reserve. The most popular bugs we collected were flies. Damselflies and dragonflies were the only order in which we didn’t collect any bugs.

**Conclusion**

After going to Pu‘u o ‘Umi, Middle Area, and Koai‘a Reserve, we conclude from looking at the data that Pu‘u o ‘Umi had the most diversity of insects. Then Koai‘a Reserve comes next, and Middle Area has the least diversity. Our hypothesis was wrong because we predicted that the Middle area would have the most diversity because we thought that it would be easier for the insects to adapt to.

If we could have done some things differently, we would have been more careful in getting data the same way in each area. One of the big things that we could have done differently was make a better purpose—that way we might have been able to get better data.

**Works Cited**

- “Pu‘u O ‘Umi,” <http://hawaii.gov/dlnr/dofaw/nars/reserves/big-island>, (1/26/10)
- Mrs. Jim (1/28/10)
- “Koai‘a,” [www.pacificworlds.com/kawaihae/land/koaia.cfm](http://www.pacificworlds.com/kawaihae/land/koaia.cfm), (1/26/10)



## **HI-MOES Insect Study Project**

### **Students of Laura Jim's class, Hawai'i Preparatory Academy**

#### **Purpose**

Determine out what orders of insects are found on the surface of each Quadrat in three areas: Pu'u o 'Umi, the in-between area, and the Koai'i reserve.

**Hypothesis:** The location with more ground cover due to falling leaves will produce more observational insects on the surface of the soil as opposed to insects hidden in the grass.

#### **Background**

We will be sampling in three different areas: Pu'u o 'Umi, the in between area, and the Koai'a Forest Reserve (which is close to the highway.) Pu'u o 'Umi is at the very top of the hill, and is a protected area for native plants and insects. We have been there recently for a HI-MOES project, and the place we will most likely be studying is near a small river relatively close to the gate (upon entering).

The spot between the two is about halfway down the hill, and is partly pastureland. Our research team will be studying an area away from human contact, surrounded by native trees, and that is relatively undisturbed, therefore offering the most reliable data possible. Finally, the Koai'a Forest Reserve is at the foot of the hill, where we have also been before. This area has lots of Koai'a trees, where some native plants have been known to live in. Also, there seems to be an abundance of cactuses. In the Koai'a Reserve, we have not gone too far into the forest, but there are, hopefully, lots of insects to study there. We will be classifying the insects that we find by means of their order. There are Coleoptera, Blattoidea, Hemiptera, Hymenoptera, Diptera, Odonata, Dermeanpetera, and Orthoptera.

#### **Materials**

- 2x PVC pipe Quadrat (1 square meter)
- 1x Tweezers
- 2x Small tuber ware container
- 3x Pens/pencils
- 3x Notebook for recording

#### **Methods**

1. Get to specific area (one of three) on reserve.
2. Choose random area by spinning in a circle 4 times while holding an object of identification. Then fling this object at any point of the fifth spin. Set the left hand top corner of the Quadrat on this object. Study encased area.
3. Watch Quadrat area for 20-25 minutes.
4. Classify insects observed.
5. Repeat steps 2-6 three times.
6. Move to next area.
7. Repeat steps 2-8 once per location.

**Data summary**

Every place that we have researched was very different from each other along the Kohala watershed. Our teams started off with climbing up the Pu‘u o ‘Umi watershed. We started observation at the sacred Pu‘u o ‘Umi and in Quadrat 1 we found bugs in Dermeanpeter and Coleoptera there was 1 in each Quadrat. In Quadrat 2, we only found 1 in order of Dermeanpetera. Then in Quadrat 3, we once again found 1 bug in order C.

Our next stop on our trip was the in-between point of the Kohala watershed. In Quadrat 1, 2, and 3, we had found absolutely nothing. Our last stop of the day was at the Koai‘a Reserve where we hit the jackpot with bugs for the whole day. In Quadrat 1, I found order Hemiptera, Coleoptera, and 2 Orthopetera. In Quadrat 2, we once again found oreder Hymenoptera in large numbers. In order Blattodea there was 1 and in Orthoptera there was 4. In Quadrat 3, we again found another large concentration of Hemitptera so we rounded to 200. In order Coleoptera, we found 5 bugs.

**Conclusion**

Our hypothesis was in part correct. In the areas with leaf groundcover, there was a higher concentration of insects. Though in areas with massive groundcover the surface insects were difficult to find.

The area we studied first in Pu‘u o ‘Umi was near the stream, but we couldn’t find very many insects. The ones that we found were either invasive or un-classifiable, such as a mosquito, an aphid, a jewel bug, and an earwig. Next, we went down to the in-between area. We got into a small ravine with steep sides. The grass was overgrown and there were quite a few less trees. We couldn’t find anything while looking in all of the Quadrats. We then moved on to the Koai‘a Reserve, and went far into the place. We were very successful there, as we found a moth, a ladybug, two houseflies, a cockroach, five jewel bugs, and lots of ants! Interestingly, though, one of our Quadrats was in a grassy area. In the future, we would better prepare our research processes by digging deeper into the ground foliage and not just examining the topsoil.

**Work cited:**

Insect Order Chart (February 5, 2010)

## **Insects Found on the Ground Versus Found on Trees**

### **Students of Laura Jim’s class, Hawai‘i Preparatory Academy**

**Purpose**

The purpose of this project is to see if insects prefer trees more than the ground or vice versa. This could be helpful information on how to find insects easily or how to keep them away.

**Hypothesis:**

Pu‘u o ‘Umi: We will probably find more in the trees than on the ground.

Middle: There probably will not be many trees for the bugs to hide in which will result in us finding them in the ground.

Koai‘a Reserve: There will probably be more on the ground.

**Background**

Bugs are widely found all around the world, even in Antarctica! The bugs were looked for in the Kohala Mountains. We looked through Pu‘u o ‘Umi, a sacred Hawaiian rainforest. We also looked through the Koai‘a Reserve, a reservation to preserve trees. They can be pests, but they also control spider populations and can be good eating! They also have many uses such as fireflies and stinkbugs. Each bug has it’s own special way of defending itself. Bugs are an important part of our everyday lives.

**Materials**

- Jar/container
- Tweezers
- Magnifying glass

**Methods**

*Locating bugs on the ground*

1. Look for bugs on ground (native insects or non-native) for half an hour.
2. If found, identify them.
3. Release them back where they were found.

*Locating bugs on the trees*

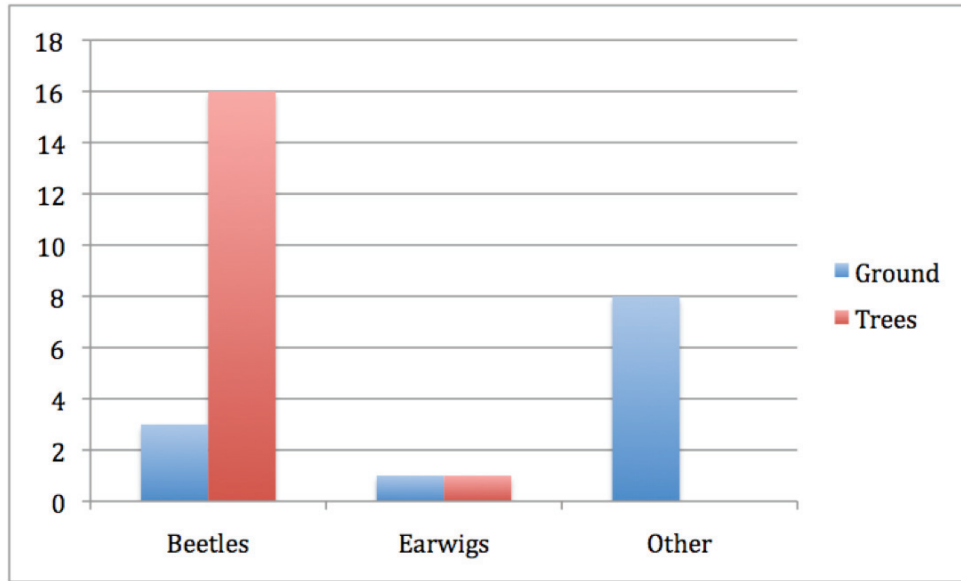
1. Look for bugs on trees (native insects or non-native) half an hour.
2. If found, identify them.
3. Release them back where they were found.

**Data Tables**

**Table 1. Bugs found in Pu‘u o ‘Umi**

Types Of Bugs	Ground	Trees
Beetles	3	16
Earwigs	1	1
Other	8	0

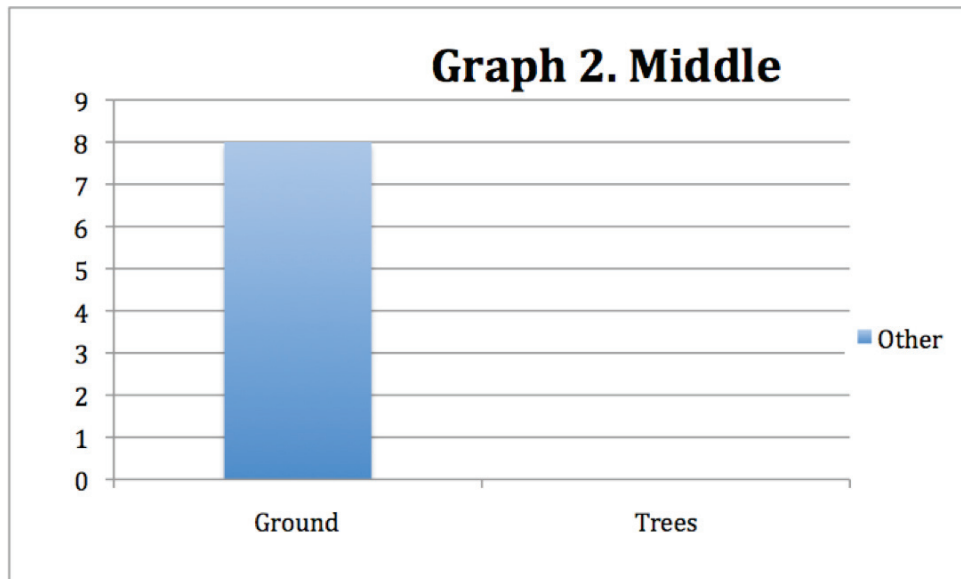
**Graph 1. Insects found in Pu‘u o ‘Umi**



**Table 2. Bugs found in the Middle**

Types Of Bugs	Ground	Trees
Other	0	8

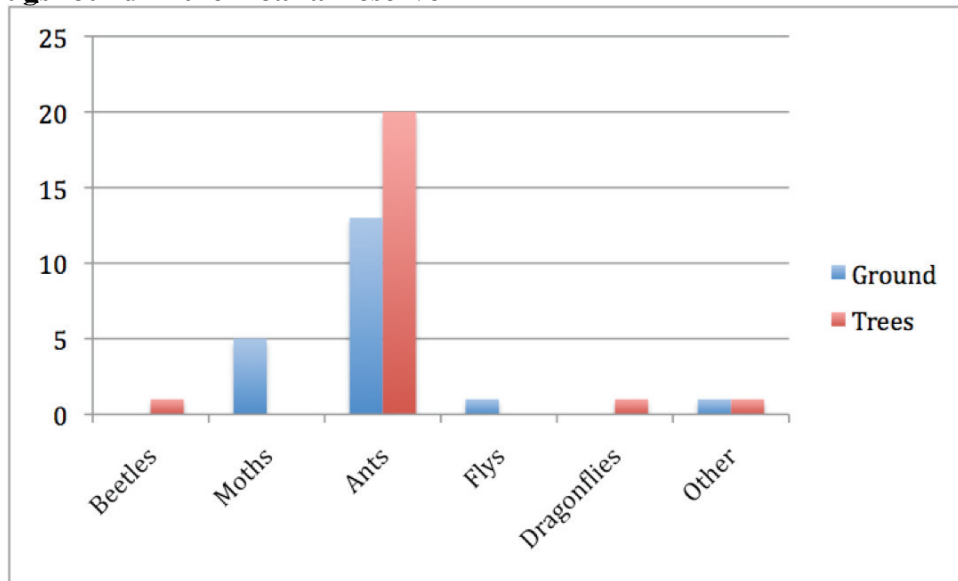
**Graph 2. Bugs found in the Middle**



**Table 3. Bugs found in the Koai‘a Reserve**

Types Of Bugs	Ground	Trees
Beetles	0	1
Moths	5	0
Ants	13	20
Flys	1	0
Dragonflies	0	1
Other	1	1

**Graph 3. Bugs found in the Koai‘a Reserve**



**Data Summary**

29 bugs were found in Pu‘u o ‘Umi. The least amount of bugs were found in the middle site, which was 8.43 bugs were found in the Koai‘a Reserve, which means it had the most bugs out of all the sites.

**Conclusion**

Our group suspected that the most would be found in Pu‘u o ‘Umi because it is filled with forest. It was the second to first most populated place with bugs behind the Koai‘a Reserve, which had the most bugs overall. We thought it would come in last. The middle only had eight little bugs, we expected for there to be quite a bit more. We are unsatisfied with our data because we didn’t have nearly enough bugs. Also, we got bitten a lot because we didn’t have safety equipment.



## Layer Depth in Different Areas of a Watershed

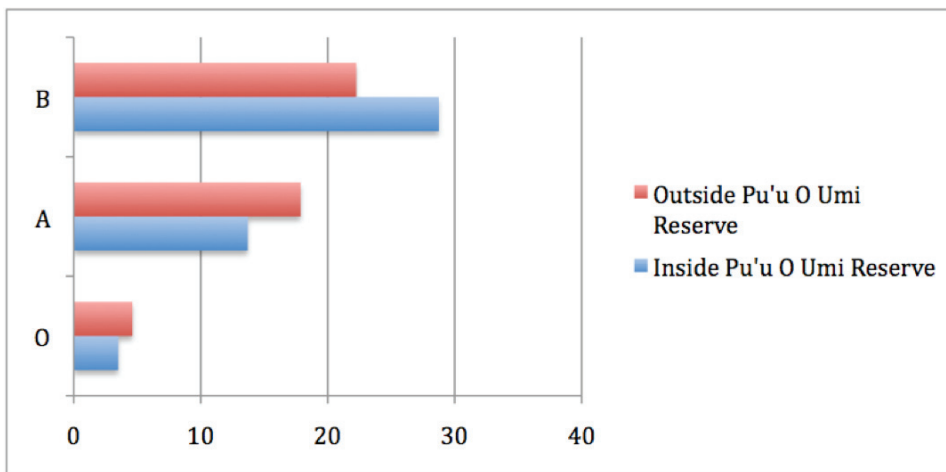
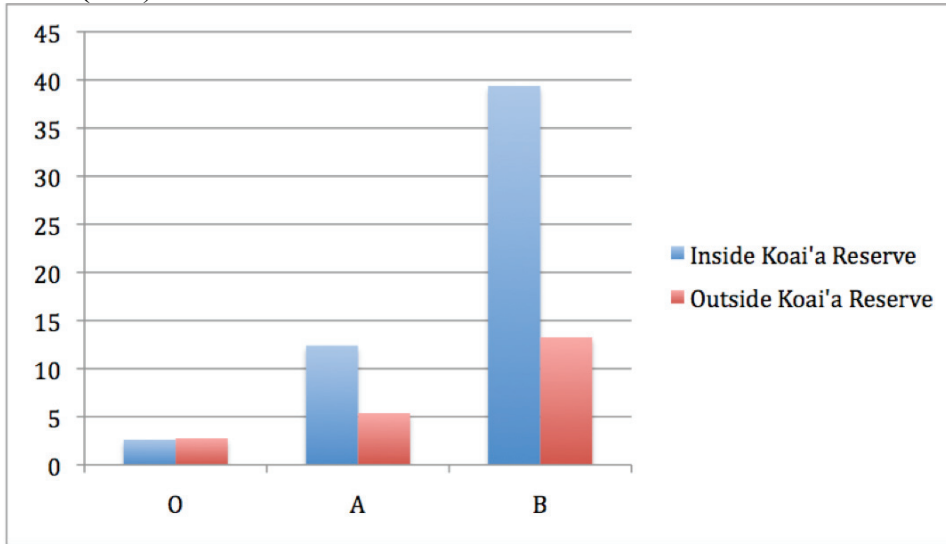
### Students of Laura Jim's class, Hawai'i Preparatory Academy

**Problem**

How large is each layer of dirt in multiple holes and how does were they are effect the results.

**Hypothesis:** The soil inside the reserve will be much loftier and airy where the soil outside the reserve will be packed down.

**Data (cms)**



**Data Summary**

In both of these tests the data was inconclusive and really didn't prove anything except that it does not really matter where the pits we tested were as long as they were a few feet from each other.

**Conclusion**

The test did not show any conclusive results and will not be able to prove anything except that it is very hard to find any conclusive change in soil at the depth of 2-3 feet deep pits.

## Soil Structures

### Students of Laura Jim's class, Hawai'i Preparatory Academy

#### Purpose

Do cattle affect the soil's compaction, layers, and texture?

**Hypothesis:** We think that it will affect it because of the cow poop that soon decomposes into the soil.

#### Background

Soil structures are the binding together of soil particle into clumps of various sizes and shapes. Here are the different kinds of soil: Platy, Prismatic, Columnar, Blocky, Granular, and Some with no structure. In the platy structure, the units of the soil are flat. They are usually horizontally set. In the prismatic structure the single united are stuck together by flat and rounded faces. A columnar structure is when there are similar prisms that are stuck together by flat or slightly vertical faces. The blocky structure is the structural units that are blocky like. The Granular structure is the structural unit that is spherical. There is one more that is called Structure less. This means there is no structures like unites in it.

#### Materials

- Measuring tape
- Shovel
- Soil Book
- Notebook
- Pen or pencil

#### Methods

1. Make groups (horizon depths, texture, structure, color).
2. Gather materials.
3. Organize pit spaces.
4. Dig 2 pits per group (2 in Koai'a, 2 in Pu'u o 'Umi, and 2 in the middle).
5. Go around to all pits and find the structure in each one.
6. Fill pits.
7. Move on to the next job.

#### KEY:

Earthworm key-  
Very few (0-5)  
Common (6-10)  
Many (10+)

Density key-  
Poking with pencil (easy, medium, hard)

**Data Tables:**

Table 1. Shape of soil found inside Pu‘u o ‘Umi Reserve

	Pit 1	Pit 2	Pit 3	Pit 4
Horizon O	Granular	Granular	Granular	Single Grain
Horizon A	Blocky	Granular	Platy	Blocky
Horizon B	None	Granular	Granular	Platy

Table 2. Shape of soil found outside Pu‘u o ‘Umi Reserve

	Pit 1	Pit 2	Pit 3
Horizon O	Granular	Single grain	Single grain
Horizon A	Granular	Granular	Granular
Horizon B	Blocky	Blocky	Blocky

Table 3. Earthworms found in Pu‘u o ‘Umi Reserve

	Pit 1	Pit 2	Pit 3	Pit 4
Horizon O	Very few	Very few	Very few	Very few
Horizon A	Very few	Very few	Very few	Very few
Horizon B	None	Very few	Very few	Very few

Table 4. Earthworms found outside Pu‘u o ‘Umi Reserve

	Pit 1	Pit 2	Pit 3
Horizon O	Very few	Very few	Many
Horizon A	Very few	Very few	Many
Horizon B	Very few	Very few	Very few

Table 5. Density of soil found in Pu‘u o ‘Umi Reserve

	Pit 1	Pit 2	Pit 3	Pit 4
Horizon O	Medium	Medium	Medium	Hard
Horizon A	Very hard	Very hard	Hard	Very hard
Horizon B	None	Very hard	Hard	Hard

Table 6. Density of soil found outside of Pu‘u o ‘Umi

	Pit 1	Pit 2	Pit 3
Horizon O	Hard	Medium	Hard
Horizon A	Hard	Hard	Hard
Horizon B	Hard	Medium	Hard

Table 1. Shape of soil found in Koai‘a Reserve

	Pit 1	Pit 2	Pit 3	Pit 4
Horizon O	Single grain	Single grain	Single grain	Single grain
Horizon A	Granular	Granular	Blocky	Granular
Horizon B	Platy	Blocky	Granular	Granular

Table 2. Shape of soil outside in Koai‘a Reserve

	Pit 1	Pit 2
Horizon O	Single grain	Single grain
Horizon A	Granular	Granular
Horizon B	Granular	Granular

Table 3. Earthworms found in Koai‘a Reserve

	Pit 1	Pit 2	Pit 3	Pit 4
Horizon O	Very few	Very few	Very few	Very few
Horizon A	Very few	Very few	Very few	Very few
Horizon B	Very few	Very few	Very few	Very few

Table 4. Earthworms found outside of Koai‘a Reserve

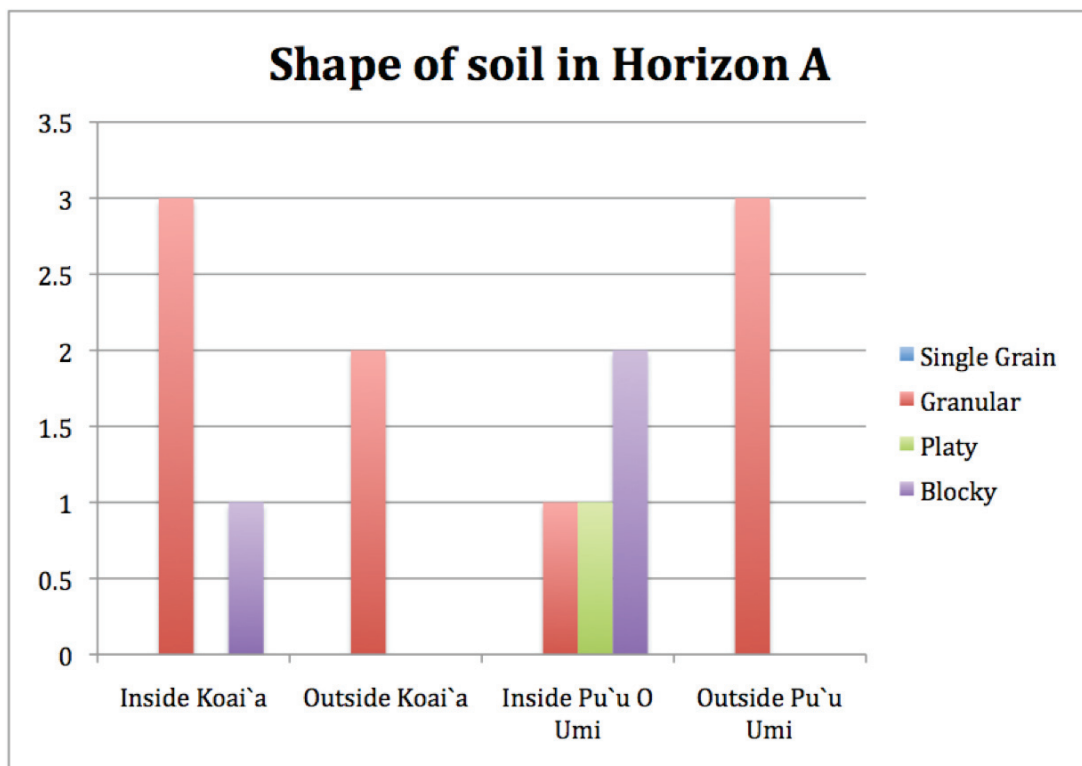
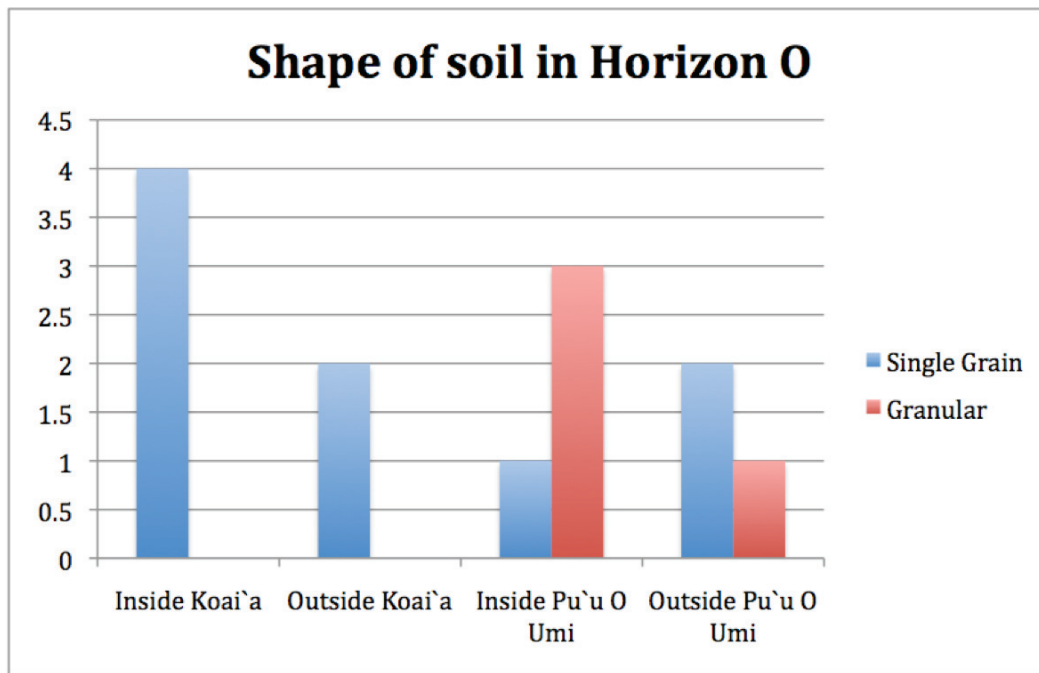
	Pit 1	Pit 2	Pit 3
Horizon O	Very few	Very few	Many
Horizon A	Very few	Very few	Many
Horizon B	Very few	Very few	Very few

Table 5. Density of soil found in Koai‘a Reserve

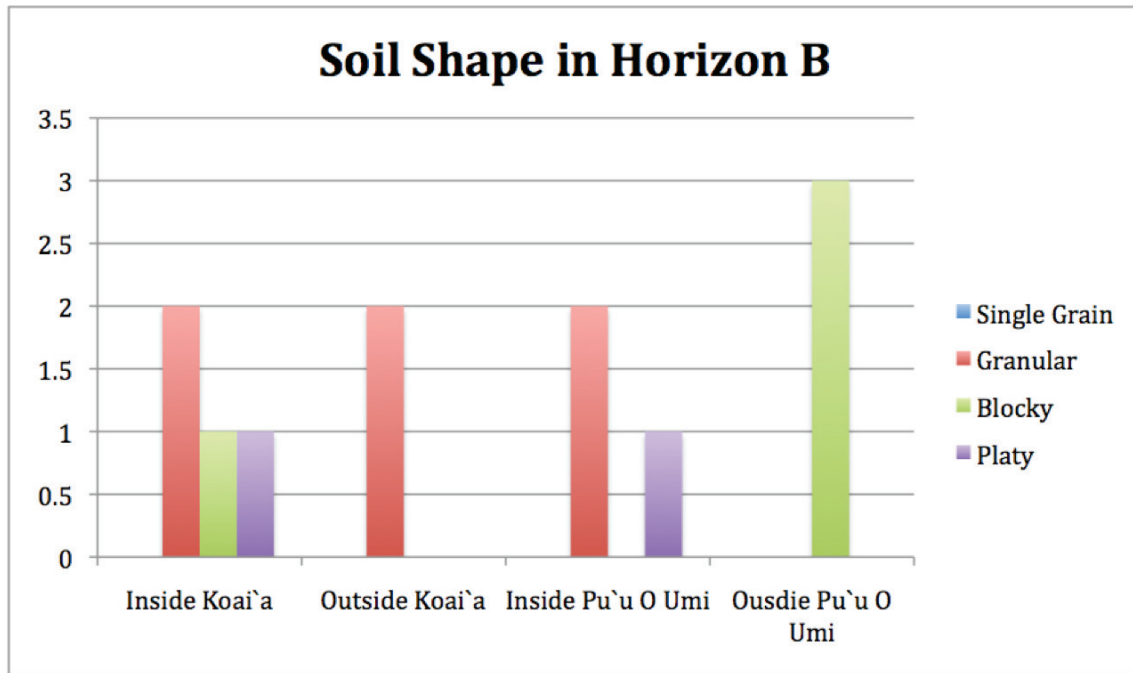
	Pit 1	Pit 2	Pit 3	Pit 4
Horizon O	Easy	Easy	Very easy	Easy
Horizon A	Hard	Easy	Hard	Medium
Horizon B	Hard	Hard	Hard	Hard

Table 6. Density of soil found outside of Koai‘a Reserve

	Pit 1	Pit 2	Pit 3
Horizon O	Medium	Medium	Hard
Horizon A	Hard	Hard	Hard
Horizon B	Hard	Medium	Hard







**Data summary**

Soil structure was mostly single grained. The O layer had the most single grained horizon. In horizon A, we had a mixture of blocky, platy, and granular. In horizon B, it was mostly granular with some platy. During Pu`u o `Umi reserve single grained was also the most in horizon O. Horizon A it was granular, blocky, and platy. In horizon B, it was mostly granular with small amounts of platy. The earthworms in all of the places were very few except for a couple of pits that were located in Pu`u o `Umi. These pits had many earthworms probably because that was the wettest area we went to. The density tended to be harder towards the bottom of the pit.

**Conclusion**

We noticed that the O layer was always thinner and the bottom layers like horizon A and B were more clumped together. We also noticed that single grained was the most we found in Horizon O. Horizon A was either granular or blocky. And horizon B changed very often. This concludes that there are some consistencies between horizons. The cows did not affect the earthworms or the soil texture. The texture of the O Horizon where the cows lived seemed to be a little easier to stick a pencil into. That could be a sign that the cows affect the top layer occasionally. Overall, the cows did not have much of an impact on the soil structure.

**Works Cited**

“Soil” <http://soilgcfc.nasa.gov/pug/propl.htm> (January, 2010)  
 “Soil Types” <http://www.rain.org/global-garden/soil-types> (January, 2010)  
 “Wikipedia” [http://en.wikipedia.org/wiki/Soil\\_structure](http://en.wikipedia.org/wiki/Soil_structure) (January, 2010)

## Tide Pool Survey Project

### Students of Ben Duke’s class, West Hawaii Explorations Academy

**Background**

The ten students of the Tide Pool Survey Project at WHEA monitored four tide pools in West Hawai‘i. At two tide pools at Keahole Point near their school (Tide pools A and C), one tide pool at the Marine Life Conservation District (MLCD) at the Old Airport in Kona (Tide pool X), and one tide pool at Kahalu‘u Bay, (Tide pool Z) the students collected data on the number of the different species of organisms present. The students also collected basic water quality data such as ammonia, nitrates, dissolved oxygen, pH, temperature, and salinity.

**Questions:**

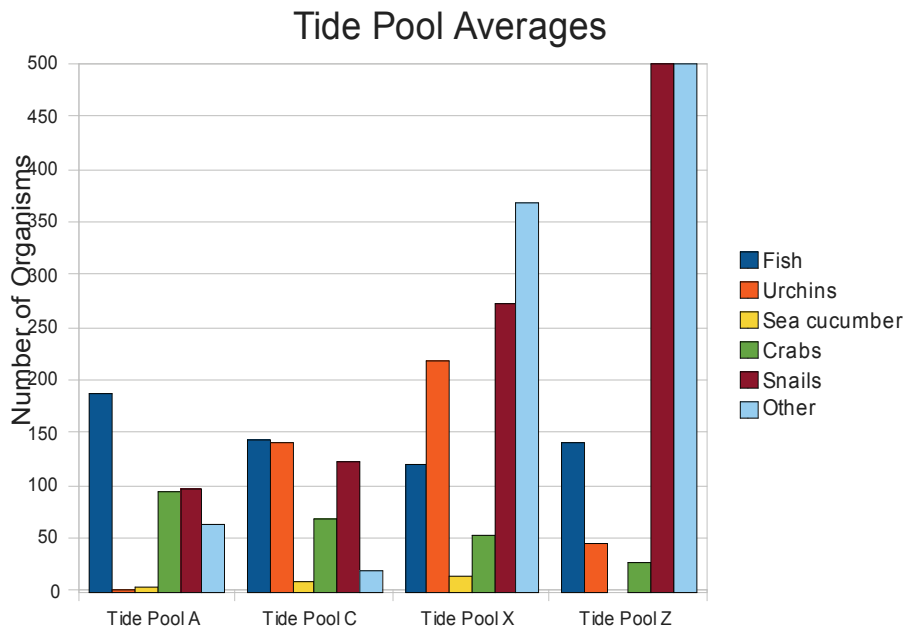
- Which tide pool has more organisms, Tide Pool A, C, X, or Z?
- What is the most common organism found in the tide pools of West Hawai‘i?

**Hypothesis:** The hypothesis is Tide Pool C will have the most organisms. In addition there will be more sea urchins than any other organism.

The students analyzed the data to determine if the protection provided by the MLCD affects the relative health of tide pools. The analysis included looking at water quality data to see if there are any connections between it and the number and species of organisms present at each tide pool. The Old Kona Airport tide pool is protected from collection of certain species (such as urchins) and no aquarium fish can be collected at Kahalu‘u Bay, while the tide pools at Keahole Point are not protected. Data collected on organisms is being shared with Sara Peck, UH Sea Grant Extension Agent for West Hawai‘i.

**Methods**

When tide pools were monitored, each pool was divided into 4-6 sections. Each student or pair of students would be responsible for counting all of the organisms in their section. Mussels, barnacles, and snails were counted within three feet of the water in the tide pool.



### Discussion and Conclusion

Kahalu‘u (Tide pool Z) and its sheltered tidal habitat seems to be best environment for mussels and snails with over 2,000 of each counted on our first visit there. The tide pool at MLC D (Tide pool X), with a more consistent influx of water, provides a great habitat for urchins, especially the rock boring urchin and juvenile reef fish, such as *kupipi* and *manini*. The tide pools at Keahole Point (Tidepools A and C) also provided safe haven for many fish species including, bright eye, aholehole, gobies, and blennies.

In analyzing their results, students considered the percentage algae coverage, tide and surf height, protective status, human activity, and water quality.

When comparing tide pools A, C, X, and Z, Tide Pool X is the healthiest even though Tide Pool Z had the most organisms, due to its wide variety of organisms. Tide Pool X is healthiest because there is little human activity around the tide pool and not many pollutants in the water like sunscreen which would be found a lot more at Kahalu‘u. Only a small amount of people swim in the cove next to Tide Pool X. Since Tide Pool X is in the MLC D it is much more protected and has a much more natural ecosystem. Tide Pool X is less than half the square footage of Tide Pool Z. This made the tide pool seem healthiest because it has a very large population of organisms for its size.

Tide Pool Z had more organisms than Tide Pool A, C, and X because of its direct connection to the ocean along with its size, protection, and enormous mussel population. Tide Pool Z had such a high mussel population because of all the fresh water springs around the area creating brackish water that mussels like.

The hypothesis was rejected and partly accepted because fish were the most common organism found in tide pools at Keahole Point (A and C). Old Kona Airport (Tide Pool X) had the most organisms. In Kahalu‘u Bay (Tide Pool Z) urchins were the most common organism.

## Changes In Types Of Mosses In Increasing Elevations

### Students of Mari Taira’s class, Waikoloa Middle School

**Introduction**

Moss is a simple type of plant that lacks conventional roots, stems, and leaves. There are approximately 12,000 species of moss, and every species is made up of non vascular leaves, non vascular stems, rhizoids, and spores. Moss refers to any species of the class “bryopsida” and is part of the division “bryophyte.” These are the first green land plants to develop during the evolutionary process. It lacks traditional vascular structures of true leaves, stems, and roots, moss growth and so is limited to moist locations. Moss is very hardy and grows almost everywhere, except under the sea. Moss grows vertically.

**Purpose**

What is the difference between lower elevation mosses and higher elevation mosses in the rainforest? Independent variable: Elevation/rainfall; Dependent variable: Types of moss.

**Hypothesis:** If we test mosses in different elevations then the mosses will have more diversity as we get higher because the higher you go the wetter it is.

**Materials**

- Quadrant
- Pencil
- Lab
- Data table
- Clip board
- Calculator
- Camera

**Methods**

1. At every hundred feet we will take 3 samples.
2. Take the quadrant, and in the square count the number of different species of moss.  
Count how many squares each species appears in
3. Record results in the data table
4. Repeat this cycle for 5 more elevations
5. Record averages per elevation.

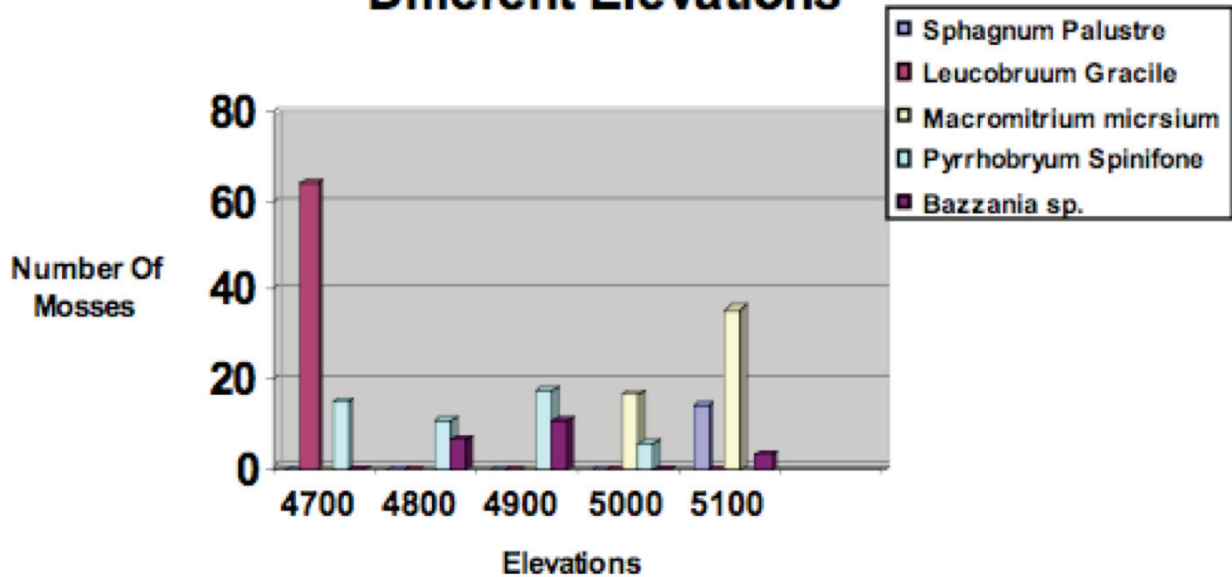
**Data Table**

Title: Total Number of Moss Species in Different Elevations

Elevation	4700	4800	4900	5000	5100
Species					
Sphagnum palustre					14
Leucobrium gracile	64				
Macromitrium miersium				17	36
Pyrrhobryum Spinifone	15	11	18	6	
Bazzania sp.		7	11		3

**Analysis:**

## Total Number Of Moss Species In Different Elevations



**Conclusion**

Our group found out from the experiment that *Leucobrium gracile* had been seen the most in 4,700 elevation. Also, *Macromitrium micrsium* was seen most often in 5,100 elevation. *Pyrrhobryum spinifone* was seen most in 4,900 elevation and *Sphagnum palustre* was seen most in 5,100 as well. *Bazzania sp* was most seen in 4900 elevation.

This data supported our hypothesis because we said as we increased elevation, diversity in moss got higher. This was true because there were three species at highest and two at the others. We think that’s because the moisture increases as we get higher. That’s because when it rains, most of the moisture is soaked up in the higher ground. That’s one possible scientific reason why we got the results that we did.

Possible errors that could have occurred would be when we recorded our observations , we might have counted a wrong amount of squares in the quadrant. Not that we actually made that error, but that’s one possibility. We could have also put the quadrant in a 100% moss area instead of throwing it randomly.

For revising our hypothesis, we could add more details in the “because” part. We could have explained that a lot more. Also, the thoughts could have been expressed more clearly and thoughtfully. For a completely new experiment based on our results, we could test the water quantity in moss. Doing this, we might be able to test water quantity in different elevations to see which elevation has the most water.

**Resources:**

Moss <<http://science.jrank.org>>

Scolari, S. “What Is Moss?” <<http://www.wisegeek.com/what-is-moss.htm>>

Purell, Melora. The Kohala Center (pictures and names of moss).

## Percentage of Ferns in the Different Elevations

### Students of Mari Taira’s class, Waikoloa Middle School

**Introduction**

For our project we chose to do a field experiment on Hawai‘i’s ferns. Ferns grow from sea level on up to 6,000 feet. There are many in Hawai‘i including the Hapu‘u fern also known as the Hawaiian tree fern. This fern can grow to a height of 25 feet with individual fronds reaching up to 9 feet long. You will likely find these ferns in the rainforest climates of Hawai‘i.

Ferns have many parts, nine parts of a fern is the scales, fiddlehead, leaflets, lobes, sub leaflet, rachis, frond, sori, and the indusium. Most ferns are leafy plants that grow in most areas under forest canopy.

**Purpose**

- What elevation has the most ferns?
- Independent variable: Different elevations
- Dependent variable: Amount of ferns

**Hypothesis:** If we go to different elevations then the amount of ferns will increase because of the wet soil.

**Materials**

- Quadrat
- Calculator

**Methods**

1. Throw an item randomly on the ground.
2. Put the middle of the quadrat right over it.
3. Count the percentage of ferns in the quadrat.
4. Record our data.
5. Repeat two times at each elevation for a total of three samples at every elevation.

**Data Table:**

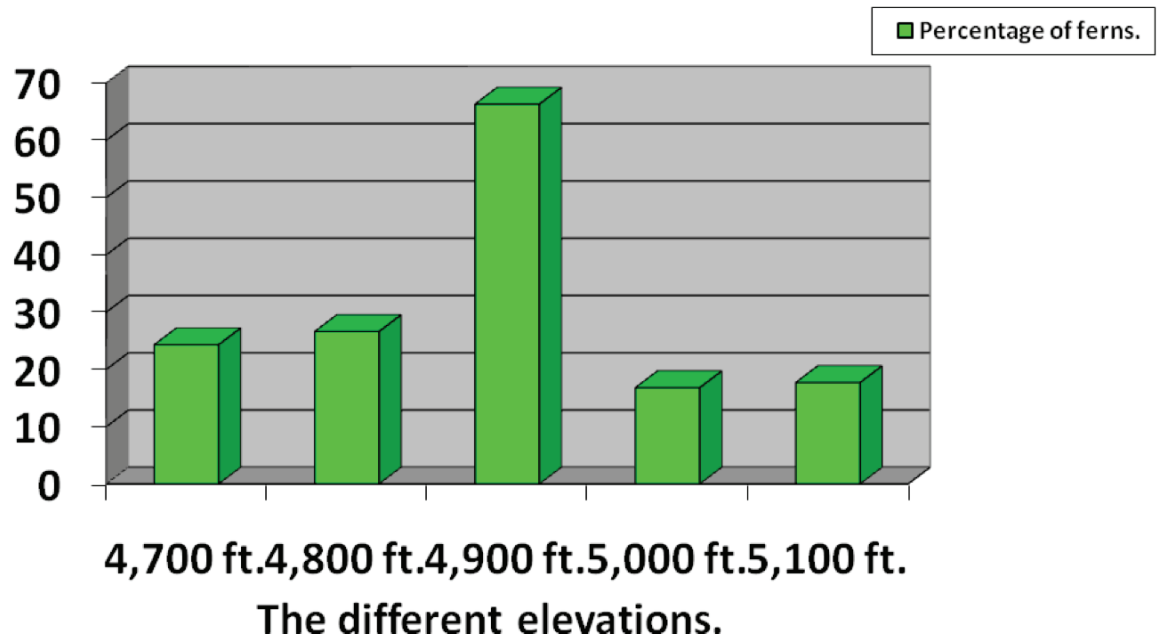
**Title: The Percentage of Ferns at the Different Elevations**

Elevation	Trial 1	Trial 2	Trial 3	Average
4,700	49 %	0 %	23.8%	24.3%
4,800	32.2 %	5.6 %	42%	26.6%
4,900	89.6 %	53.2 %	56%	66.3%
5,000	39.2 %	8.4 %	2.8%	16.8%
5,100	29.4 %	23.8 %	0%	17.7%



**Analysis:**

**Percentage of ferns in the different elevation.**



**Conclusion**

In our lab we found out that the elevation that had the most ferns was the 4,900 feet. No, our results did not support our hypothesis because our hypothesis was if we go to different elevation then the amount of ferns will increase because of the wet soil, and from 4,700-4,900 it did increase but after that elevation 5,000-5,100 the percentage of ferns decreased.

The reason we think that the 4,900 mark increased so much is because maybe the ground level wasn't too steep. We think this because if it was too steep then the water would slide down and the ferns wouldn't get enough water. If it was too flat then the ferns might get too much water and die.

Some errors that could have occurred in our procedures were that maybe for the second step we might have not put the middle of the quadrat directly over the quarter. Then we might have not gotten the right percentage of ferns.

We would revise our hypothesis for the next experiment by comparing the soil at the 4,900 ft. mark to all the other elevations, to see why the 4,900 mark has the most ferns. We would be comparing the different soils and the amount of nutrients in the soil.

A new experiment we could do based on the results of this experiment is we could look at the different soils and see which one the ferns grow best in or we could test to see if ferns grow better in a steep or flat leveled environment.

## **Dissolved Oxygen Changes Over Time**

### **Students of Stacey Newman, Kealakehe High School (AP Biology)**

#### **Background**

For our HI-MOES project, our class took a camping trip to Spencer Beach Park and took our water samples there every two hours. Our class had many hypotheses that would test a variety of things; however, our main focus was on dissolved oxygen throughout the day.

**Hypothesis:** Our hypothesis was that we believed the dissolved oxygen level would be the highest during the day due to the fact that the plant would be going through photosynthesis more during the day.

#### **Methods**

Although Spencer Beach was where we got our main samples and collected the data, we also tested water from Kahalu'u, Maumae Beach, the Harbor, and the water tank in Kona. We used three different test kits, including kits for dissolved oxygen, turbidity, and salinity, and compared those results to those obtained using probes, which ended up working much better. Our data was very successful. All of our results supported our hypothesis. As it got later in the day, the dissolved oxygen concentration went down slightly and then drastically from 4:30–6:30 a.m. We began to take samples at 6:30 p.m. and stopped at 10:30 a.m.

#### **Data Table**

Time	Temp °C	dO <sub>2</sub> %	dO <sub>2</sub> (mg/L)	Conductivity
6:30 p.m.	24.5	58.4	11.9	47014
8:30 p.m.	24.28	53.5	10.8	48718
10:30 p.m.	23.94	47	9.4	50255
12:30 a.m.	23.56	44	8.6	47964
2:30 a.m.	23.9	46.9	9.4	48378
4:30 a.m.	23.53	41.8	8.4	50805
6:30 a.m.	22.89	25	4.9	42210
8:30 a.m.	25.07	27	5.2	41300
10:30 a.m.	25.47	30	6	45100

#### **Discussion and Conclusion**

One thing we could have done differently would be to take samples for twenty-four hours to compare the results and see if it made a circle in the amount of dissolved oxygen that was present in the water. As a class we discussed why we got the results we did and we figured out that it was because of photosynthesis. The algae in the water use the sun to photosynthesize and make oxygen. With a decrease in the amount of sun comes a decrease in the amount of oxygen produced.

## **Pu‘u Kawaiwai Ecological Study**

### **Students of Megan Dehning, Innovations Public Charter School**

#### **Background**

7/8 grade students from Innovations Public Charter School first went on an exploratory journey to the wet and dry forest at Pu‘u Kawaiwai on Kohala Mountain. While there, all 44 students had the opportunity to visit and make observations in both locations. Upon returning to school, students generated questions based on their observations in the forests. These resulted in one overarching research question that the students were interested in investigating: What are the ecological differences between the wet and dry forest on Pu‘u Kawaiwai?

Once the students defined the question, they decided what ecological variables they wanted to measure. They settled on ambient air temperature, relative humidity, soil moisture, soil temperature, soil percolation and absorption, and soil composition. They also decided to survey the plants and animals using square meter quadrats. We practiced using our instruments and collecting data at school prior to heading out into the field.

During our field data collection day, half of the students journeyed to the wet forest, while the other half remained in the dry forest. In pairs, students took measurements for air temperature, soil temperature, relative humidity, and surveyed for plants and animals in three different locations within each forest. They also collected soil samples for further analyzing back at school.

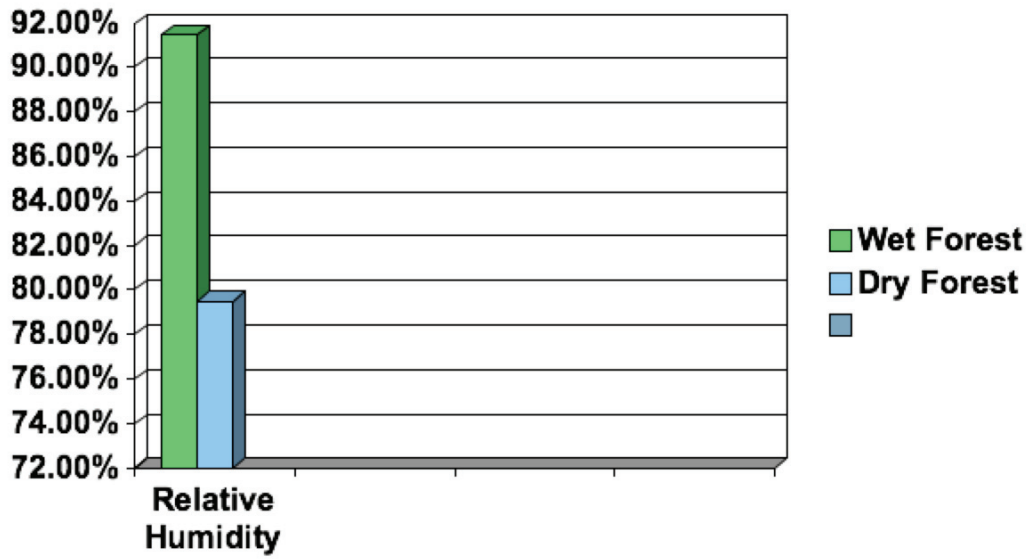
In the classroom, students averaged the data collected for air temperature, soil temperature, and relative humidity for each forest. In addition, they compiled a list of all plants and animals surveyed at both locations. Finally, students used the soil samples to determine the soil composition, percolation and absorption, and moisture content for both the wet and dry forests. After all the data was analyzed, students worked as whole class groups to reach their conclusions about the ecological differences between the wet and dry forests.

**Question:** What are the ecological differences between the wet and dry forest on Pu‘u Kawaiwai?

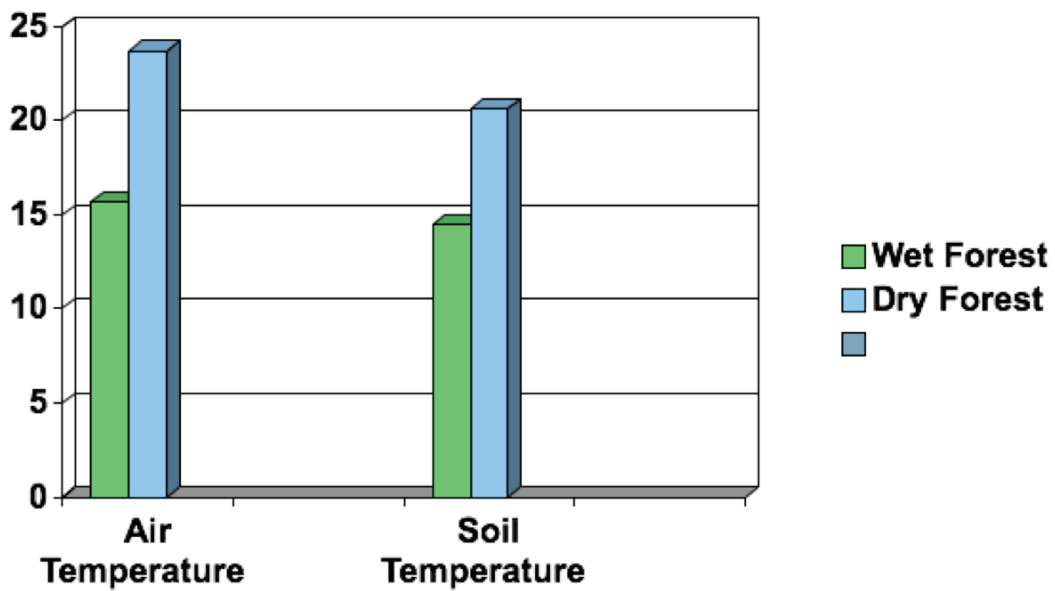
#### **Methods**

- Transport class to Pu‘u Kawaiwai.
- Split class into two groups (wet/dry).
- Go to first location with partner and set up quadrats.
- Measure relative humidity, soil temperature, air temperature, and surveyed plants and animals.
- Took measurements in three separate locations to better average the data.
- Collected soil samples to analyze back at school.
- Averaged class data to determine more precise measurements for air temperature, soil temperature, and relative humidity.
- Split the class into three different categories of soil analysis: absorption and percolation, composition, and soil moisture.

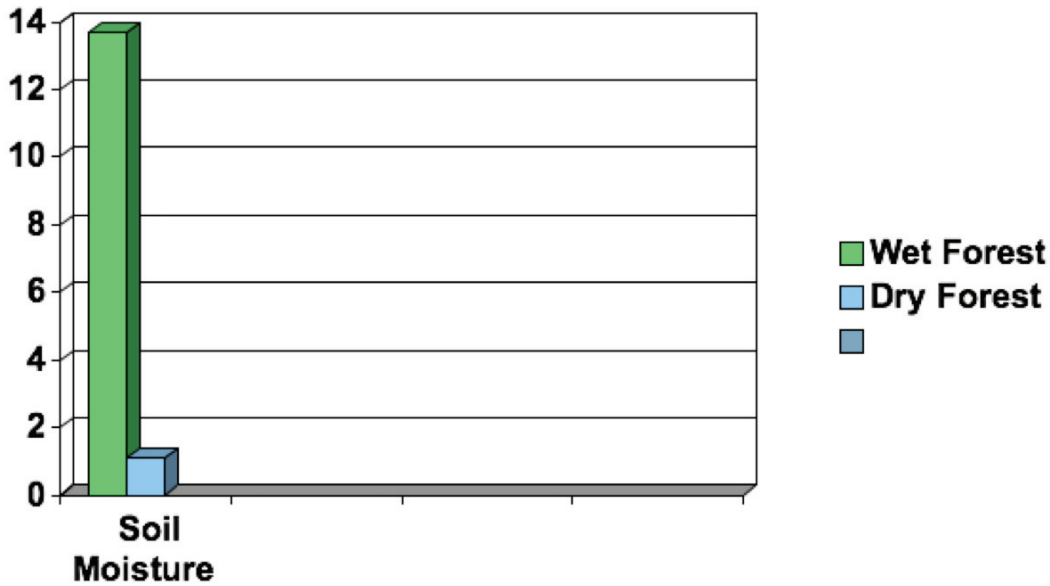
**Graph 1: Relative Humidity**



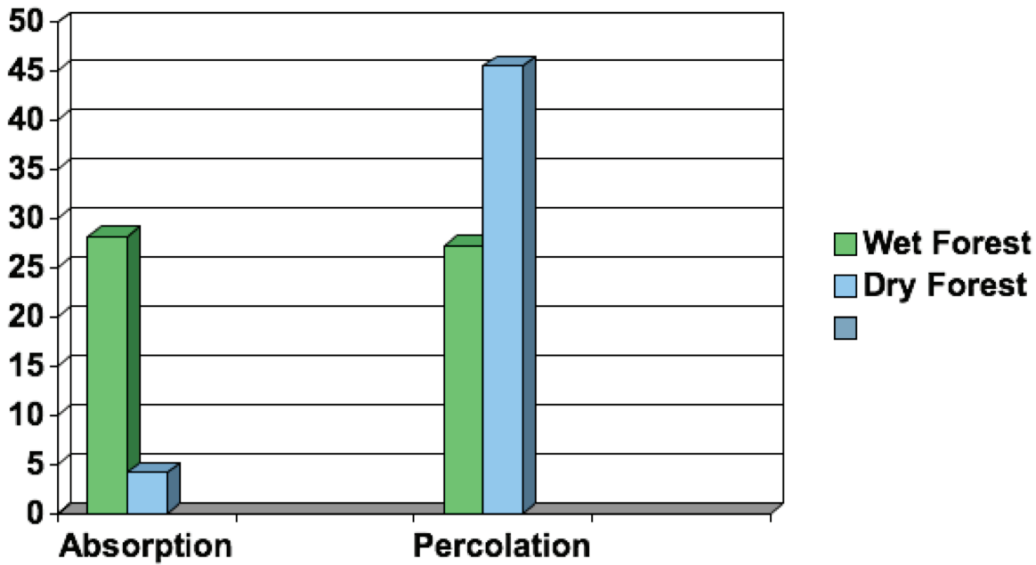
**Graph 2: Temperature**



**Graph 3: Soil Moisture**



**Graph 4: Soil Absorption and Percolation**



**Soil Composition:**

Wet Forest: Spongy and sticky; a lot of plant debris (leaves, sticks, etc.); small organisms; real dark brown in color; not so many layers; very few rocks; silt-like soil.

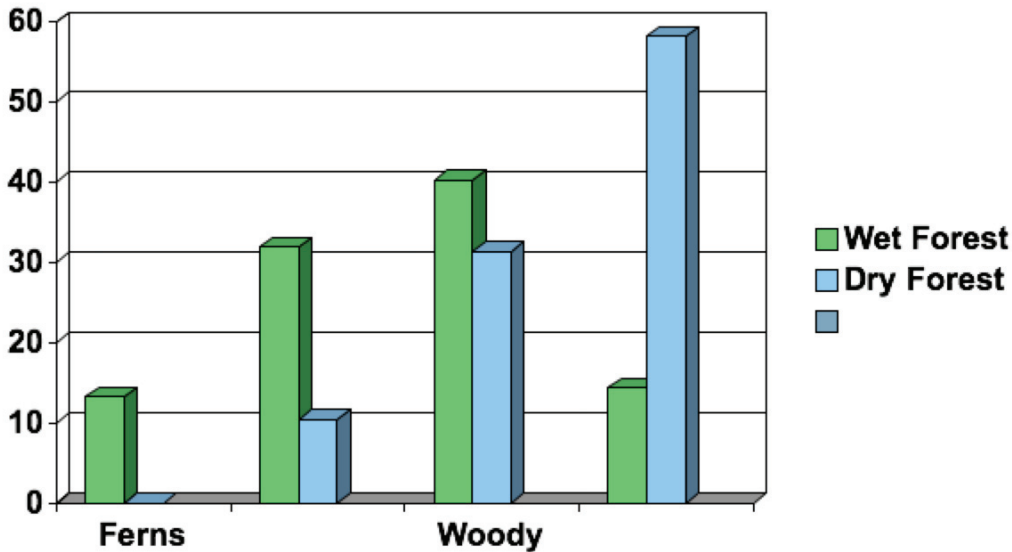
Dry Forest: Powdery and smooth; light brown in color; very compact; had many small hair-like roots; very few layers; sandy feeling in some parts; hydrophobic; more dense materials.

**Plants**

Wet Forest: Ferns 13.2%; Mosses 31.9%; Herbaceous 14.3%; Woody 40.3%

Dry Forest: Ferns 0%; Mosses 10.4%; Herbaceous 58.2%; Woody 31.3%

**Comparison of Plant Types**



**Evidence of Animals**

Wet Forest: Beetles, Apapane, Amakihi, Elepaio, Pig Tracks

Dry Forest: Ladybugs, Ants, Beetles

**Conclusion**

The temperature was 8 °C cooler in the wet forest than it was in the dry, probably because of the higher the elevation and the cooler the temperature.

Relative humidity was 12% lower in the dry forest than it was in the wet. This makes sense because the warmer the air, the more water vapor it can hold and the lower the relative humidity. Also, the weather in the wet forest was cold and misty with lots of water dripping from the leaves.

Soil temperature was cooler by 6 °C in the wet forest. In addition to the air being cooler, this is probably because of the high humidity, lack of sunlight, and dense covering of leaves on the forest floor that insulate the soil.

Wet forest soil contained 12.6 g more moisture than the dry forest soil, most likely because water on ground is not able to evaporate as quickly due to the tree canopy and cloud cover.

Wet forest soil absorbed 24.1 g more water than the dry soil. The dry soil percolated 18.3 g more water than the wet soil.

We noticed that the water beaded up on the dry soil. The dry soil was very powdery and fine. We think that when it rains in the dry forest the water most likely rolls right off. This may contribute to erosion during heavy rains.

Plants in the dry forest likely have very shallow roots because of the low water absorption in soil. Dry forest plants are likely to have fewer leaves because of the dry soil and hotter temperatures. Fewer leaves prevents evaporation. The dry forest area contained lots of cactus and grass, both which can grow with very little water.

Wet forest soil absorbed much more water because all of the plant debris soaks it up like a sponge.

The trees are much taller and there are many more plants in the wet forest. The roots of the trees in the wet forest are likely to be bigger and deeper.



**Comparing Kahalu‘u Beach Park & Kūki‘o Beach Park  
Marine Water Quality; Human Activity/Impact; Snorkel Transect Surveys;  
“ReefWatchers” Fish Count; and Coral Cover Quadrant Survey  
Students of Lisa Diaz’s class, Kealakehe Intermediate School**

**Coral and Algae Cover Survey**

*Kahalu‘u Beach Park (Friday, April 23, 2010 == 9:00 am – 1:00 pm Unit 1)*

	Percentage							
	one	two	three	four	five	six	seven	eight
<b>Lobe Coral</b>	0	0	0	0	0	0	0	0
<b>Cauliflower Coral</b>	0	0	16	8	0	0	0	0
<b>Antler Coral</b>	0	0	0	0	0	0	0	0
<b>Mound Coral</b>	4	0	0	0	0	0	0	0
<b>Other Coral</b>	0	0	0	0	0	0	0	0
<b>Plant-like Algae</b>	0	0	4	0	0	4	0	0
<b>Coralline Algae</b>	8	16	0	4	0	8	0	0
<b>Other Algae</b>	0	0	0	0	0	2	36	28

*KŪKI‘O BAY Beach Park Friday, April 24, 2010 == 9:00 am – 1:00 pm Unit 1*

	Percentage							
	one	two	three	four	five	six	seven	eight
<b>Lobe Coral</b>	0	0	0	0	2	0	0	4
<b>Cauliflower Coral</b>	4	12	12	0	0	0	0	12
<b>Antler Coral</b>	0	0	0	0	0	0	0	0
<b>Mound Coral</b>	0	0	0	0	4	1	16	0
<b>Other Coral</b>	0	0	0	0	0	0	4	0
<b>Plant-like Algae</b>	0	4	4	4	4	4	4	4
<b>Coralline Algae</b>	20	20	4	4	0	0	4	4
<b>Other Algae</b>	0	0	0	0	0	0	0	0

**Urchin Count Summary**

*Kahalu‘u April 23, 2010:*

1. One collector urchin (all though many were seen outside quadrant)
2. No long spine urchins
3. Two pencil urchins (all though many were seen outside quadrant)

*Kūki‘o April 24, 2010:*

1. No collector urchins
2. One long spine urchin
3. One pencil urchin

**Water Quality Study**

Our class accomplished 10 Marine Water Quality Tests at both Sites. We found no significant difference in the overall water quality between sites.

**2010  
H2o Quality HI MOES study**

Test Type	Kahalu'u 4/23/10	Kahalu'u 4/23/10	Kukio 4/24/10	Spencer 4/2/10
Time	10:00 AM	12:30 PM	12:45 PM	12:45 PM
PH	8.4	8.5	8.4	8.2
Temperature C	25.9	28.2	27	26.7
EC	20 mS	20 mS	20 mS	20
TDS	10 ppt	10 ppt	10 ppt	10 ppt
Temperature C	26.7	28.6	26.7	27.7
Temperature C	27	30	26.7	27
PPM Salinity	1.02-1.03	1.023	1.025	1.02
Phosphate	< 1	0	< 1	< 1
Nitrite	< 2	< 0.1	< 0.2	0
Nitrate	0 mg	0 mg	0 mg	10 mg
Amonia	< 0.5	0.5	< 0.5	< 0.5

**Human Activity**

Our study looked at the number of people snorkeling, swimming, surfing, fishing and the number of vessels in the bay, as well as turtles. We found there to be significantly higher human activity at Kahalu'u Bay.

**Kahalu'u Beach Park**

Friday, April 23, 2010  
9:00 am – 1:00 pm

**Number of People on the Beach:**

10:00 am	12:00 pm	1:00 pm
139	173	153

**Number of People... Fishing...**

Time	Snorkel	Swim	Surf	Spear	Line	Net	Vessels	Turtles
10:00 am	35	5	20	0	0	0	1	1
12:00 pm	24	16	13	0	0	0	1	2
1:00 pm	21	11	30	0	0	0	0	2

**Kukio Bay**

Saturday, April, 24, 2010  
9:00 am – 1:00 pm

**Number of People on the Beach:**

10:00 am	12:00 pm	1:00 pm
10	27	20

**Number of People... Fishing...**

Time	Snorkel	Swim	Surf	Spear	Line	Net	Vessels	Turtles
10:30 am	0	0	2	0	0	0	1	20
12:00 pm	1	3	0	0	0	0	1	10
1:00 pm	3	5	2	0	0	0	0	6

**Kukio Tidepool**

Saturday, April, 24, 2010

9:00 am – 1:00 pm

**Number of People on the Beach:**

10:00 am	12:00 pm	1:00 pm
46	41	22

**Number of People... Fishing...**

Time	Snorkel	Swim	Surf	Spear	Line	Net	Vessels	Turtles
10:30 am	0	3	0	0	0	0	1	0
12:00 pm	0	7	0	0	0	1	1	0
1:00 pm	5	3	4	0	0	0	0	0

**Reef Watcher's Fish Transect Survey**

**Kealakehe Inter. School  
Reef Watcher's Fish Transect Survey**

	Kahalu'u 4/23/10	Kukio 4/24/10
Convict Surgeon/ Manini	23	
Gold ring Surgeon/ Kole	2	
Lavender Tang		5
Orange Spine Naso		3
Yellow Tang	27	10
Achilles Tang	1	1
Moorish Idol		4
Hawaiian Sergeant		
Indo- Pacific Sergeant		3
Pacific Gregory		
Multiband Butterfly		
Four Spot Butterfly	2	2
Saddle Wrasse	3	
Bird Wrasse		
Cleaner Wrasse	2	
Yellowtail Wrasse		
Pale Nose Parrotfish	9	1
Bullet Head Parrot	5	
Red Lip Parrot		
Black Durgon	8	7
Yellow Fin Goatfish	1	
Manybar Goatfish		
Roi	1	
Ta'ape		
Forceps Butterfly		
Reef Triggerfish	3	
<b>Total Fish</b>	<b>87</b>	<b>36</b>

### **Comments/Differences**

Kahalu‘u is an open access public beach; therefore, more people go there and could collect urchins or cause pollution. Kūki‘o is a limited public access beach, which means less people, less pollution, and more urchins. Kūki‘o is a lot larger area than Kahalu‘u, which could mean that urchins could be spread out and why we did not find as many as we expected in the quadrants at Kūki‘o. Kahalu‘u has a break wall that stops the waves and Kūki‘o does not, so there could have been more circulation in the water.

### **Conclusion**

Kahalu‘u is an open access, public, County beach park established more than 30 years ago. Kahalu‘u Beach Park is the most popular snorkeling beach park in West Hawai‘i. Hundreds of people enjoy Kahalu‘u Beach Park daily. The septic tank sewage system may be old and in need of an upgrade.

Kūki‘o (Kikaua Point Park) is a limited public access beach with much less human activity. Entry is controlled by security guards at a gate. Only 30 cars are allowed to enter with a pass. Passes are controlled at the gate—when a car goes out, another can come in with a pass. Kūki‘o is a NEW private resort of exclusive homes. The public beach restrooms were built in 2004. The sewage at Kūki‘o is treated through a central plant, mauka of the highway far from the ocean. “Gray water” is used on plants, the golf course, and landscaping.

Kūki‘o is a larger area than Kahaluu. Kūki‘o Bay has many immature green sea turtles: 6 were seen hauled out and basking on beach. The fish and urchin diversity is lower at Kūki‘o — maybe because of the larger area and species are spread out. The coral cover is significantly more at Kūki‘o —possibly due to less people using snorkel area.

## **Po‘o Hawai‘i Pond Restoration**

### **Students of Pilimai Traub’s class, Ke Kula ‘o ‘Ehunuikaimalino**

In ancient times, the Mo‘i Wahine (Queen) would come to bathe at Po‘o Hawai‘i at sunset; no one was allowed to look upon the pond at that time.

#### **Problem**

The introduction of Tilapia into Po‘o Hawai‘i pond has changed the native ecosystem of this important historical site.

Since the moon directly affects the tides, how will different moon phases affect Po‘o Hawai‘i?

#### **Water Quality Measurements**

#### **Materials**

- Distilled water
- Graphing calculator
- Probes
- Cups
- Stop watch
- Notes/composition book
- Pen/pencil
- Po‘o Hawai‘i Pond
- GPS

#### **Methods**

Due to the size of Po‘o Hawai‘i, 11 stations were set up around the pond and one station off shore to collect water samples. These locations were identified and recorded using a GPS.

#### **Sample Sites**

Station	Location
Offshore	N19°34.696 W 155°58.124
1	N19°34.707 W 155°58.053
2	N19°34.710 W 155°58.048
3	N19°34.709 W 155°58.045
4	N19°34.703 W 155°58.043
5	N19°34.698 W 155°58.042
6	N19°34.696 W 155°58.048
7	N19°34.693 W 155°58.049
8	N19°35.689 W 155°58.056
9	N19°34.700 W 155°58.051
10	N19°34.702 W 155°58.053
11	N19°34.702 W 155°58.055

**Tidal height:** Inverse relationship - During low tide the temperature is slightly higher; at high tide the temperature is slightly lower.

**Sunlight:** The temperature of the pond is relatively stable during the day due to the fresh water spring located on the mauka side of the pond.

**Biomass:** Based on observations, Po‘o Hawai‘i pond is home to a large population of organisms; however, the spring and tidal circulation maintains stable temperatures.

**Flow rates of spring:** During low tide there is an increase in the flow rate at the fresh water spring; during high tide there is an increase in the flow rate of seawater into the pond.

**pH**

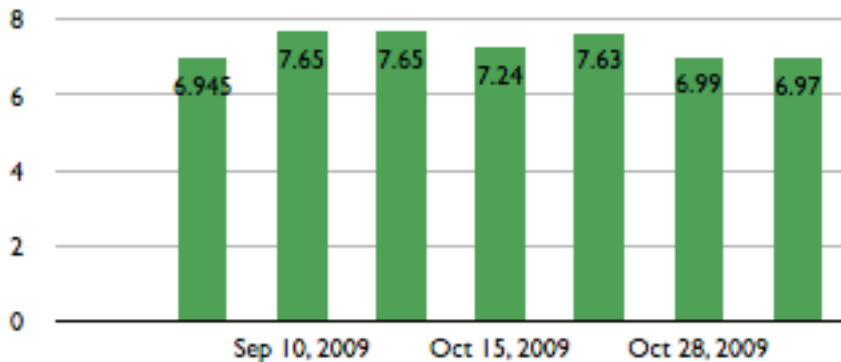
**Question:** How does the pH affect Po‘o Hawai‘i Pond.

**Hypothesis:** If the tide is high then the pH will be lower when compared to the pH at a high tide.

At Po‘o Hawai‘i, pH ranged from 6.2 to 7.67. Offshore pH ranged from 6.35 to 7.01.

**Variable: Po‘o Hawai‘i Pond**  
VARIABLE

STATION	SEP 4, 2009	SEP 10, 2009	SEP 17, 2009	OCT 15, 2009	OCT 21, 2009	OCT 28, 2009	NOV 4, 2009
		+	+	+	+	+	+
1	6.2	7.67	7.77	6.35	7.71	6.15	6.18
2	6.7	7.72	7.79	7.05	7.54	6.70	6.66
3	7.64	7.73	7.74	7.13	7.62	6.84	6.73
4	6.9	7.62	7.60	7.23	7.62	6.96	6.91
5	7.0	7.65	7.69	7.24	7.57	6.99	7.00
6	7.1	7.48	7.53	7.36	7.62	7.06	7.07
7	7.1	7.66	7.62	7.35	7.55	7.12	7.12
8	7.1	7.61	7.58	7.38	7.61	7.20	7.17
9	7.2	7.61	7.62	7.46	7.68	7.23	7.24
10	7.2	7.78	7.57	7.51	7.69	7.27	7.24
11	7.2	7.67	7.60	7.55	7.73	7.33	7.38
AVG.	6.945	7.65	7.65	7.24	7.63	6.99	6.97





The pH is reasonable and acceptable for the life in Po‘o Hawai‘i pond. The pH is very balanced for having so much vog and acid from the volcano. The pH in the water is primarily influenced by the photosynthesis and respiration. During the night hours the plants and animals produce carbon dioxide through respiration, lowering the pH; in the day the plants use carbon dioxide in photosynthesis increasing the pH levels in the pond. I accept my hypothesis because the data that I collected supports my hypothesis. The data to support my hypothesis is that during a high tide the pH was lower than most times it was 6.945, 6.97 and 7.63. And during low tide the pH was higher than usual, it was 7.24 and 6.99. During mean tides the pH was exactly the same—the numbers were 7.65 and 7.65.

### **Dissolved Oxygen**

Dissolved oxygen levels ranged from 6.2 ppm to 8.5 ppm. This range of DO can adequately support the organisms in the pond. During low tide the DO levels dropped, and during high tide the DO levels increased. DO levels in the pond are affected by rate of photosynthesis and respiration. During the day DO levels increase throughout the day due to photosynthesis, and at night DO levels drop due to the respiration of plants and animals in the pond.

### **Nitrates**

**Question:** How does the nitrate levels fluctuate in Po‘o Hawai‘i Pond?

**Hypothesis:** Nitrates levels are influenced by waste products produced by organisms in the pond and vegetation that decomposes in the pond. During high tides nitrate levels dropped, while at low tides nitrate levels tended to increase.

Nitrate levels ranged from 1 (ppm) part per million to 6.1 ppm.

### **How does the tides effect the salinity of the Pond?**

Salinity is a measure of the total amount of dissolved solids in water, and since salts make up approximately 99% of these solids, it is usually the only compound that is considered. Salinity is usually measured as grams (1 g) per kilogram (1000 G) of water or parts per thousand (ppt). A salinity of 34 ppt is the average for tropical oceans. Salinity increased at low tide and decreased during high tide. There is a higher level of dissolved solids at low tide than at high tide. The salinity ranged from 6.0 ppt to 11.8 ppt.

**Question:** How does the tides affect the turbidity of Po‘o Hawai‘i Pond?

**Hypothesis:** If the tides are high, then the turbidity would be low compared to the turbidity at high tide.

### **Materials**

- Graphing Calculator
- Turbidity Probe
- Pen/Pencil
- Distilled Water
- Stop Watch

### **Methods**

To collect the turbidity data, I connected the turbidity probe into the graphing calculator. After whoever had collected the water samples using the rope to lower the cup into the pond and

scooping the water, I calculated the turbidity by putting the probe into the cup. I used the stop watch to keep accurate data and then waited a minute to determine the turbidity. Then, eventually I will compare the turbidity from the turbidity data calculated from the pond at ‘Ehunuikaimalino.

**Conclusion**

In conclusion, the turbidity is appropriate for Po‘o Hawai‘i Pond at Keauhou. Therefore, I accept my hypothesis. When the tide arose, the turbidity dropped low making the water not as murky as at low tide and while the tide ebbed the turbidity increased causing the water to become murkier. While the tide was at an average height, the turbidity was average as well. The murk comes from the foliage. As it falls into the pond from up above the pond, it begins to break down becoming murk that lies at the bottom of the pond. Also, the murk comes from the living organisms in the pond; when they dispose of their waste it sinks to the bottom. With high turbidity levels, it can reduce the amount of light reaching lower depths, which can inhibit growth of organisms affecting the organisms.

Date	Week 1	Week 2	week 3	week 4	week 5
Average (Po‘o Hawai‘i Pond)	24.6	31.8	32.0	27.5	35.5
Average (School Pond)	41.7	22.0	27.3	31.3	27.0

After each week we attended Po‘o Hawai‘i Pond, I calculated the averages between the Pond at our school and Po‘o Hawai‘i Pond. The table and graph above shows both averages.

**Invertebrate Study**

**Objective**

To identify the different types of species and population in both the Po‘o Hawai‘i Pond and the shoreline of Keauhou (Kahalu‘u).

Make observations and analyze upon the shoreline of Keauhou (Kahalu‘u) to identify the different types of invertebrates and to estimate the population. Then, investigate the Po‘o Hawai‘i Pond for similar, or different results of invertebrates to determine the comparison between the ocean and the pond.

The different types of invertebrates identified in Po‘o Hawai‘i pond are Hi‘iwai, ‘A‘ama crab, and ‘opae (shrimp).The total population of invertebrates in general within the pond is approximately 500-600. Along the shoreline it is estimated at approximately 10,000+.

## Participating Schools HI-MOES 2009-2010

Innovations Public Charter School

<http://www.ipcs.info/>

75-5815 Queen Ka‘ahumanu Hwy.,  
Kailua-Kona, Hawai‘i 96740

West Hawaii Explorations Academy

<http://www.whea.info/>

73-4460 Queen Ka‘ahumanu Highway, #105  
Kailua-Kona, Hawai‘i 96740

Hualalai Academy

<http://www.hualalai.org/>

74-4966 Kealakaa Street  
Kailua Kona, Hawai‘i 96740-1500

Kealakehe High School

<http://www.khswaveriders.org/>

74-5000 Puohulihuli Street  
Kailua-Kona, Hawai‘i 96740

Kealakehe Intermediate School

<http://kealakeheint.k12.hi.us/>

74-5062 Onipa‘a Street  
Kailua-Kona, Hawai‘i 96740

Ke Kula ‘o ‘Ehunuikaimalino

81-1041 Konawaena School Rd.  
Kealakekua, Hawai‘i 96750

Waikaloa Middle School

<http://www.k12.hi.us/~waikoloa/>

68-1730 Ho‘oko Street  
Waikoloa, Hawai‘i 96738

Hawai‘i Preparatory Academy

<http://www.hpa.edu/>

65-1692 Kohala Mtn. Rd.  
Kamuela, Hawai‘i 96743

Waimea Middle School

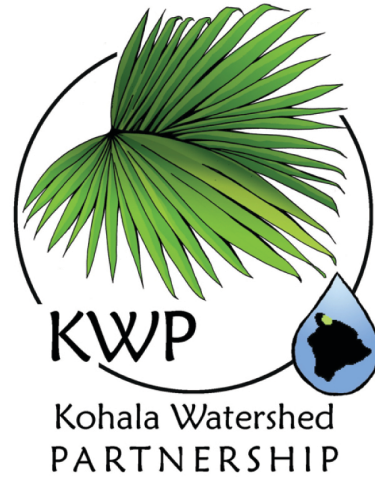
<http://www.waimeamiddleschool.org/wms/Home.html>

67-1229 Mamalahoa Hwy.,  
Kamuela, Hawai‘i 96743

Parker School

<http://www.parkerschool.net/>

65-1224 Lindsey Road  
Kamuela, Hawai‘i 96743



## THE KOHALA CENTER

**Mailing Address:**

The Kohala Center  
P.O. Box 437462  
Kamuela, HI 96743

Tel: 808-887-6411 | Fax: 808-885-6707

For more information visit us at: [www.kohalacenter.org](http://www.kohalacenter.org)

---

© 2010 The Kohala Center. All rights reserved.

For information on permission for reprints and excerpts, contact The Kohala Center.