2012

Swinomish Shoreline Restoration

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Contents

BACKGROUND INFORMATION

The Swinomish Indian Tribe has been collecting data since 2003 for a shoreline restoration project. This project is important for the community to establish baseline conditions for what the shoreline looks like at several sites. It is also important to collect the data to monitor changes once a baseline is established. Existing or potential environmental impacts of this important area are able to be monitored with this data as well.

In this report we looked at three main variables from the data collected. Those variables were elevation, mean sediment size and percent vegetation. The way we looked at these variables was often through time (yearly mean) or by location on the beach (mean by grouped station) that data was collected from. This data was collected from 7 different Nearshore Points on the Swinomish waterfront. Also, some of the sites had armoring (bulkheads) and others didn't so we decided to look on any impacts it had on elevation.

Field Methods

The first step in the data collection process was setting up the beach transect. This process involved running a meter tape down the beach towards the tidal line. By placing flags down the beach they were able to mark stations every 2 meters moving towards the water. This allows them to monitor different locations on a vertical transect at specific intervals moving towards the water. Using a tripod level and stadia rod they were able to calculate the elevation at each station. At each station they laid down a $1/4m^2$ grid. With this grid they were able to estimate the vegetation density and the species of vegetation. Using this same grid they were able to collect data on substrate types, density and size of sediment at each station.

The data collection method for the variables we looked at was very consistent over the 10 years with the only exceptions being that in more recent years specificity in which plant species is recorded has become more precise, and the number of samples per year has decreased as the study has continued.

Statistical Methods

For all tests run in this report we used an alpha value of 0.05. This means that a p-value must be lower than this alpha value to reject the null hypothesis. The exception to this is the Shapiro-Wilk test which we used an alpha value of 0.10. The two types of test we ran in this report were parametric and non-parametric tests. A parametric test is used when all the data sets being evaluated is normally distributed (normal). A non-parametric test is used when one of or all of the data sets being evaluated are not normally distributed.

When looking at station information from the field for statistical analysis we often grouped the stations. The grouped stations we used were 0-9m, 10-19m, 20-29m,30-39m,40-49m,50m+. These values represent the distance in meters towards the water that the data was collected from. When looking at correlations by station the means from these group stations are what was calculated and used in the test.

SUMMARY STATISTICS

Elevation, Sedimentation, and Vegetation Change Over Time

We were interested in seeing if there was a change in elevation, sedimentation, and vegetation at each of our seven sites as time passed. The mean value for each site was calculated for each year. For elevation, the change in the mean from the previous year was calculated and, for visualization purposes, plotted for each site (Appendix, Fig. 1). To determine if the data was parametric for elevation, we looked at the Q-Q Plot (Fig. 2) and performed a Shapiro-Wilk test (Table 1). Based on the Q-Q Plots, all sites seemed to have elevation data that was normally distributed and the Shapiro-Wilk test confirmed this for every site except LTP. Ultimately, we decided to treat the data as parametric because of the Q-Q Plot. For sedimentation and vegetation the mean grain size(mm) and mean percent vegetation was calculated and plotted vs time (Figures 3 and 4). Normality of the sedimentation and Vegetation data was determined by the Shapiro-Wilk test; if the data was non-parametric then it was normalized by the log function.

Elevation Change and Armoring

We were interested in seeing if bulkheads made a difference in how the elevation changed. We used the same data that was used for testing elevation change over time (already determined to be parametric), but we added to it a categorical variable related to armoring: bulkhead or no bulkhead.

Cluster Analysis of the Sites

We were interested in seeing how the seven sites were grouped according to a cluster analysis. More specifically, if the armoring and banking geography played a role in the grouping (Table 8).The variables used for this were the individual yearly means of the elevation, sedimentation, and vegetation for each site (Fig. 5). The years include 2003-2011 for elevation and vegetation; and 2003-2010 for sedimentation as there was no 2011 data for this variable.

Correlation between Elevation and Sedimentation by Station

From our data compiled throughout all of our studied stations, we decided to run normality tests to see if our variables elevation and sediment size were normally distributed as we move into the tidal line. We chose to use the Shapiro-Wilk test on both of our variables. For sediment size our normality test gave us a P-value of 0.0001713, this tells us to reject the null hypothesis and we can conclude that this data is not normally distributed. Our elevation variable test gave us a P-value of 0.01239, this tells us that we fail to reject our null hypothesis and that this data is normally distributed. Since one of our variables is normally distributed and one is not normally distributed, it is correct to use the Spearman's Rank Correlation Rho test for non-parametric data, instead of a parametric test that assumed both of our variables are normally distributed. This test gave us a P-value of 0.000002161, and a rho correlation coefficient of 0.6732. This tells us to reject our null hypothesis and that this data is significantly correlated to each other. We can conclude that there is a significant correlation between elevation and grain size are positively correlated by station.

Correlation between Elevation and Sedimentation through Time

Once we compiled our data into a table that explained the mean elevations and sedimentation (grain size in mm) we chose to test both of our numeric ratio variables for normality using a Shapiro-Wilk test. This test helped us examine our data to determine whether we needed to use a parametric or non-parametric correlation test. Our data from the Shapiro-Wilk Test for Normality is shown in our calculations. From this test, we determined that a P-value for the elevation variable of 0.00523 will lead us to reject our null hypothesis of our data being normally distributed. From the test of normality on our grain size variable, we got an even lower P-value of 0.000006495. This would again lead us to reject our null hypothesis and conclude that the data is not normal. From this normality test, we decided to run a Spearman's Rank Correlation Rho Test between our non-parametric distributions. From this test, we found P-value of 0.277 and a rho value of .1335. This rho value shows the correlation coefficient between these two variables through time. From this data we would fail to reject our null hypothesis and conclude that these variables are not significantly correlated.

Correlation between Sedimentation and Vegetation by Station

The average sediment grain size (Mm) was found by averaging the four main sediment size subgroups by each grouped stations (meters): 0-9, 10-19, 20-29, 30-39, 40-49, and 50+ meters seaward for all seven locations. A Shapiro-Wilk test was performed for normality.

The average percent of vegetation was found by taking the difference of the unvegetated percent from a hundred percent which was then averaged for each grouped stations for all seven locations. A Shapiro-Wilk test (Table 9) was also performed for normality with the same assumptions as previously stated.

Again, in the instance where one variable was normal and the other irregular, logarithm transformations were made to change the irregular variable into parametric data. In this instance, both variables were also found to not be normal.

Correlation between Sedimentation and Vegetation through time

The average sediment grain size (Mm) was found by averaging the four main sediment size subgroups: Largest Gravel Size, Most Common Gravel Size, Other Common Size, and Smallest Grain Size for each year ranging from 2003 to 2012 for all seven locations. To test this sediment variable for normality, a Shapiro-Wilk test was performed in which it assumes normality if the p-value is greater than 0.1.

The average percent of vegetation was found by subtracting the unvegetated percent from a hundred percent which was then averaged for each year from 2003 to 2012 for all seven locations. To test this vegetation variable for normality, a Shapiro-Wilk test was also performed (Table 10) with the same assumptions as previously stated.

If both sedimentation and vegetation variables were normal, the data was parametric. If both variables were not normal, the data was non parametric. In the instance were one variable was normal and the other irregular, logarithm transformations were made to change the irregular variable into normal data. In this situation, both variables were found to be not normal.

Correlation between Elevation and Vegetation by Station

To determine which test for correlation to run we must first understand a few things about our data. Considering that the correlation tests for data that is parametric have a stronger power than the tests for nonparametric data, it would be useful to know if the data is parametric, and if it is not then we can normalize it to have a more accurate and stronger analysis. Utilizing the Shapiro-Wilk test we determined whether or not the data was parametric or not for the elevation data per station and the vegetation data per station (Table1, Table6 respectively). Since both variables are parametric in every case, or were parametric when log transformed, we were able to run a Pearson's product-moment test for correlation. The null hypothesis for a Pearson's test is that there is no correlation between the two data sets. To reject the null the p-value must be smaller than 0.05 and the correlation coefficient would be close to 1 or -1. The results showed no indication at any site that there was a correlation between the vegetation and the elevation when analyzed by stations (Table 12).

Correlation between Elevation and Vegetation through Time

This data is different from the station data because the averages of each site are grouped by the change over the years instead of the change in distance from the shoreline. This data was analyzed using the same process as the correlation data by station. We ran a Shapiro-Wilk test for normality, and found that all the data was either normal or could be log transformed to be normal. Then we ran a Pearson's product-moment test to determine if the parametric data was in fact correlated or not. Again, the null hypothesis is that the data sets are not correlated, and if the p value is lower than 0.05 and the correlation coefficient is close to 1 or -1, then we can reject the null that there is no correlation, and determine that there may in fact be a correlation. Two sites (SKA 5 and SB 1) rejected the null hypothesis demonstrating that there may be a correlation (Table 13). The five other sights gave no inclination that the null should be rejected.

STATISTICAL ANAYLSIS AND HYPOTHESIS TESTS

Elevation Change over Time

To determine if elevation was changing over time at a site, we first had to come up with hypotheses to test. We came up with a null and alternative hypothesis that were applicable to each site and are as follows:

H_0: The mean change in mean elevation is equal to zero

H_a: The mean change in mean elevation is equal to zero

Since we determined the data was parametric, we tested these hypotheses by performing a 1-sample, 2-tailed t-test on the data for each site. In all cases, we failed to reject the null hypothesis (Table 2). This means that no site had a statistically significant change in elevation over time.

Sedimentation Change over Time

To determine if sedimentation was changing over time at a site, we first had to come up with hypotheses to test. We came up with a null and alternative hypothesis that were applicable to each site and are as follows:

H_0: The mean change in sedimentation size is equal to zero

H_a: The mean change in sedimentation size is not equal to zero

Since we determined the data was parametric, we tested these hypotheses by performing a 1-sample, 2-tailed t-test on the data for each site. In all cases, we rejected the null hypothesis (Table 5). All sites had a statistically significant change in mean sedimentation size over time.

Vegetation Change over Time

To determine if the percent vegetation was changing over time at a site, we first had to come up with hypotheses to test. We came up with a null and alternative hypothesis that were applicable to each site and are as follows:

H_0: The mean change in percent vegetation is equal to zero

H_a: The mean change in percent vegetation is not equal to zero

Since we determined the data was parametric, we tested these hypotheses by performing a 1-sample, 2-tailed t-test on the data for each site. In all cases, we failed to reject the null hypothesis (Table 7). All sites had a statistically significant change in mean percent vegetation over time.

Elevation Change and Armoring

The approach we used to determine if armored sites showed a different change in mean elevation was to use a two-sample t-test. In one sample, we grouped the sites that had bulkheads. These were KB and SKA4. Our second sample was composed of LTP, SKA3, SKA4, SB and TB, the sites that were unarmored. We then ran a two-sample, two-tailed t-test with the null hypothesis, H_0, that the mean change in elevation in the armored sample equaled the mean change in elevation in the unarmored sample. This test produced a p-value=0.4948. Since this p-value is greater than our alpha level of 0.05, we fail to reject our null hypothesis. Furthermore, we also ran an ANOVA to see if the factor of armoring made a difference in the change in mean elevation. The results (Table 3) supported the results of the t-test. It appears that the presence of bulkheads is not having a significant impact in how the elevation has changed at any location in the ten years of sampling.

Cluster Analysis of the Sites

Using a Canberra distance algorithm the seven sites were grouped and it seems that the armoring and banking geography did cause the sites to be grouped. So elevation, sedimentation, and percent vegetation are most similar for sites with similar armoring and banking geography.

Mean Sedimentation vs. Average Percent Vegetation Correlation by Grouped Stations

Ho = There is no correlation between the average sediment grain size and the average percent of vegetation by grouped stations.

Ha = There is a correlation between the average sediment grain size and the average percent of vegetation by grouped stations.

Since both sedimentation and vegetation were found not to be normal data, a non-parametric Spearman correlation test was run.

The findings of the test (Table 11) showed that as we increase the distance in meters towards the water (by stations), there is not a strong enough significance to come to the conclusion that there is a correlation (Figure 6) between average sediment grain size (Mm) and average vegetation (%) for all locations. We fail to reject the null hypothesis.

Mean Sedimentation vs. Average Percent Vegetation Correlation through Time

Ho = There is no correlation between the average sediment grain size and the average percent of vegetation as time goes by.

Ha = There is a correlation between the average sediment grain size and the average percent of vegetation as time goes by.

Since both sedimentation and vegetation were found to not be normal data, a non-parametric Spearman correlation test was run.

The findings of the test (Table 11) showed that as the years go by there is a significant negative correlation (Figure 7) between average sediment grain size (Mm) and average vegetation (%) for all locations. We reject the null hypothesis.

Mean Elevation vs. Mean Sedimentation Correlation by Grouped Stations

Ho = Mean elevation and mean sediment size are not correlated.

Ha = Mean elevation and mean sediment size are correlated

Since both sedimentation and vegetation were found to not be normal data, a non-parametric Spearman correlation test was run.

Figures 8 and 9 are only an example of one site of collected data from our community partners. For these set or correlation tests, our information from all sites was compiled into one table to one correlation test. These two graphs show a correlation of the data presented, from one site.

Mean Elevation vs. Mean Sedimentation Correlation through Time

Ho = There is no correlation between the mean elevation per year and the average sediment size per year.

Ha = There is a correlation between the mean elevation per year and the average sediment size per year.

Mean Elevation vs. Average Percent Vegetation Correlation through Time

Ho = There is no correlation between the mean elevation per year and the average percent vegetation per year.

Ha = There is a correlation between the mean elevation per year and the average percent vegetation per year.

All of the data sets were able to be normalized or were normal to begin with, so a Pearson's product-moment test for correlation was run. The results are in Table 13.

Mean Elevation vs. Average Percent Vegetation Correlation by Grouped Stations

Ho = There is no correlation between the mean elevation per group of stations and the average percent vegetation per group of stations.

Ha = There is a correlation between the mean elevation per group of stations and the average percent vegetation per group of stations.

All of the data sets were able to be normalized or were normal to begin with, so a Pearson's product-moment test for correlation was run. The results are in Table 12.

SUMMARY

In this report we looked at three main variables, elevation, sediment size and percent vegetated. We evaluated the data to determine the long term trends. We were able to determine that of our 3 variables elevation was not changing over time, whereas for sediment size and percent vegetated there was a significant change in the mean over time for all sites. The next question this project looked at was does armoring have an impact on elevation change overtime. We found from a t-test of armored versus non-armored sites the means are not significantly different. We used a Canberra distance algorithm and were able to determine elevation, sediment size and percent vegetation are more similar for sites with similar armoring and bank geography.

Correlations were the next set of tests we ran on our data. We looked at means by group station and year of all of our 3 main variables. When looking at correlations we used Pearson or Spearman's correlation test depending on whether our data was parametric or not. A significant correlation we found were mean sedimentation vs. percent vegetation through time. For this correlation we found that they were strongly negatively correlated (rho=-0.75). Mean sedimentation and elevation also showed a strong positive correlation when looking at their relationship by grouped station (rho=0.67). For percent vegetation and elevation we found significance for only one site SKA 5. At SKA 5 elevation and vegetation were negatively correlated by year (r=-0.72)

FUTURE WORK

In the testing we looked at only three main variables over time and station, the mean grain size in millimeters, the mean percent of each transect covered in vegetation, and the mean elevation of the transect. However in the raw data there were many more variables that could be looked at. Categorical variables such as the type of vegetation delineated by red, brown, and green algae, kelp, and eel grass, as well as the numerical percentages of those variables covering the transect, or the variables of the grain of gravel, various measures of sand, silt, and clay, as well as the most common sizes in millimeters present could be analyzed. Future study of this data could produce a clearer picture by looking at how these unused variables relate into the data already processed. Some of the tests that we recommend for these new variables would be to combine them with the already processed data and perform PCA tests on them to see how each site relates to each other and which variables are more interrelated. Performing some ANOVA and Tukey tests would also help clarify the relationship between sites. An unused variable is the changes between the sites on if they are hard armored, soft armored, or unarmored which also might play a role in the beach dynamic.

One trend we chose not to look at was how the data was affected by season. This could have played a factor in our yearly means, because the number of samples each year started to decrease it is possible that years with more spring and summer samplings could show more percent vegetation for example. This would be a factor to explore in further research and keep in mind during data collection. To further look at our same variables we could also have the mean for the variables grouped by the station ranges that we used for each year they were gathered to also get a better idea of if any particular station range is changing over time not just the total average for the stations or years separately.

For anyone looking into further understanding the state of these beaches we would also advise searching both for literature where others have already analyzed similar variables on other beaches and for if there is any public data with similar variables for other beaches. With this larger picture of what other people have already done, and found for other beaches a clearer picture develops of trends that may be happening on a larger scale to beaches and also what a more stable beach may look like in comparison to a deteriorating or restoring beach and compare that to our own studied beaches. If our group would have been able to spend more time analyzing the data we would have explored potential relationships with categorical variables such as plant species, we would have looked at soft vs. hard armoring's effects on the beach profile, we would have explored the seasonal effects on data collection and we would have liked to see other literature of similar variables to see what questions they asked and what their findings were.

ACKNOWLEDGEMENTS

The Swinomish Indian tribal community water recourses department and Todd and Karen Mitchell for gathering and letting us use the data.

To the Center for Service Learning for bringing community and university together making this possible.

To Robin Kodner for helping address our concerns and teaching us the skills to even attempt this project.

APPENDIX

FIGURES

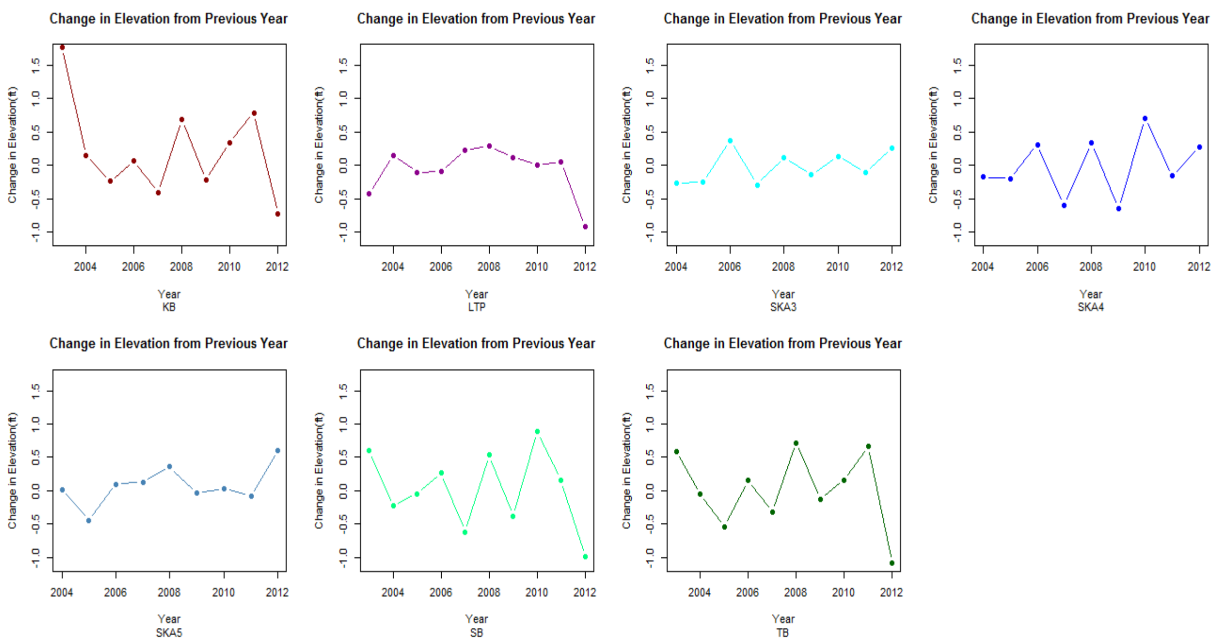


Figure 1. Year vs. Change in mean elevation from previous year (ft) for each site. KB=Kiket Bay, LTP=Lone Tree Point, SKA3=Sneeoosh Bay 3, SKA4=Sneeoosh Bay 4, SKA5=Sneeoosh Bay 5, SB=Similk Bay, TB=Turners Bay.

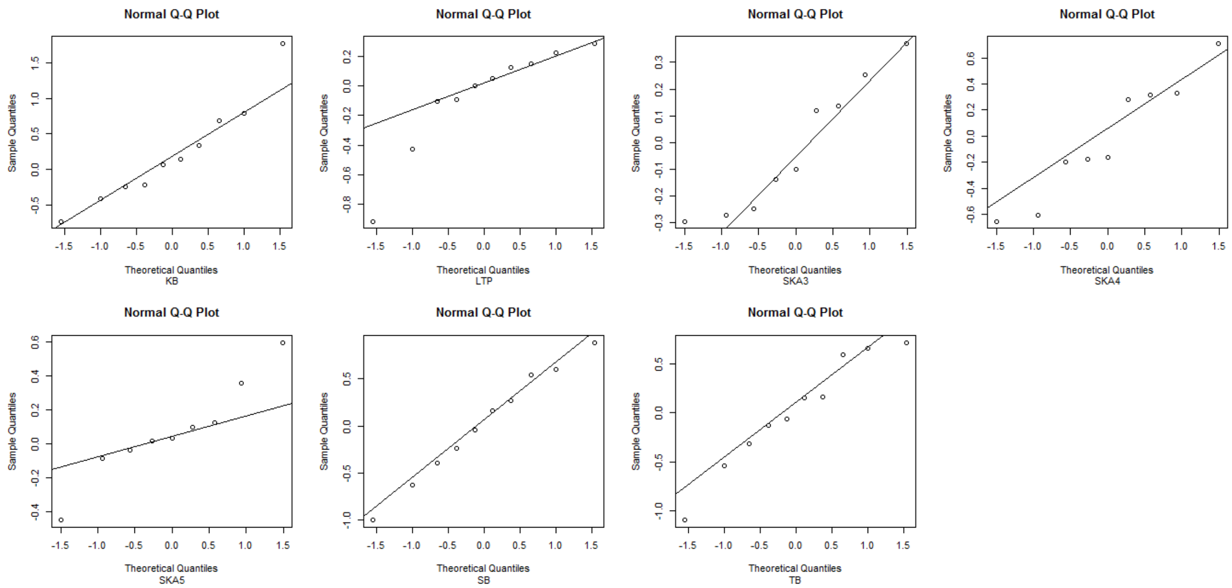
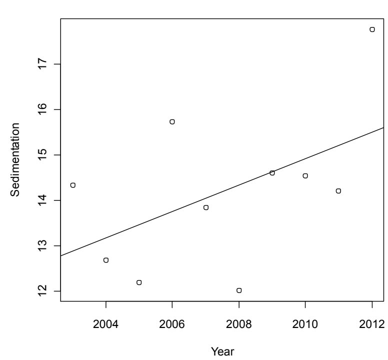
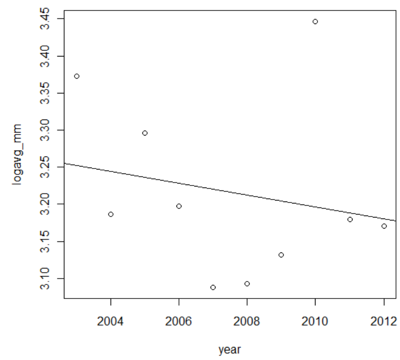


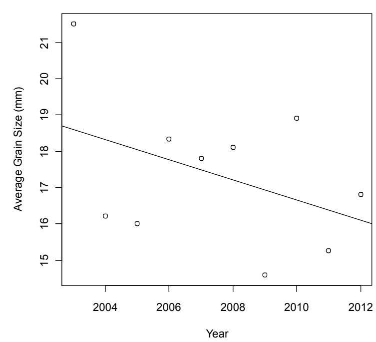
Figure 2. Quantile-Quantile plots the change in mean elevation from previous year at each site location. KB=Kiket Bay, LTP=Lone Tree Point, SKA3=Sneeoosh Bay 3, SKA4=Sneeoosh Bay 4, SKA5=Sneeoosh Bay 5, SB=Similk Bay, TB=Turners Bay.



Ska3



KB



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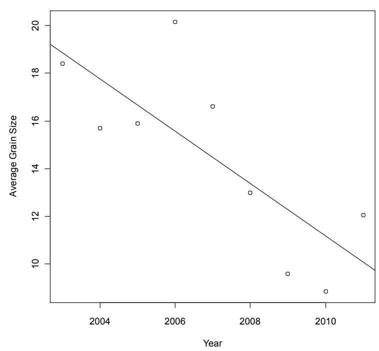

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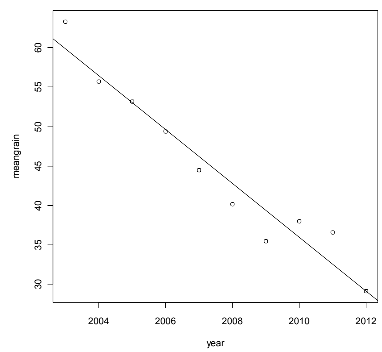
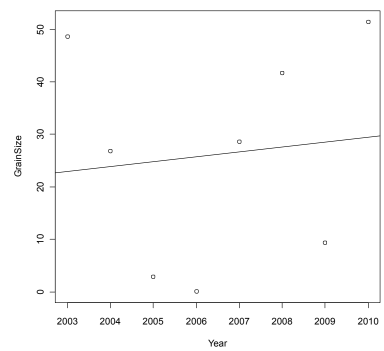


SKA4



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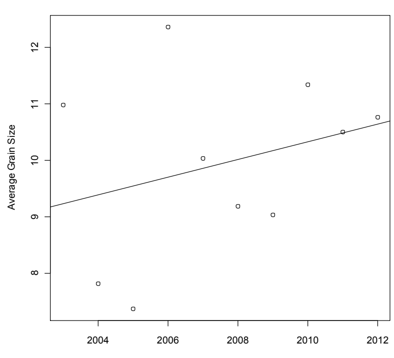
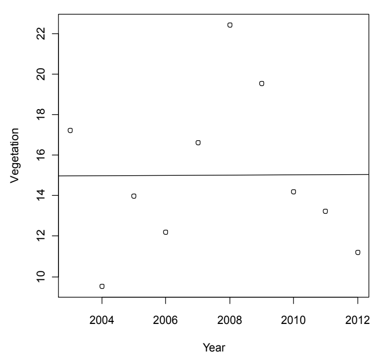
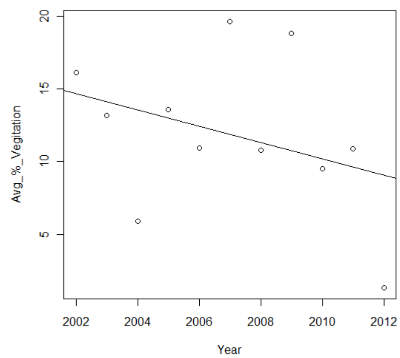


TB

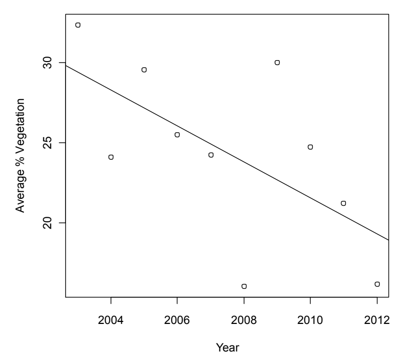
Figure 3. Mean Grain Size (mm) vs. Year for each site. KB=Kiket Bay, LTP=Lone Tree Point, SKA3=Sneeoosh Bay 3, SKA4=Sneeoosh Bay 4, SKA5=Sneeoosh Bay 5, SB=Similk Bay, TB=Turners Bay.



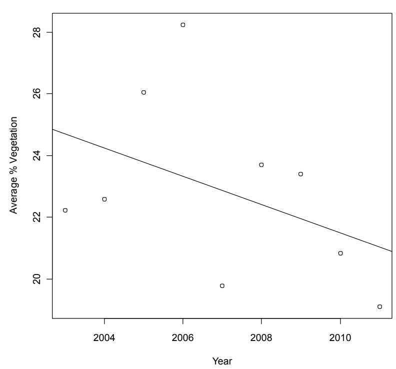
SKA3



KB



LTP



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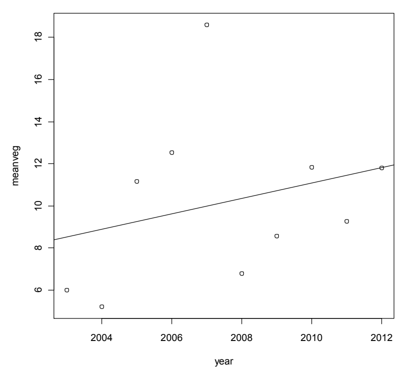
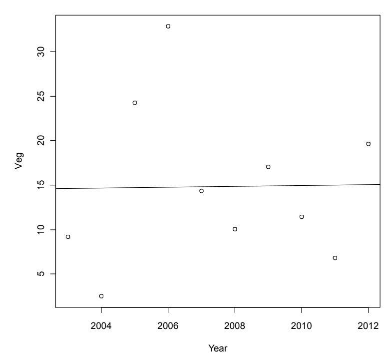


SKA4



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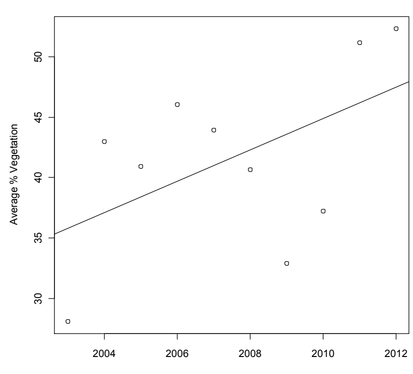

TB

Figure 4. Mean Percent Vegetation vs Time for each site. KB=Kiket Bay, LTP=Lone Tree Point, SKA3=Sneeoosh Bay 3, SKA4=Sneeoosh Bay 4, SKA5=Sneeoosh Bay 5, SB=Similk Bay, TB=Turners Bay.

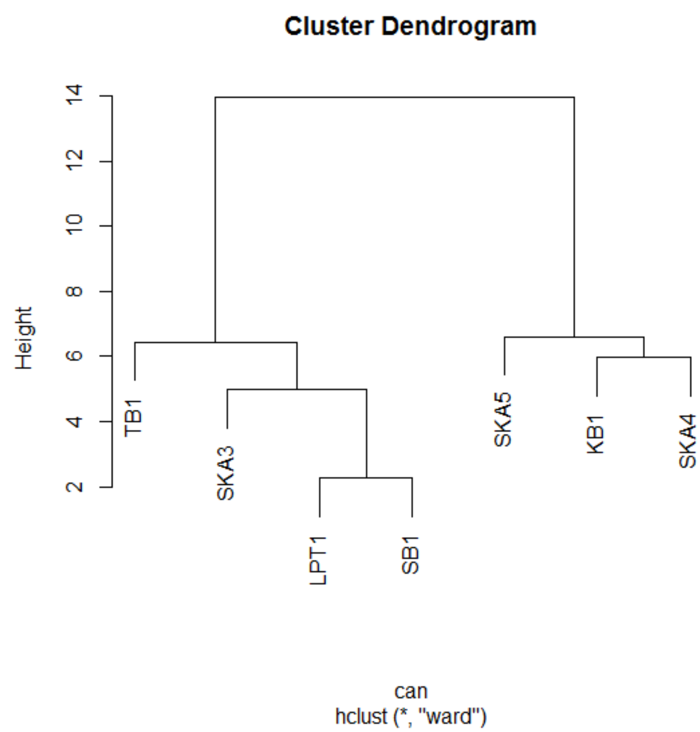

Figure 5. A cluster analysis of the seven sites using a Canberra distance

Correlation between Sedimentation and Vegetation by stations

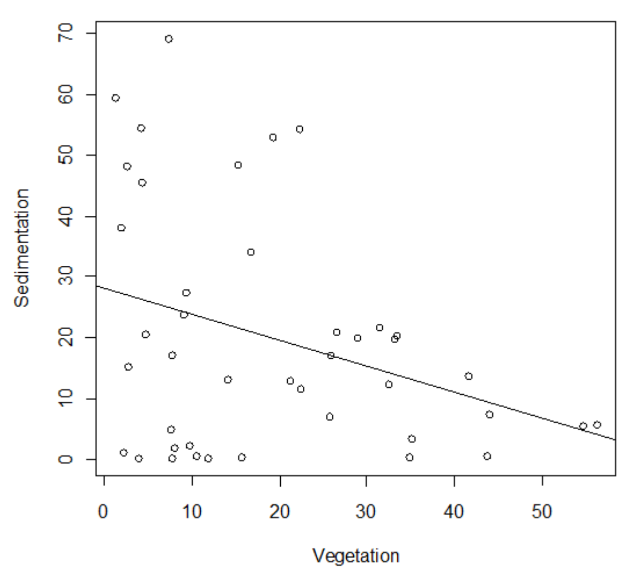

Figure 6. Correlation between average sediment size (Mm) and average vegetation (%) by stations at all locations**.** There is not a strong enough significance to see a correlation.

Correlation between Sedimentation and Vegetation through time

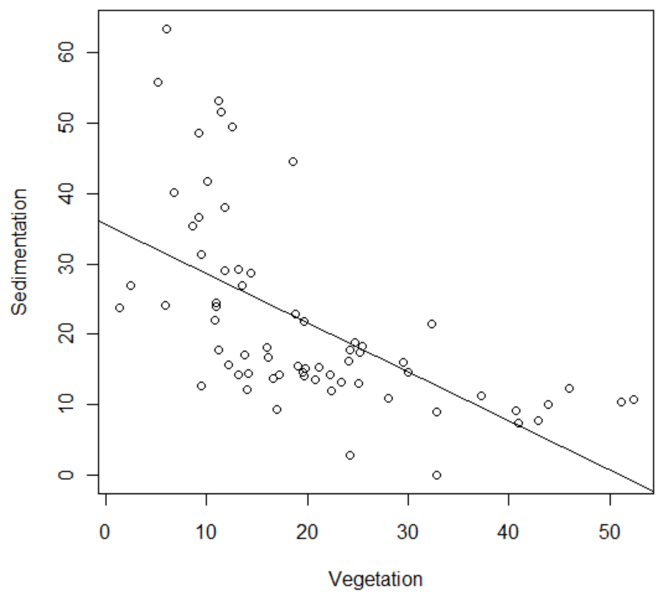

Figure 7. Correlation between average sediment size (Mm) and average vegetation (%) through time at all locations**.** Somewhat of a strong negative correlation can be seen.

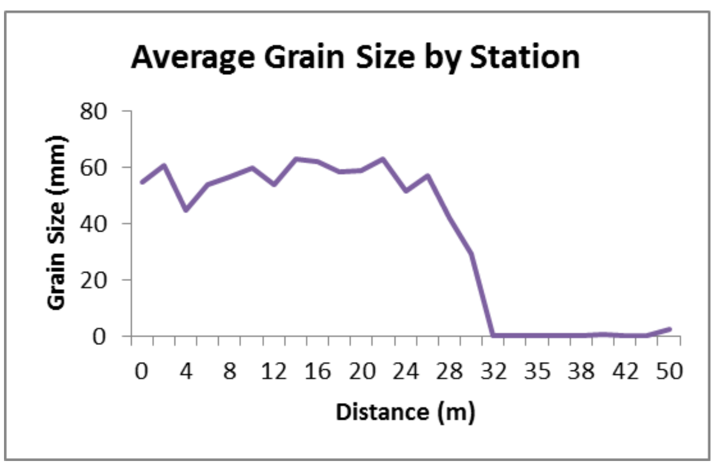

Figure 8. Shows the average grain size by station for our SKA4 site of collected data.

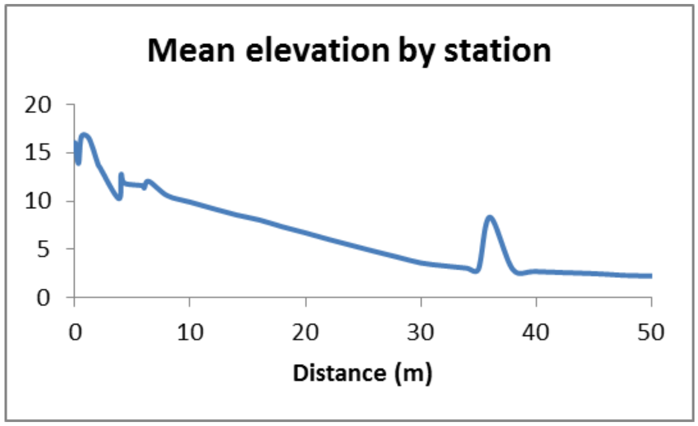

Figure 9. Shows the mean elevation by station of our SKA4 analyzed data.

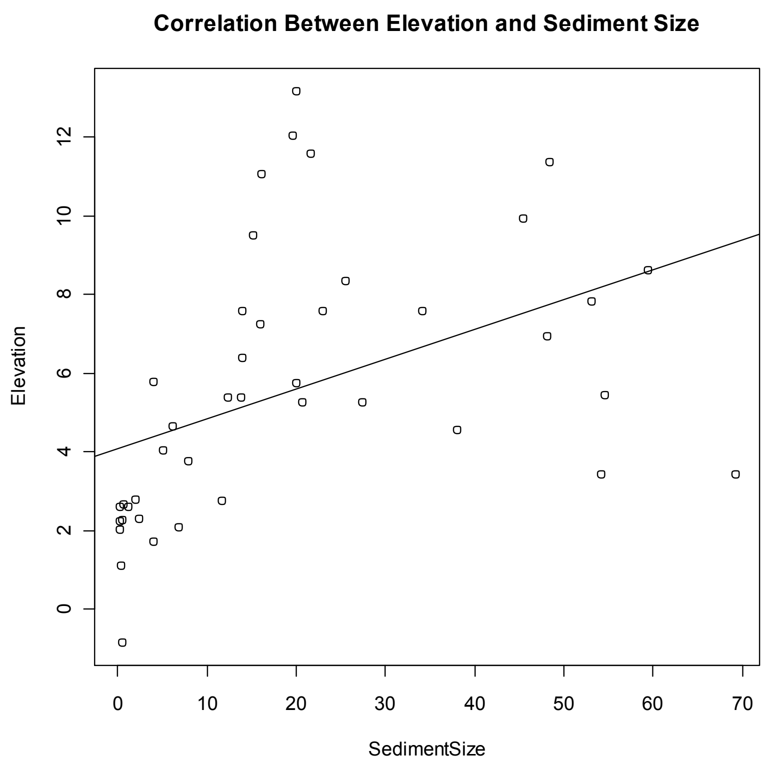

Figure 10. Shows a scatter plot of elevation and sediment size by station, this was our data that showed a significant correlation, the statistical analysis shows the exact values from our tests of this data.

TABLES

Site	p-value	Conclusion
KB	0.551	Normal
LTP	0.03913	Not normal
SKA3	0.3152	Normal
SKA4	0.5056	Normal
SKA5	0.6728	Normal
SB	0.977	Normal
TB	0.6317	Normal

Table 1. P-value produced by the Shapiro-Wilk test performed for each site on the change in mean elevation from previous year.

Site	t-score	d.f.	p-value	Interpretation
KB	0.9585	9	0.3629	Fail to reject H_o
LTP	-0.6202	9	0.5505	Fail to reject H_o
SKA3	-0.232	8	0.8223	Fail to reject H_o
SKA4	-0.1115	8	0.914	Fail to reject H_o
SKA5	0.7584	8	0.47	Fail to reject H_o
SB	0.0828	9	0.9358	Fail to reject H_o
TB	0.0792	9	0.9386	Fail to reject H_o

Table 2. Results of the 1-sample, 2-tailed t-test for each site to determine if the elevation changed significantly.

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Bulkhead	1	0.151	0.1509	0.65	0.423
Residuals	65	15.104	0.2324		

Table 3. Summary of results from the ANOVA test on the change in mean elevation by the factor of bulkheads.

Site	p-value	Conclusion
KB	0.1696	Normal
LTP	0.7622	Normal
SKA3	0.4251	Normal
SKA4	0.8559	Normal
SKA5	0.3505	Normal
SB	0.7751	Normal
TB	0.8533	Normal

Table 4. P-value from the Shapiro-Wilk test performed for each sites mean grain size data. KB was log transformed for normality.

Site	t-score	d.f.	p-value	Interpretation
KB	85.4264	9	2.091e-14	Reject H_o
LTP	27.0818	9	6.182e-10	Reject H_o
SKA3	26.1397	9	8.47e-10	Reject H_o
SKA4	4.5565	9	0.0002157	Reject H_o
SKA5	3.6396	7	0.008292	Reject H_o
SB	11.2027	8	3.614e-06	Reject H_o
TB	19.8706	9	9.614e-09	Reject H_o

Table 5. Results of the 1-sample, 2-tailed t-test for each site to determine if the mean sedimentation size changed significantly.

Site	p-value	Conclusion
KB	0.7741	Normal
LTP	0.4864	Normal
SKA3	0.8541	Normal
SKA4	0.4148	Normal
SKA5	0.7803	Normal
SB	0.7862	Normal
TB	0.8856	Normal

Table 6. P-value from the Shapiro-Wilk test performed for each sites mean percent vegetation

Site	t-score	d.f.	p-value	Interpretation
KB	7.3613	10	2.422e-05	Reject H_o
LTP	14.0206	9	2.025e-07	Reject H_o
SKA3	12.0096	9	7.648e-07	Reject H_o
SKA4	4.4033	9	0.0003054	Reject H_o
SKA5	5.2199	9	0.0005493	Reject H_o
SB	23.4799	8	1.151e-08	Reject H_o
TB	17.4366	9	3.033e-08	Reject H_o

Table 7. Results of the 1-sample, 2-tailed t-test for each site to determine if the mean percent vegetation changed significantly.

Site	Armoring	Banking
KB	Armored	Low bank
LTP	Unarmored	Low bank
SKA3	Unarmored	Low bank
SKA4	Soft Armor	High bank
SKA5	Unarmored	High bank
SB	Unarmored	Low bank
TB	Unarmored	Low bank

Table 8. Armoring and Banking geography for each site

Variable	Shapiro Wilk test p-value	Conclusion	Interpretation
Sedimentation	0.0001516	Not normal	We have non parametric data
Vegetation	0.003436	Not normal	

Table 9. Shapiro-Wilk test results for averaged Sedimentation and Vegetation by stations.

Variable	Shapiro Wilk test p-value	Conclusion	Interpretation
Sedimentation	4.696e-06	Not normal	We have non parametric data
Vegetation	0.0004044	Not normal	

Table 10. Shapiro-Wilk test results for averaged Sedimentation and Vegetation by year from 2003 to 2012.

Correlation test	Spearman rank test p-value	Correlation coefficient	Interpretation
Through time	2.2e-16	-0.7461888	We reject the null hypothesis
By stations	0.1271	-0.2391216	We fail to reject the null hypothesis

Table 11. Results of Spearman's rank correlation tests for correlation between Sedimentation and Vegetation through time and by stations for all locations.

Site	P-value	Pearson's Correlation Coefficient	Conclusion
KB1	0.6475	-0.2395494	No Correlation
LTP1	0.1742	0.6364631	No Correlation
SKA3	0.917	0.05541915	No Correlation
SKA4	0.7347	0.178778	No Correlation
SKA5	0.3062	0.5056432	No Correlation
TB1	0.6337	-0.172517	No Correlation
SB1	0.6076	-0.1878788	No Correlation

Table 12. The results from Pearson's test for correlation for elevation vs. vegetation by station, the null hypothesis was that there is no correlation, and all p-values were too high, and the coefficients were too small to reject the null.

Site	P-value	Pearson's Correlation Coefficient	Conclusion
KB1	0.1477	-0.4929418	No Correlation
LTP1	0.9984	-0.00074207	No Correlation
SKA3	0.6072	-0.1858738	No Correlation
SKA4	0.4542	-0.2679557	No Correlation
SKA5	0.04225	-0.724085	Correlation
TB1	0.3412	0.3368289	No Correlation
SB1	0.004825	-0.8376498	Correlation

Table 13. The results from Pearson's test for correlation for elevation vs. vegetation by year, the null hypothesis was that there is no correlation, and all p-values were too high, and the coefficients were too small to reject the null.