Flowering Rush Sediment Characterization in Forest Lake, MN

Brandon Paulson and Casey Clemensen
What is Flowering Rush?

• Invasive aquatic plant
• Native to Eurasia, first found in North America in 1897
• Spread through trade, backyard wetlands
• Two genetic karyotypes: diploid and triploid
• Diploid reproduces via sexual reproduction and rhizomatic fracturing
• Triploid reproduces only by rhizomatic fracturing
• Prohibits recreation by interfering with boat propellers, fishing, swimming, and provides habitat for the great pond snail which hosts parasites
Main Goal of the Project

• Determine if sediment characteristics such as grain size and composition influence the distribution of Flowering Rush in Forest Lake
Characterization Techniques

- Carbon/Nitrogen Analysis
- X-ray Fluorescence (XRF)
- Loss on Ignition (LOI)
- Sieve and Hydrometer
Loss on Ignition

- Organic material
  - Flowering Rush locations = 4.03%
  - Non-Flowering Rush locations = 1.92%
  - P-value = 0.247
Nitrogen Analysis

- Flowering Rush mean = 0.179%
- Non-Flowering Rush mean = 0.066%
- P-value = 0.240
Carbon Analysis

- Flowering Rush mean (3.7%)
- Non-Flowering Rush mean (1.62)
- P-value = 0.185
X-ray Fluorescence Data

- **Potassium**
  - Flowering Rush locations = 9549 ppm
  - Non Flowering Rush locations = 10016 ppm
  - P-value = 0.683
XRF Data

- Sulfur
  - Flowering Rush locations = 882 ppm
  - Non-Flowering Rush locations = 768 ppm
  - P-value = 0.773
XRF Data

- Iron
  - Flowering Rush locations = 9014 ppm
  - Non-Flowe ring Rush locations = 4739 ppm
  - P-value = 0.072
XRF Data

• Calcium
  • Flowering Rush locations = 84727 ppm
  • Non-Flowering Rush locations = 46549 ppm
  • P-value = 0.20
Sieve and Hydrometer

- Mean grain size
  - Flowering Rush locations = 3.287
  - Non-Flowering Rush locations = 3.27
  - P-value = 0.960
- Mean grain size = \( \text{phi} 16 + \text{phi} 50 + \text{phi} 84 / 3 \)
Phi = -\log_2 d where d = grain diameter in millimeters
Discussion

• No significant difference between sediment samples in areas with and without Flowering Rush at the 95% confidence level
  • Potential correlation between Fe concentrations and sites with Flowering Rush (p=0.072)

• Urban et al. determined a significant relationship between high Fe concentrations in porewater, high Fe release from sediment, and the presence of *Ultricularia inflata*
Future Research

- Another study focused on iron concentrations in sediments with more sample sites
- Biotic interactions (competition, predation)
- Hydrology of the lake (might be hard for rhizomatic fragments to travel from southeast to northeast part of lake)
University of St. Thomas

Forest Lake
What Sediment Characteristics Does Flowering Rush Prefer?

Brandon Paulson and Casey Clemensen
ESCI 430
May, 2017
Introduction

Invasive species have become a topic of high concern as climate change continues raising the average global temperature. As temperature increases invasive species are capable of moving further north, into previously uninhabitable areas. Flowering rush, or *Butomus umbellatus*, is an invasive aquatic plant that has recently begun impacting lakes within the United States. Flowering rush is a plant derived in Eurasia, and was first found within North America in Canada’s Saint Lawrence river in 1897 (Jacobs, 2011). The species was also spread through means of trade within the United States. As people planted Flowering Rush within their backyard wetlands the invasive plant was capable of reaching other bodies of water when flooding occurred.

Flowering rush has two distinct genetic karyotypes, one being a diploid gamete, which is capable of sexual reproduction. The other variant is triploid, which is solely capable of breeding through asexual rhizomatic fracturing. Diploid species are also capable of asexual reproduction (Parkinson, 2010). The individuals found within Forest Lake are diploid, making management of the invasive difficult. In some instances such as the Detroit Lakes area, mechanical removal techniques have been shown to make Flowering Rush infestations worse (Madsen 2016). The plant is specialized to have root systems that have carbohydrate rich rhizomes within the roots of the plant. The extra carbohydrates within the root systems allow for more successful growth once the broken off rhizome floats to a different region to germinate. The roots are also specialized to break off of the main plant and disperse at minimal force, typically a wave of ~2mph (Parkinson, 2010). Thus, removal typically results in fragmentation of the root system, or only partial removal of the specimen.

Flowering Rush is a species which has been influencing many fish species as well as prohibiting recreation by interfering with boat propellers, fishing, swimming, and providing habitat for the great pond snail which hosts parasites that cause swimmer’s itch (Parkinson, 2010). The main impacts appear to be the change in areas where no aquatic plants were found before infestation, leaving fish species that breed in open water to lose their breeding territories. This environmental change causes a shift in species abundance towards those that use aquatic plants for breeding, thus causing major ecosystem alterations (Jacobs, 2011).

With removal of the species being difficult to manage, the Comfort Lake Forest Lake watershed district partnered with the University of Saint Thomas to research potential lake sediment characteristics both allowing the presence and deterrence of Flowering Rush. This study aims to determine more about the ecology of Flowering Rush, specifically focusing on the question about sediment characteristic preference. Because plants rely on sediment composition and nutrient availability to successfully germinate and begin the process of growth, sediment characteristic preference could be crucial to know for future management. It was found, however, that Flowering Rush may actually do better in conditions where nutrient availability is low (Trebitz, 2007). This condition was unclear, however it could be due to Flowering Rush being a weak competitor, so it is capable of cultivating regions with no other plant species.

We tested the grain size distribution, elemental composition, carbon and nitrogen percentages, and total organic matter. We hypothesized that sites containing Flowering Rush would have different grain sizes as well as sediment compositions, in regions where Flowering Rush is present and where it is absent. We assume this hypothesis to be true, because there
are areas where Flowering rush is not found within Forest Lake, so there must be a reason why this is occurring. We predict sediment size to influence growth, since past research has demonstrated that certain macrophytes are capable of increased growth rates within the roots and shoots while growing in clay rich sediments (Li, 2012).

**Methods**

*Sample Collection*-  
We collected sediment samples from Forest lake on Saturday, February 11th 2017. Ice augers were used to drill holes in the ice and bucket augers were used to collect sediment samples from the bottom of the lake. All samples were collected in the littoral zone as this is where Flowering Rush is present. A total of 20 sediment samples were collected, 11 samples from areas where Flowering Rush is present (FR locations) and 9 samples where Flowering Rush is not present (NFR locations). The use of a pre-existing ArcGIS shapefile provided by the CLFLWD was used to determine GPS points of known Flowering Rush to determine the sampling areas (Sorenson, pers. comm). Sediment samples were placed in labeled ziplock bags. Figure 1 shows areas in the lake where Flowering Rush currently exists. Figure 2 shows the locations where samples were taken. Table 1 in Appendix A shows the sample identification number, Flowering Rush status, and the GPS locations for each sample location.
Figure 2: Sampling locations on Forest Lake. Sampling locations are indicated by white and pink dots. White dots indicate locations where Flowering Rush is present, pink dots indicate locations where Flowering Rush is not present. Sampling locations on the east side of the lake were infested with Flowering Rush, while sampling locations on the west side were primarily Flowering Rush free.

Sediment Characterization - Loss on Ignition -

Loss on ignition (LOI) was used to determine percent organic matter in each sample. We followed the Mybro et al. 2005 LOI standard operating procedure. Empty, labeled crucibles were weighed, filled with about 1-5 cm³ of sediment, then weighed again. The samples were then dried in an oven set at 100 degrees Celsius overnight to remove water from the samples. Samples were then weighed again, and placed in a muffle furnace set at 550 degrees Celsius to burn off organic matter for four hours. Samples were taken out of the muffle furnace and allowed to cool for 1 hour before being weighed again. All weights throughout the procedure were recorded in an excel file. An LOI Macro file was used to calculate the organic and inorganic percentages of each sample.
**Carbon/Nitrogen Analysis**

Before Carbon/Nitrogen (C/N) analysis, small portions of sediment were taken out of each wet sample and dried in an oven at 40 degrees Celsius for two days to dry the samples. One blank (empty tin capsule) and five aspartic acid standards of varying masses (1-5 mg) were burned in the C/N analyzer as a quality control measure. For analysis of unknowns, dried sediment samples were placed in tin capsules, weighed in the microbalance, and analyzed using a Flash EA 1112 instrument in the Geology Laboratory. Data were reported as percent carbon and percent nitrogen for each sample which was saved for later analysis.

**XRF**

X-Ray Fluorescence (XRF) was used to determine the elemental compositions of the sediments. The same samples used for C/N analysis were used for XRF analysis. With the exception of not sieving our sediment samples (the samples were already fine grains), we followed the sample preparation and analysis techniques described by Goldstein et. al, 1996. Small amounts of sample were poured into a container used specifically for XRF analysis. The XRF container with the sediment sample was then placed in a Niton XL3 XRF reader, the lid was closed, and the X-ray was turned on. Each sample took 90 seconds to run and elemental composition data was output by the reader and transcribed into a personal excel file. The Niton XL3 XRF reader has a 95% confidence level.

**Sieve and Hydrometer**

Based on our literature review, the sieve and hydrometer method of determining grain size distribution is less expensive and just as accurate as other grain size analysis techniques (Cheetham et. al). From this information, and because we already had the necessary equipment, we concluded that we would determine grain size distribution of the sediments using the sieve and hydrometer method.

We followed a slightly modified version of the methods described by the LacCore Grain Size Pretreatment Standard Operating Procedure (2013) developed by Laura Triplett and Jessica Heck at the University of Minnesota and Brian Schumacher with the Environmental Protection Agency for the grain size pretreatment. Other than weighing samples before and after the digestion and drying the samples in an oven after digestion, our procedure followed the protocol described by Schumacher in section 4.3 of his report titled *Methods for the Determination of Total Organic Carbon (TOC) in Soils and Sediments, 2002.* Organic matter was removed in order to get an accurate reading of grain size distribution during sieve and hydrometer analysis. All of the remaining wet sediment samples from our collection were dried at 40 degrees Celsius for four days, then digested. For the digestion, dried samples were placed in labeled beakers and heated to 85 degrees Celsius in a hot water bath to facilitate a hydrogen peroxide reaction. 30% hydrogen peroxide was continually added to each sample until bubbling stopped, signifying the end of the reaction. Then, sediment samples were air dried before sieve and hydrometer analysis.

For hydrometer analysis, we followed the Standard Test Method for Particle-Size Analysis of Soils (ASTM, 1998). After drying, representative sediment samples were weighed, run through a No.10 sieve (2 mm mesh size) and weighed again. The percentage of grains
smaller than 2mm and larger than 2mm in diameter were calculated from these weights. The sediment that passed through the No. 10 sieve was collected, and 50 grams of each sample was weighed out if the sample looked primarily clayey or silty, and 100 grams was weighed out if the sample looked sandy. Those representative samples were then placed in 250 mL beakers, 125 mL of sodium hexametaphosphate solution was added, stirred, and allowed to soak for 16 hours to disaggregate the sediment. After soaking for 16 hours, the soil-water slurries were stirred again using a mechanically operated stirring device, emptied into a dispersion cup, and distilled water was added to fill the cup half full. Next, the soil-water slurries were transferred to glass sedimentation cylinders and distilled water was added until the total volume reached 1 liter. The cylinders were capped using a rubber stopper and turned upside down and back right side up for one minute before being set on a flat surface. Hydrometer and temperature readings were then taken at 1, 2, 5, 15, 30, 60, 250, and 1140 minutes after being agitated and set on the flat surface. After the final hydrometer reading, the suspension was transferred to a No. 200 sieve (0.075 mm mesh size) and washed with tap water until the wash water became clear. The sediment retained in the sieve was then transferred to a container and dried at 110 degrees Celsius. Next, the samples were weighed and run through a sieve stack consisting of the No.10, 40, 100, and 200 sieves. To determine the percent of each grain size in the sieve stack, we determined the mass of each section of the sieve stack on a balance. Calculations for determining the grain size distribution were done by following the directions in the Standard Test Method for Particle-Size Analysis of Soils.

**Results**- Raw results are available in appendix A, including summary statistics of all variables measured in the study (Table 2).

**Loss on Ignition**

Percent organic matter ranged from 0.44 to 16.44% in FR locations. Percent organic matter from NFR locations had a much smaller range, from 0.36 to 6.5%. The mean percent organic material is 4.03 percent for FR locations, and 1.92 percent for NFR locations. Standard deviations were 5.17 for FR locations and 2.37 for NFR locations. A two sample T-test was used to determine if the difference in means were significant. The T-test output a P-value of 0.247, meaning the results are not significant at the .05 level. Although the difference is not significant, FR locations did tend to have slightly higher percentages of organic matter than NFR locations. Figure 3 compares the FR locations to the NFR locations in box and whisker plots.
Carbon/Nitrogen Analysis-

The mean nitrogen percentages for FR locations and NFR locations were 0.179% and 0.066%, respectively. The standard deviation was 0.267 for FR locations and 0.113 for NFR locations. Again, a two sample T-test was used to determine if the difference in nitrogen means between locations with and without Flowering Rush were significant. The T-test output a P-value of 0.240, meaning the nitrogen results are not significantly different at the .05 level. Figure 4 compares the nitrogen percentages in FR locations to NFR locations in box and whisker plots. Mean carbon percentages for FR locations and NFR locations were 3.7% and 1.62%, respectively. The standard deviation was 4.29 for FR locations and 2.26 for NFR locations. The T-test output a P-value of 0.185, meaning there is not a significant difference in carbon percentages between locations with and without Flowering Rush at the .05 level. Figure 5 displays box and whisker plots of the percent carbon values in FR locations and NFR locations. C:N ratios were also analyzed, and results showed values primarily ranging from 15 to 50. A T-test concluded that the C:N ratios in FR locations and NFR locations are not significantly different with a P-value greater than .05.
Although many elements were examined using the XRF, we chose to particularly examine potassium, calcium, iron and sulfur because these elements often differ in different types of sediments. Two sample T-tests were used to determine if the concentrations of these elements significantly differed between locations with and without Flowering Rush. The mean value of potassium in FR locations was 9549 ppm with a standard deviation of 3565 and the mean value of potassium in NFR locations as 10016 ppm with a standard deviation of 876. The potassium means were not significantly different, with a P-value of 0.683. The mean value of calcium in FR locations was 84727 ppm with a standard deviation of 77715 and the mean value...
of calcium in NFR locations was 46549 ppm with a standard deviation of 49311. The calcium means were not significantly different, with a P-value of 0.200. The mean value of iron in FR locations was 9014 ppm with a standard deviation of 6897 and the mean value of iron in NFR locations was 4739 ppm with a standard deviation of 1610. The iron means were also not significantly different, with a P-value of 0.072. The mean value of sulfur in FR locations was 882 ppm with a standard deviation of 809 and the mean value of sulfur in NFR locations was 768 ppm with a standard deviation of 912. The mean values of sulfur were not significantly different, with a P-value of 0.773. Figure 6 compares the potassium, sulfur, iron, and calcium concentrations between FR locations and NFR locations.

Figure 6: Box and whisker plots comparing the potassium (top left), sulfur (top right), iron (bottom left), and calcium (bottom right) concentrations in FR locations to NFR locations. No differences were significant at the 95% confidence level.

Sieve and Hydrometer-

Grain sizes were analyzed in phi units, which is the logarithmic transformation of millimeters into integers using the formula phi = -Log2d where d is equal to the grain diameter in millimeters. The graphic mean grain size for FR locations was 3.287 phi with a standard deviation of 0.981, and the graphic mean grain size for NFR locations was 3.27 phi with a standard deviation of 1.11. A two sample T-test resulted in a P-value of 0.960, meaning that the average grain size of FR locations does not differ from the average grain size for NFR locations.
Figure 7 compares the graphic mean grain sizes in FR locations to NFR locations in box and whisker plots. The graphic mean grain size for each sample was calculated using the cumulative frequency graphs of grain size (Figures 9 and 10, Appendix A) and the equation \( \text{phi } 16 + \text{phi } 50 + \text{phi } 84 / 3 \). Weighted and normalized to 100% mean grain sizes were also calculated to get more representative results than the graphic mean grain sizes. The weighted mean is just another method used to determine the mean. We normalized the graphs to 100% because many of them were above or below 100%, possibly due to poor hydrometer readings from extreme foam in some samples. The weighted means were calculated by multiplying each midpoint value between two points on the cumulative frequency graphs by the proportion of sediment between the two points, and summing each of those values. The weighted and normalized mean grain sizes were also not significantly different between FR locations and NFR locations. Figure 8 compares the graphic mean grain sizes between FR locations and NFR locations and the weighted, normalized mean grain sizes between FR locations and NFR locations. Figure 11 in Appendix A displays the cumulative frequency graphs normalized to 100% for the FR locations. Figure 12 in Appendix A displays the cumulative frequency graphs normalized to 100% for the NFR locations.
Figure 8: Box and whisker plots comparing the normalized means for weighted grain sizes and graphic grain sizes between FR locations and NFR locations. Weighted grain sizes were not significantly different between sites with FR and those without.

**Discussion**

LOI, Carbon/Nitrogen, XRF, and sieve and hydrometer results showed no significant difference between sediment samples from FR locations and NFR locations in bivariate analysis at the 0.05 significance level. The presence of foam in some of the samples during hydrometer readings made hydrometer readings difficult and could have resulted in somewhat inaccurate readings for some of the samples. Ethyl alcohol was added to very foamy samples in attempts to reduce the abundance of bubbles with little success.

Although not quite significant at the 95% confidence level (P = .072), XRF results revealed higher iron concentrations on average in sediment samples containing Flowering Rush. No other studies in the literature have reported higher iron concentration in sediments where Flowering Rush is present, possibly because there has not been much research on Flowering Rush and its sediment preferences. It is possible that a larger sample size could result in significant differences in iron concentrations between Flowering Rush sediments and sediments without Flowering Rush at the .05 level. However, due to limitations in time and resources, we were unable to conduct research upon a larger sample set. Another study has found a significant relationship between high iron concentrations in porewater, high iron release from the sediment, and the presence of the aquatic invasive plant *Utricularia inflata* (Urban et. al, 2012). This suggests that there could be a relationship between high iron concentrations and aquatic invasive plants. Further studies on Forest Lake to investigate possible relationships between iron concentrations and Flowering Rush presence could follow similar methods to the Urban et. al study.

After conducting this research, we can determine that there must be other factors involved with the mechanism of Flowering Rush seed germination, since it is only found within some regions of Forest Lake. Because Flowering Rush has only been in Forest lake for a few years, perhaps the invasive plant is slowly spreading from the southeast to northwest part of the lake and needs more time before establishing itself in the northeast part of the lake. Other
studies could look through a different lens in order to pinpoint the differences within the sediment. Future research could also look at other biotic interactions in the region, thus determining a source of nutrient competition or even aquatic species consumption of the plant.
## Appendix A

### Table 1: GPS Sampling Locations

*All coordinates are in the Universal Transverse Mercator (UTM) coordinate system:*

<table>
<thead>
<tr>
<th>Sample</th>
<th>Flowering Rush Status</th>
<th>Easting</th>
<th>Northing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Present</td>
<td>506824.230</td>
<td>5012708.370</td>
</tr>
<tr>
<td>2</td>
<td>Present</td>
<td>506859.949</td>
<td>5012650.162</td>
</tr>
<tr>
<td>3</td>
<td>Present</td>
<td>506890.376</td>
<td>5012590.631</td>
</tr>
<tr>
<td>4</td>
<td>Present</td>
<td>506905.590</td>
<td>5012511.255</td>
</tr>
<tr>
<td>5</td>
<td>Present</td>
<td>506643.652</td>
<td>5012759.303</td>
</tr>
<tr>
<td>6</td>
<td>Present</td>
<td>506674.770</td>
<td>5012725.100</td>
</tr>
<tr>
<td>7</td>
<td>Present</td>
<td>506548.402</td>
<td>5012741.443</td>
</tr>
<tr>
<td>8</td>
<td>Present</td>
<td>506439.261</td>
<td>5012653.469</td>
</tr>
<tr>
<td>20</td>
<td>Present</td>
<td>501351.148</td>
<td>5013836.258</td>
</tr>
<tr>
<td>24</td>
<td>Present</td>
<td>504981.000</td>
<td>5013171</td>
</tr>
<tr>
<td>25</td>
<td>Present</td>
<td>504067.000</td>
<td>5013173</td>
</tr>
<tr>
<td>9</td>
<td>Absent</td>
<td>501355.987</td>
<td>5013600.591</td>
</tr>
<tr>
<td>10</td>
<td>Absent</td>
<td>501432.188</td>
<td>5013479.941</td>
</tr>
<tr>
<td>11</td>
<td>Absent</td>
<td>501544.371</td>
<td>5013427.024</td>
</tr>
<tr>
<td>12</td>
<td>Absent</td>
<td>501625.206</td>
<td>5013377.201</td>
</tr>
<tr>
<td>13</td>
<td>Absent</td>
<td>501768.410</td>
<td>5013327.300</td>
</tr>
<tr>
<td></td>
<td>Absent</td>
<td>501688.305</td>
<td>5013336.007</td>
</tr>
<tr>
<td>----</td>
<td>--------</td>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Absent</td>
<td>501275.000</td>
<td>5013566.000</td>
</tr>
<tr>
<td>22</td>
<td>Absent</td>
<td>501353.000</td>
<td>5013703.000</td>
</tr>
<tr>
<td>21</td>
<td>Absent</td>
<td>501349.000</td>
<td>5013790.000</td>
</tr>
</tbody>
</table>

Figure 9: Cumulative frequency graphs for grain size distributions at FR sampling sites.
Figure 10: Cumulative frequency graphs for grain size distributions at NFR sampling sites.

Figure 11: Cumulative frequency graphs for grain size distribution at FR sites after normalizing to 100%.
Figure 12: Cumulative frequency graphs for grain size distribution at NFR sites after normalizing to 100%.
Table 2: Statistics for all Variables Measured in the Study

<table>
<thead>
<tr>
<th>Sample</th>
<th>Easting</th>
<th>Northing</th>
<th>Veg or No Veg</th>
<th>Graphic Mean (Phi)</th>
<th>Graphic Mean SD (phi)</th>
<th>Graphic Skewness (Phi)</th>
<th>Weighted Normalized Mean</th>
<th>% Nitrogen</th>
<th>% Carbon</th>
<th>K (ppm)</th>
<th>Ca (ppm)</th>
<th>Fe (ppm)</th>
<th>S (ppm)</th>
<th>% Organic</th>
<th>% Inorganic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50682</td>
<td>501270</td>
<td>Present</td>
<td>4.63</td>
<td>1.41</td>
<td>0.1177</td>
<td>4.1903 92738</td>
<td>0.7765</td>
<td>0.0398</td>
<td>11.606</td>
<td>43482</td>
<td>712</td>
<td>169</td>
<td>114</td>
<td>246</td>
</tr>
<tr>
<td>2</td>
<td>50685</td>
<td>501265</td>
<td>Present</td>
<td>2</td>
<td>1.7</td>
<td>0.1826 5</td>
<td>1.8111 16944</td>
<td>0</td>
<td>0</td>
<td>0.5121</td>
<td>78957</td>
<td>117</td>
<td>212</td>
<td>506</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>50689</td>
<td>501259</td>
<td>Present</td>
<td>3.6</td>
<td>3</td>
<td>0.5442 95</td>
<td>1.9659 97526</td>
<td>0.0236</td>
<td>0.0785</td>
<td>1.8039</td>
<td>34693</td>
<td>108</td>
<td>412</td>
<td>766</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>50690</td>
<td>501251</td>
<td>Present</td>
<td>3.83</td>
<td>1.39</td>
<td>0.5632 48</td>
<td>4.4186 49678</td>
<td>0</td>
<td>0</td>
<td>1.4134</td>
<td>4142</td>
<td>145</td>
<td>408</td>
<td>275</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>50664</td>
<td>501275</td>
<td>Present</td>
<td>3.82</td>
<td>2.97</td>
<td>0.4358 723</td>
<td>2.4336 98662</td>
<td>0</td>
<td>0</td>
<td>1.2840</td>
<td>38305</td>
<td>103</td>
<td>760</td>
<td>961</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>50667</td>
<td>501272</td>
<td>Present</td>
<td>3.86</td>
<td>1.69</td>
<td>0.3478 77</td>
<td>4.1212 31364</td>
<td>0.2407</td>
<td>91321</td>
<td>9.8605</td>
<td>81398</td>
<td>213</td>
<td>262</td>
<td>290</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>50654</td>
<td>501274</td>
<td>Present</td>
<td>4.63</td>
<td>1.36</td>
<td>0.0255 76396</td>
<td>4.6867 44831</td>
<td>0.5811</td>
<td>46121</td>
<td>9.4212</td>
<td>60834</td>
<td>582</td>
<td>135</td>
<td>105</td>
<td>226</td>
</tr>
<tr>
<td>8</td>
<td>50643</td>
<td>501265</td>
<td>Present</td>
<td>2.27</td>
<td>1.07</td>
<td>0.2068 45786</td>
<td>2.3746 54584</td>
<td>0.0022</td>
<td>0.0658</td>
<td>1.5636</td>
<td>7743</td>
<td>912</td>
<td>998</td>
<td>551</td>
<td>133</td>
</tr>
<tr>
<td></td>
<td>50135</td>
<td>501360</td>
<td>Absent</td>
<td>3.99</td>
<td>1.025</td>
<td>0.3133</td>
<td>4.2641</td>
<td>0.1910</td>
<td>4.6835</td>
<td>930</td>
<td>939</td>
<td>378</td>
<td>169</td>
<td>2</td>
<td>5.3</td>
</tr>
<tr>
<td>---</td>
<td>---------</td>
<td>----------</td>
<td>---------</td>
<td>-------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>-----</td>
<td>------</td>
<td>-------</td>
<td>------</td>
<td>-------</td>
<td>---------</td>
</tr>
<tr>
<td>10</td>
<td>50143</td>
<td>501374</td>
<td>Absent</td>
<td>2.6</td>
<td>1.06</td>
<td>0.3461</td>
<td>2.6402</td>
<td>0.2563</td>
<td>994</td>
<td>137</td>
<td>325</td>
<td>8</td>
<td>343</td>
<td>0.65</td>
<td>99.35</td>
</tr>
<tr>
<td>11</td>
<td>50154</td>
<td>501342</td>
<td>Absent</td>
<td>2.63</td>
<td>1.533</td>
<td>0.3460</td>
<td>2.4712</td>
<td>0.1891</td>
<td>103</td>
<td>804</td>
<td>283</td>
<td>7</td>
<td>0</td>
<td>0.42</td>
<td>99.58</td>
</tr>
<tr>
<td>12</td>
<td>50162</td>
<td>501337</td>
<td>Absent</td>
<td>2.57</td>
<td>0.0512</td>
<td>0.3721</td>
<td>4.2395</td>
<td>0.1052</td>
<td>141</td>
<td>595</td>
<td>113</td>
<td>0</td>
<td>0</td>
<td>0.36</td>
<td>99.64</td>
</tr>
<tr>
<td>13</td>
<td>50176</td>
<td>501332</td>
<td>Absent</td>
<td>2.57</td>
<td>1.644</td>
<td>1.0304</td>
<td>2.3959</td>
<td>0.1687</td>
<td>116</td>
<td>200</td>
<td>470</td>
<td>1</td>
<td>337</td>
<td>0.49</td>
<td>99.51</td>
</tr>
<tr>
<td>14</td>
<td>50168</td>
<td>501333</td>
<td>Absent</td>
<td>2.45</td>
<td>0.977</td>
<td>0.4640</td>
<td>2.3720</td>
<td>0.1344</td>
<td>902</td>
<td>932</td>
<td>523</td>
<td>2</td>
<td>194</td>
<td>0.35</td>
<td>99.65</td>
</tr>
<tr>
<td>20</td>
<td>50135</td>
<td>501333</td>
<td>Present</td>
<td>3.05</td>
<td>1.407</td>
<td>0.1118</td>
<td>3.7119</td>
<td>1.4350</td>
<td>958</td>
<td>108</td>
<td>609</td>
<td>5</td>
<td>533</td>
<td>1.53</td>
<td>98.47</td>
</tr>
<tr>
<td>21</td>
<td>50134</td>
<td>501379</td>
<td>Absent</td>
<td>2.57</td>
<td>2.367</td>
<td>0.2459</td>
<td>2.7772</td>
<td>0.2833</td>
<td>100</td>
<td>152</td>
<td>398</td>
<td>6</td>
<td>366</td>
<td>0.67</td>
<td>99.33</td>
</tr>
<tr>
<td>22</td>
<td>50135</td>
<td>501370</td>
<td>Absent</td>
<td>4.79</td>
<td>2.756</td>
<td>0.5438</td>
<td>3.5364</td>
<td>2.9818</td>
<td>943</td>
<td>111</td>
<td>371</td>
<td>4</td>
<td>136</td>
<td>2.51</td>
<td>97.49</td>
</tr>
<tr>
<td>23</td>
<td>50127</td>
<td>501356</td>
<td>Absent</td>
<td>5.26</td>
<td>2.546</td>
<td>0.3751</td>
<td>4.1494</td>
<td>5.7609</td>
<td>936</td>
<td>131</td>
<td>770</td>
<td>5</td>
<td>261</td>
<td>6.5</td>
<td>93.5</td>
</tr>
<tr>
<td>24</td>
<td>50498</td>
<td>501317</td>
<td>Present</td>
<td>2.07</td>
<td>1.610</td>
<td>0.3032</td>
<td>1.9063</td>
<td>6.5976</td>
<td>112</td>
<td>150</td>
<td>328</td>
<td>6</td>
<td>576</td>
<td>1.19</td>
<td>98.81</td>
</tr>
</tbody>
</table>
Works Cited