SALINITY MOVEMENT WITHIN DOG RIVER

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Saltwater intrusion is an increasing problem in coastal areas. As urban development depletes the water table and climate change causes sea levels to rise, the dynamics of Dog River have become threatened. The purpose of this research is to better understand how salinity moves into Dog River. To accomplish this, salinity measurements were taken using a Hydrolab Minsonde. These measurements were used to locate a boundary between the freshwater and saltwater, and understand how salinity changes with depth. Research results show that saltwater from Mobile Bay can move well inland depending on tidal variances, and salinity values change with depth. This study will help to shed light on saltwater intrusion in Dog River, and provide a basis for future studies.

Keywords: Saltwater, intrusion, salinity, stratification

Introduction

As coastal cities continue to develop, saltwater intrusion has become an increasing problem. Rising populations have created increased demand for drinking water. These population centers pull water from the ground, lowering the water table. As the water table is depleted, higher density saltwater moves in to replace it. Rivers can provide conduits for saltwater, allowing it to infiltrate inland. As saltwater moves inland, it has drastic effects not only on the water table, but the environment as well (Ning et al., 2010). In Dog River, marshes and cypress trees are under stress due to salinity far upstream. As the development of Mobile continues, salinity threatens to continue moving upstream.

An estuary is a transitional zone where fresh water from a river or stream meets saltwater. Saltwater is more dense than fresh water, so when the two meet, they do not always mix easily. Tides, river discharge, and wind are a few physical factors

that can determine how the water is mixed (Steele et al., 2010). Rivers that discharge directly into a body of saltwater and are weakly influenced by tidal currents can create a sharp boundary between water masses, creating a wedge between the two (Ibanez et al., 1997). Seen in Figure 1 below, the lighter freshwater floats on top of the saltwater wedge, which extends to the river bottom.

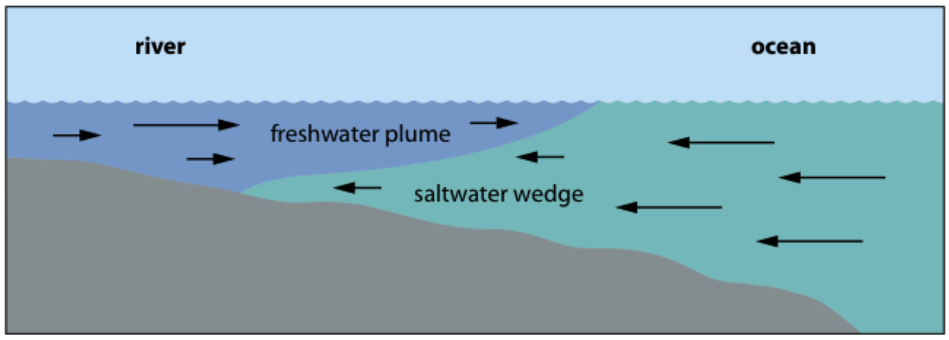

Figure 1: Salt-wedge
Retrieved from http://www.biodiversitybc.org/assets/Taking~Natures~Pulse/figure-14.png

These estuaries are called salt-wedge estuaries, or highly stratified estuaries. A small amount of mixing does occur, but is usually light (Sierra et al., 2003). The mouths of the Mississippi River and the Hudson River are examples of salt-wedge estuaries (Geyer et al., 2010).

The location of the salt-wedge is not fixed. Tides and discharge cause a wedge to move up and down a river. At low tide, the river can push the saltwater back toward the mouth of the river. At high tide, the saltwater pushes into the estuary, moving the wedge farther up the river (Stanne et al., 1996). Periods of heavy rain and drought also greatly affect the location of the salt-wedge. Heavy rains will increase the amount of freshwater into an estuary, pushing it down the river. Droughts have

the opposite affect, reducing freshwater flow and allowing the wedge to infiltrate upstream (Kurup et al., 1998).

Research Question

Saltwater has been found upstream in Dog River, but exactly where it meets the freshwater, no one knows. In an estuary like that of Dog River, a sharply stratified boundary can be created between the two masses. Is there a stratified boundary between the two, and if so, where is it located? The location of this boundary is greatly affecting by the tides and constantly moves up and downstream. What is the location of the salt front at low and high tide?

Methods

A Hydrolab Minisonde was used to take salinity measurements between the mouth of Dog River and Halls Mill Creek. I began at the Dog River Bridge and paddled upstream. Every thirty seconds, I would lower the Minisonde into the water, as in Figure 2 below.

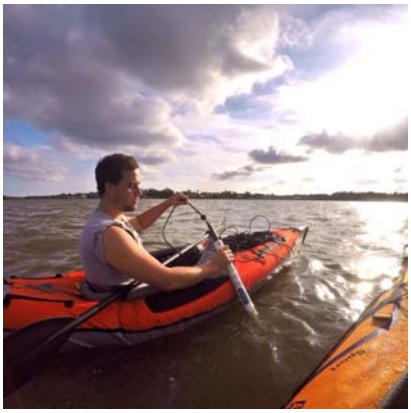

Figure 2: Measuring surface salinity with the Hydrolab Minisonde

These measurements were taken at the surface, three meters, and five meters. At each test site, I would record the GPS coordinates.

Results

A sharply stratified boundary was not found between freshwater and saltwater, but stratification was found throughout the test area. Low tide saw the greatest amount of stratification, with one site measuring 3.57 ppt at the surface and 4.12 ppt at three meters. Though stratification was found throughout, it was not uniform. The difference in salinity from top to bottom varied with each test site.

Salinity data show that the tides have a large effect on the movement of saltwater upstream. At low tide, the salt front was located 0.74 miles from the mouth of the river. At high tide, the salt front was found 1.58 miles upstream. The difference between the two can be seen in Figure 3.

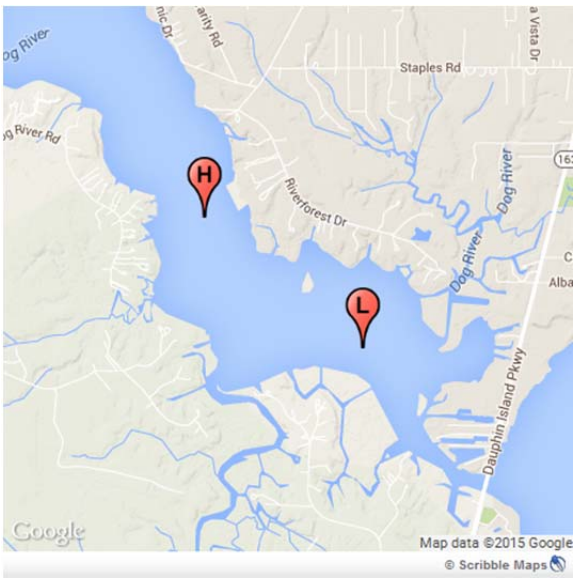

Figure 3: The location of the salt front at low tide (L) and high tide (H).

Though water immediately upstream from the front was not fresh, salinity levels dropped rapidly.

In the Figures 4 and 5 below, we see average salinity levels as they approach the salt front.

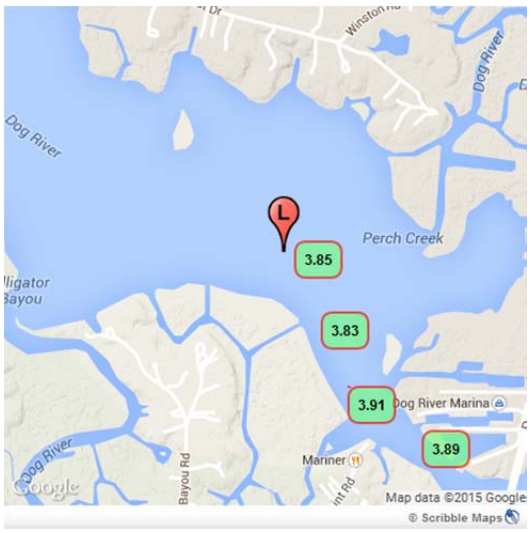

Figure 4: Salinity levels at low tide

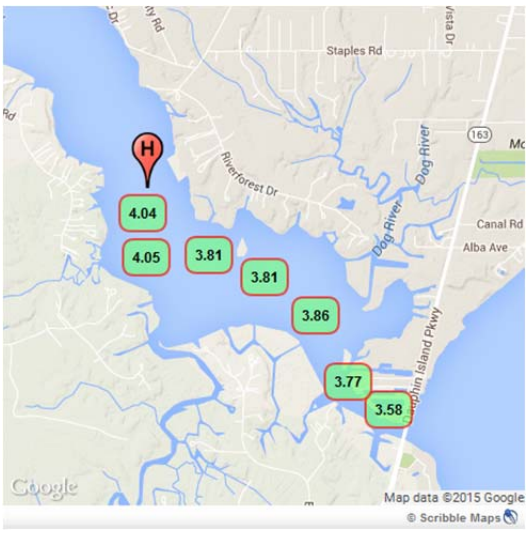

Figure 5: Salinity levels at high tide

When salinity data were recorded during high tide, values actually increased from the mouth of the river to the salt front.

Conclusion

After conducting research and spending time testing on Dog River, there are a few things that I believe would produce more beneficial results. Firstly, it is important to allow enough time to survey the area. Research was conducted on a kayak, meaning that testing multiple sites was very time consuming. The most

important change would be the time of year that this type of study is conducted. Spring can bring high amounts of rain to Mobile, increasing the freshwater discharge of the river. Higher discharge means that saltwater cannot intrude inland as far. The best time to conduct this study would be during the late summer months and into early fall. River discharge would be diminished, and saltwater would be allowed to move much farther upstream. Even during the spring, salinity values of 1.25 ppt were found as far upstream as Dog River (Luscher) Park. Overall, I believe this research to be beneficial. As saltwater intrusion becomes an increasing problem, it is important that we keep track of its movement into the river. The health of Dog River depends upon it.

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