The Effects of Weather on the Distribution of Suspended Sediments in Lake Tecumseh

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Overview

The purpose of this experiment was to observe the potential impacts of weather on the physical conditions of Lake Tecumseh in Virginia Beach, with specific emphasis on turbidity outflow.

Introduction

Causes of Turbidity

The effects of man-made drainage ditches created in 1959 turned Lake Tecumseh into a source of sedimentation, which harmfully drains into Back Bay. Back Bay is an important wildlife refuge for wintering waterfowl. The ditches created a wind-tidal system in which the lake drains completely into the bay and the surrounding watershed during storms and in the winter months. The increased turbidity and drainage of the lake inhibits the growth and accumulation of beneficial hydrophytes which reduce turbidity by preventing erosion as well as providing habitat for wildlife. When the lake drains during the winter, the eroding shoreline is exposed to frost heave, and when the lake refills in the spring, the silt becomes suspended in the water column and drains into the Back Bay Estuary. This increased turbidity reduces the amount of light entering the water column, which also inhibits hydrophyte growth (Madsen et al. 2004).

Figure 1. Sediment Mixing at Asheville Bridge Canal from Lake Tecumseh

- Clear Day (9/26/08)
- Stormy Day (11/05/08)

U.S. Fish and Wildlife Service Involvement

The U.S. Virginia Fish and Wildlife Service predicted the harmful effects of digging the drainage ditches in 1958, and issued a warning that the proposed Princess Anne County Watershed Project would cause "irreparable damage" to the fish and wildlife resources in the area. Recently, the Fish and Wildlife Service proposed a new project in which submerged weirs would be constructed across the entrance to main canals, Asheville Bridge Creek, and a second ditch. The weirs would stabilize water levels by restricting water movement from the lake, and prevent the lake from fully draining. Sedimentation outflow from the lake would potentially be greatly reduced.

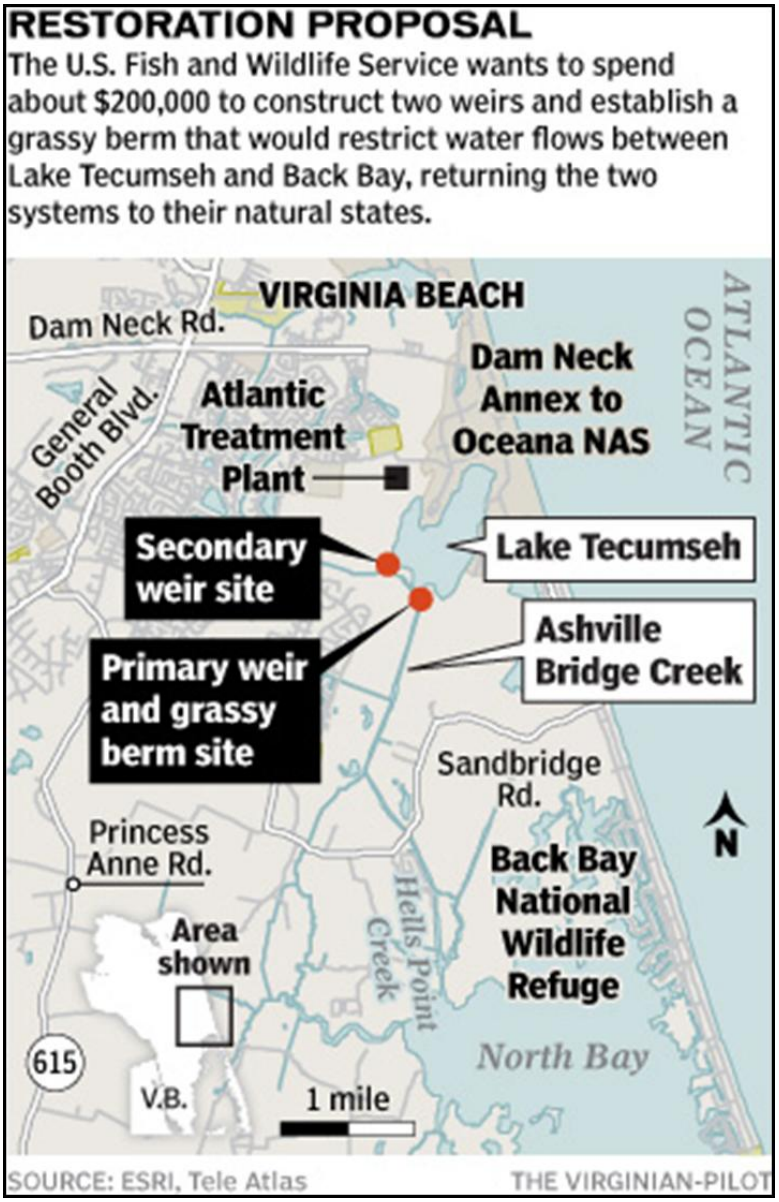

Figure 2. Locations for the proposed weirs.

Public Concerns

This $200,000 initiative was cancelled before the weirs were constructed when the government sponsor of the project pulled out due to numerous concerns and questions from the local community. For years, these canals served as recreational kayaking and boating areas, and locals were concerned that the weirs would restrict their access. Members of the community also questioned whether enough evidence existed to indicate that the introduction of weirs were even necessary, and whether they would actually provide the desired outcome. A major concern is public education about this issue, because most of the community have never had a chance to actually see the lake when it drains completely- the general conception is that it only drains in the winter, when in fact it may drain several times in the course of the year.

The Purpose of Our Study

Our study, with the help of U.S. Fish and Wildlife Service Employee Will Smith, examines the impact of weather conditions upon turbidity of the lake and its canals. It also attempts to establish Lake Tecumseh not as a sink of sedimentation, but as a source. This data is significant because it may provide evidence that the proposed weirs could greatly improve environmental conditions in the lake, while minimally reducing recreational opportunities for the public. In addition, our data may provide an opportunity for greater public education and awareness of why sedimentation in Lake Tecumseh is an issue.

Fish Kill

On September 26, 2008, a strong Northeastern storm occurred in the area of Lake Tecumseh. The wind tidal currents caused the lake to drain nearly completely. The day after the storm, a significant fish kill was recorded with an estimated 150 specimens of adult white perch found near the perimeter of the lake. The estimate was made by walking along the coast in 50 step increments (each step app. 2 feet) and counting all dead fish in sight perpendicular to the shore. We hypothesized that the massive fatalities were caused by a sudden increase in turbidity due to high wind velocity uplifting sediment into the water column and deoxygenating the lake. In addition, the sudden drop in water level as water was blown out of the lake further reduced the lake's carrying capacity for white perch. Finally, excess suspended particles could potentially clog gillrakers and gill filaments, reducing ability to absorb oxygen, and suffocating the fish (Bruton 1985, Tomasson 1983).

Figure 3. White Perch, *Morone americana*

Methods

- For this study, water parameters such as turbidity, temperature, depth, and dissolved oxygen were measured on a calm sunny day (10/31/08) in several points around the lake, along the drainage ditches, and at the mouth of Back Bay.
- A Hydro lab Surveyor and a DRT-ISCE Turbidometer were used. Measurements were taken mid-range in the water column.
- At each waypoint a water sample was taken to confirm turbidity results in the lab.
- Way point positions were marked using a Garmin GPS device, loaded onto ArcMap v 9.2, and superimposed onto an aerial image of the area.
- Hydrograph data was obtained from a monitoring well for February-March 2008, and water depth fluctuations were matched to weather data from http://www.weatherunderground.com to provide a correlation between storms and low water levels in the lake.
- Additional water samples were taken on a stormy day (11/05/08) in several of the waterways leading to and from Lake Tecumseh by Willard Smith. The two data sets were analyzed using Microsoft Excel.

Figure 4. Methods
Collecting water samples

Will Smith collecting hydrograph data from monitoring well.

Hydro lab Surveyor

Results

- Turbidity remained relatively consistent throughout Lake Tecumseh and the outflow system into Back Bay during the calm day.
- Turbidity ranges increased dramatically during the stormy day, with the most significant increase in turbidity occurring at the outflow of Lake Tecumseh, which measured between 48-67 ntu. (Fig 5).
- Fig 6. shows relative water levels over a several month timeline. Dates with significant weather conditions are indicated below.

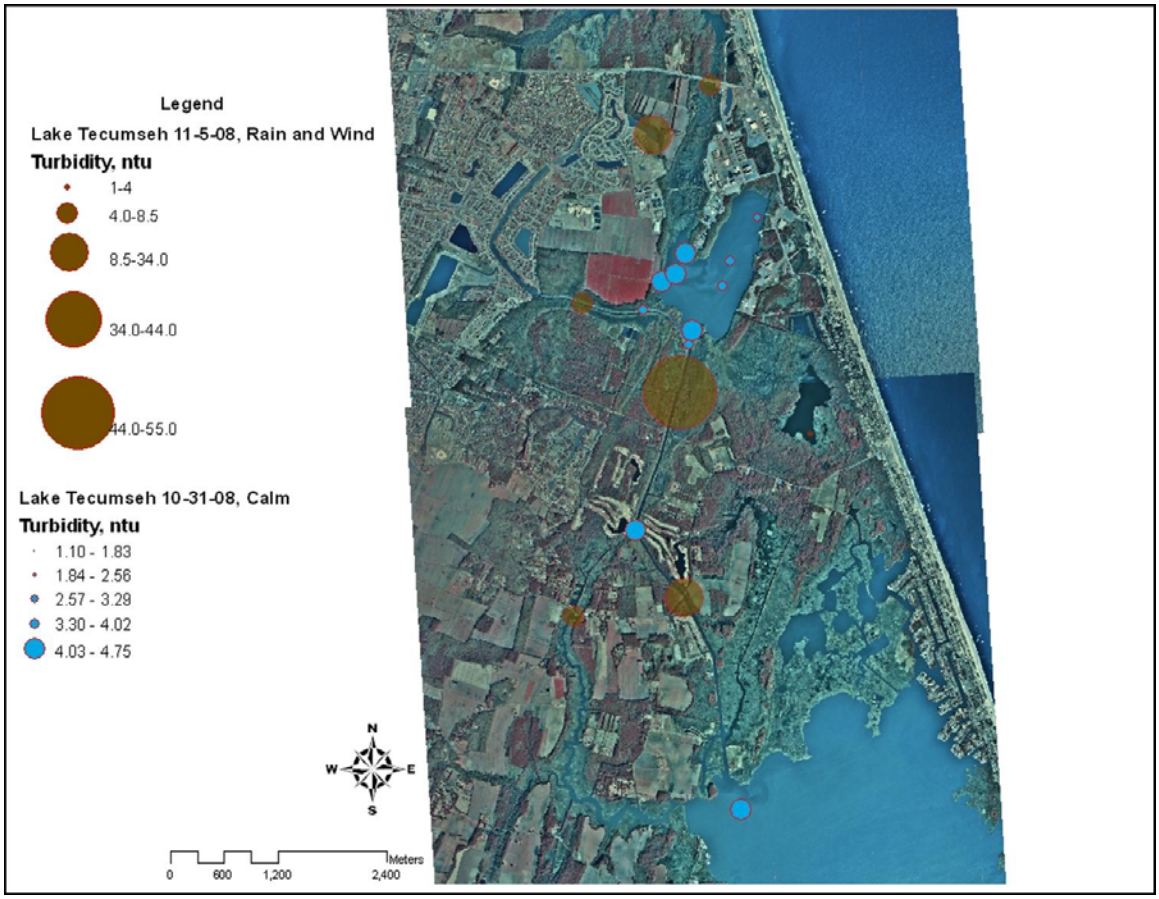

Figure 5. GIS aerial map displaying turbidity readings for Lake Tecumseh. Brown circles represent data from a stormy day (11/05/08), blue circles represent data from a calm day (10/31/08).

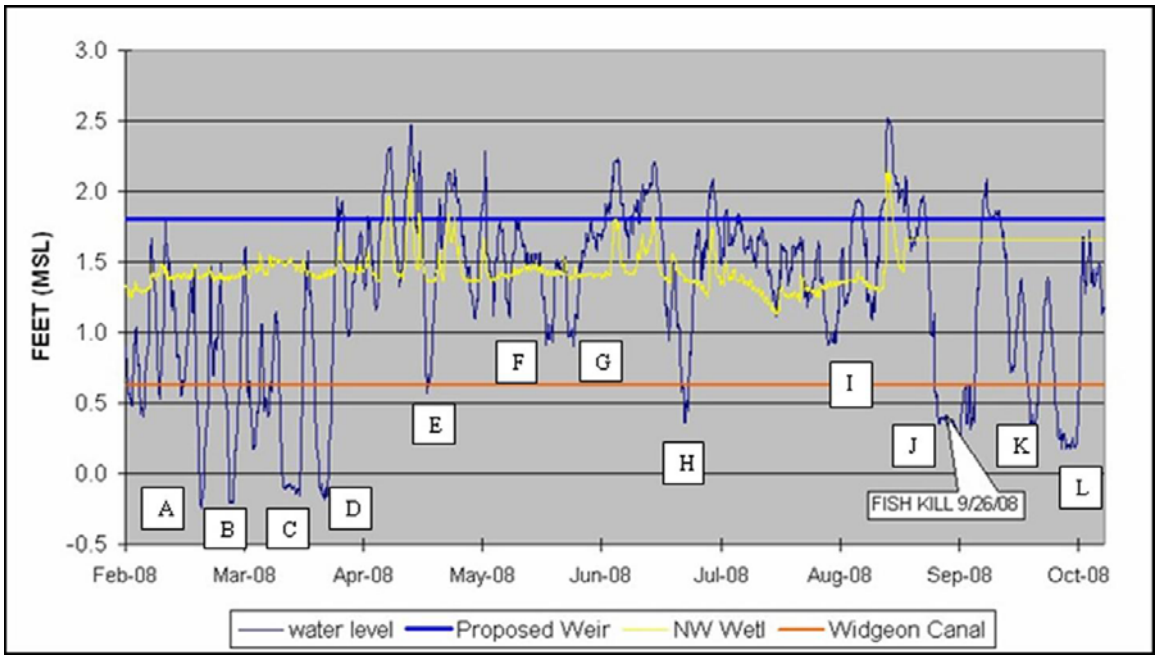

Figure 6. Hydrograph data spread showing the water level of Lake Tecumseh over a several month period. Points of Interest are as follows: A)03/20/08, 43mph gusts, B)03/28/08, 33mph gusts, C)04/12/08, 38 mph gusts, D)04/21/08, 31mph gusts, E)05/15/08, 22mph gusts, F)06/17/08, 37 mph gusts, G)06/27/08, 32mph gusts, H)07/23/08, 36mph gusts, I)08/31/08, 20mph gusts, J)09/26/08, 47 mph gusts, K)10/18/08, 32 mph gusts, L)10/27/08, 40 mph gusts. Winds were primarily in the South-South West direction.

Discussion

- •The higher turbidity on the stormy day suggests that Lake Tecumseh is a source of sedimentation and high turbidity levels, especially because the highest value was at the junction of Asheville Bridge Creek and Lake Tecumseh. The hydrograph data (Fig. 6) provides evidence that water levels in Lake Tecumseh correlate with wind speed. Days with low water levels at the lake exhibited higher wind speeds in the southern direction (http://www.weatherunderground.com). This provides evidence that significant amounts of turbid water is blown out of the lake and into Back Bay several times in the course of a year.
- Reed (2006) reported that weirs decreased sediment flow out of a turbid water source.
- Will Smith proposes to place two weirs, one in front of the entrance to Asheville Bridge Creek. These should minimize lake inflow and outflow, reducing sediment leaving the lake (Reed 2006).
- Weirs would establish a minimum water level of 1.8 feet in the lake, and prevent sediment laden waters from leaving the lake. This could prevent future fish kills because less variable water levels would allow for more stable water conditions such as temperature, salinity, dissolved oxygen, etc.
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Acknowledgements & Sources
CNU Biology, Chemistry and Environmental Science Department; Willard Smith from the U.S. Fish and Wildlife Service, Dr. Robert Atkinson, Jackie Roquemore

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