

White Lake—Understanding a Complex System

Workshop #1, July 9, 2019

Effective Lake and Watershed Management is based on understanding how lakes work, and how they change, particularly with respect to the changes that result from human activities

Understanding comes from monitoring and assessments—Data! Information/data can help identify management targets and goals

An Example of a Watershed Management Plan

Developed With a Collaborative Planning Process

Partners and Stakeholders Develop Goals and Objectives

A Plan Also Defines Partner Responsibilities and Funding Needs



LAKE MATTAMUSKEET WATERSHED RESTORATION PLAN

An anchor to the past, a path to the future

OCTOBER 20, 2016

FORWARDED BY NORTH CAROLINA PARKS SERVICE

THE STATE OF NORTH CAROLINA • 2016 • 100% RECYCLED PAPER • 50% POST CONSUMER WASTE

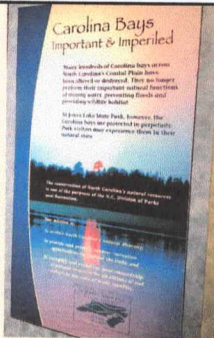
White Lake is a Carolina Bay Lake

Unique, Naturally Formed Elliptical Shape, Defined by Sand Ridge

Connection to Surrounding Wetlands—less with White Lake than other Bay Lakes

Shallow—Maximum Depth 8.5 to 9.5 feet

All of the Bay Lakes are Owned by the State of NC



White Lake

1,068 acres

4.8 miles of shoreline

Average depth 6-7 feet



Singletary Lake

572 acres

3.9 miles of shoreline

Average depth 6-7 feet



Jones Lake

225 acres

2.2 miles of shoreline

Maximum depth 7.5-8.5 feet



Lake Waccamaw

9,000 acres
14.2 miles of shoreline
Average depth 7-7.5 feet

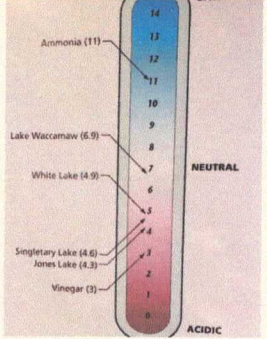


Most Bay Lakes Have Acidic Water (except Waccamaw)

pH is a measure of acid or base level

The pH scale is logarithmic, so a one-unit change is a 10-fold difference

Aquatic life (fish, plants, algae) generally more abundant in neutral water lakes

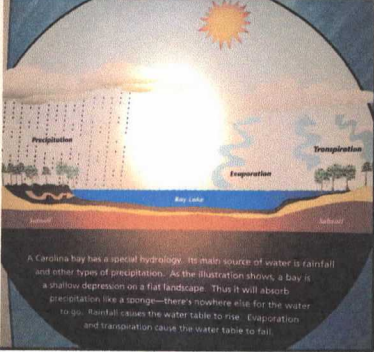


Bay Lake Hydrology

Main source of water is rainfall on lake surface

Rainfall also causes the groundwater table to rise

Evaporation and transpiration cause a significant loss of lake water and groundwater

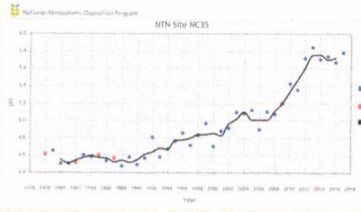


A Carolina bay has a special hydrology. Its main source of water is rainfall and other types of precipitation. As the illustration shows, a bay is a shallow depression on a flat landscape. Thus it will absorb precipitation like a sponge—there's nowhere else for the water to go. Rainfall causes the water table to rise. Evaporation and transpiration cause the water table to fall.

Over 90% of Source Water to White Lake is Rainfall

Rainfall pH in this area was very acidic—in the mid-4s—similar to groundwater

In the past 15 years there has been an increase of 1 full unit in pH (a 10-fold change)



Data from the National Atmospheric Deposition Laboratory in Chatham, NC

Photosynthesis—what plants and algae do—can cause substantial increases in pH levels

In recent years, increases in pH over the growing season of 2 units—a 100-fold difference—at White Lake

Higher pH levels open the door for bad actors such as harmful algae and the aquatic weed Hydrilla

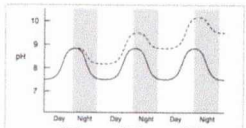


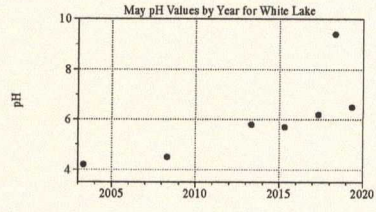
Figure 1. Idealized depiction of pH cycling during a 3-day period in two ponds. In both ponds, pH rises during the day as carbon dioxide is removed through photosynthesis and falls at night (when carbon dioxide is added to the water through respiration). The solid line represents pH changes in a pond where cyanobacteria bloom up to 100% during the day. The dashed line represents pH changes in a pond where cyanobacteria bloom to 50% during the day. The shaded area represents pH changes in a pond where cyanobacteria bloom to 25% during the day. The shaded area represents pH changes in a pond where cyanobacteria bloom to 10% during the day.

Bad Actor Algae—Cyanobacteria—Ruled the Neighborhood in the Spring of 2018

The alum treatment removed the cyanobacteria, and other more typical algae moved back in

The treatment also reduced nutrient levels

With less photosynthesis, pH levels declined



Ongoing Monitoring of White Lake

Critical to good management
Better able to identify trends, particularly with nutrients, algae, pH

This is a unique system and still not well-understood

Town of White Lake is supporting this work

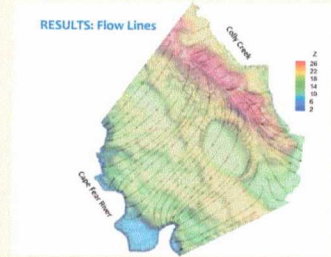
Aquatic vegetation surveys also being conducted to monitor Hydrilla

Groundwater Studies by Zamora and Shank

This work was also funded by the Town and was completed in April 2019

No indications that deep groundwater from confined aquifer is entering lake—shallow groundwater only

Groundwater flows toward the lake on northern and eastern shoreline and away from the lake in the southwest

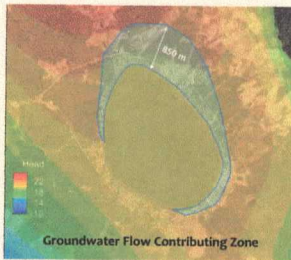


Groundwater Contributing Zone for White Lake

Eastern side of the lake has higher topography and head (pressure) so largest amount of flow comes from this region

On an annual basis, up to 6% of lake volume contributed by groundwater seepage

No indication that pumping from blueberry farms is having an impact

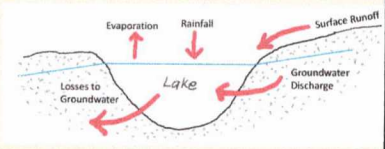


Water Loss from White Lake

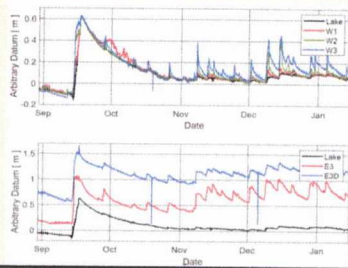
Evaporation and transpiration—highest in summer months

Flow into groundwater table on western side of lake

Flow from Turtle Cove = to what enters as stormwater? (not as significant by comparison with the other losses)



Groundwater Levels at Western Shore (top) and Eastern Shore (bottom) Compared to Lake Levels (Aug. '18 to Jan. '19)



Seasonal High Groundwater Table in December 2018

29.5 inches of rain in September (Hurricane Florence)

7.5 inches of rain in December

89 inches of rain for 2018



What About Nutrient Sources?

Nutrient Pollution

The Effects

The presence of excess nutrients in air and water can affect human health, the environment and the economy. Federal, state and local governments spend billions of dollars per year to mitigate these effects.

NOTICE

An algae bloom has made this area potentially unsafe for water contact. Avoid direct contact with visible surface scum.

Learn more about:

- Human health effects
- Environmental effects
- Economic effects

Nutrients Already in the Lake vs. Nutrients Entering the Lake

Nutrients in plants and animals, can be rapidly recycled with decomposition

Nutrients in the sediments—resuspension causes a “fertilization effect”

Estimate in-lake source as 2/3 of total—there is a lot of phosphorus in the sediments

Groundwater study found nutrient hotspots, due to wastewater leakage

Stormwater runoff—pipes and ditches directing water to the lake—assessing these sources now with grant project

Animal waste (including birds) and lawn fertilizers

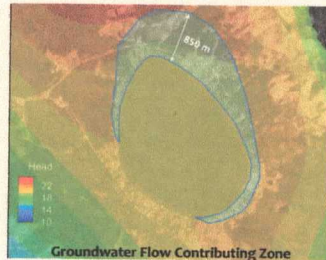
Atmospheric deposition of nitrogen, phosphorus (?)

Development in the Groundwatershed

Rainfall onto impervious surfaces—roads, parking lots, buildings—results in runoff rather than infiltration

Generally have water quality problems when impervious surface area is 10% or more of watershed

Groundwater also entering sewer lines, going to WWTP



How Do We Have a Healthy Lake for All?

Are there some uses of the lake that are in conflict?

How can visitors and residents practice good stewardship?



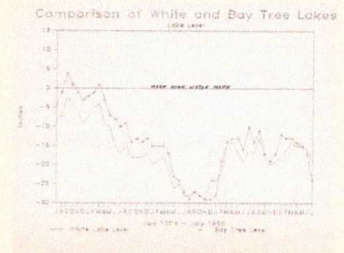
What are the Objectives for Managing White Lake?

- Meet Water Quality Standards
- Maintain Desirable Aesthetic Conditions
- Maintain Natural Ecological Functions
- Support Lake-Based Recreation and Tourism

Lake Level Fluctuations

Bay Lakes show very similar trends—when evaporation + transpiration exceeds rainfall (usually in summer), lake levels drop

Dr. Peter Zamora: “White Lake is a giant groundwater recharge zone—water in the lake eventually goes into the deeper aquifer or nearby surface waters (creeks)”



Bathymetric Map of White Lake

Depth varies with lake level
 Maximum depth 9.5 feet or less
 Nearshore areas very shallow
 Boating activity stirs up sediments and algae (discussion of this in 1990)
 Increase in size of boats—more of an impact



July is Lake Appreciation Month

Annual State of the Lake Report Card



White Lake 2019
State of the Lake Report Card

Water Clarity <small>Southlake still an issue</small>	A+
Algae and Aquatic Plants <small>Less of filamentous algae at the port Bivalve harvest and shellfish present</small>	B-
Nutrients <small>Low in water column, high in sediments and groundwater (nitrate)</small>	B
pH <small>Much lower than last year</small>	B+
Stewardship <small>Reactions of park visitors, who use of the lake</small>	

Score by Department

2018-2019 Improvements Due to Alum Treatment and High Rainfall in Fall—Flushing of Lake

Bay Lakes Tourism

80-mile driving tour to visit Carolina Bay Lakes, and ride on a Cape Fear ferry

Birdwatching ecotourism Singletary Lake nearby

