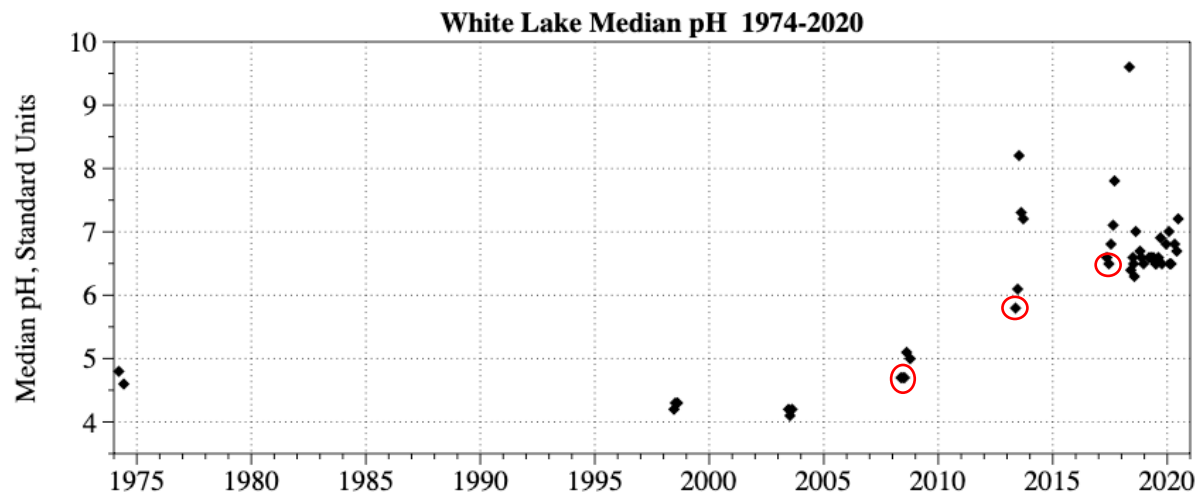
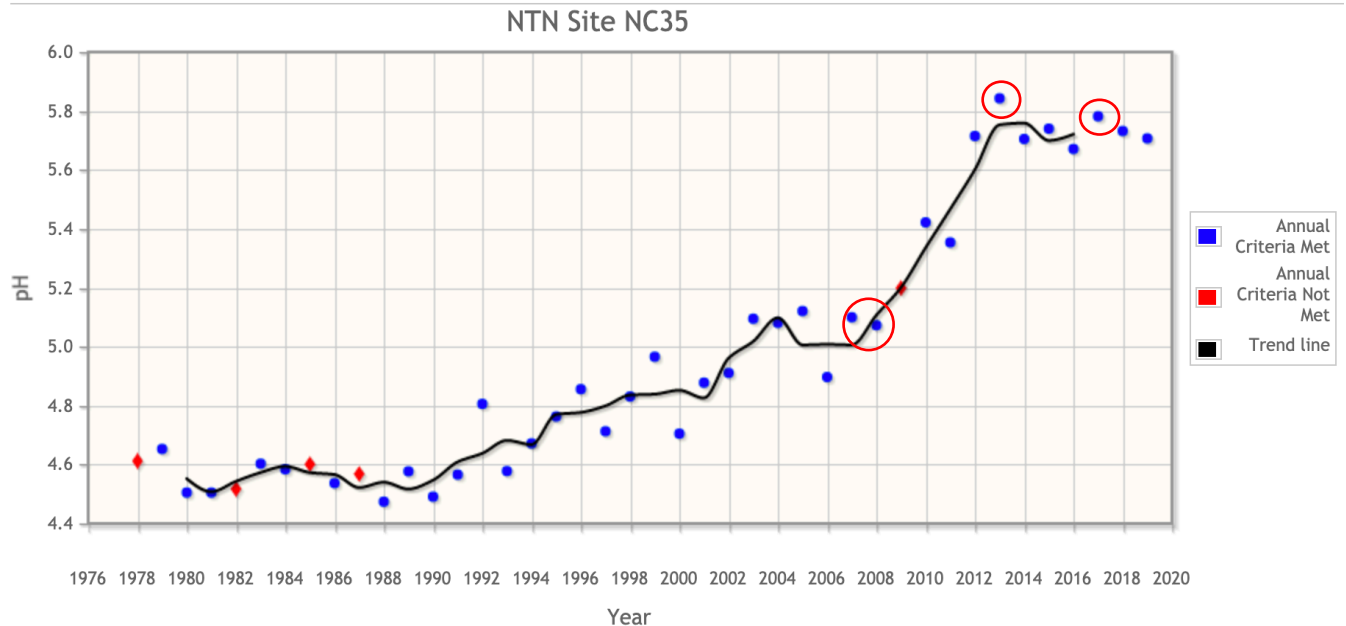


## White Lake pH Changes Associated With Rainfall pH Changes

White Lake pH levels have historically been below 5; a trend of increasing pH began prior to 2008, with a subsequent escalation of a full unit over the five-year time period 2008-2013. The graph below includes data from White Lake reports; water quality monitoring began in 1998 (June-August), and was continued every five years (May-September), while monthly monitoring has been maintained since 2018. The period of rapid change in lake pH (red circles) corresponds with a nearly one-unit increase in rainfall pH (data in the bottom graph shows the median annual rainfall pH measured at the National Atmospheric Deposition Program station in Clinton, NC [NTN Site NC35]). Prior to that change, rainfall at this location was categorized as acid rain, while it is presently categorized as normal (although still slightly acidic).

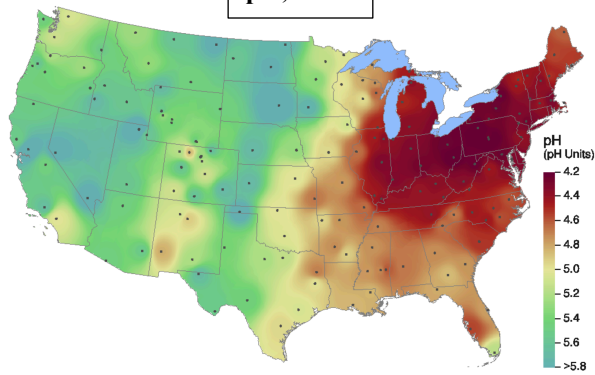


National Atmospheric Deposition Program



Visual documentation of changes in rainfall pH levels is also provided by the Clean Air Status and Trends Network (NADP is part of this) annual maps:

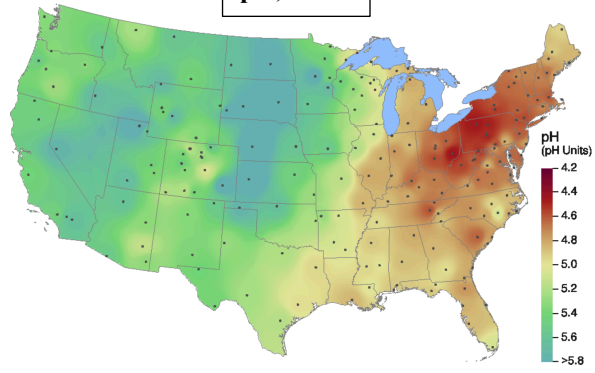
pH, 1989



Source: NADP

USEPA/CAMD 01/25/18  
Download map: map012518pH-0189

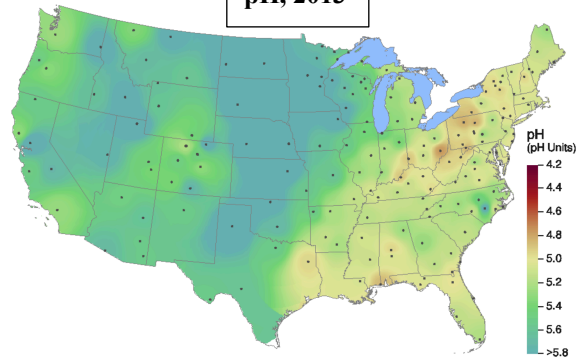
pH, 2008



Source: NADP

USEPA/CAMD 01/25/18  
Download map: map012518pH-0208

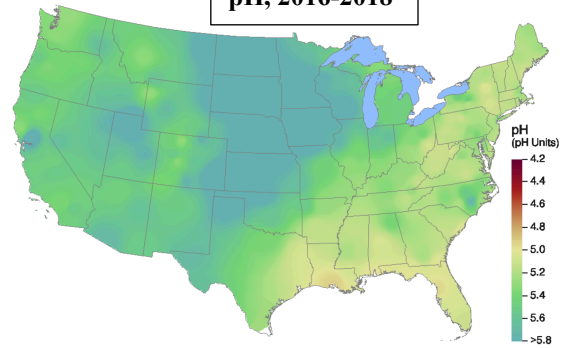
pH, 2013



Source: NADP

USEPA/CAMD 01/25/18  
Download map: map012518pH-0213

pH, 2016-2018



Source: NADP

USEPA/CAMD 10/18/19  
Download map: map101819pH-0216-2018

A July 2013 algal bloom (red oval in the table below) sent the lake pH above 8 for the first time, as algal photosynthesis and growth created a deficit of carbon dioxide (a product of respiration, which acts as an acid in water). The bloom followed high rainfall (including several large rainfall events) in the months of June and July, after an extended period of low rainfall.

**A Comparison of White Lake Water Quality Data for July, From 2003-2020**

	7/7/2003	7/15/2013	7/20/2017	7/12/2018	7/10/2019	7/16/2020
Mean Temperature (C)	29.1	28.6	30.4	29.2	29.0	31.0
Water Clarity, Measured as Secchi Depth (m)	2.9	1.25	1.5	1.75	1.5	1.0
Turbidity (NTU)	1.7	4.3	3.0		1.9	2.6
Mean Algae Abundance, Measured as Chlorophyll a Concentration (µg/L)	4	27.7	9.6	6	8.5	9.7
pH Range (std. units)	4.1	8.0-8.3	6.6-6.8	6.5-6.9	6.5-6.6	6.9-7.0
Dissolved Oxygen (mg/L)	7.6	8.0	7.0	7.3	7.2	7.6
Mean Total Nitrogen (mg/L)	0.11	0.41	0.61	0.70	0.62	0.64
Mean Total Phosphorus (mg/L)	0.02	0.02	0.02	0.02	0.018	0.024
Number of Samples	3	3	3	7	6	6

Rainfall data from Town of White Lake WWTP (B. Stafford, Town of White Lake, personal communication); regional averages from (<https://www.usclimatedata.com/climate/elizabethtown/north-carolina/united-states/usnc0205>). High rainfall in the summer of 2013 (grey oval), associated with the algae bloom in July.

**Monthly Rainfall (inches) for White Lake 2012-2020**

Month	2020	2019	2018	2017	2016	2015	2014	2013	2012	Monthly Average for Region
January	4.5	2.75	4.20	7.0	3.0	2.5	2.0	1.75	2.75	3.81
February	6.7	2.25	2.00	1.5	10.7	5.5	1.5	2.5	4.0	3.44
March	3.7	3.25	3.95	3.7	1.55	4.15	ND	1.0	7.0	3.91
April	5.1	7.25	6.75	6.75	6.75	4.55	ND	1.75	2.25	3.12
May	12.25	1.20	7.70	2.7	4.5	4.20	ND	2.25	9.25	3.67
June	7.15	5.25	10.00	4.5	3.65	8.70	3.0	17.0	2.0	4.70
July		6.00	4.75	6.75	3.75	3.0	4.65	11.25	8.6	5.75
August		5.35	6.25	5.6	4.12	9.4	9.75	8.25	9.75	5.95
September		5.00	29.45	5.2	15.0	4.7	7.0	1.0	5.0	5.29
October		3.60	2.25	2.95	14.25	9.75	1.7	1.75	2.25	3.38
November		4.90	4.25	1.0	0.50	7.25	4.15	0	2.25	3.16
December		6.00	7.5	5.45	5.1	6.5	3.7	5.75	4.25	3.14
Total		52.80	89.05	52.8	72.87	70.20		54.25	59.35	49.32

In 2017, a filamentous cyanobacterial bloom developed in September (mean chlorophyll  $a = 55.5 \mu\text{g/L}$ ; NCDEQ 2017), which persisted into 2018, so that pH levels increased rapidly from 7.5 in April to over 9 in early May (with a mean chlorophyll  $a = 52 \mu\text{g/L}$  on May 2; Envirochem/LIMNOSCIENCES 2018). Median pH levels since the low-dose alum treatment (in early May 2018) have been much less variable over the summer season.

### Data Sources:

Envirochem/LIMNOSCIENCES. 2018. White Lake, NC 2018 Monitoring Program Report to the Town of White Lake.

LIMNOSCIENCES. 2019. White Lake, NC 2019 Monitoring Program Report to the Town of White Lake. Available at [www.whitelakewatch.com](http://www.whitelakewatch.com)

National Atmospheric Deposition Program. <http://nadp.slh.wisc.edu/data/ntn/plots/ntntrends.html?siteID=NC35>  
Data accessed August 1, 2020

North Carolina Department of Environment and Natural Resources. 2004. Basinwide Assessment Report--Cape Fear River Basin. Division of Water Quality, Intensive Survey Branch.

North Carolina Department of Environment and Natural Resources. 2014. Lake and Reservoir Assessments, Cape Fear River Basin. Water Sciences Section, Intensive Survey Branch.

North Carolina Division of Environmental Quality. 2018. 2017 White Lake Water Quality Investigation. White Lake, Bladen County (Cape Fear Basin). Division of Water Resources Water Sciences Section.

US Environmental Protection Agency Clean Air Status and Trends Network (CASTNET). <http://epa.gov/castnet>  
Annual maps for pH accessed August 9, 2020

Weiss, C.M., and E.J. Kuenzler. 1976. The trophic state of North Carolina lakes. Water Resources Research Institute of the University of North Carolina Report Number 119.