USGS continuous water-quality monitoring at Lake Mattamuskeet National Wildlife Refuge

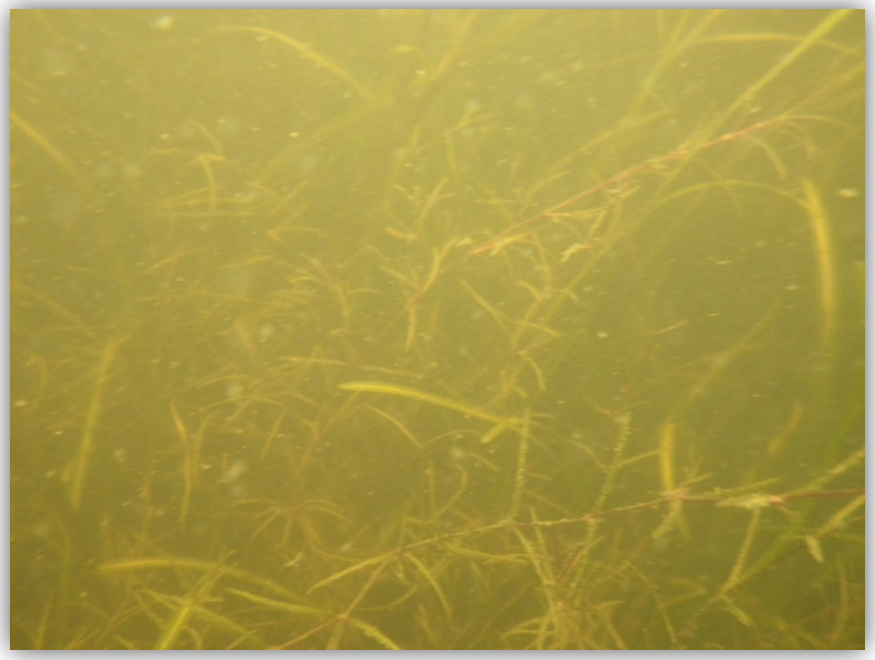
Michelle Moorman

USGS NC Water Science Center

USGS
science for a changing world

The aquatic vegetation communities of the east and west sides of Lake Mattamuskeet are different.

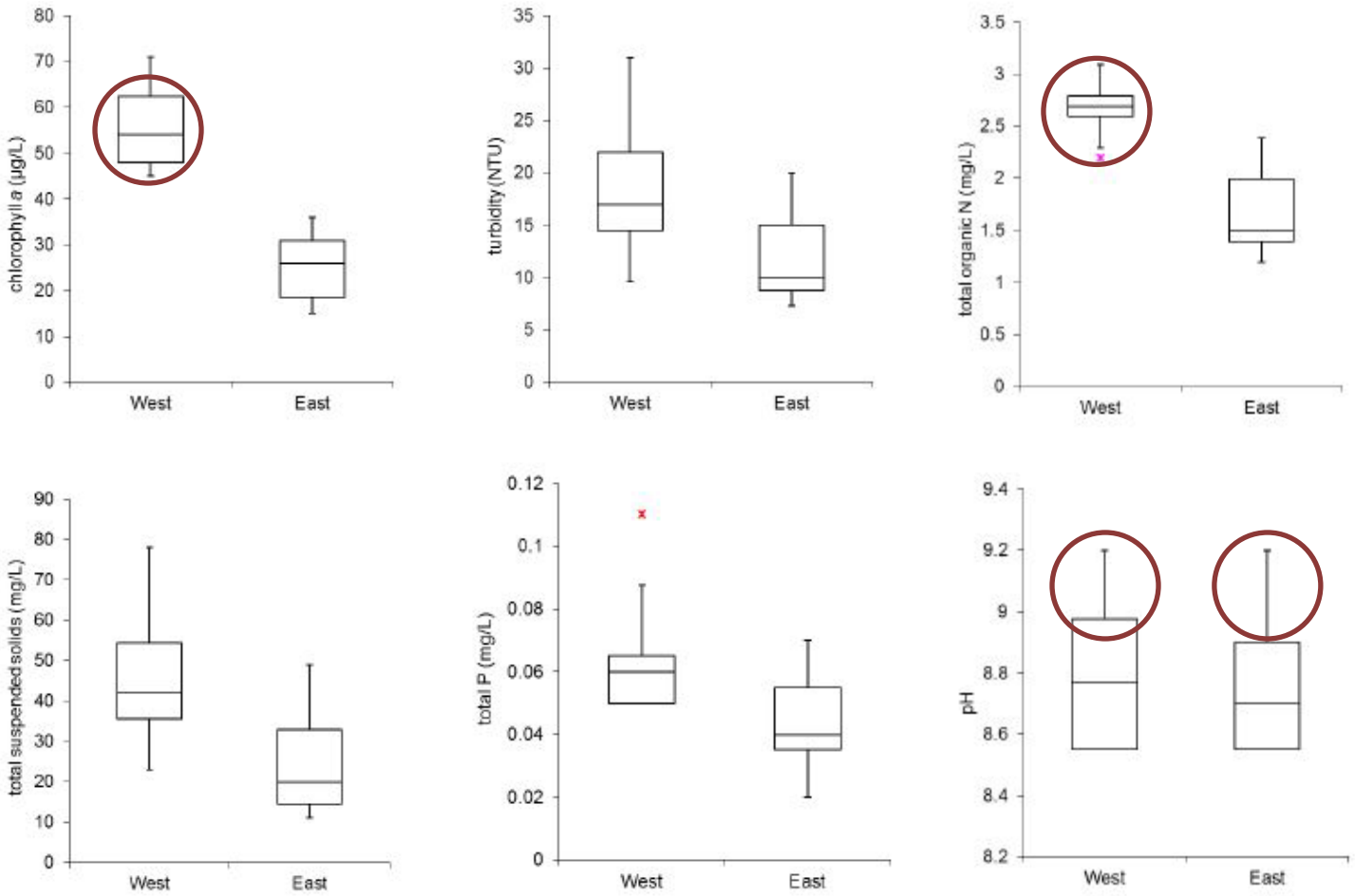
West Side – Hyper-eutrophic, Dominated by algae



East Side – Eutrophic, Dominated by submerged aquatic vegetation

Photos from Summer, 2012

Summary Data from DWQ 2012 Lakes Assessment



Conceptual movement of hydrology in Lake Mattamuskeet (developed by Mike Piehler, UNC IMS)

Mattamuskeet W
Mattamuskeet E
Frying Pan Landing
45
94
264
Image © 2013 TerraMetrics
© 2013 Google
Image © 2013 DigitalGlobe
Google ea
Imagery Date: 4/2/2012 35°28'15.00" N 76°11'02.53" W elev 0 ft eye alt 40.5

USGS's role in water-quality monitoring at Lake Mattamuskeet

- Continuously monitor water quality every 15 minutes
  - Installed September 2012
  - Continuous Temp, pH, Specific Conductivity and Salinity, Dissolved Oxygen, and Turbidity
- Help develop and implement routine monitoring of:
  - Basic measurements of lake health (nutrients, water clarity, salinity, conductivity, dissolved oxygen, chlorophyll *a*)

Access data at: http://waterdata.usgs.gov/nc/nwis

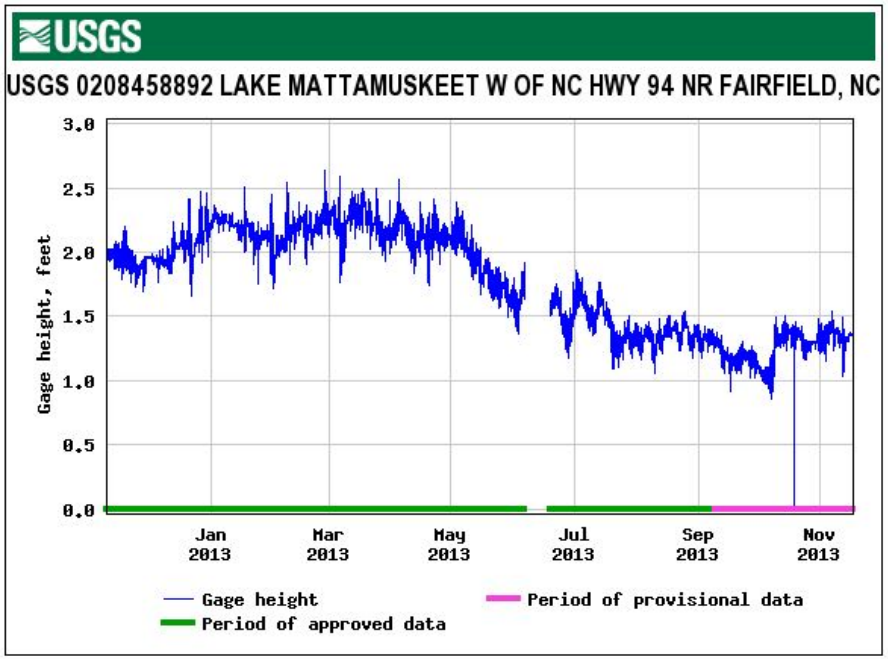
http://waterdata.usgs.gov/nc/nwis/current/?type=quality

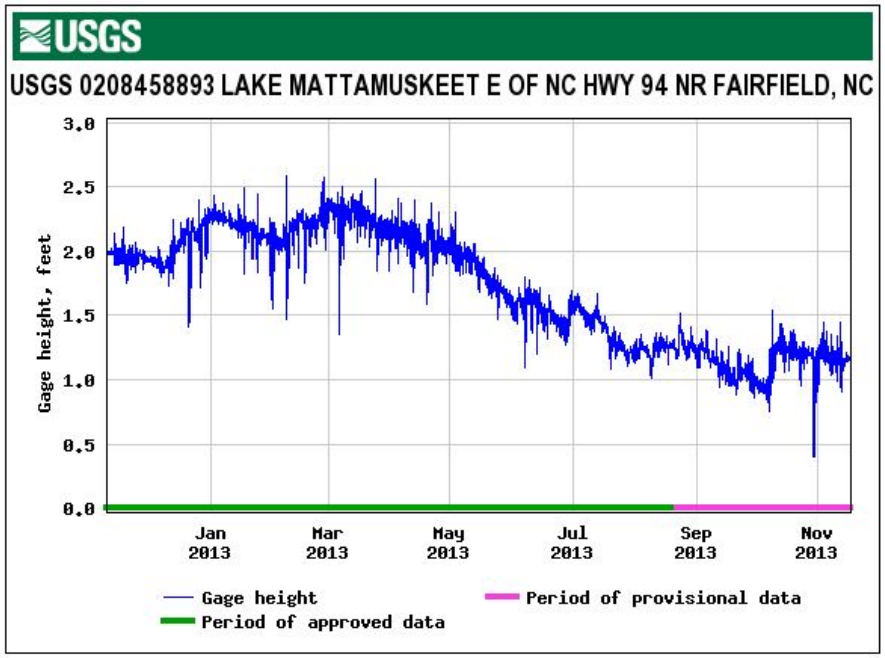
USGS Current Conditi

0208062765	ROANOKE RIVER AT HALIFAX, NC	11/17 19:15 EST	7.4	126	13.9	9.7
02081022	ROANOKE RIVER NEAR OAK CITY, NC	11/17 18:45 EST	7.5	136	13.4	9.7
02081094	ROANOKE RIVER AT JAMESVILLE, NC	11/17 19:00 EST	7.2	142	12.0	9.5
0208114150	ROANOKE RIVER AT NC 45 NR WESTOVER, NC					
	BOTTOM	11/17 19:30 EST	7.3	166	13.5	Eqp
	TOP	11/17 19:30 EST	7.3	160	13.7	9.1
• 03020105 Pamlico Sound						
0208458892	LAKE MATTAMUSKEET W OF NC HWY 94 NR FAIRFIELD, NC	11/17 19:15 EST	8.9	2,820	13.7	Eqp
0208458893	LAKE MATTAMUSKEET E OF NC HWY 94 NR FAIRFIELD, NC	11/17 19:15 EST	8.3	2,760	14.0	10.9
• 03020201 Upper Neuse						
02087182	FALLS LAKE ABOVE DAM NR FALLS, NC	11/17 19:00 EST	--	--	15.3	--
• 03030003 Deep						
02101726	ROCKY R AT US 64 NEAR SILER CITY, NC	11/17 19:30 EST	7.0	105	10.2	8.1
• 03040101 Upper Yadkin						
02111000	YADKIN RIVER AT PATTERSON, NC	11/17 17:45 EST	--	--	11.0	--

Gage Height

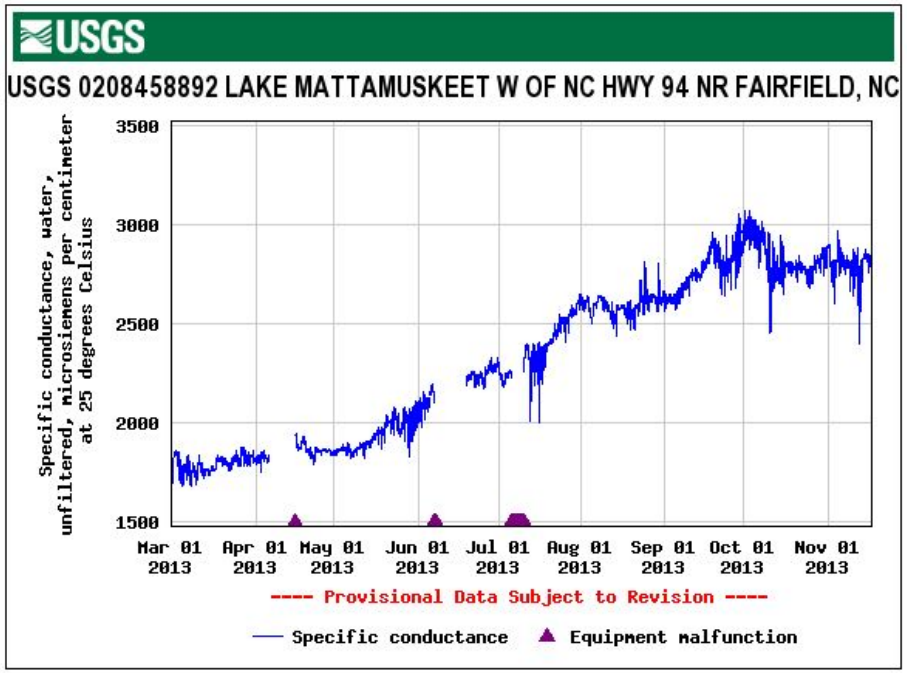
Gage height measures the lake level. It is common that water levels decrease during NC summers due to terrestrial plant growth and evaporation.

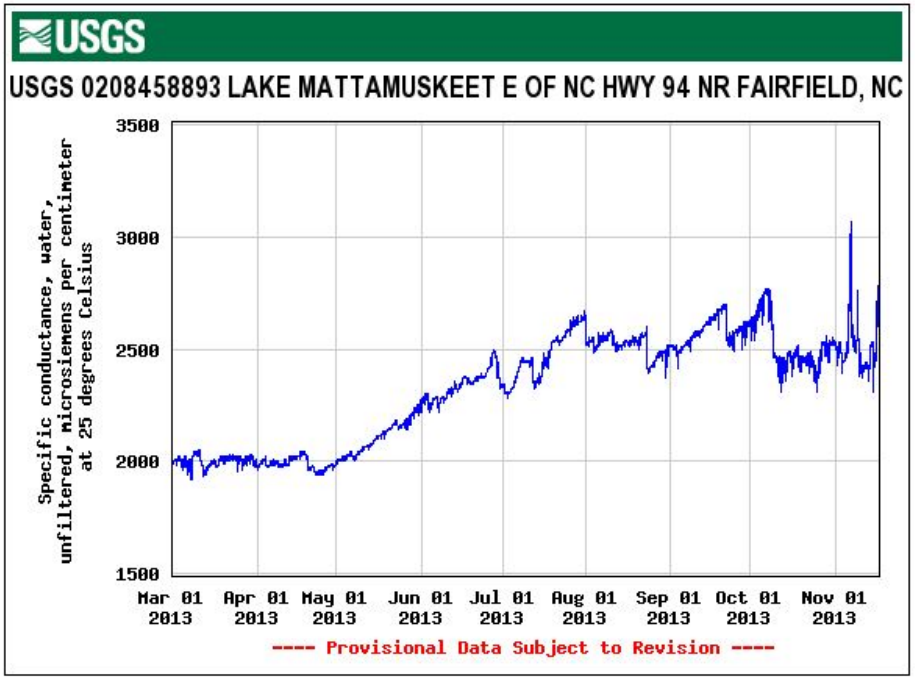




Specific Conductance

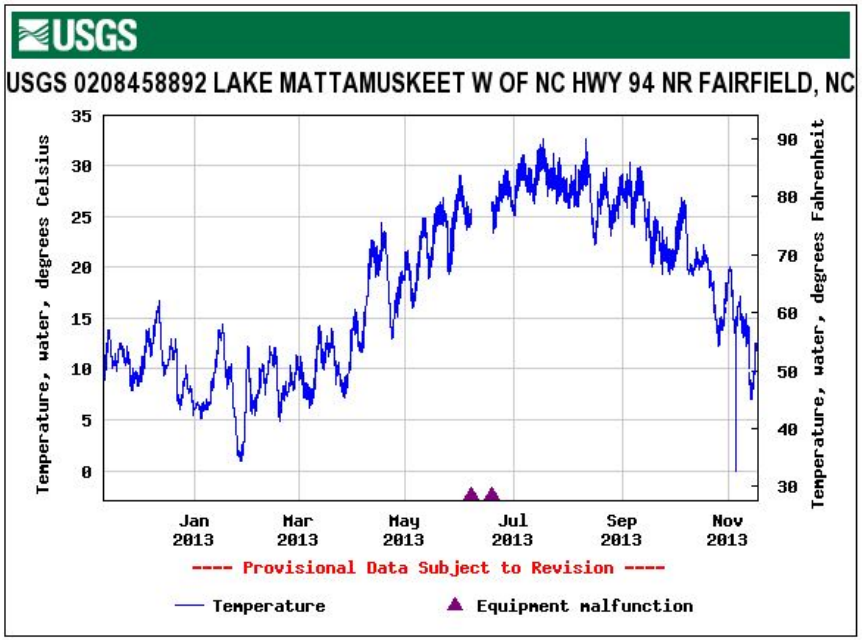
Specific Conductance is an indicator of the total dissolved solids in water. Salinity can be calculated from Specific Conductance and Temperature. Salinity values in the lake range between 0.8 and 2.2 ppt.

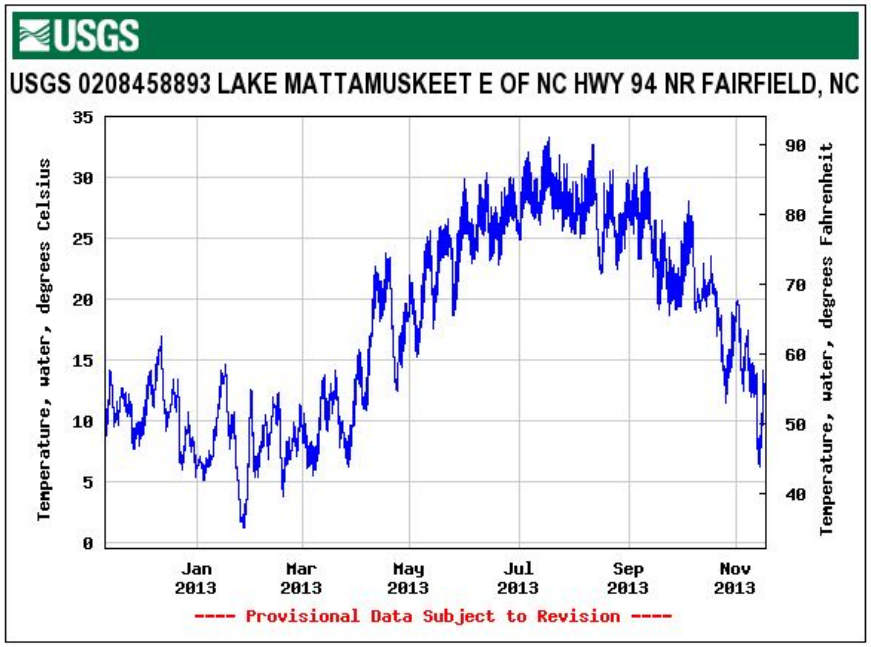




Temperature

Temperature is driven by daily, seasonal and climatic events.





Dissolved Oxygen

Low dissolved oxygen events known as hypoxia can have a negative impact on fisheries, the state standard for DO impairment is <4.0 mg/L

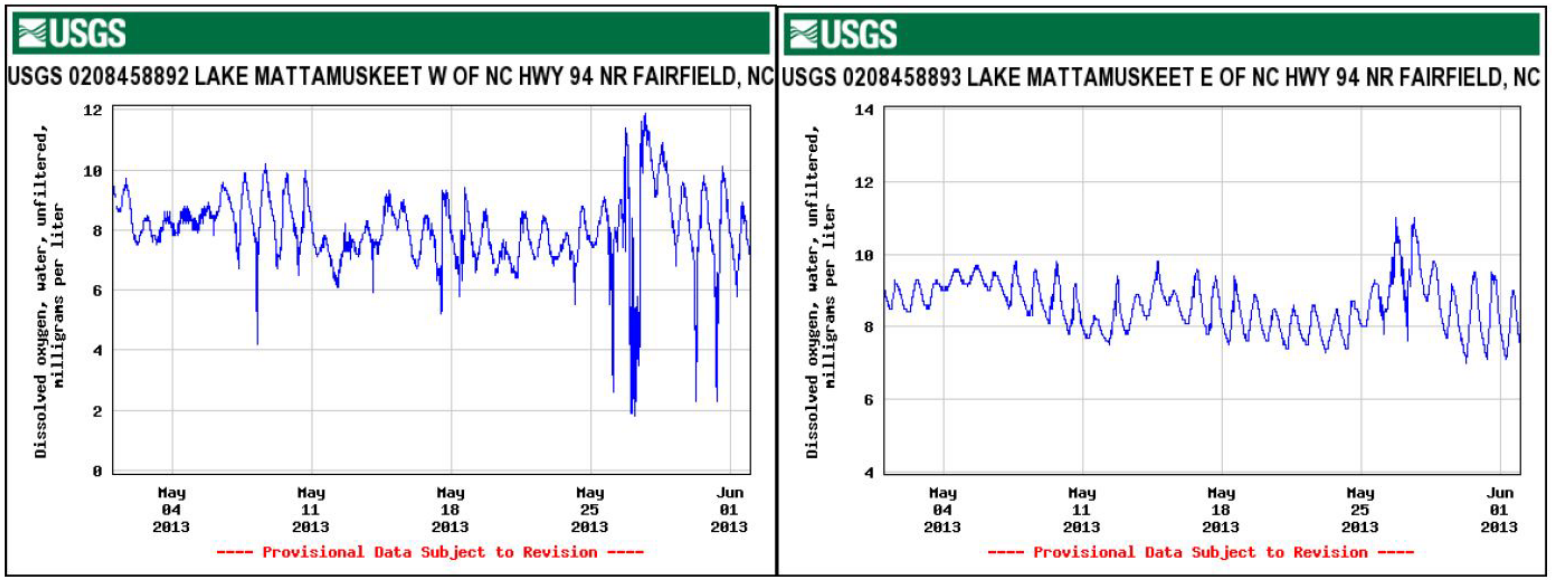


Figure 1. Provisional data from the monitoring stations documented dissolved oxygen concerns on the west side of the lake and a difference in the quality of water on either side of NC Highway 94.

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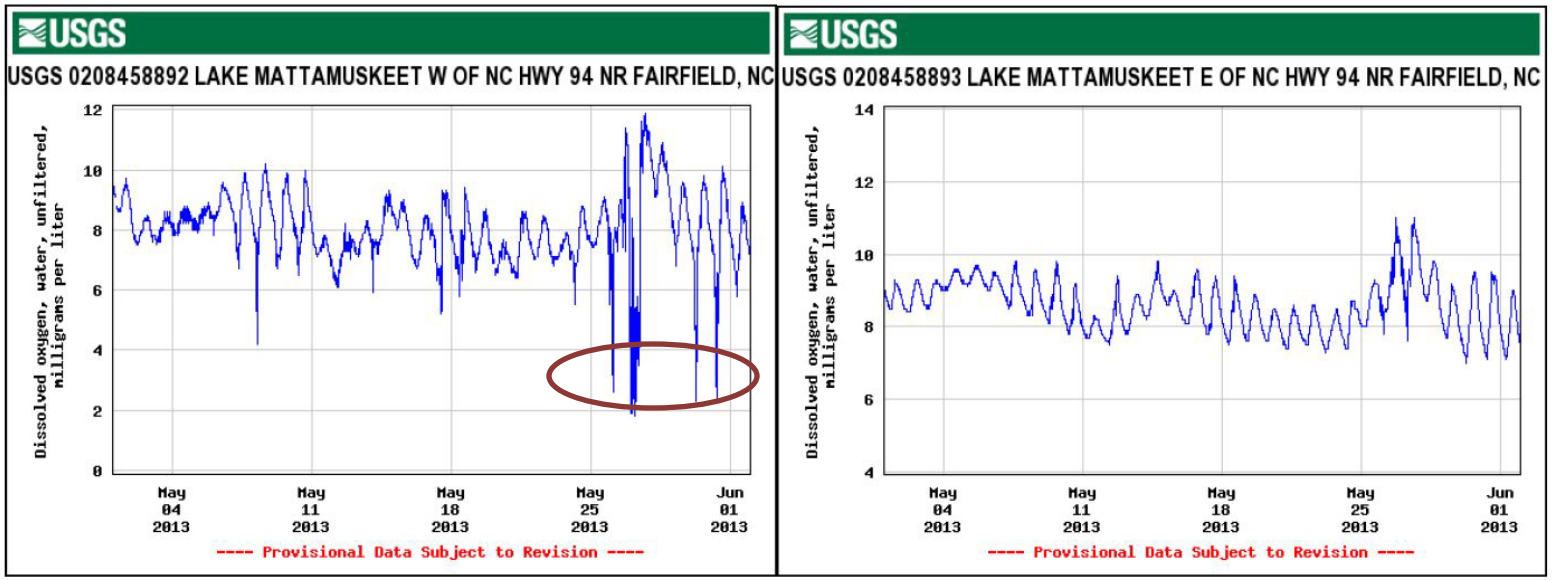

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pH

pH (parts Hydrogen) is a measure of how acidic or basic a sample of water is. High pH is caused by excessive plant photosynthesis.

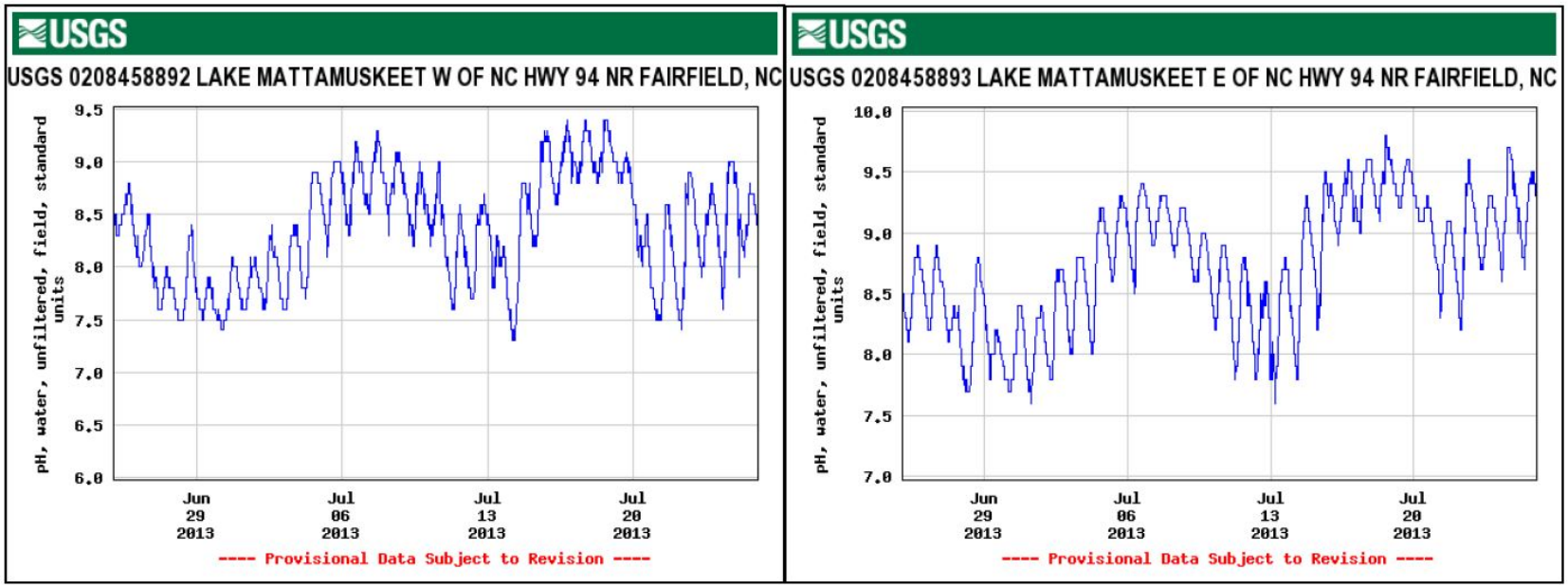

Figure 2. Provisional data from the monitoring stations documented pH values outside the 6.0 - 9.0 standard units range of North Carolina water quality standards on both sides of the lake this summer.

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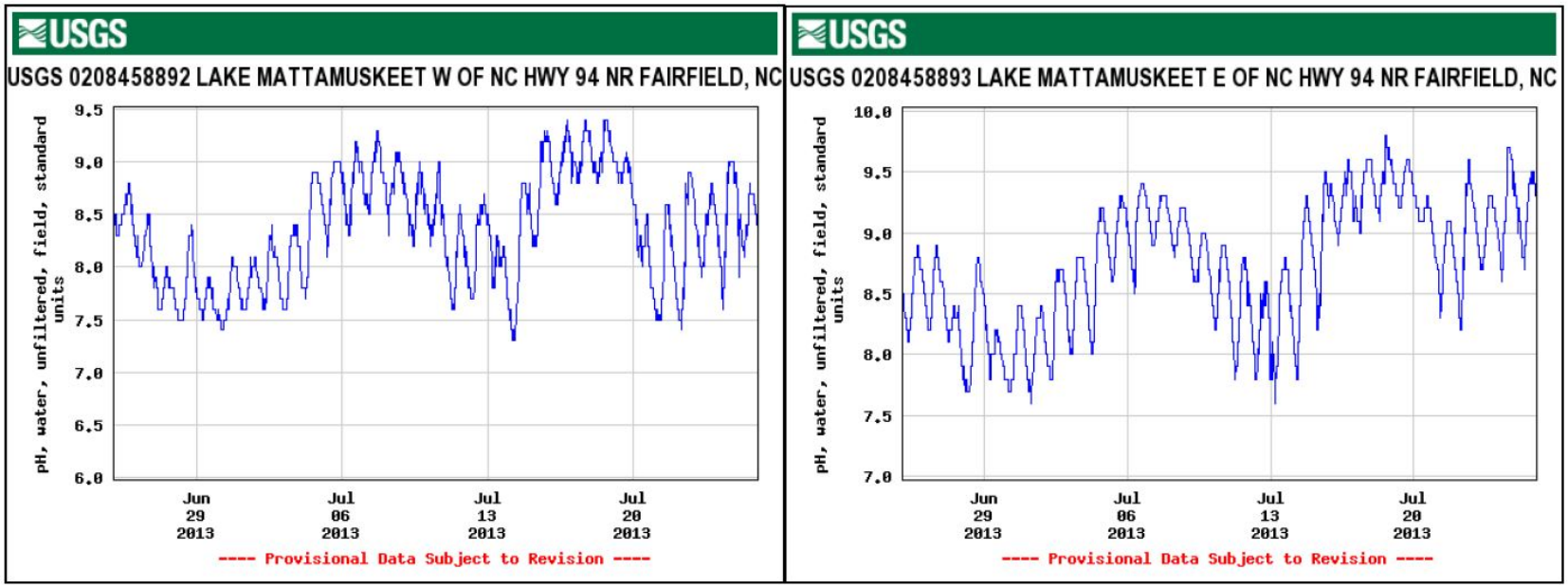

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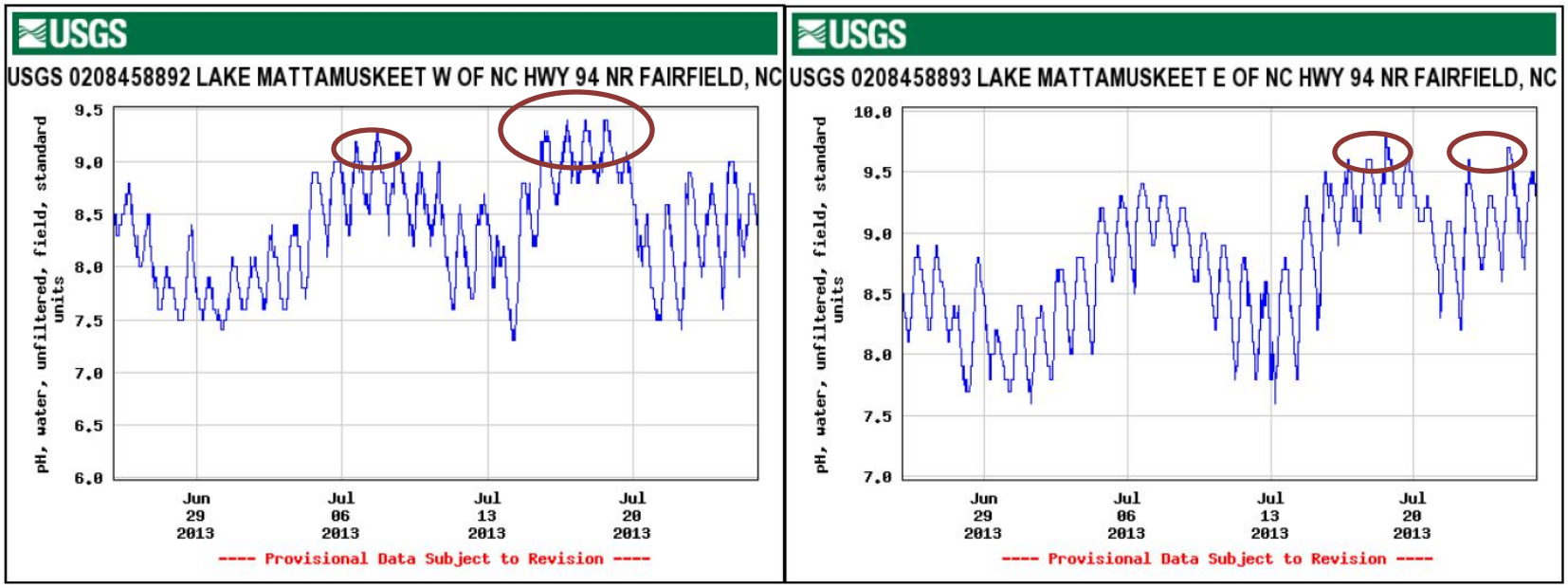

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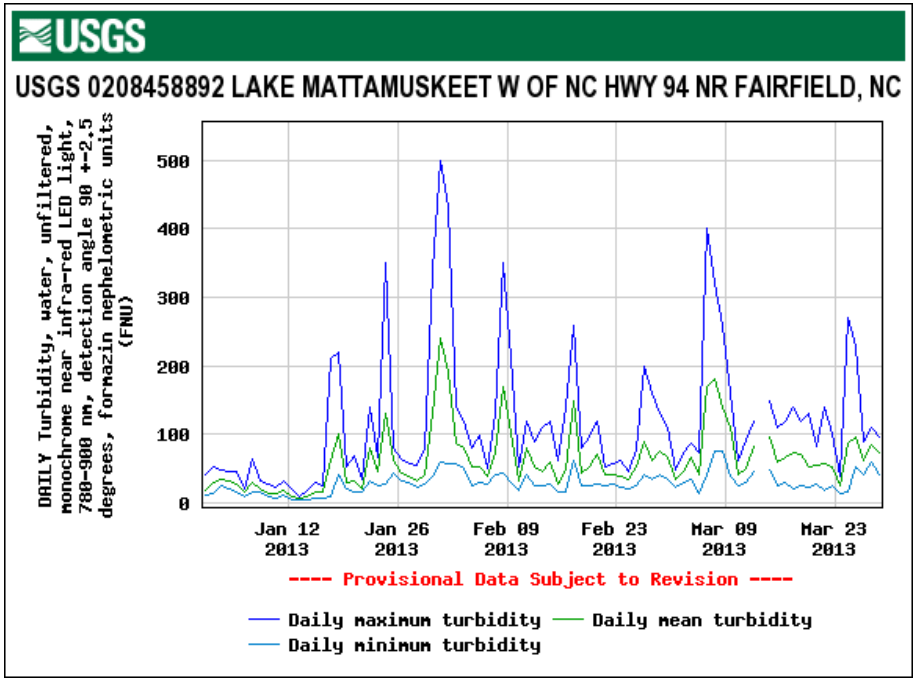
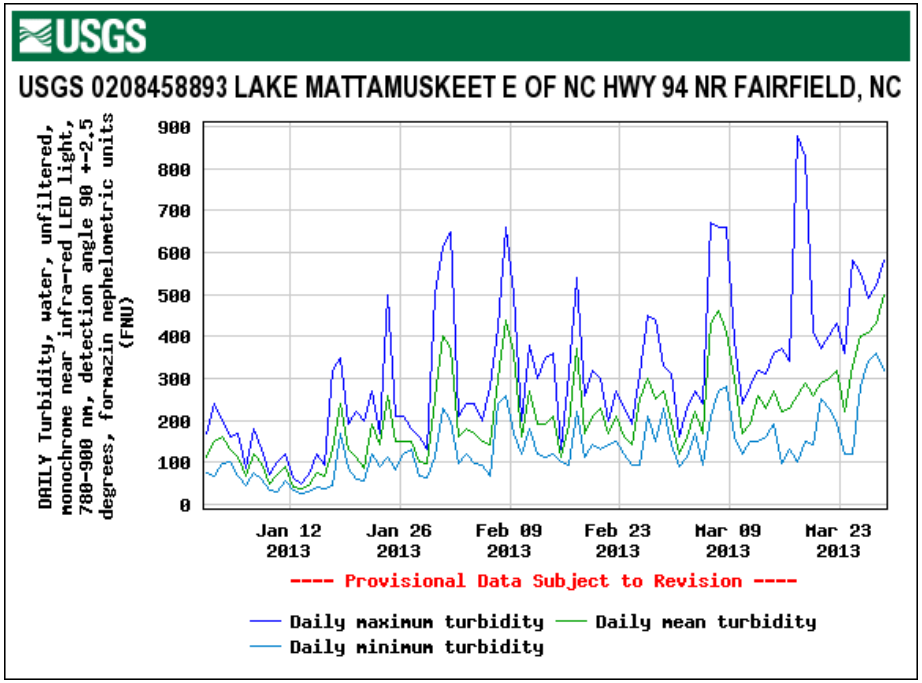
Turbidity

Turbidity is a measure of water clarity. High turbidity can be caused by algal blooms or sedimentations.

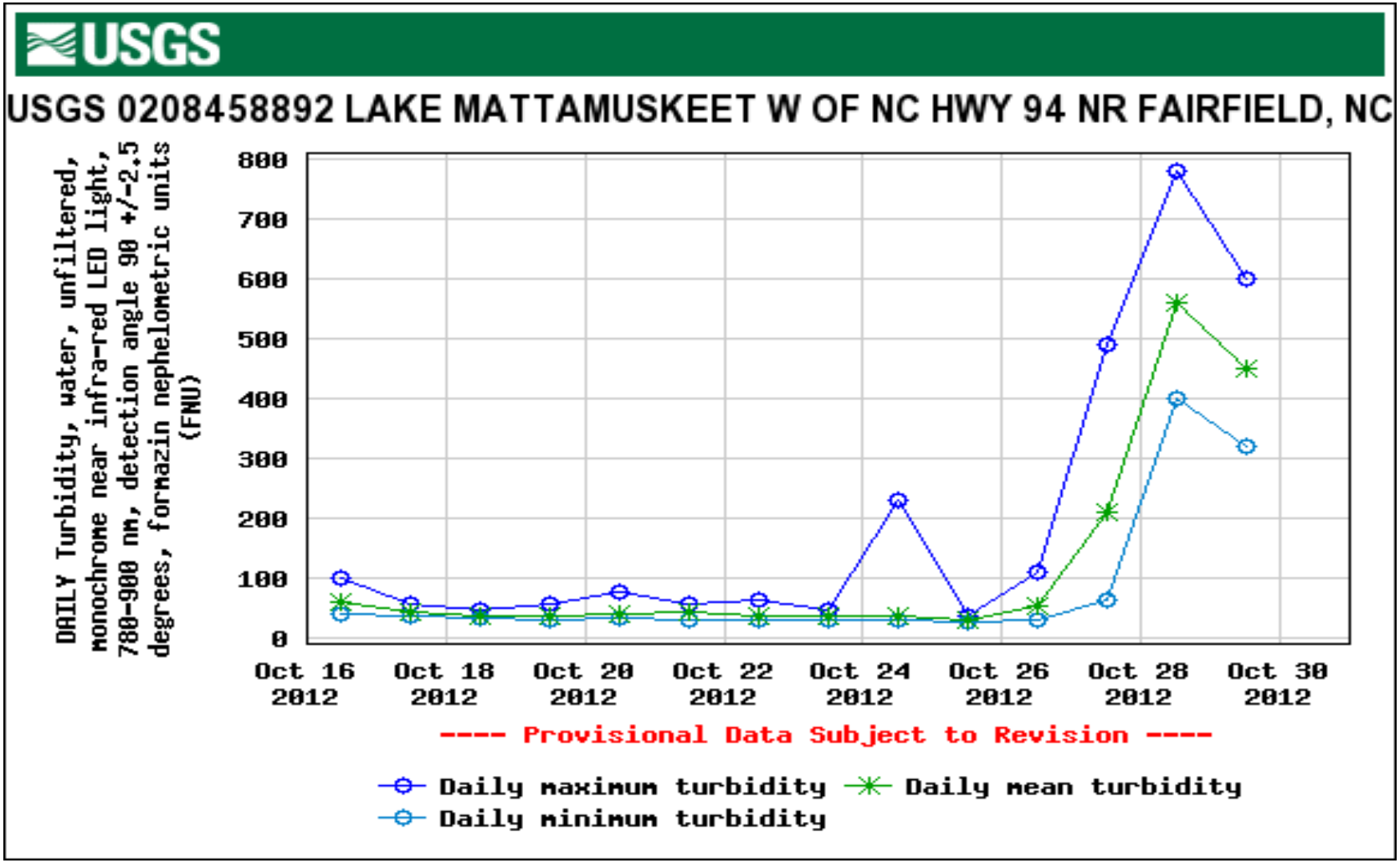
Turbidity often increases during the winter at Lake Mattamuskeet and was higher on the east. The state standard is 50 NTUs.



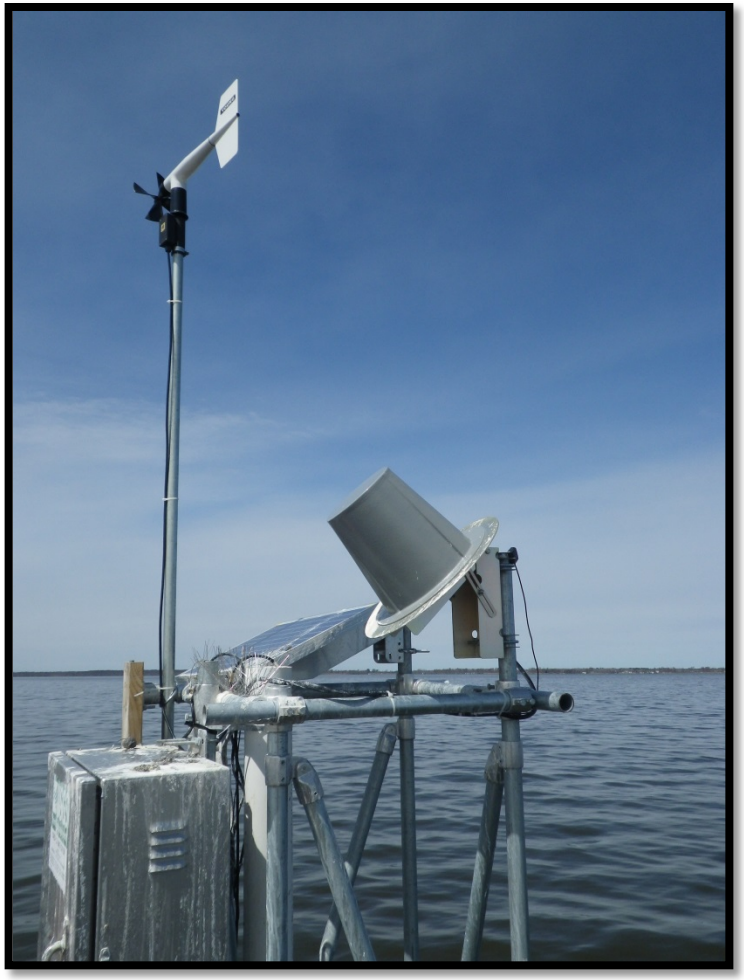


Hurricanes and storms increase wind and run-off:

High turbidity measurements occurred during Hurricane Sandy

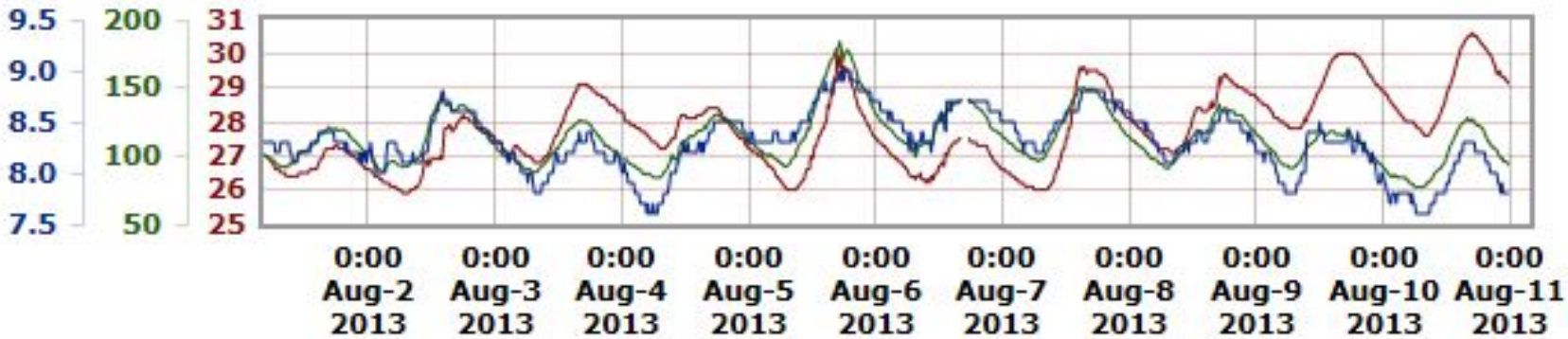


Wind speed and direction were added to platform in March 2013 to help with data interpretation

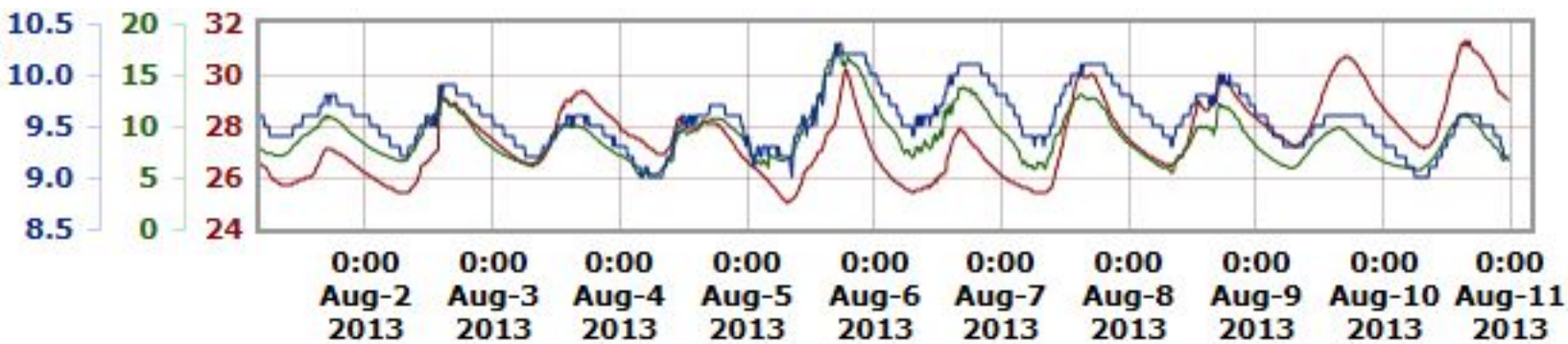


Summer Water Quality Data

Mattamuskeet West Data



Mattamuskeet East Data



Explanation

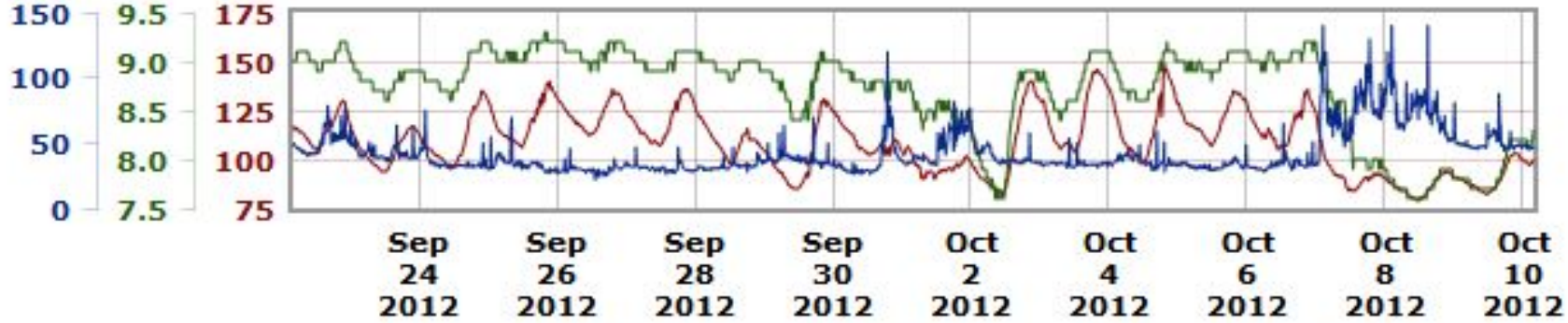
26.6 Temperature

6.3 Dissolved oxygen

9.3 Ph

Water quality changes from summer to winter

Mattamuskeet West Data



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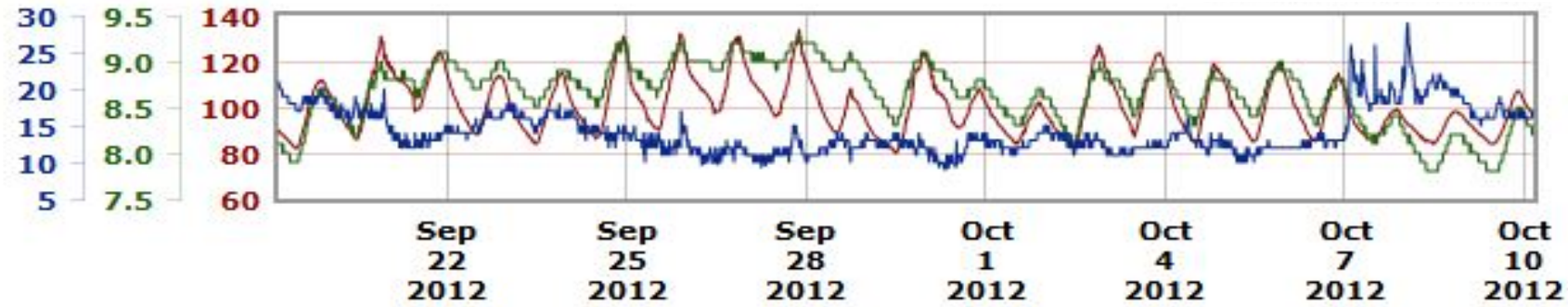


Dissolved oxygen, water, unfiltered, percent of saturation

pH, water, unfiltered, field, standard units

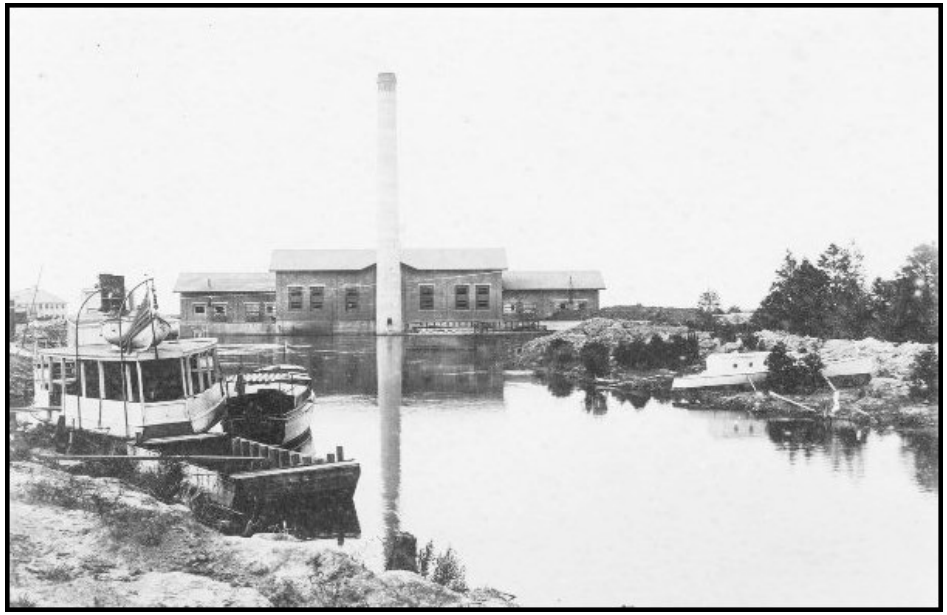
Turbidity, water, unfiltered, monochrome near infra-red LED light, 780-900 nm, detection angle 90 +-2.5 degrees, formazin nephelometric units (FNU)

USGS is a partner in cooperative water-quality sampling on a bi-monthly basis

Physical Data	Chemical Data	Biological Data
Dissolved Oxygen (mg/L)	NH3 as N (mg/L)	Chlorophyll *a* (ug/L)
Water Temperature (C°)	TKN as N (mg/L)	Phytoplankton
pH (s.u.)	NO2 plus NO3 as N (mg/L)	
Conductivity (umhos/cm)	TON as N (mg/L)	
Secchi depth (m)	TN as N (mg/L)	
Salinity (ppt)	TIN as N (mg/L)	
	TP as P (mg/L)	
	Total Solids (mg/L)	
	Suspended Solids (mg/L)	
	Turbidity (NTU)	

If saltwater intrusion is a concern, what are the potential sources of salt water?

- Flow from the canal to the lakes due to:
  - Wind events blowing water from the sound to the lake
  - Flow from the sound to the lake because the water level in the lake is lower than water level in the sound
- Groundwater intrusion



If eutrophication is a concern, what are the potential sources of nutrients?

- Elevated nutrients, particularly phosphorous in the lake sediment
- Atmospheric deposition
- Run-off from agriculture and waterfowl impoundments
- Groundwater inputs from agriculture
- Nutrients being retained due to poor drainage of the lake

USGS recommendations for future science

1. Quantify water movement in the outfall canals
2. Develop a water budget for the lake that quantifies:
   - Lake water inputs from precipitation, groundwater, and drainage and outfall canals
   - Lake water loss from evapotranspiration, outfall canals, and groundwater
   - Develop a salinity budget for the lake
3. Quantify the sources of excess nutrients in the Lake and determine if they can be managed
4. Develop a management plan for Lake Mattamuskeet restoration based on the best available science

Project Benefits

- Provides Lake water-quality data in real-time.
- USGS staff collect water-quality samples monthly when they service instruments.
- Provides real-time information to target collection of other important water-quality data such as Chlorophyll *a* and nutrients.
- Ensures data quality and long-term, on-line, data access in USGS databases that are publically available.

Questions?