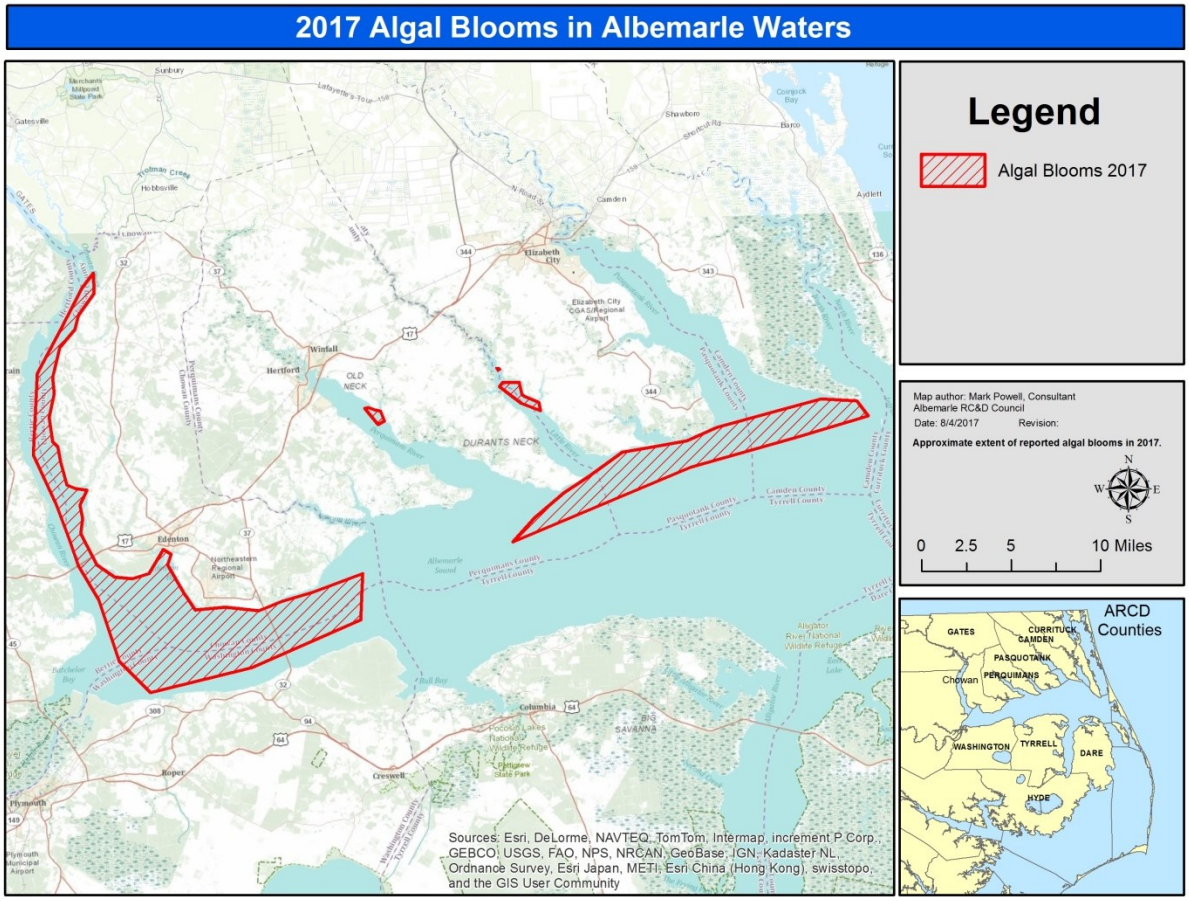
Algal Blooms in the Albemarle – What We Know and Do Not Know

After an absence of 35 years, algal blooms have returned to the waters of the Albemarle, with blooms in the Chowan River, Little River, and Albemarle Sound in 2015, 2016 and 2017, and the Perquimans River in 2017 (Figure 1). Algal blooms are fed by warm temperatures, sunlight and too much nutrients in the water, mainly nitrogen (N) and phosphorus (P) carried by stormwater runoff.

Figure 1. Approximate extent of algal blooms in 2017.



Stormwater in our region flows through drainage canals, creeks and rivers to the Albemarle and Pamlico Sounds. Stormwater can be exposed to nutrients and pesticides from agricultural fields and lawns, oil and grease from roads, parking lots, and other pollutants from septic tank systems, solid waste storage and processing sites, and commercial properties.

Widespread and persistent algal blooms negatively impact recreational boating, fishing and nature tourism, which are important drivers for regional economic growth. Annual, widespread and persistent algal blooms also may lower waterfront property values. Lake Champlain in Vermont is a current, well-documented example.

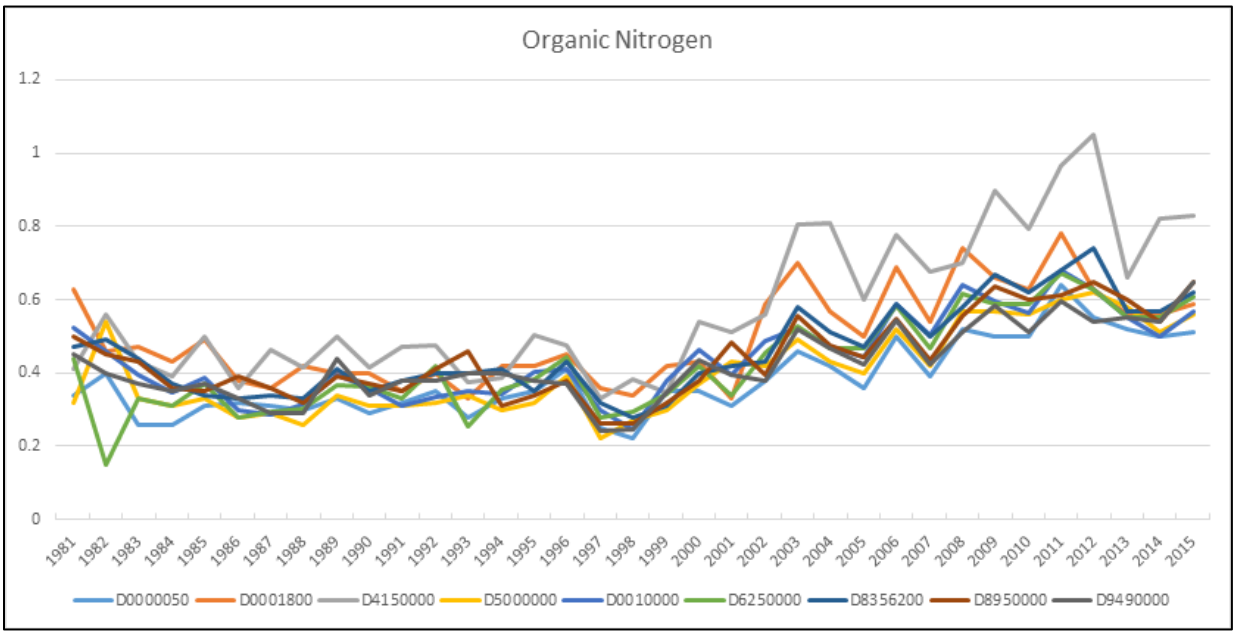
Each resident can help reduce pollutants carried in stormwater. The Albemarle RC&D web page on algal blooms has basic information on algal blooms including health and economic effects, and steps that residents may take to reduce pollutants and help prevent algal blooms in our shared waters.

To understand why the blooms have returned, NCDEQ Water Resources is analyzing water quality data from monitoring stations on the Chowan River, Little River and Albemarle Sound[1]. The preliminary analysis of data is helping us better understand what is changing in Albemarle waters, and how the changes may be contributing to algal blooms.

From about 2000 to 2015, the Chowan River had a steady increase in organic N from the Virginia border to the western Albemarle Sound (Figure 2). The largest increase in organic N was recorded at monitoring station D41500000 on Potecasi Creek in Hertford County (Figures 3 and 4). The next largest increase in organic N was recorded at monitoring station D0001800 on the Chowan River at the VA border. Station D9490000 is at the Chowan River Bridge over Highway 17.

The source of increasing organic N along the river has not been identified.

Figure 2. Chowan River Organic N from nine monitoring stations.



[1] Ambient data were pulled from STORET (EPA STOage and RETrieval) data warehouse for water quality monitoring data collected by Division of Water Resources Water Sciences Section through 2015 and processed using quality assurance criteria and statistical analyses developed specifically for development of the 2017/2018 DWR Chowan and Pasquotank River Basin Plans.

NCDEQ water quality monitoring stations in the Albemarle region are shown in Figure 3.

Figure 3. NCDEQ Division of Water Resources Albemarle water quality monitoring stations.

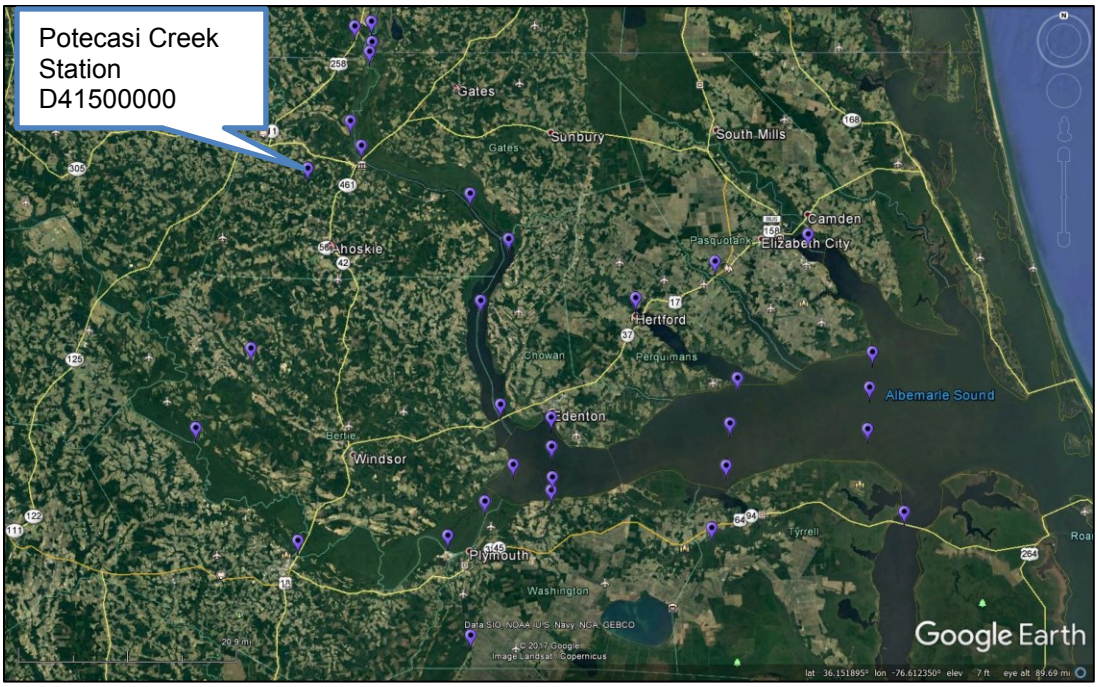
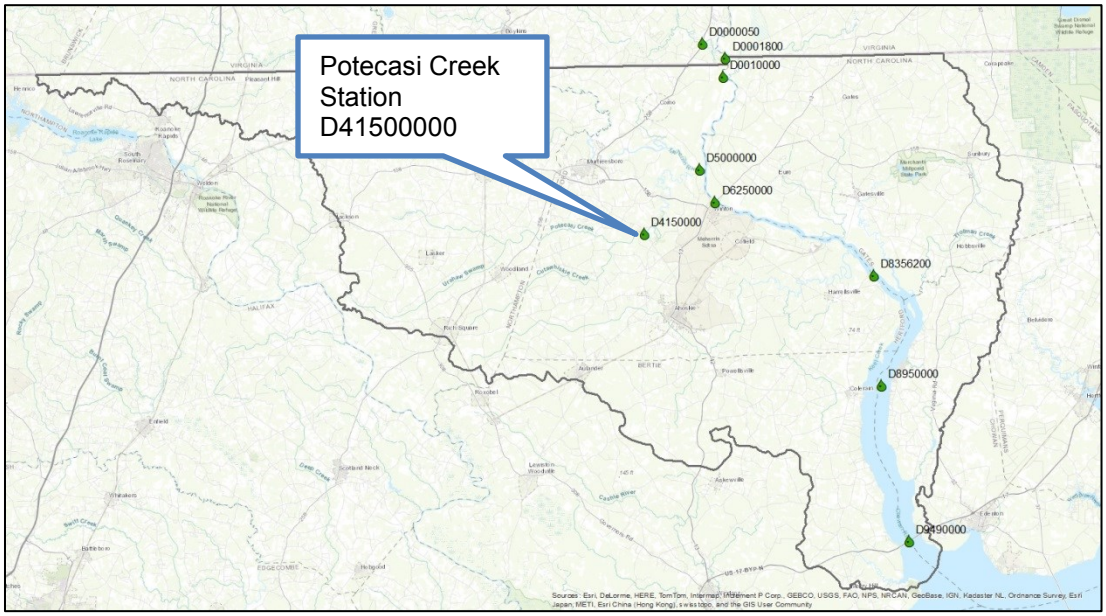
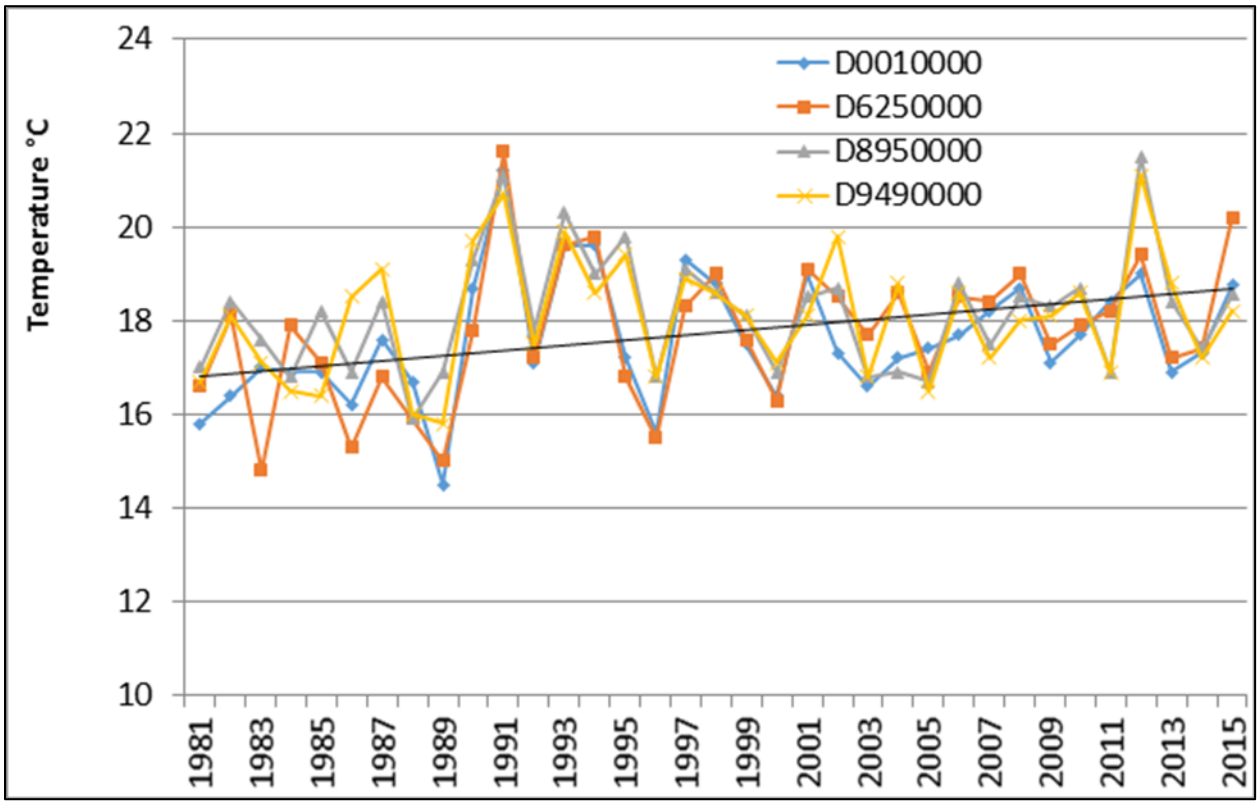


Figure 4. NCDEQ Division of Water Resources water quality monitoring stations along the Chowan River.



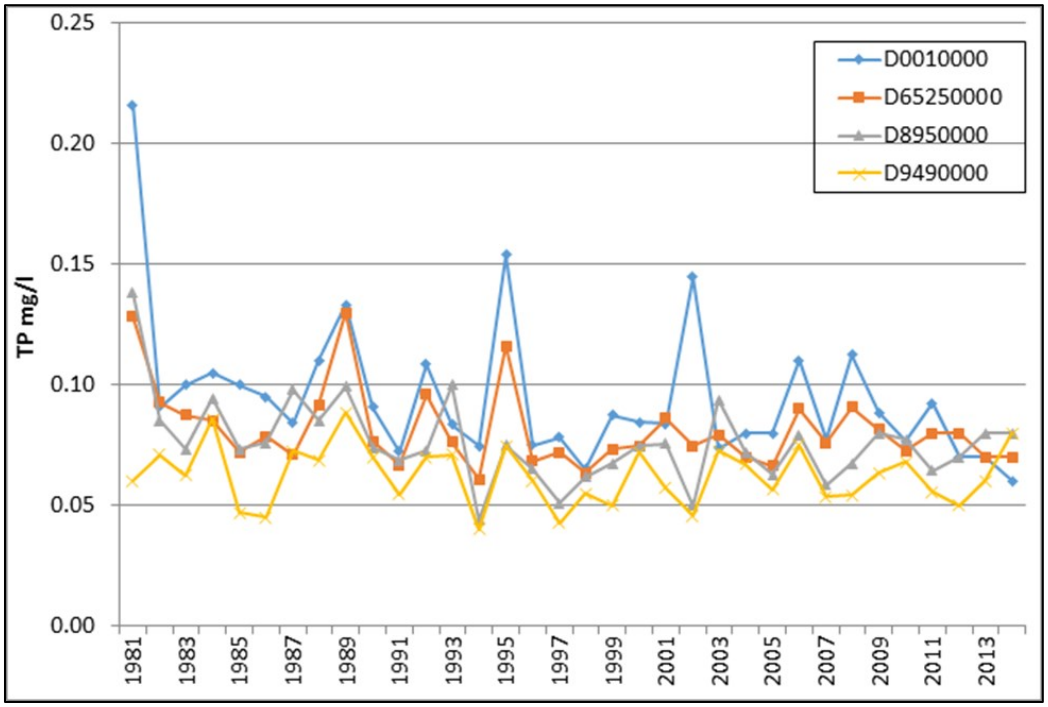
From 1981 to 2015, the mean annual water temperature of the Chowan River (from the VA line to the Hwy 17 Chowan River bridge) increased approximately two degrees Celsius (Figure 5). By comparison, a study published by the Maryland Center for Environmental Science showed the water temperature of Chesapeake Bay increasing between 0.5 and 1 degree C per decade for the last 30 years.
www.sciencedaily.com/releases/2015/10/151014084835.htm

Figure 5. Chowan River mean annual water temperature.



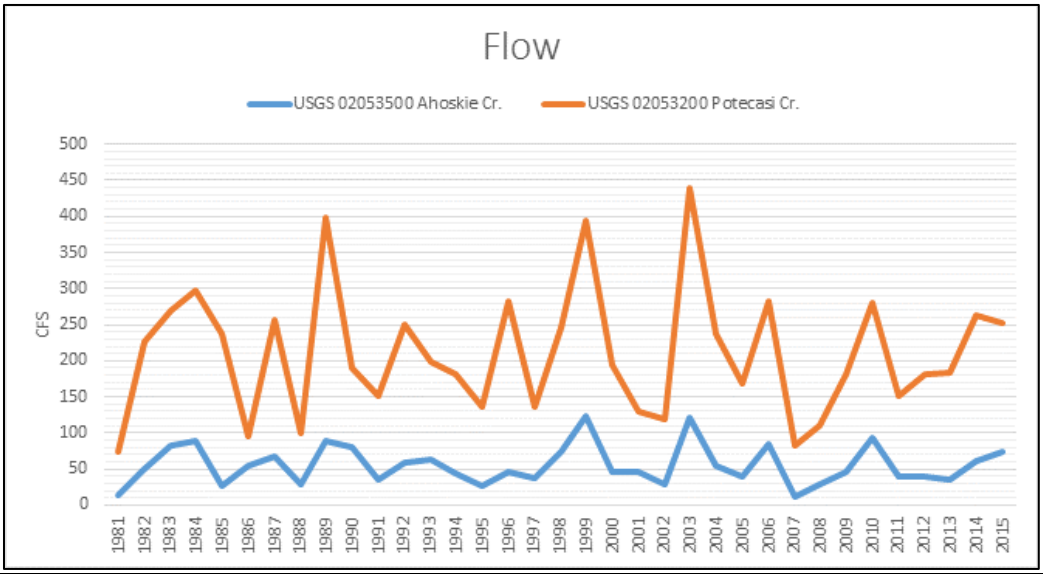
From 1981 to 2013, the Chowan River has not seen an increase in Total P (Figure 6).

Figure 6. Chowan River Total Phosphorus.



Spikes in P in the Chowan River may be compared to water flow at USGS monitoring stations on Ahoskie Creek and Potecasi Creek (Figure 7).

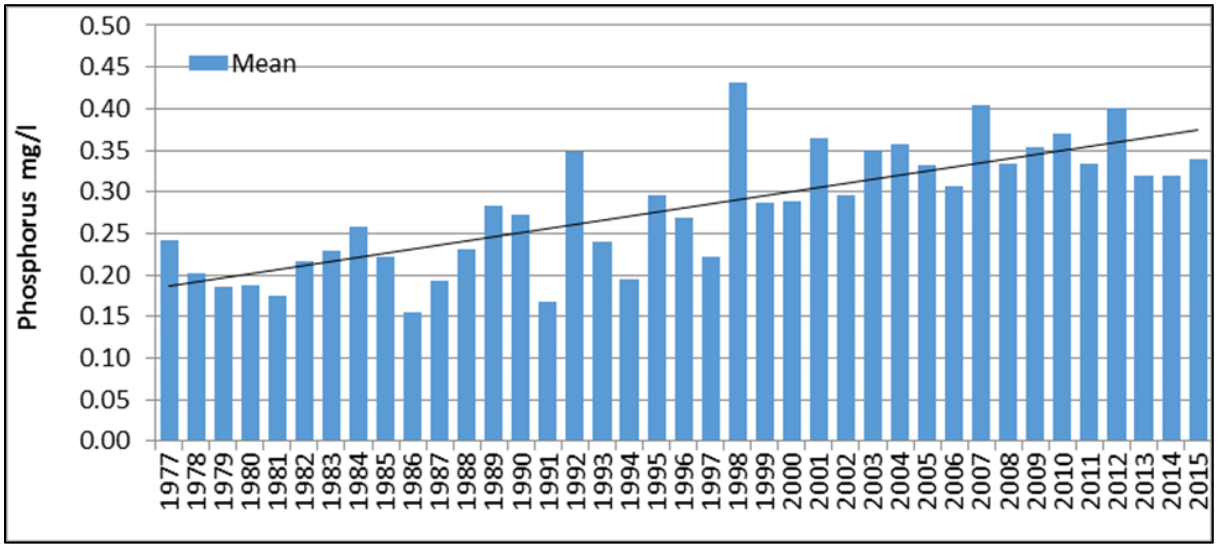
Figure 7. USGS water flow monitoring stations along the Chowan River.



The Little River in Perquimans and Pasquotank counties experienced algal blooms in the upper sections of the river in 2015 and 2016. A bloom appeared in 2017 in Dance's Bay on the lower section of the river. A resident said it was the first bloom she had seen in her 35 years of living on the water.

From 1977 to 2015 the Little River has experienced a steady increase in P (Figure 8).

Figure 8. Little River Phosphorus from one monitoring station at US 17.



The Albemarle RC&D Council is working with partners in Perquimans and Pasquotank counties to improve water quality in the Little River watershed. The project used grants from the Clean Water Management Trust Fund, US Fish and Wildlife Service, and EPA 319 to construct 6,800 feet of in-stream wetlands on main drainage canals in 2016, and will use a new EPA 319 grant to construct 3,200 feet in-stream wetland in 2018. These wetlands will help filter nutrients, mainly N and P, and sediment, which will help improve the water quality of the Little River.

Read more about the effort to restore the Little River watershed.

Why is N increasing in the Chowan River and P increasing in the Little River?

Key research questions include:

- Are there new sources of agricultural, residential, and industrial discharges in the Chowan and Little River watersheds that are contributing significantly to the algal blooms?
- Is the clearcutting of riparian forests significantly increasing water temperature in the Chowan and Little Rivers?
- Is increased decomposition of soils in riparian clearcuts causing a release of nitrogen and phosphorus in quantities that are stimulating algal blooms?

Riparian forests, commonly cypress and gum in NE NC, are critical for storing and filtering stormwater, and providing key habitat for fish and wildlife. Riparian forests are slow growing, and there is a lack of information on how recent, wide-spread clearcutting is impacting water temperature and nutrient release into Albemarle waterways.

A swamp forest harvest study (Ensign and Mallin, 2001) helps shed light on some of these important questions: Stream Water Quality Changes Following Timber Harvest in a Coastal Plain Swamp Forest. Important results include:

Compared with the control creek, the post-clearcut Goshen Swamp displayed significantly higher suspended solids, total nitrogen, total phosphorus, total Kjeldahl nitrogen and fecal coliform bacteria, and significantly lower dissolved oxygen over a 15 month period. Longer-term deleterious effects included recurrent nuisance algal blooms that had not been present during the 2 1/2 years before the clearcut. Although a 10m uncut buffer zone was left streamside, this was insufficient to prevent the above impacts to stream water quality.

A 1983 study of land-use, nutrient yield and eutrophication in the Chowan River basin found that swamp forests removed 83% of the total N and 51% of the total P in streams passing through these wetlands (Craig and Kuenzler, 1983). The study concluded that due to the importance of swamp forests as nutrient buffers, special protection should be given to these areas.

Read the 1983 study Land-Use, Nutrient Yield and Eutrophication in the Chowan River Basin.

A series of experiments performed by scientists from NC State University, studying buffers in the North Carolina coastal plain, found that riparian buffers with widths between (roughly) 150 ft and 200 ft, removed as much as 94% of nitrogen in 5 ft deep wells and 86% in 10 ft deep wells, when the buffers were well positioned in relation to groundwater flows (Messer *et al*., 2012). Another study at the site found a 150 ft buffer reduced nitrates entering the stream by 76% to 92% (Wiseman *et al*., 2014). A study of

a much wider buffer – greater than 400 ft. – found that significant reductions were concentrated in the 200 ft of buffer closest to the stream edge, where groundwater and leaf litter were most available (Johnson *et al*., 2013).

For more information on the importance of riparian buffers: North Carolina's RIPARIAN BUFFERS: A Scientific Review

Action items to effectively address algal blooms.

1. Special funding for state agencies to participate in a NC and VA research effort to identify sources of increasing temperature and Organic N in the Chowan River and Albemarle Sound
2. Special funding for a land-use change study (using satellite imagery, aerial imagery, drones and ground verification) in the NC/VA Chowan River Basin (Figure 9)
3. Additional staff support and resources to NCDEQ Division of Water Resources (DWR) to complete updates of the Chowan River Basin Management Plan and the Pasquotank River Basin Management Plan (Figure 10)
4. Additional staff support, and funding for equipment, for the DWR Estuarine Monitoring Team to monitor water quality and algal blooms
5. Special funding for additional water quality monitoring on creeks that flow into main rivers of the Albemarle
6. Special funding to local governments and conservation organizations to work with residents and communities on managing stormwater runoff, and monitoring water quality
7. Special funding to Soil and Water Conservation Districts and local conservation organizations to develop an incentive program for private landowners to conserve swamp forest buffers.

Figure 9. Chowan River Basin in NC and VA.

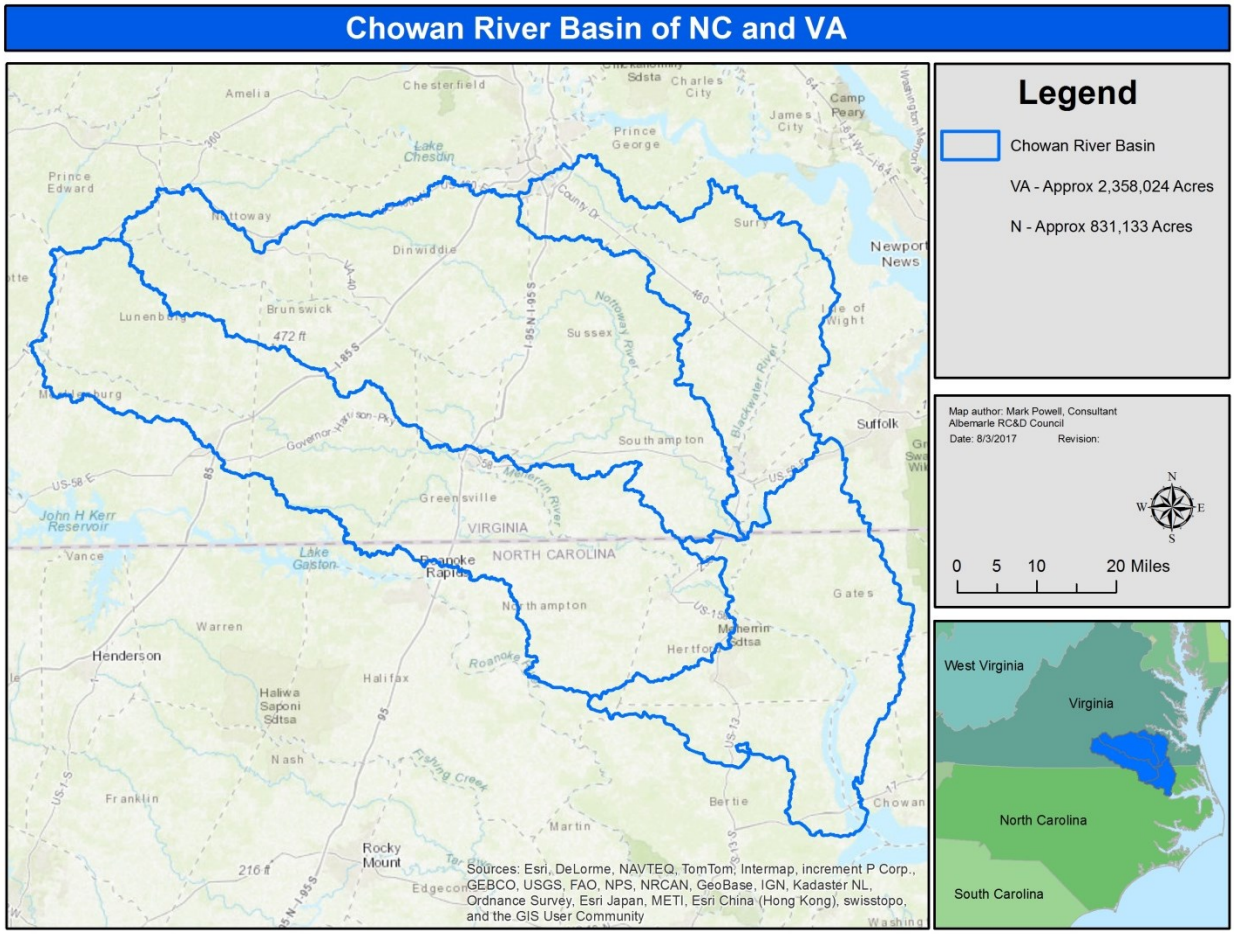


Figure 10. Pasquotank River Basin.