TOXIC CYANOBACTERIA:
BENTHIC HARMFUL ALGAL BLOOM COMMUNITIES IN THE SHENANDOAH RIVER

A Collaboration with ICPRB and USGS

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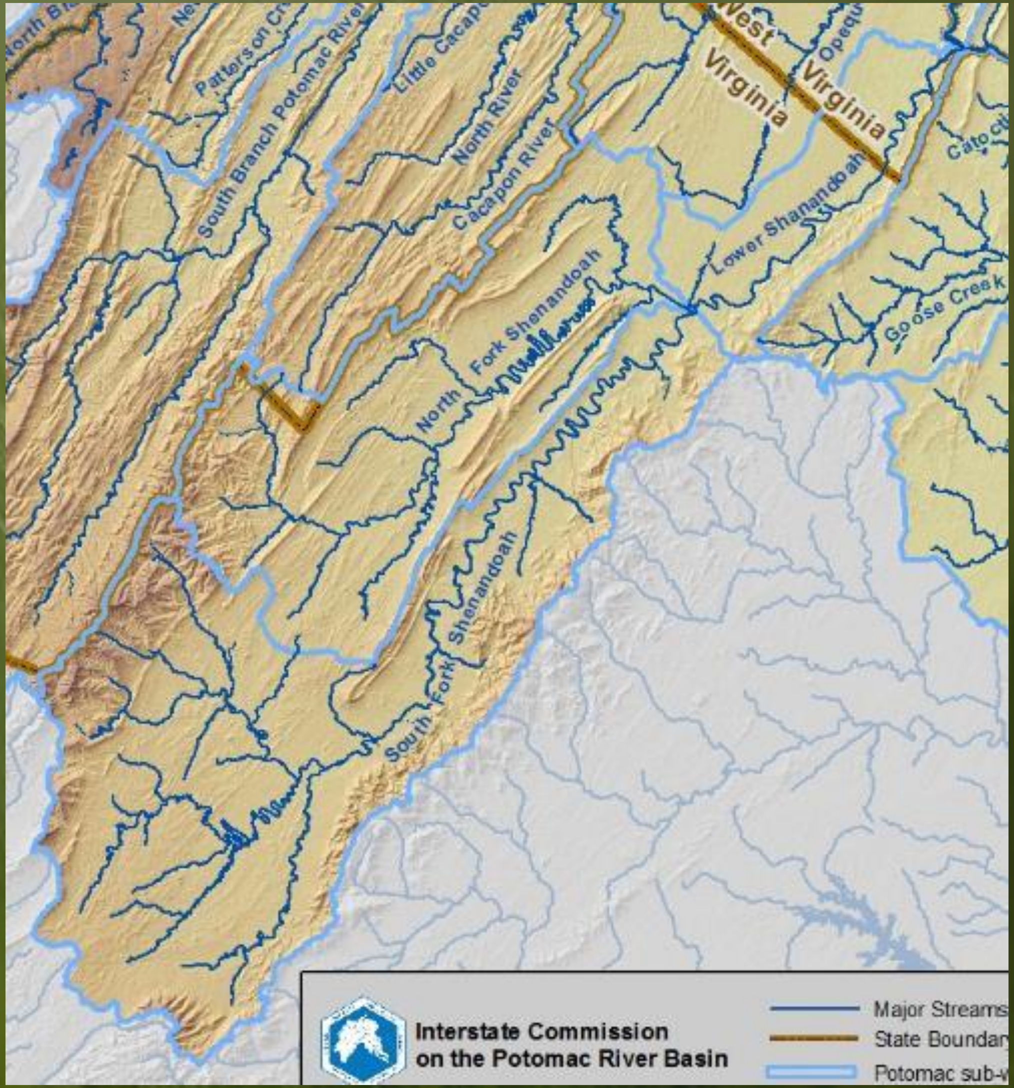
The Shenandoah River is the largest tributary of the Potomac River

-The River itself runs from the confluence of the North and South Forks near Front Royal to its confluence with the Potomac River in Harper’s Ferry, a distance of some 56 miles

-The South Fork is the larger of the two forks with a length of almost 100 miles itself and two tributaries: North River (55 miles long) and South River (53 miles long)

-The North Fork has a length of 105 miles

-Both North and South Forks arise along the east flank of the ridge separating Virginia and West Virginia, but most of their watershed drains land within the Shenandoah Valley.



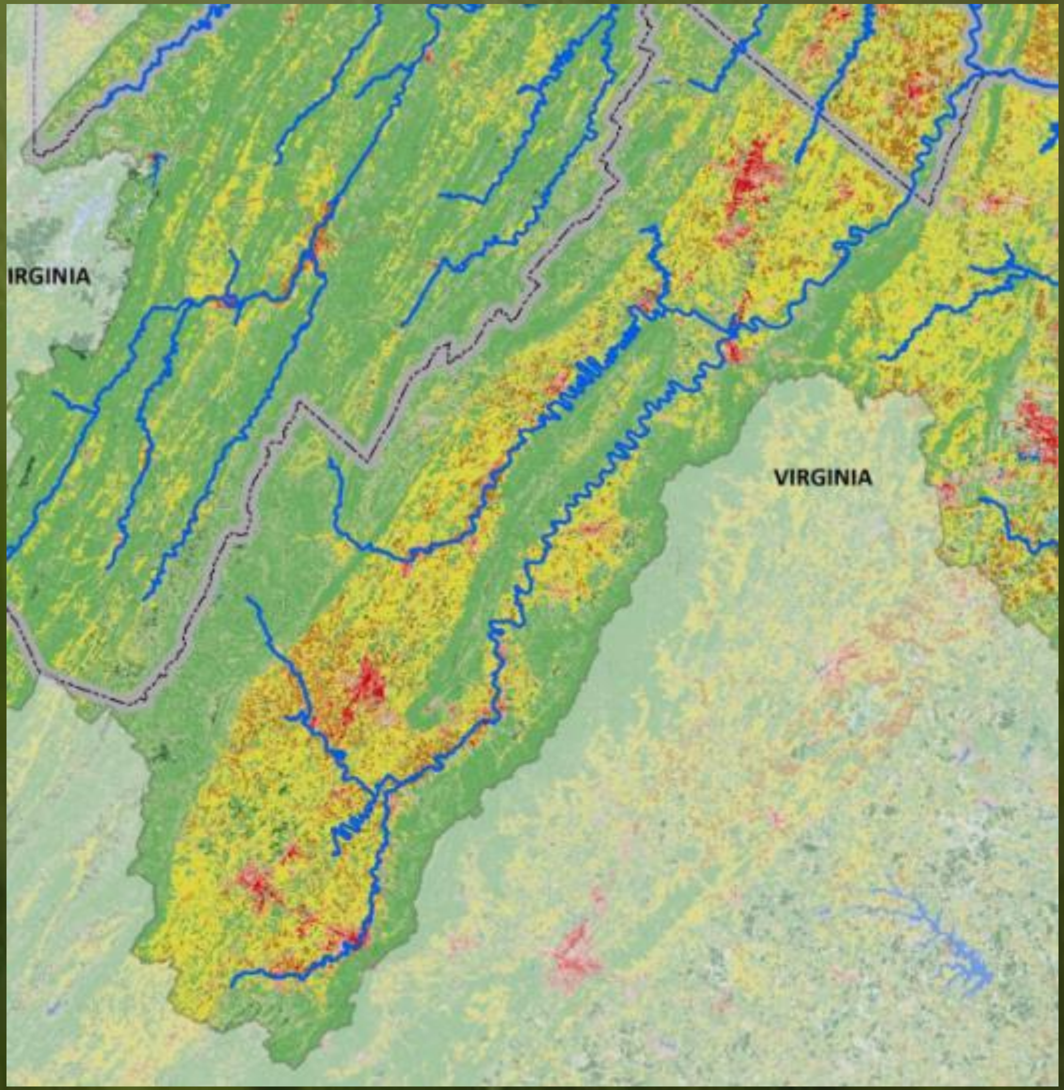
Land use in the Shenandoah Watershed is predominantly agriculture and forest. In this diagram:

Green: Deciduous Forest

Yellow: Pasture Land

Orange: Cutivated Crops

Red: Developed (Urban/Suburban)



-The Shenandoah and its larger tributaries are important recreational assets for the Commonwealth of Virginia with tourism accounting for a significant part of the economy of the area.

-Recreational activities include canoeing, kayaking, fishing, hiking, and sight-seeing

-Most, if not all of these activities depend on having clean, flowing water

-The other economic engine in the Shenandoah watershed is agriculture

-While potentially compatible, these two activities may not always be in harmony if nutrients from agricultural practices fuel excess primary production resulting in filamentous algal growths in the shallow river.

Top right: Potomac Waterkeeper web site. Bottom right: Painting by Ed Hatch

-Filamentous algal blooms have plagued the Shenandoah River for at least a decade. These growths have rendered recreational activities more difficult and certainly less appealing.

-Originally these blooms consisted mainly of green algae which, while aesthetically and sometimes troublesome for boating and fishing, do not present a danger to aquatic life, livestock, or humans from toxins.

Alan Lehman/Potomac Waterkeeper Network from Earth Justice article. May 30, 2017

-In July of 2021 significant growths of benthic cyanobacteria capable of producing cyanotoxins were found in the North Fork of the Shenandoah River.
-On July 19 anatoxin a and microcystin were detected at the Strasburg site at Bethel Road.
-And at the end of July saxitoxin, anatoxin a and microcystin were observed at three sites.
-This led to issuance of a Health Advisory for the North Fork cautioning the public to avoid water contact within affected parts of the river which eventually extended for 53 miles of the North Fork. Water intakes for the Cities of Woodstock, Strasburg, and Winchester were also affected.
-A subsequent smaller bloom was observed in 2022.

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-These blooms led the Virginia General Assembly to pass legislation to fund studies of the HAB blooms in the Shenandoah River and a similar situation in Lake Anna to determine the causes, extent, and possible mitigation of these HAB blooms.

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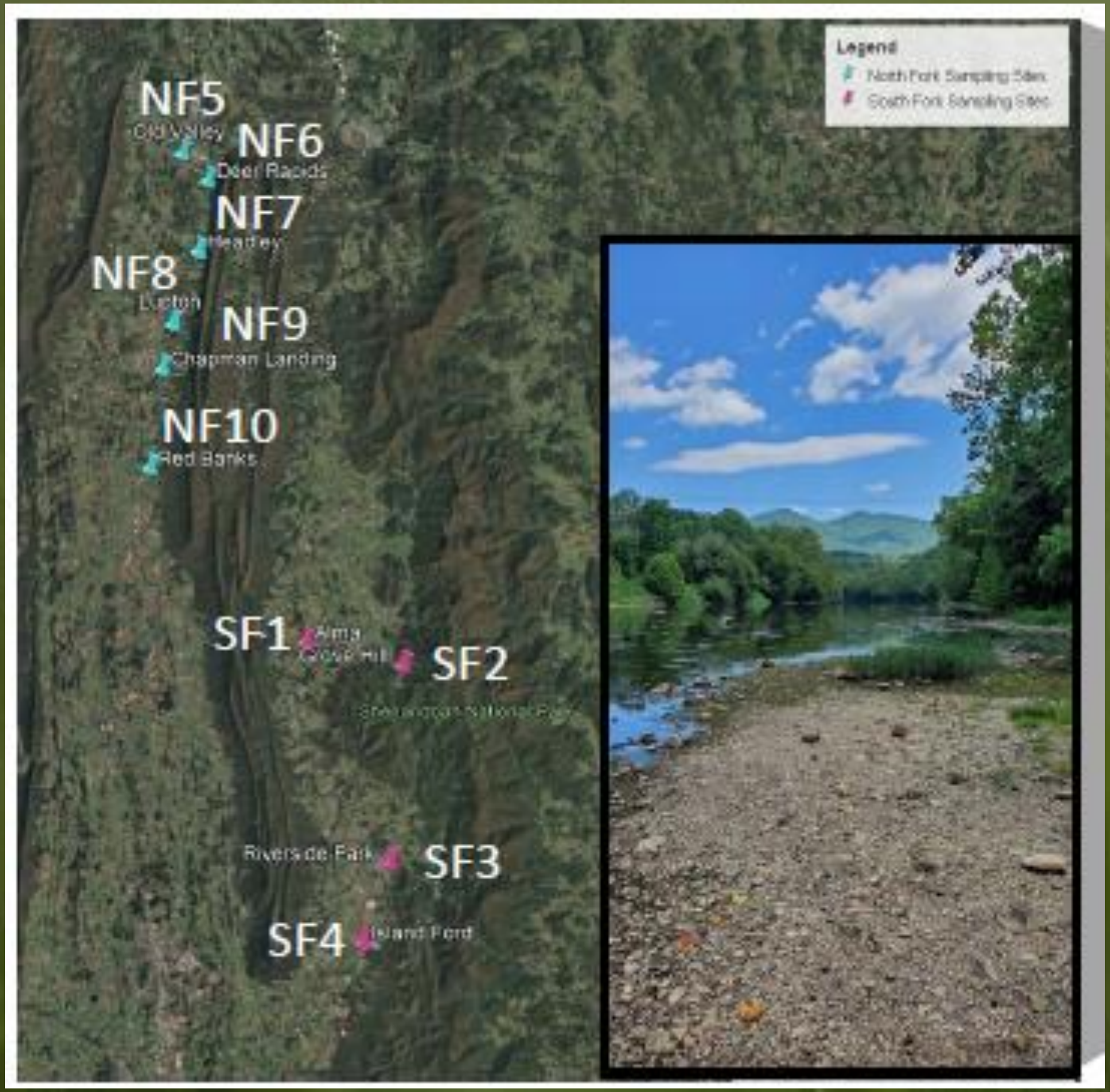
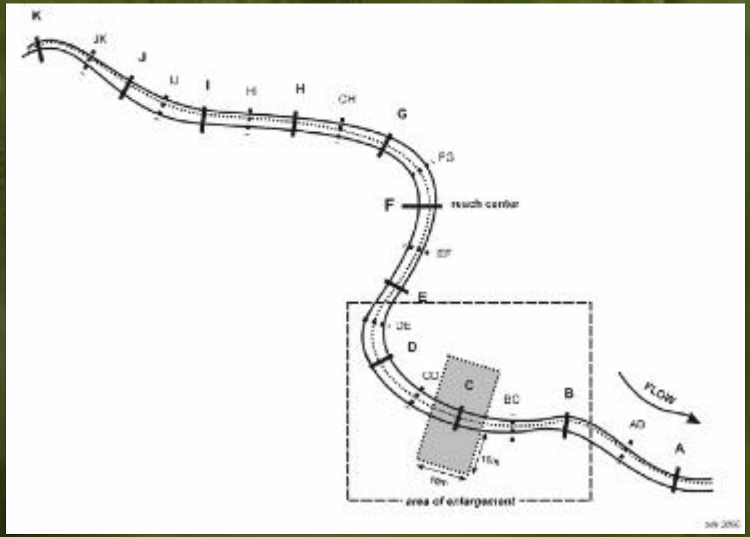
-The studies are being managed by the Virginia Department of Environmental Quality and they contracted with USGS and ICPRB to conduct the work. ICPRB in turn subcontracted with the Potomac Environmental Research and Education Center at George Mason University to analyze the samples collected for taxonomy,

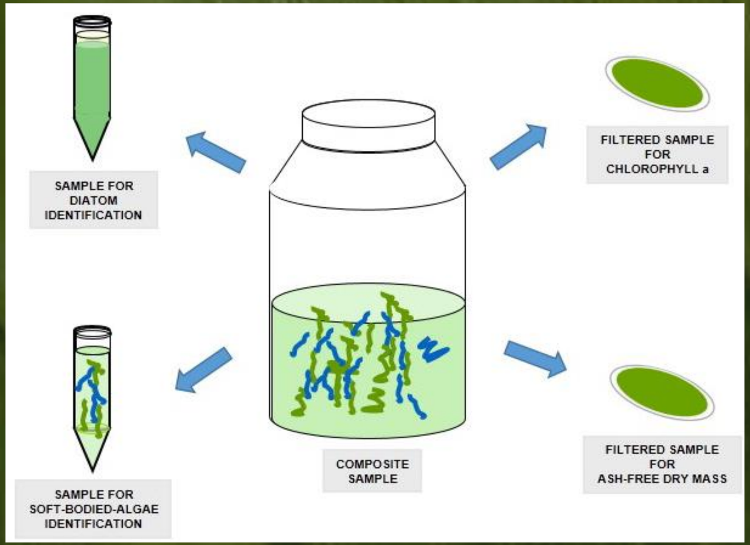


Benthic algal sampling stations include:
-6 on the North Fork concentrated in the area of the 2021 Health Advisory
-4 on the South Fork which has also seen some cyanobacterial outbreaks
-USGS water column samples are taken at 4 existing stations on the two forks

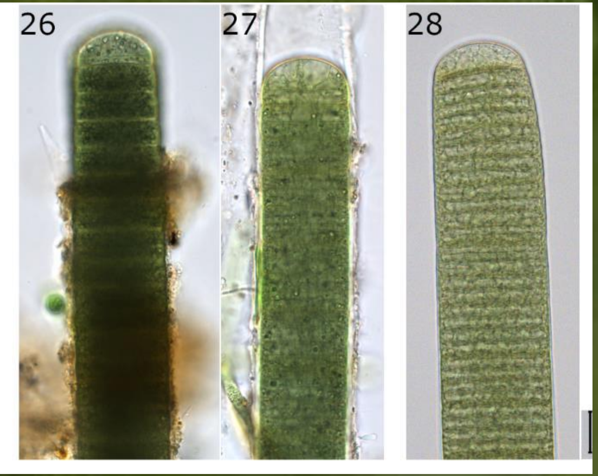
The sampling design involves:

- Quantitative sampling of algal mats
  - stratified random sampling
  - create one composite sample
- Qualitative sampling of selected mats
  - those encountered outside of the above
- Water column samples collected at 4 USGS stations





Figures from Ode et al. 2016



Measurements being made include:

-Taxonomic identification and enumeration of all filamentous algae

-Algal pigments including chlorophyll a (found in all algae) and phycocyanin (found only in cyanobacteria)

-Ash-free dry weight which gives an idea of the total biomass of algae

-ELISA assays on mats and water to determine the presence of toxins

-LC-MS assays to determine toxin concentrations

-Funded from a 4VA grant from GMU: Molecular analyses

Photos: Courtesy of Sydney Brown and Rosalina Christova

GMU Team:

- R. Christian Jones, Director, PEREC (pigments and AFDW)
- Rosalina Christova, Asst. Professor (algal taxonomy)
- Scott Glaberman, Asst. Professor (ELISA testing)
- Benoit Van Aken, Assoc. Professor, (LC-MS analysis)
- Greg Foster, Professor (LC-MS analysis)
- Jen Salerno, Asst. Professor (molecular analysis)

Many thanks to:

- Mike Selickman, ICPRB
- Doug Chambers, USGS

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