VIMS reports intense and widespread algal blooms

September 1 2015, by David Malmquist

An exceptionally dense bloom of Alexandrium monilatum was observed in lower Chesapeake Bay along the north shore of the York River between Sarah's Creek and the Perrin River on 8/17/2015. Credit: © W. Vogelbein/VIMS.

Water sampling and aerial photography by researchers at William &

Mary's Virginia Institute of Marine Science show that the algal blooms currently coloring lower Chesapeake Bay are among the most intense and widespread of recent years.

VIMS professor Kimberly Reece reports that water samples collected near the mouth of the York River on August 17 contained up to 200,000 algal cells per milliliter, the densest concentration she has seen in nearly 10 years of field sampling. A sample with a concentration of even 1,000 algal cells per milliliter is visible to the naked eye and considered dense enough to be called a bloom.

The current blooms are dominated by a single-celled protozoan called *Alexandrium monilatum*, an algal species known to release toxins harmful to other marine life, particularly larval shellfish and finfish. Since mid-August, VIMS has received sporadic and localized reports of small numbers of dead fish, oysters, and crabs from the lower York River and adjacent Bay waters associated with nearby blooms, although a direct cause/effect relationship has not been established for any of these events.

Aerial photography and water sampling by VIMS professor Wolfgang Vogelbein between August 17th and 27th confirmed the blooms' intensity in the lower York River, and revealed that they extended much farther up the York River and out into Chesapeake Bay than previously reported. The flyovers were facilitated by the Virginia Marine Resources Commission.

"This is new and important information," says Vogelbein, "as we have never appreciated that *Alexandrium* extends so far into the mainstem of the Bay or so far up the York River." Bloom patches in the mainstem reach from the York River to the mouth of the Rappahannock River, across the Bay to within 3-4 miles of Cape Charles, and as far south as the Chesapeake Bay Bridge-Tunnel. The bloom patches are most dense on the western side of the Bay, with other areas experiencing less activity. "The main body of the bloom is several miles off shore," says Vogelbein, "and thus wasn't appreciated prior to the recent flyovers."

Alexandrium monilatum is one of several species of harmful algae that are of emerging concern in Chesapeake Bay. It was first conclusively detected in Bay waters in 2007, when Reece and colleagues used microscopy and DNA sequences to identify it as the dominant species of a bloom that persisted for several weeks in the York River. There are generic reports of *Alexandrium* in the Bay from the mid-1940s, and specific reports of *A. monilatum* in the mid-1960s, but none in the intervening decades.

The recent sampling and aerial photography show that the epicenter of the *A. monilatum* bloom is near the mouth of the York River. Smaller, less dense patches are visible within Mobjack Bay and its tributaries, the Back and Poquoson rivers, and near the mouth of the James and Elizabeth rivers.

Reports of algal blooms in the lower York River started around July 22nd. As in recent years, the initial summer blooms began with concentrations of the alga Cochlodinium polykrikoides, before shifting after 2-3 weeks into blooms dominated by *A. monilatum*. As of the last week of August, the *A. monilatum* bloom in the York River persists but has grown markedly less dense.

New tools to better understand blooms and toxins

Monitoring the scope and impacts of an algal bloom is notoriously difficult, particularly in areas like Chesapeake Bay where tides, winds, currents, and a convoluted shoreline combine to create blooms that are both patchy and ephemeral.

The bloom of *Alexandrium monilatum* during late August 2015 extended well into the mainstem of Chesapeake Bay off the mouth of Mobjack Bay and the York River. Credit: © W. Vogebein/VIMS.

A further complication is that the blooms typically contain a changing mix of algal species, some of which may or may not—depending on environmental conditions—produce the toxins that transform an innocuous algal aggregation into a harmful algal bloom or HAB.

"We see high variation among our samples," says Reece, "even between those that were collected from sites a few hundred yards apart or taken from the same site a few hours apart."

To better characterize local blooms and their potential impacts, Reece and Vogelbein have recently joined with colleagues at VIMS and other institutions to bring new tools and techniques to their efforts.

One of these collaborations involves the use of Dataflow, a high-tech instrument used to monitor water quality over large areas. Deployed from a small boat operating at speeds up to 25 knots, Dataflow passes surface water collected through a keel-mounted pipe past an array of water-quality sensors that record dissolved oxygen, salinity, temperature, turbidity, chlorophyll, and pH—all parameters that relate to algal abundance.

In mid-August, VIMS professor Iris Anderson teamed with colleagues Jen Stanhope, Hunter Walker, and Gail Scott to run Dataflow through several bloom patches in the lower York River. This was supplemented by a simultaneous Dataflow run in the lower James River by colleagues at Old Dominion University and the Hampton Roads Sanitation District. Both teams are now comparing their sensor data with water samples taken enroute to further explore potential links between water quality and bloom characteristics.

The Dataflow runs got a serendipitous boost from an ongoing study of algal productivity by VIMS professor Mark Brush and post-doctoral researcher Sam Lake. Their monthly sampling of photosynthesis and respiration in the York River happened to take place on the same day and will help put the Dataflow measurements in a seasonal context.

On yet another front, VIMS professor Jian Shen will feed data from the Dataflow runs into his three-dimensional computer model of water flow in Chesapeake Bay. The model holds promise for predicting bloom dynamics, potentially giving shellfish growers and other concerned parties advance warning of any impacts.

The Dataflow cruises in the York and James rivers were also accompanied by over-flights from a NASA Langley airplane that was equipped with electromagnetic sensors and cameras, and by the collection of data from NASA satellites. Researchers are now "ground-truthing" the aerial and satellite imagery by comparing it with direct measurements of algae and water quality from samples collected at the same time and in the imaged locations.

Wolf Vogelbein, Sarah Pease, and Kim Reece collect oysters to test for potential health impacts from a bloom.

Reece sees great promise in collaborating with scientists at NASA and NOAA to advance model development and the use of remote sensing for predicting algal bloom patterns in Chesapeake Bay.

Lab work and bioassays

Once water samples from a bloom are returned to VIMS, researchers in a number of labs begin the laborious process of identifying the species present and characterizing any toxins.

Members of the Reece lab—Bill Jones, Gail Scott, and Alanna MacIntyre—use both microscopic analyses and DNA tests to identify potentially harmful algal species. Development of these molecular DNA assays is a primary focus of Reece's research at VIMS. The lab group plans to extract and analyze DNA from about 300 of the 500 water samples collected so far this summer.

VIMS professor Juliette Smith—working with adjunct professor Tom Harris—has focused her efforts on characterizing the complex array of toxins that algae can generate. "A single cell can produce multiple toxins," says Smith. "In addition, the same toxin can be produced by multiple species. For instance, saxitoxins, which cause paralytic shellfish poisoning, can be produced by both dinoflagellates and cyanobacteria."

Smith and other researchers at VIMS are also testing to what degree bloom-derived toxins might be moving up the food web to impact marine life and potentially human health. Graduate student Sarah Pease is using funds from Virginia Sea Grant to monitor the health of caged oysters in waters near the Goodwin Islands, and is also working with Smith to conduct toxin analyses on oyster tissues.

Pease and Patrice Mason—members of Vogelbein's lab—are conducting toxicity "bioassays" with algae from both laboratory cultures and field samples. These tests involve bathing small numbers of oysters and finfish—both larvae and adults—in waters with increasing concentrations of algal cells and, more recently, isolated and purified toxins. They are a standard method for gauging the effects of HABs on living organisms. This year's bioassays are still in progress.

Provided by Virginia Institute of Marine Science