Monitoring and Management of Algal Blooms in Virginia: an Interagency Approach to Freshwater and Coastal HABs in Recreational and Shellfish Waters.

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Background:

Algal blooms annually occur throughout Virginia's lakes, rivers, estuaries and coastal zones including those that may affect human and environmental health through toxin production or other impacts. The **Virginia Harmful Algal Bloom Taskforce** is a collaboration of state regulatory agencies and academic research institutions initiated in 1997 to address the growing concern of HABs throughout the Commonwealth. This includes both freshwater recreational advisories and management of shellfish growing areas in response to marine biotoxins.

Virginia Harmful Algal Bloom Taskforce: Primary Support Members

VDH Virginia Department of Health – Protecting You and Your Environment; DEQ Virginia Department of Environmental Quality; Old Dominion University; VIMS William & Mary Virginia Institute of Marine Science

Bloom history:

Chesapeake Bay is subject to annual seasonal blooms of a succession of potential HAB species. Environmental impacts include shading, anoxia and fishkills. *To date, there has been only one precautionary shellfish closures due to marine biotoxins (Dinophysis 2002) and no HAB related human illnesses from Virginia shellfish.*

2016 Estuarine Blooms:

- *Dinophysis acuminata* <0.1-20 cells/ml February-July
  Okadaic acid in 1 sample 0.179ng/ml seawater- VA Eastern Shore
- *Pseudo-nitzschia* spp. <10-1060 cells/ml February-September
- *Karlodinium veneficum* <10-12,460 cells/ml March-September
- *Cochlodinium polykrikoides* <10-67,000 cells/ml June-September
- *Alexandrium monilatum* <10-119,770 cells/ml July-October

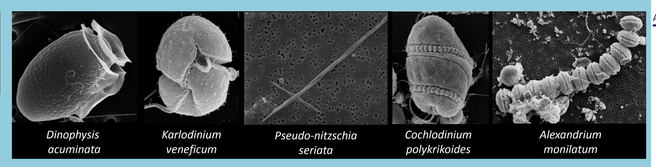
Two fishkills associated with *A. monilatum* blooms

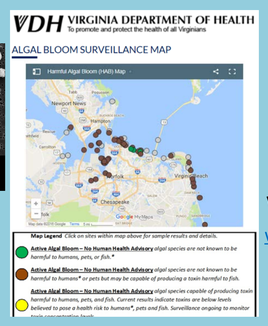
Estuarine HAB Monitoring

Shellfish Marine Biotoxin Control:

- 75 routine phytoplankton stations in shellfish growing areas
- Monthly seawater collections (March-October)
- Additional bloom response collections as needed
- Phytoplankton identification and enumeration by microscopic and/or QPCR analyses (ODU, VIMS, VDH)
- ELISA tests of seawater samples as initial screening
- LCMS-MS analyses of shellfish samples
- Growing area closure/reopening issued following National Shellfish Sanitation Program criteria and Virginia Biotoxin Contingency Plan

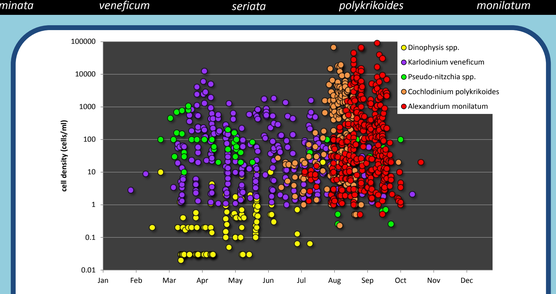
Algal species	Impacts	Main Toxin	NSSP shellfish growing area closure level (toxin w/in meat)	Regional threshold (cell density in water column)
Alexandrium tamarense species complex	Paralytic Shellfish Poisoning	Saxitoxin	80µg /100g	presence
Karenia brevis	Neurotoxic Shellfish Poisoning	Brevetoxin	0.8mg /kg	presence
Dinophysis spp.	Diarrhetic Shellfish Poisoning	Okadaic acid	0.16 mg/kg	≥10 cells/ml
Pseudo-nitzschia spp.	Amnesic Shellfish Poising	Domoic acid	2mg/100g	≥ 1,000 cells/ml
Alexandrium monilatum	Fish/invertebrate mortality	Goniodomin A	NA	≥ 1,000 cells/ml
Cochlodinium polykrikoides	Fish/invertebrate mortality		NA	≥ 1,000 cells/ml
Karlodinium veneficum	Fish mortality	Karlotoxins	NA	≥ 10,000 cells/ml

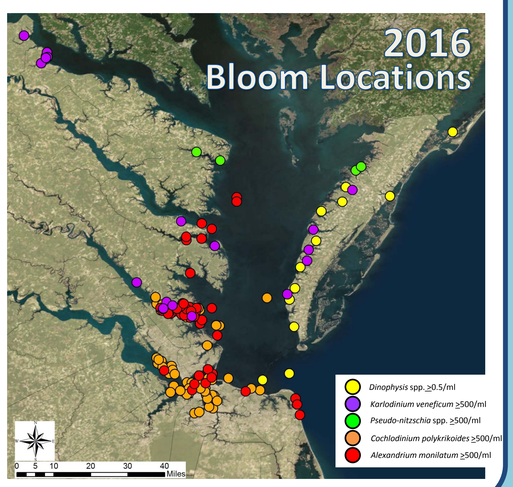


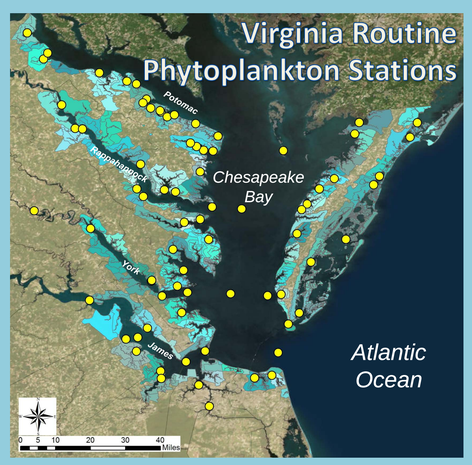


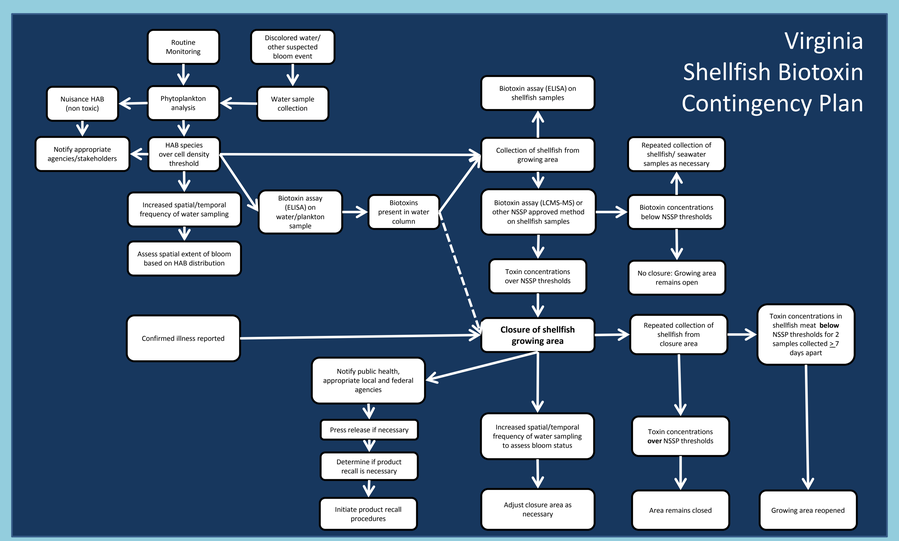
Website:

Bloom status, advisories, and guidance info posted on VDH HAB page www.vdh.virginia.gov/environmental-epidemiology







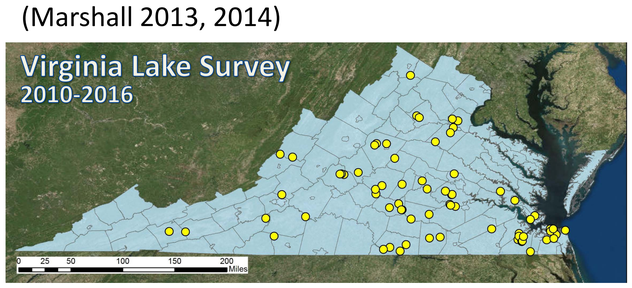


Ongoing and upcoming work:

- Refining threshold advisories for regional bloom species
- Expanding biotoxin screening of ASP and DSP in coastal waters
- Deployment of sentinel shellfish/ SPATT proxies for toxin surveys
- Continued investigation of lethal/non-lethal effects of *Cochlodinium/A. monilatum* to fish and invertebrates
- Coordination with NOAA/NASA to incorporate remote sensing into bloom prediction

Inland Freshwater HAB Monitoring

- 2010-2016 survey of 67 lakes and reservoirs for initial characterization of plankton composition and presence of potential HAB species (VDH, ODU)
- Identification of at least one potentially toxic cyanobacteria species in a majority of lakes (Marshall 2013, 2014)



- Coordinated bloom response and sampling with regional lake managers and HAB taskforce
- Phytoplankton identification and enumeration by microscopic analyses
- ELISA micro-titer and strip tests of water column and/or surface scum samples

Regional algal species	Potential toxins
Anabaena spp.	saxitoxin, anatoxin-a
Aphanizomenon flos-aquae	cylindrospermopsin anatoxin-a
Cuspidothrix issatschenkoi	anatoxin-a
Cylindrospermopsis raciborskii	cylindrospermopsin
Microcystis aerguinosa	microcystin
Planktothrix isothrix	microcystin

Virginia Recreational Water Guidance for microcystin and Microcystis blooms

- Developed and adopted in 2012 by VDH DEE to guide public health decisions

Monitoring results	Management decisions
5,000 to <20,000 *Microcystis* cells/mL	Local agency notification; initiate bi-weekly water sampling
20,000 to 100,000 *Microcystis* cells/ml	Public notification indicating a harmful algal bloom is present in recreational water; initiate weekly sampling
• >100,000 *Microcystis* cells/ml, or • >6µg/L microcystin concentration, or • Blue-green algal "scum" or "mats" on water surface	Immediate public notification to avoid all recreational water contact where bloom is present; continue weekly sampling

Bloom history:

Cyanobacteria blooms are annual occurrences in several smaller lakes and ponds primarily during summer months. Public notifications and warnings have been posted related to *Microcystis* and *Plankthothrix* blooms (2013-2016).

2016 Freshwater Blooms

- *Anabaena circinalis* – July, max 9500 cells/ml
- *Euglena sanguinea* – July, >20,000 cells/ml
  -first report of bloom in Virginia
  -negative for euglenophycin (Zimba Texas A&M CC)

- *Microcystis aeruginosa/ M. wesengergii*
  -blooms in multiple lakes/ponds-July-August
  -cell densities 10^3 – 10^7 (including surface scum)

-Woodstock Pond- Advisory posted 8/15-12/15
-Microcystin concentrations in water 0.15->10ppb with highest levels in surface scum 1.84->10ppb

Ongoing and upcoming work:

- Review and adopt EPA draft recreation advisories for microcystin and cylindrospermopsin
- (USEPA 2016)
- Refining threshold advisories for regional bloom species- beyond *Microcystis.*
- Expanding screening (ELISA) of microcystin, cylindrospermopsin, anatoxin-a, saxitoxin
- Collaboration with state partners to utilize continuous monitoring and modeling into bloom prediction to allow for faster response