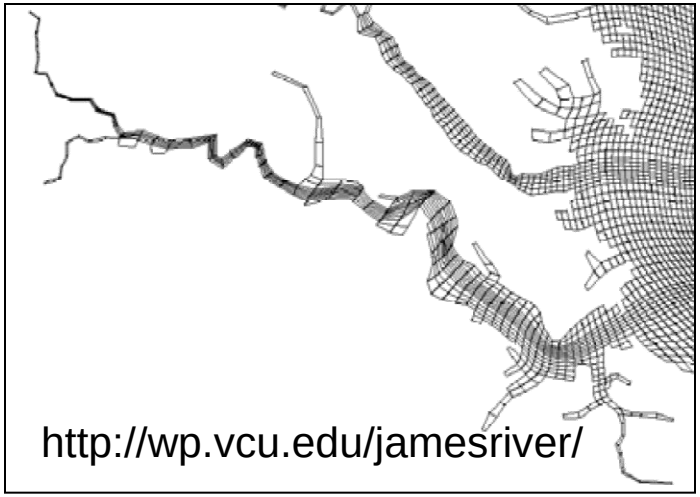
Human Health Risks Associated with Microcystin in the James River Estuary.



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Study Site

Chesapeake Bay

- largest estuary in USA;
- 3rd largest estuary in the world.

James River

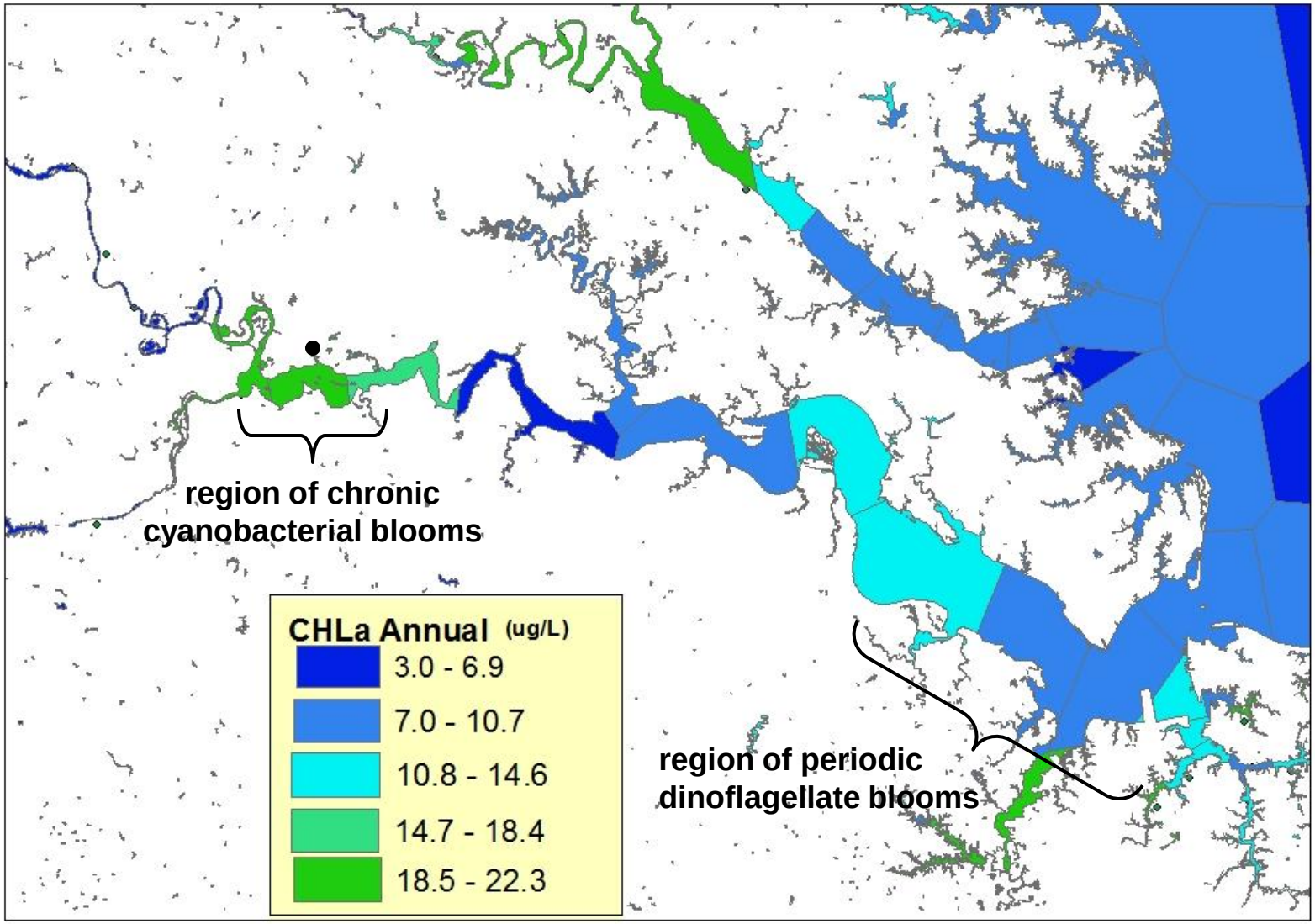
- southern-most sub-estuary of CB;
- third largest by discharge and nutrient load.

James River Long-term Monitoring

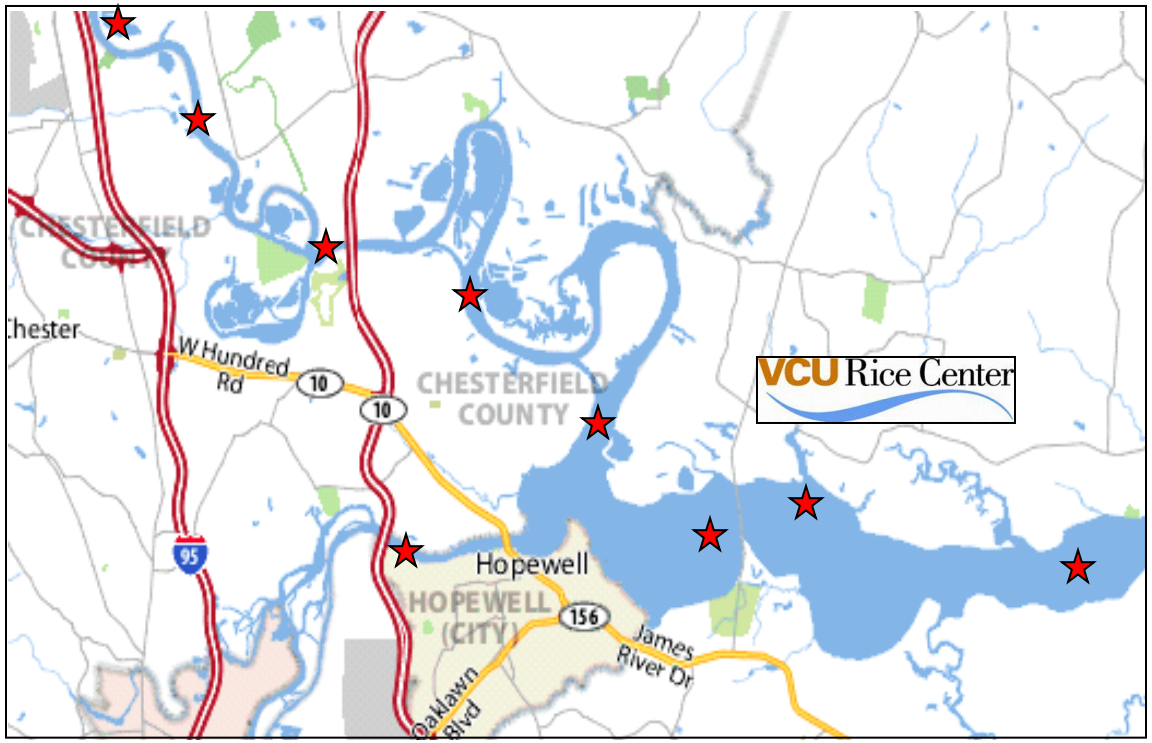
VA Department of Env. Quality (1980–present)

- River & Point source Inputs (daily discharge, monthly & episodic chemistry)
- Estuarine water quality including nutrients & CHLa (monthly at 12 stations)
- Phytoplankton Communities (monthly at 3 stations)
- Higher trophic levels (occasional surveys)

Harmful Algal Blooms in the James



Algal Blooms in the James: Why here?



Sampling locations for VCU weekly monitoring (2010-present).

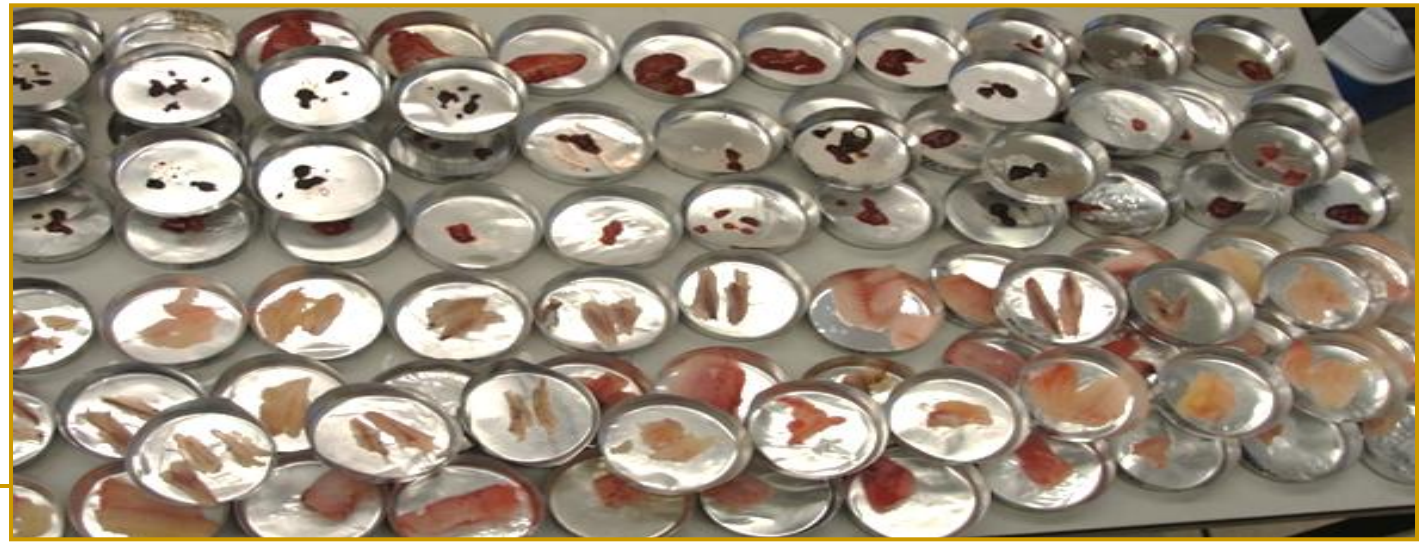
Persistent blooms occur in the region where the James transitions from a narrow, deep channel to a wide shallow channel.

Shallow areas provide more favorable light conditions which enhance algal growth.

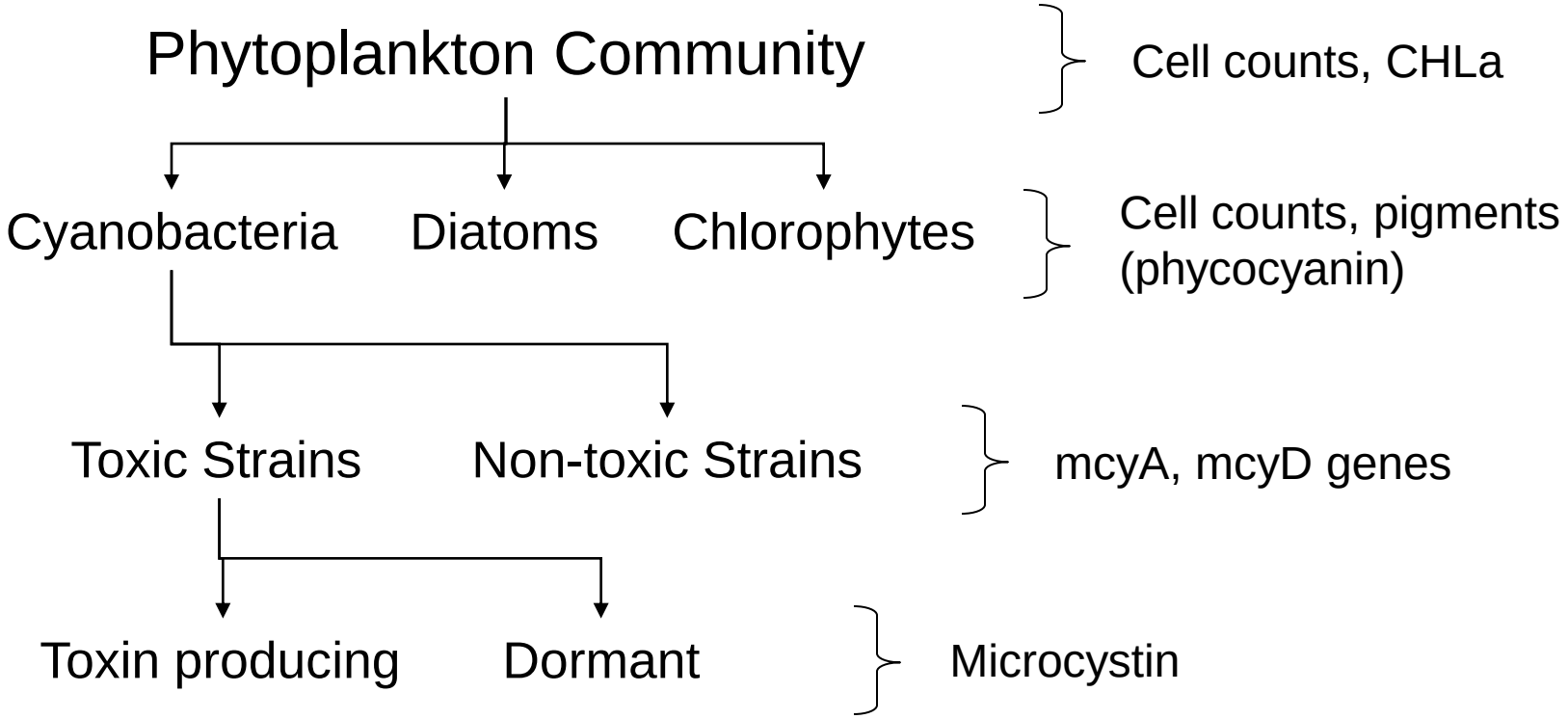
see Bukaveckas et al. (2011) Estuaries & Coasts

Studies on Microcystin in James

- 1980-2010: none
- 2011: water (weekly at 5 stations May-October)
- 2012: water (as above), sediments (monthly at 3 stations), fish & shellfish tissue samples (monthly at one site)



Methods: Toxins & Toxin Producers



Methods: Fish & Shellfish Tissues

- Common species sampled monthly (~75 individuals)
- Livers and Muscle dried, ground, extracted in 75% Methanol, centrifuged and supernatant diluted to < 5% Methanol (Wilson et al 2008, Garcia et al 2010).
- Samples processed with Abraxis© ELISA Microcystin Kit
- Recovery efficiency: Muscle ~80%, Liver ~75% (comparable to literature values: 50-114%). All blanks returned 0.

Gizzard Shad

YOY Gizzard

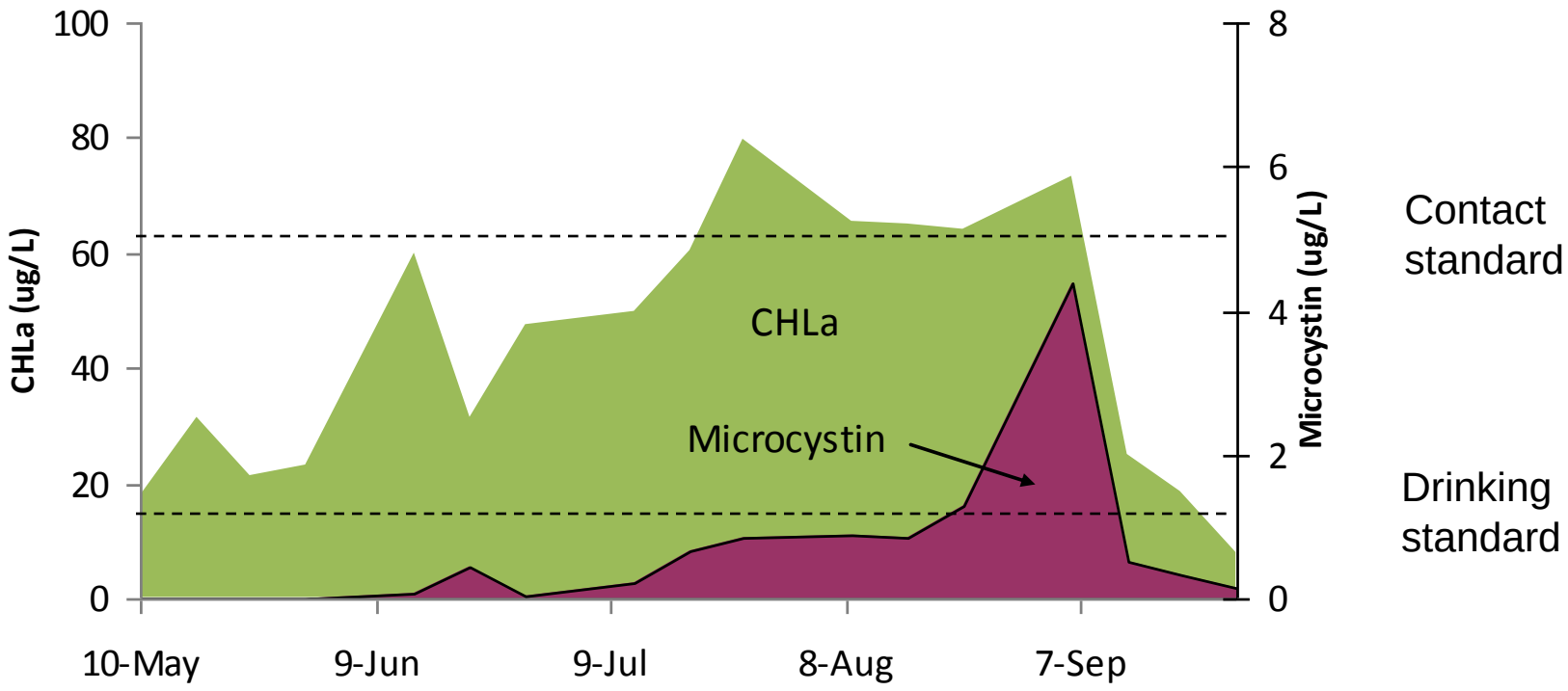
Atlantic Menhaden

Blue Catfish

Threadfin Shad

Clams (Rangia) & crabs also collected

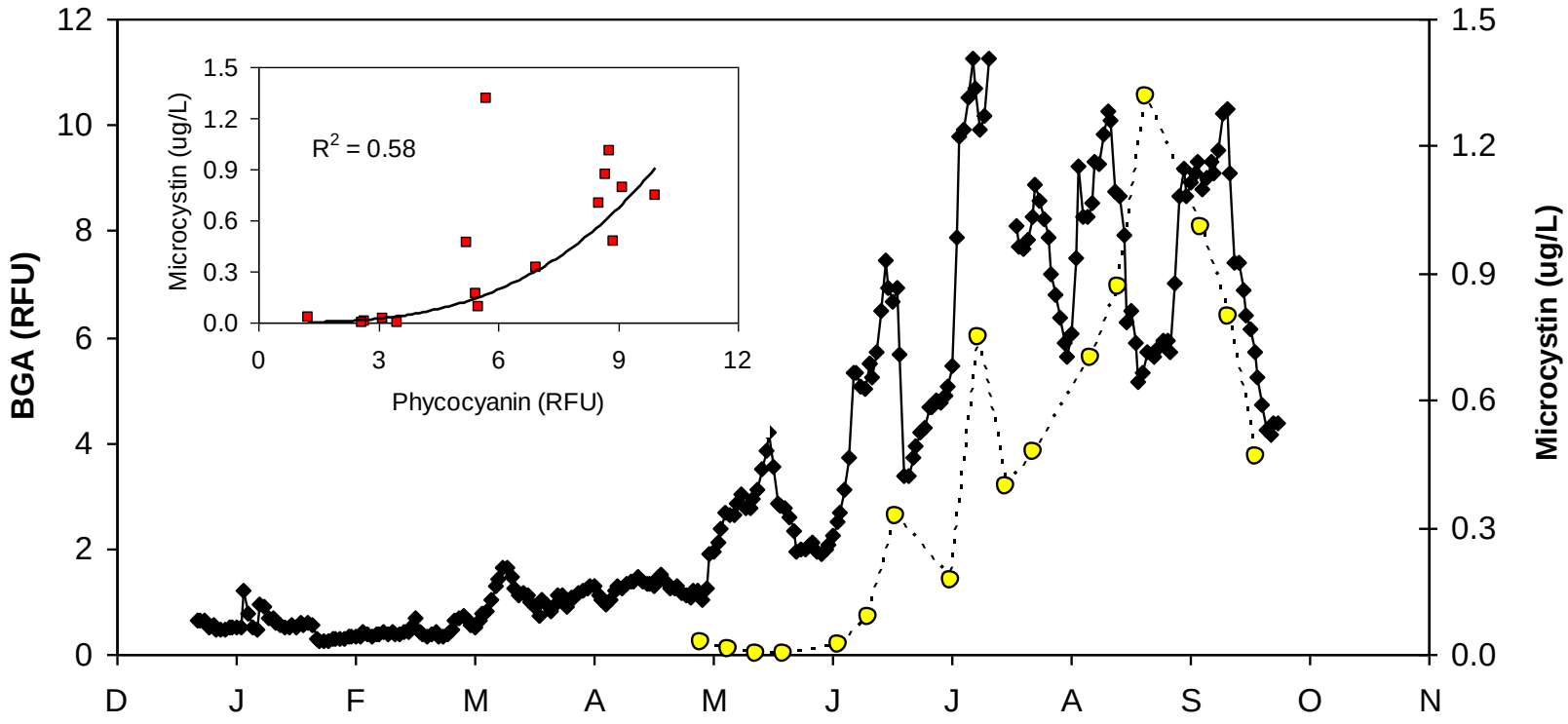
Microcystin in the James (2011)



Microcystin in tidal fresh James 2012

- Detected in 104 of 105 water samples during May through October.
- Detected in 11 of 60 sediment samples during same period.
- Detected in 254 of 379 (67%) individuals for fish and shellfish. Highest incidence of Microcystin contamination in blue crabs (viscera = 100%; muscle = 64%).

HAB Events 2012



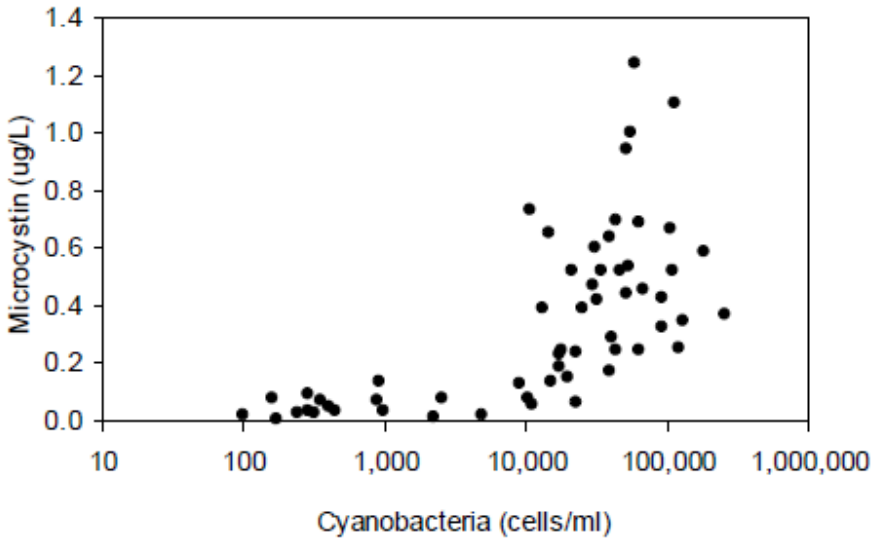
Continuous monitoring of cyanobacteria-specific pigments (phycocyanin) was found to be a useful predictor of toxin events.

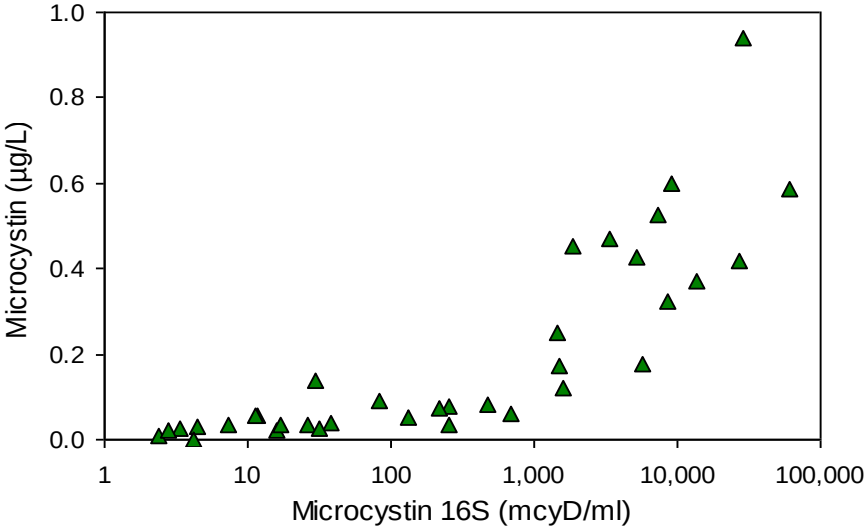
Tracking Toxin Producers

CHLa correlated with Microcystin, but low predictive power.

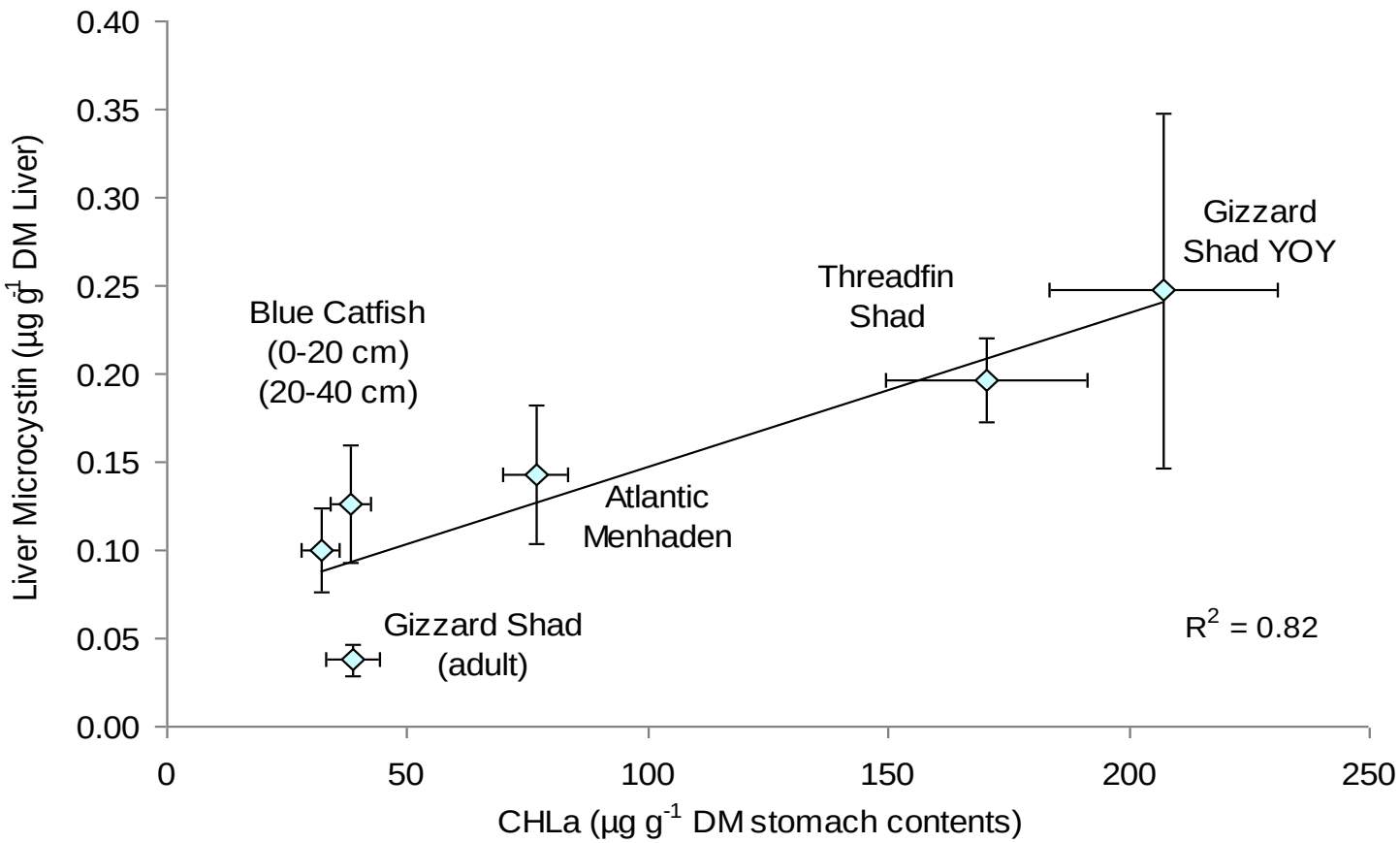
Cyanobacteria cell densities and copy numbers for mcyD gene significantly related to Microcystin (with strong threshold effects).

The number of copies of the toxin-coding gene was 20% of the total number of cyanobacteria gene copies. This proportion was higher (40%) during periods of elevated toxin concentration (July and August).

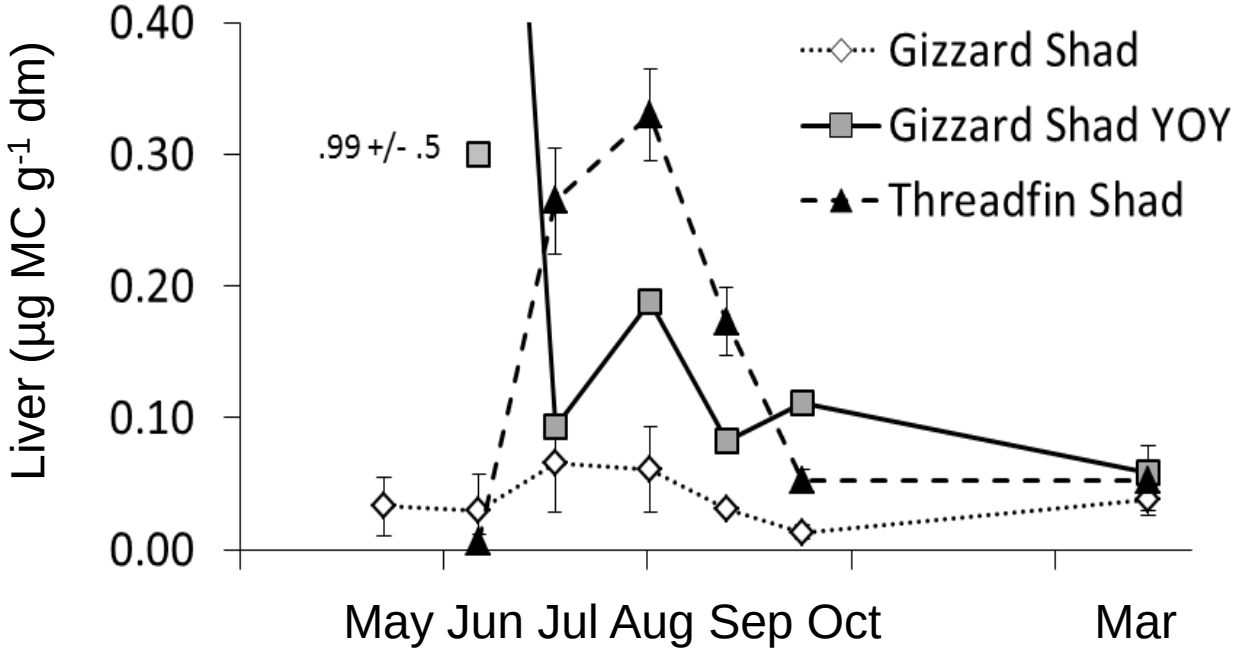




Microcystin in Fishes of the James

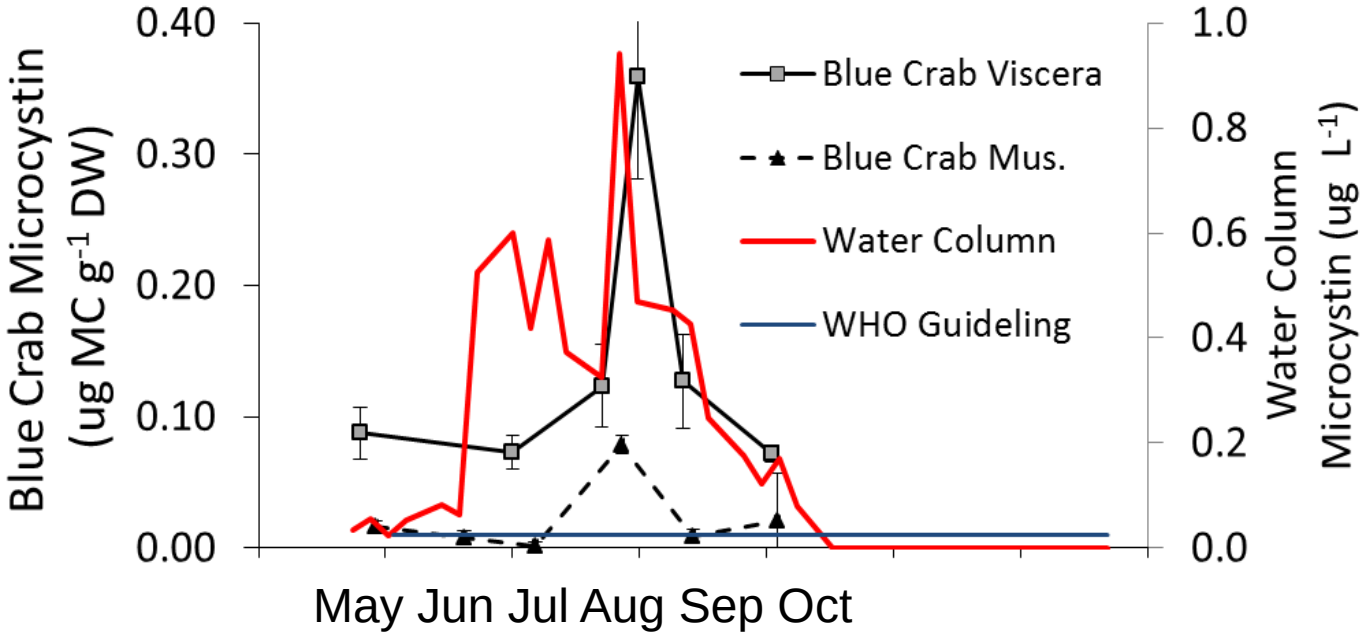


Microcystin in Fish Tissues



Seasonal patterns for fish tissues follow water column Microcystin concentrations, but toxin persists over-winter when undetected in water.

Microcystin in Shellfish



Toxin levels in blue crab muscle tissue exceeded WHO TDI guidelines in August (viscera concentrations exceeded TDI in all months).

Microcystin & Human Health Concerns in James River Estuary

- High concern: blue crabs exceed WHO TDI guidelines.
- Moderate concern: water column concentrations exceed standards for finished drinking water but not recreational contact.
- Low concern: fish tissue concentrations below TDI, low levels in game species.

Research Activities: 2013

- Continued monitoring of algal blooms and toxins in water and biota of the Upper James
- Toxic effects of Microcystin on plankton, shellfish, and fish.
- Downstream transport of toxin (to saline estuary)

Policy implications: Do current CHLa-based water quality standards and associated nutrient caps protect against impairments arising from cyanotoxin events?