# Physicochemical controls on suitable habitat and distribution of Didymosphenia geminata in the mid-Atlantic region

Matt Shank
SRBC
2016 AMAAB Annual Meeting
31 March 2016

#### Outline

- What is didymo?
- Current distribution in mid-Atlantic
- Physicochemical controls
- The Pine Creek experience
  - Temporal/spatial dynamics



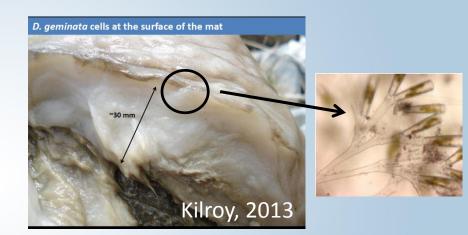
Didymo cell from West Branch Pine Creek, Nov 2015

Future Research

#### What is didymo?

- Didymosphenia geminata
  - 'rock snot'

Single celled diatom algae



- External cell wall composed of silica
- Can produce stalks for attachment to substrate (the nuisance part)

## **Ecology**

- Does not do well in eutrophic conditions
  - ("Didymo paradox")



Green algae bloom in eutrophic conditions



Didymo response to eutrophic conditions

- Didymo coverage negatively correlated with dissolved P
  - stalk length increased 250% after 2 weeks of nutrient deprivation!



Cullis et al. 2012; Sundareshwar et al. 2011; Kilroy and Bothwell, 2012

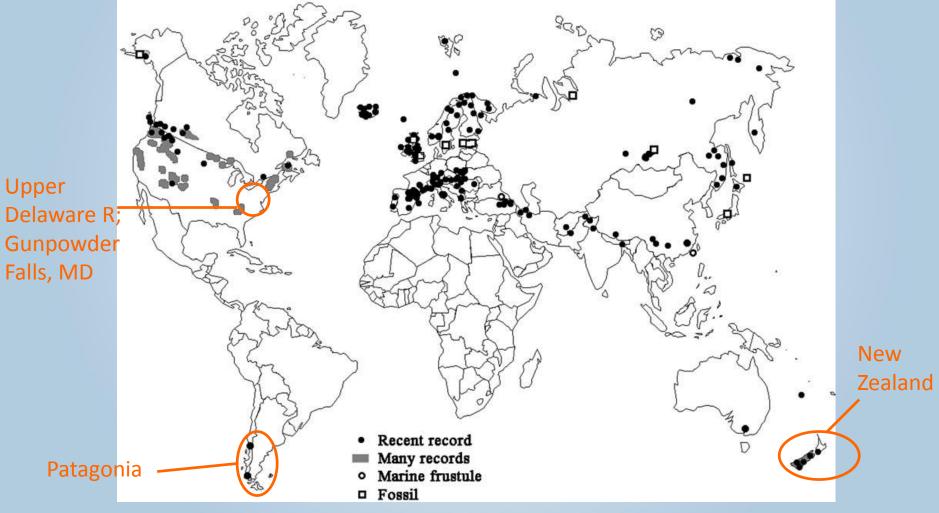
#### Didymo – Habitat Preferences

- Flow regulated areas (tailwaters)
  - Prevents scouring
- Large, rocky substrate
- Temperature range: 32-73°F
  - Highest didymo biomass where temp is below 64°F (18°C)
- Abundant ambient light
- pH values above neutral
- Low dissolved Phosphorus concentrations
  - oligotrophic

Rost et al 2011; James et al 2013; Kirkwood et al 2009; Kirkwood et al 2007

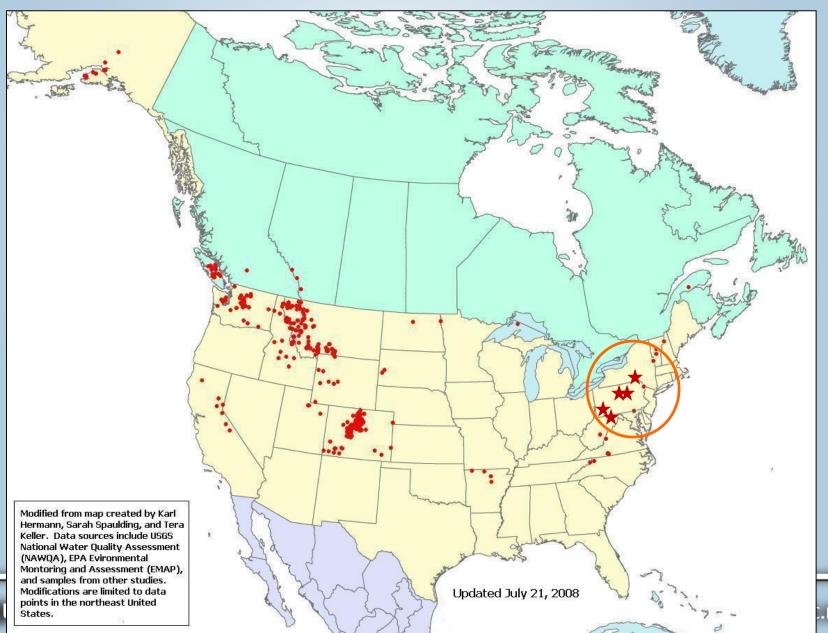


#### Current distribution



World-wide distribution of records for D. geminata. Recent nuisance blooms in orange. source Whitton et al., 2009

#### Current distribution



#### Current distribution

- Large nuisance blooms uncommon in native range historically
  - has recently been expanding range and bloom intensity within native range
- Previously, didymo was believed to be <u>introduced</u> largely because it kept showing up in high recreation areas (e.g. trout streams, tailwaters, etc..)
- Paradigm shifting research suggest didymo is <u>more historically widespread</u> than originally thought, just becoming a nuisance due to changing environmental conditions
  - Role of climate change and "oligotrophication"
  - Could be acting invasively in native range
- Not clear if didymo is native or introduced in mid-Atlantic

Lavery et al., 2014; Bothwell et al., 2014; Taylor and Bothwell, 2014

Didymo on sonde tube at W. Br Pine Ck

Susquehanna River Basin Commission

## **Didymo Impacts**

- Impacts to base trophic levels/benthic habitat/periphyton nutritional content
  - Displacement of native algae/ increase pollution tolerance
  - = Effects on nutrient cycling and ecosystem function

-implications for higher trophic levels (e.g. macros, fish)

- Impacts to macroinvertebrates
  - Macro diversity; Scrapers, etc. living on course substrates; EPT taxa
  - Chironomids and Oligochaets (pollution tolerant)
  - = Reduced assemblage diversity; taxonomic and functional homogenization
- Impacts to fish
  - Potential for didymo to smother trout redds, decreasing recruitment
  - Significant declines (50%) of brown trout population in S.D.
    - loss of EPT prey; impacts on the spawning success of brown trout
    - Reduced viability of eggs in redds

Reid and Torres 2014; Larson 2007; Richardson et. al, 2013; Ladrera et al. 2014; Kilroy et al. 2009; Bickel and Closs 2008; James and Chipps 2010

Upper Delaware R - DRBC



Burrowing mayfly (Ephemera)



Wild Brook Trout - Ninemile Run



#### Didymo impacts

#### Recreation:







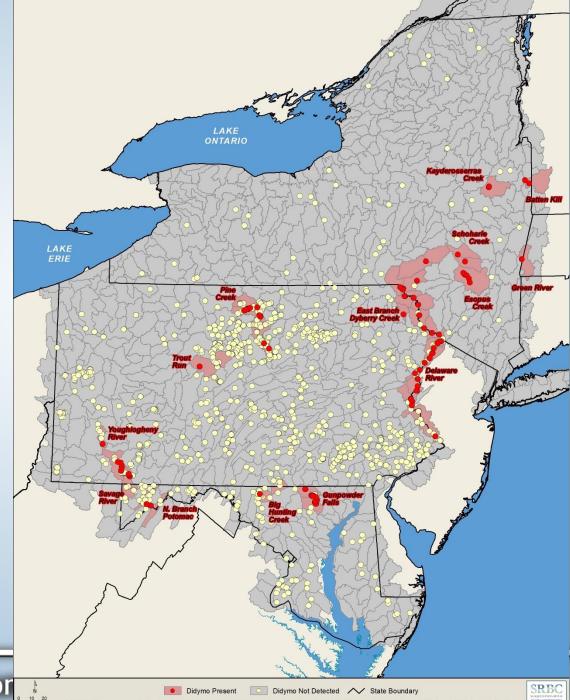


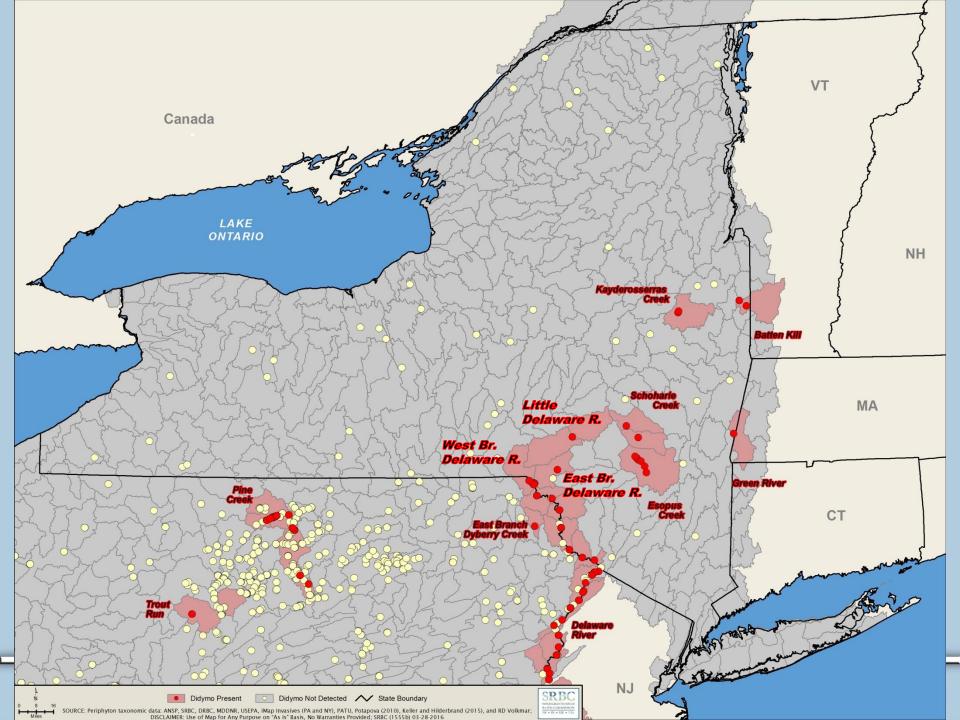


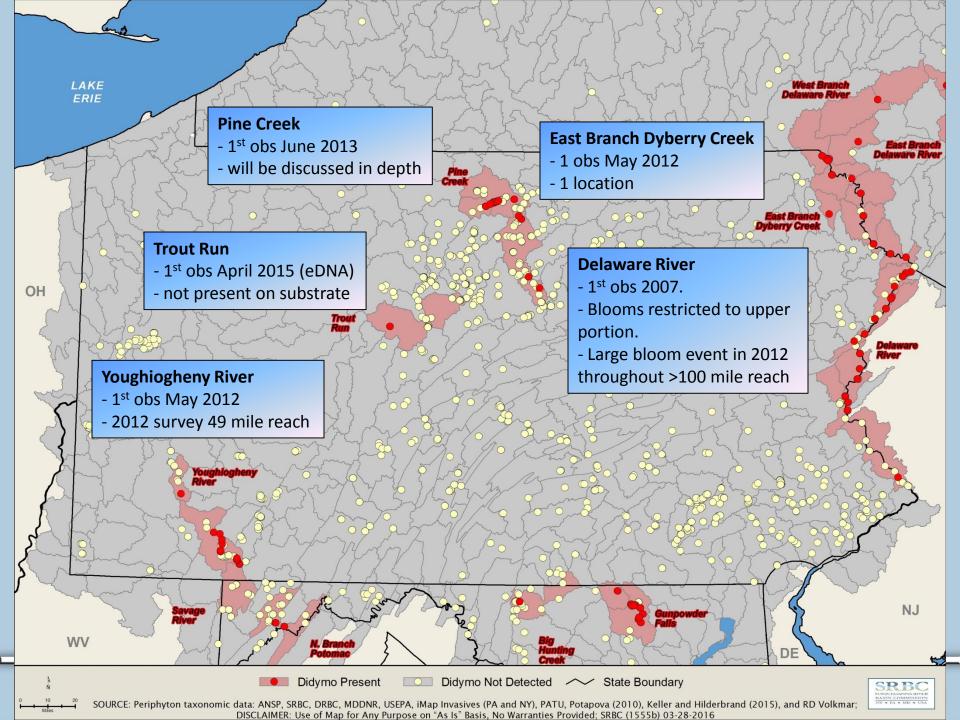


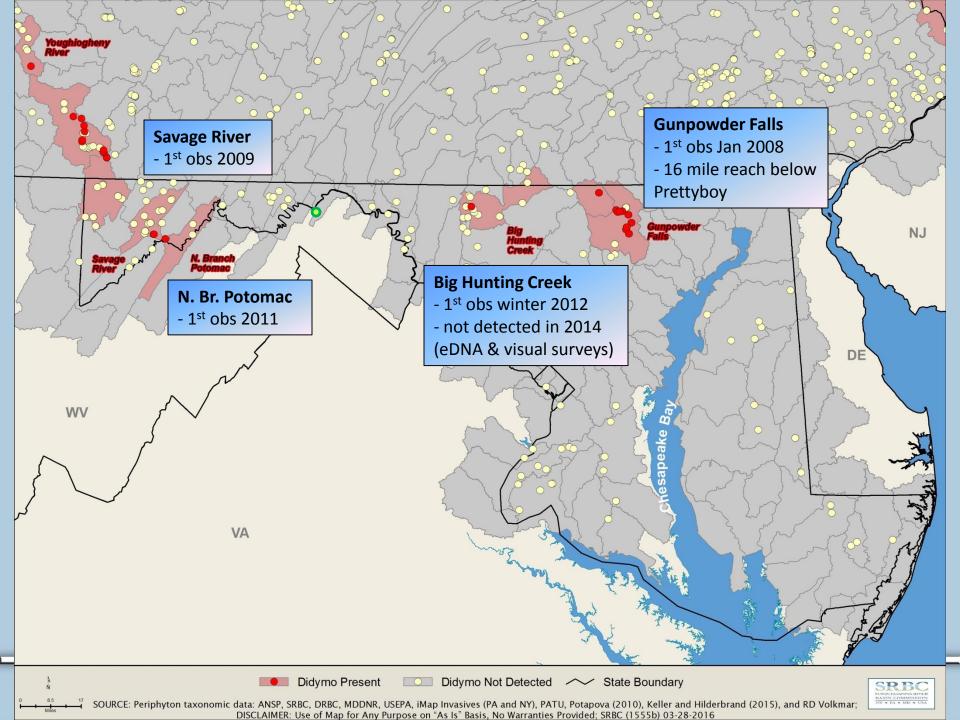
#### compiled 2451 records

- 397 positive
- 14 watersheds





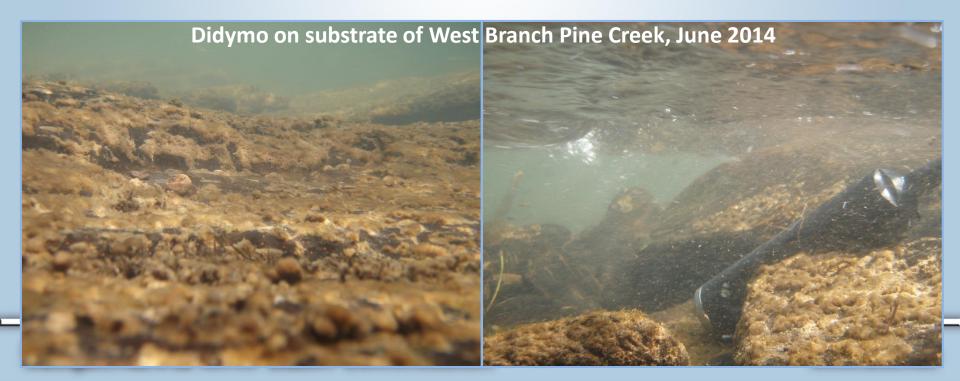




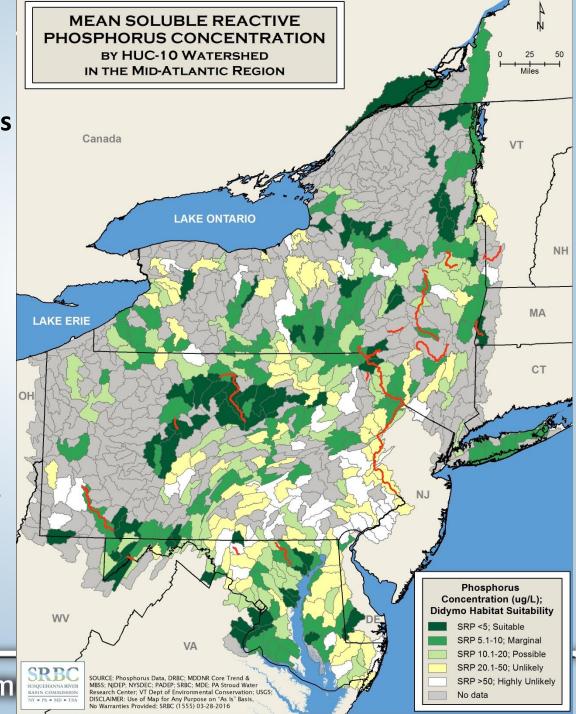
# What is controlling distribution?

Bothwell et al. (2014):

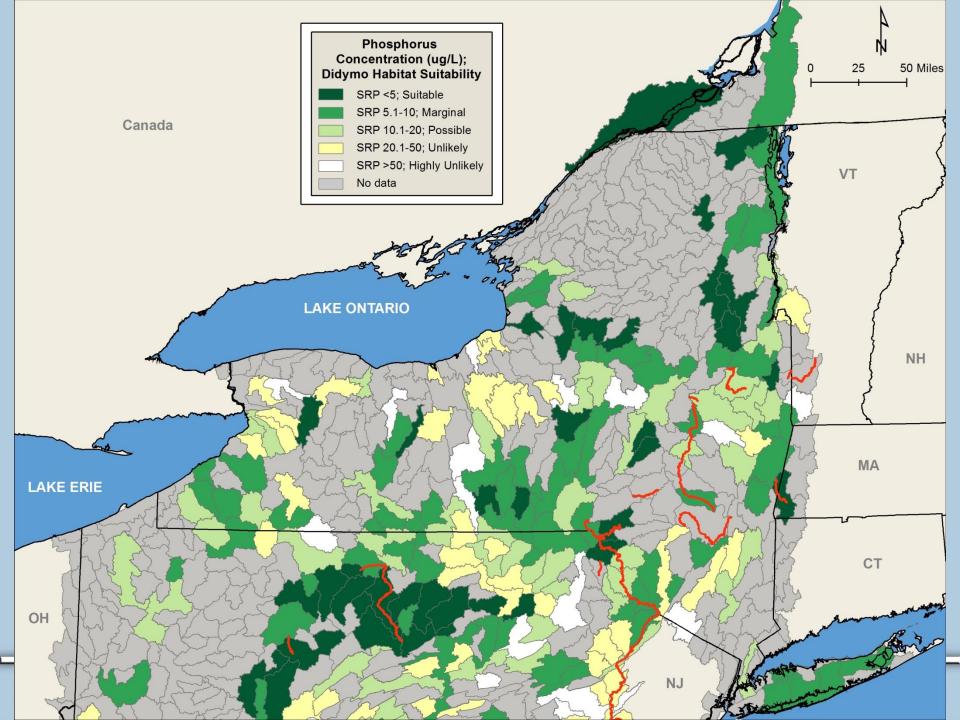
"Once the suite of physical (higher light, low turbidity, stable substratum and flow) and chemical (specific pH range, minimum Ca and Si, maximum Na and Cl) prerequisites are met, we have shown that it is the concentration of **soluble available P [SRP]** that explains the timing and spatial distribution of blooms where *D. geminata* cells are present."

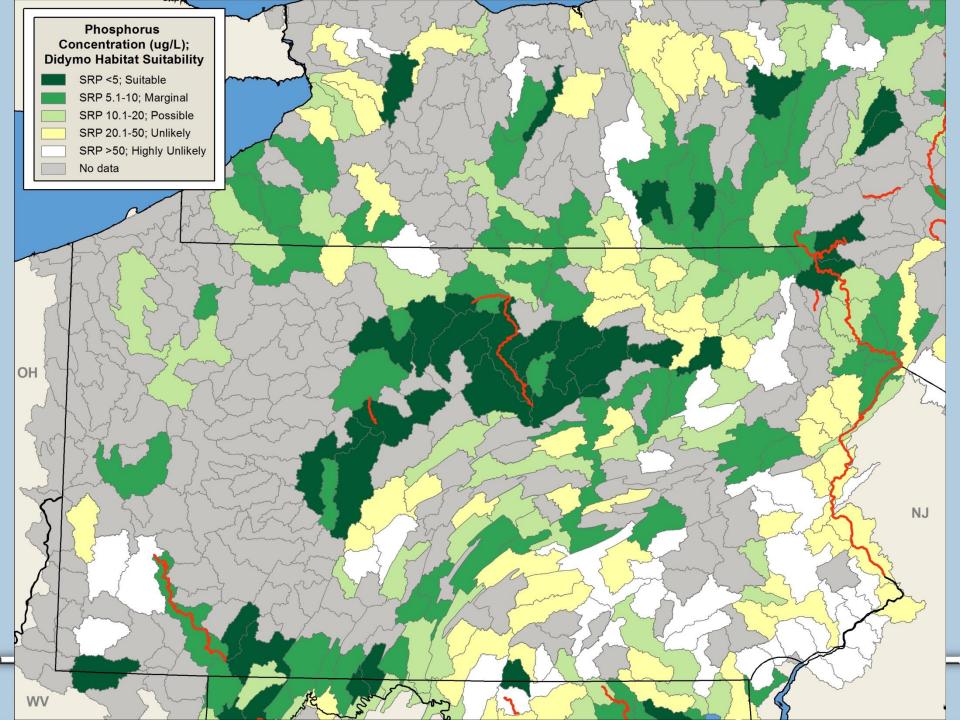


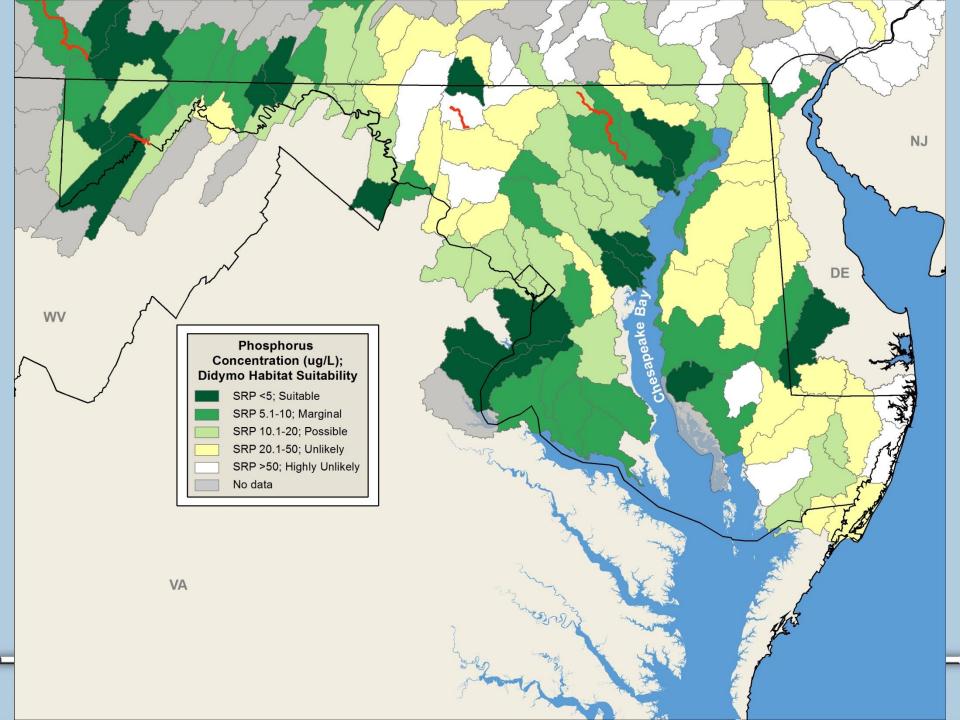
- compiled 35,607 SRP records
  - 2,576 in NY
  - 12,017 in PA
  - 21,014 in MD
- >1 obs in 358/725 HUC10 watersheds (49%)
- SRP <10 μg/l (didymo)</li>
- SRP <5 in PA non-tailwaters</li>

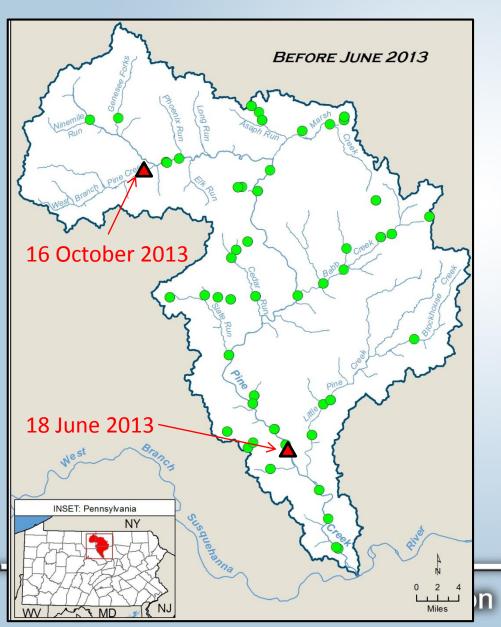


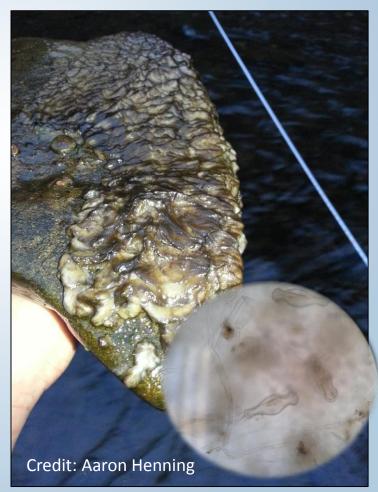
Susquehanna River Basin Com

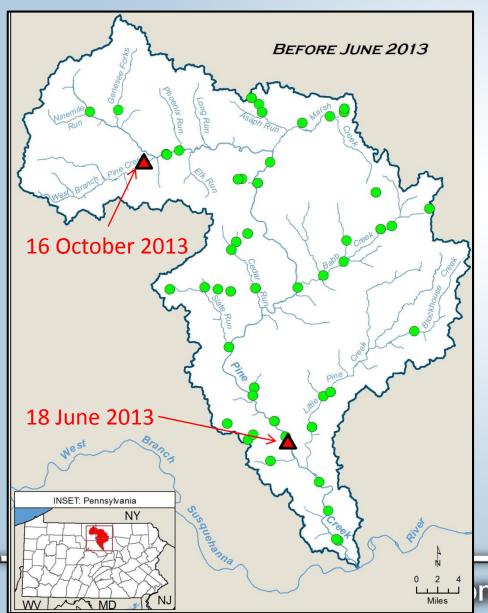




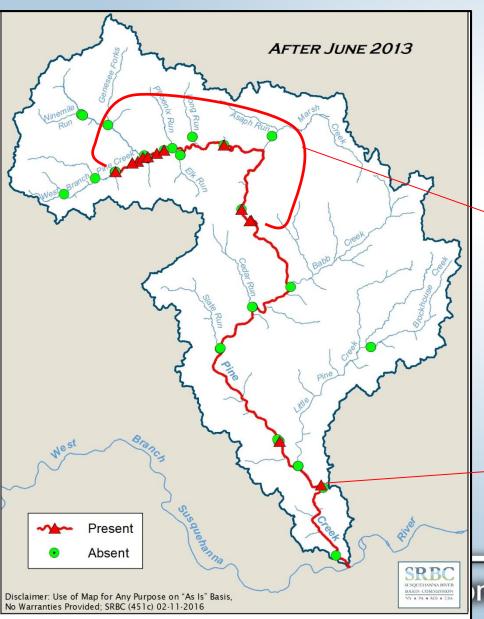




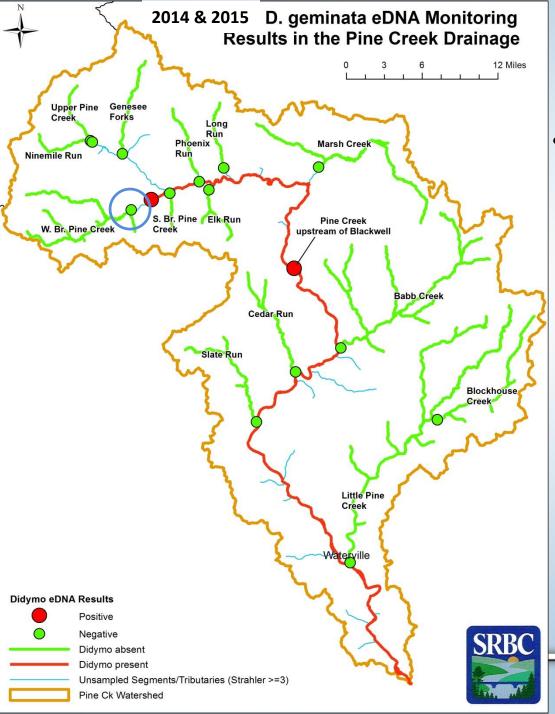




- 112 algal records
- 3 in close proximity to 1<sup>st</sup> discovery
- no evidence of didymo prior to 2013



- since 2013
  - 84 samples
  - 25 confirmed didymo
  - didymo on substrate from West Branch Pine Creek at Crippen Run downstream to Tiadaghton access in the Pine Creek gorge
  - cells detected in water column as far down as Ramsey



- repeated sampling using eDNA and microscopy did not detect presence of didymo:
  - Ninemile Run
  - Genesee Forks
  - Phoenix Run
  - Long Run
  - Elk Run
  - Marsh Creek
  - Babb Creek
  - Cedar Run
  - Slate Run
  - Blockhouse Creek
  - Little Pine Creek



Keller and Hilderbrand, 2015

# WELLSBORO Sampling Site With SRP Concentration (µg/I) Cell Density Site NPDES Discharge Town/Village Didymo Present 6000 4000 2000 1000 500 INSET: Pine Creek in Pennsylvania

# The Pine Creek Experience

 cell density highest in nutrient poor section high in watershed

 SRP inputs cause decrease in cell density moving downstream

- SRBC RWQMN station
  - $-70.6 \,\mathrm{mi^2}$
  - 4<sup>th</sup> order
  - 0.63% slope
  - Median 6/3/10 12/31/15:

• pH: 6.99

• Temp: 10.1 °C

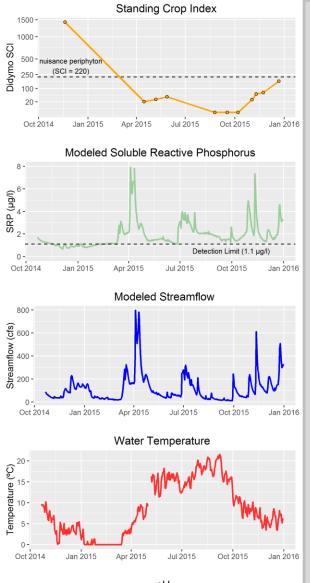
• SpCond: 45 μs/cm

• DO: 10.79 mg/l

• Turbidity: 1.6 NTU







7.5 -

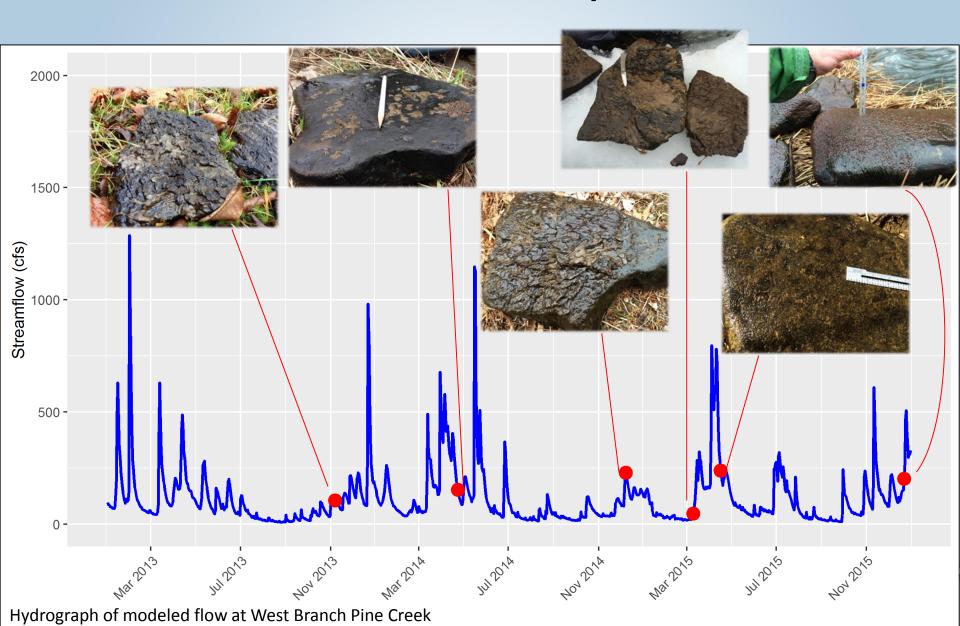
H<sub>6.5</sub> -

Oct 2014

Jan 2015

Jul 2015

- Standing Crop Index (visual assessment of didymo cover)
  - association with continuously monitored variables



#### **Future Research**

- Determine native/non-native status of didymo
  - Paleolimnological analysis of sedimentary diatom assemblages in riverine impoundments in NY, PA, & MD
- Fill presence/absence data gaps throughout mid-Atlantic
- Refine quantitative relationships between didymo presence/bloom formation and physicochemical variables



Continue to decontaminate field gear!



#### Acknowledgments



- Funding
  - PA Sea Grant, SRBC
- Collaborators
  - Marina Potapova, Kelly Maloney, Dan Spooner, Dale Honeyfield, Stephen Keller, Bob Hilderbrand
- Technical Assistance
  - Bob Volkmar, Jeff Zimmerman, Dawn Hintz, Graham Markowitz, Katie Kline, Jason Cessna
- Data Collection
  - Andy Leakey, Matt Elsasser, Aaron Henning, Blake Maurer, Luanne Steffy,
     Dave Haklar, John Balay
- Data Compilation
  - Erik Silldorff, Bob Limbeck, Tim Daley, Jeff Butt, Josh Lookenbill, Rick Spear,
     Michael Kashiwagi, Katherine Hanna, Jason Cessna, Katie Dunlap, Jake Lemon,
     Heidi Krahling

## Questions?

mshank@srbc.net

Link to report on PA didymo research:

http://seagrant.psu.edu/topics/invasive-species/research/didymosphenia-geminata-pennsylvania-investigation-current-and

Didymo on bedrock in upper Pine Creek, June 2014