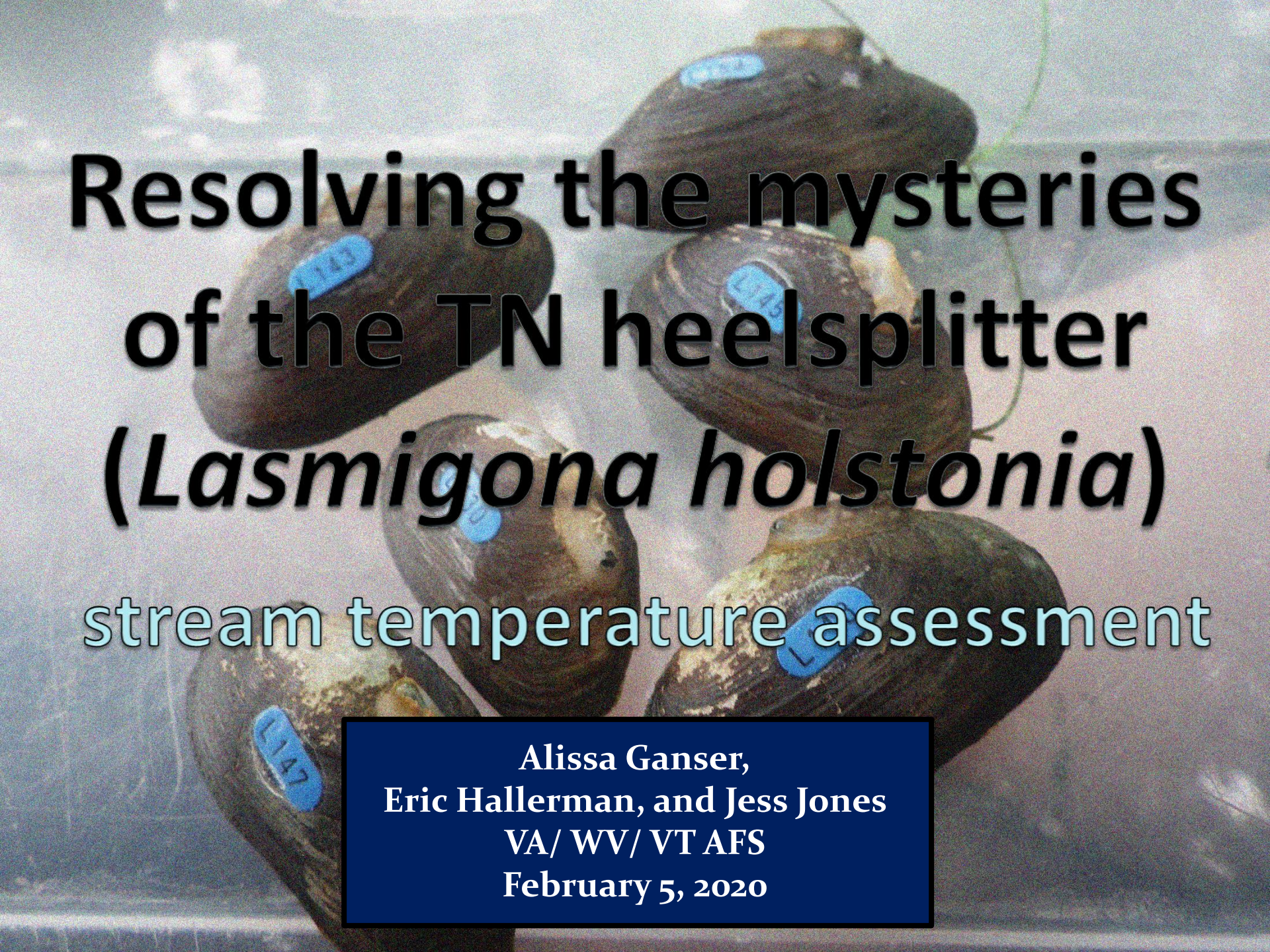


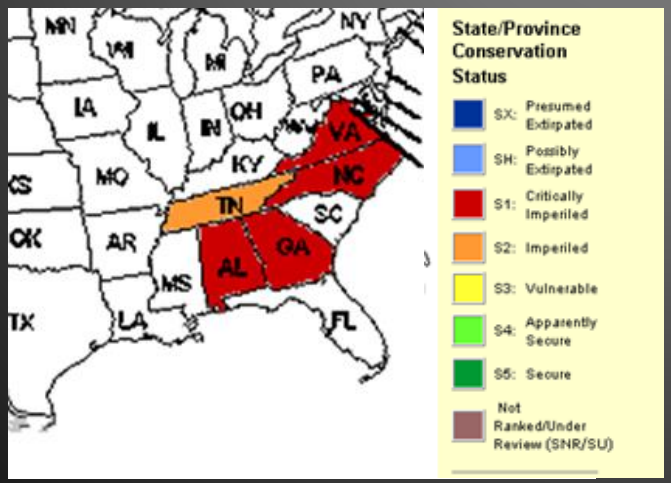
Resolving the mysteries of the TN heelsplitter (*Lasmigona holstonia*)

stream temperature assessment

Alissa Ganser,
Eric Hallerman, and Jess Jones
VA/ WV/ VT AFS
February 5, 2020

Lasmigona holstonia

- Tennessee heelsplitter
- Candidate for listing under ESA
- State endangered in VA
- Habitat: small, fine sand/mud streams where few to no other mussel species occur, other characteristics unknown




Plum Creek, VA

NatureServe

slideshare.net/mcclungmuseum/cumberlandian-mussel-types

What we know so far

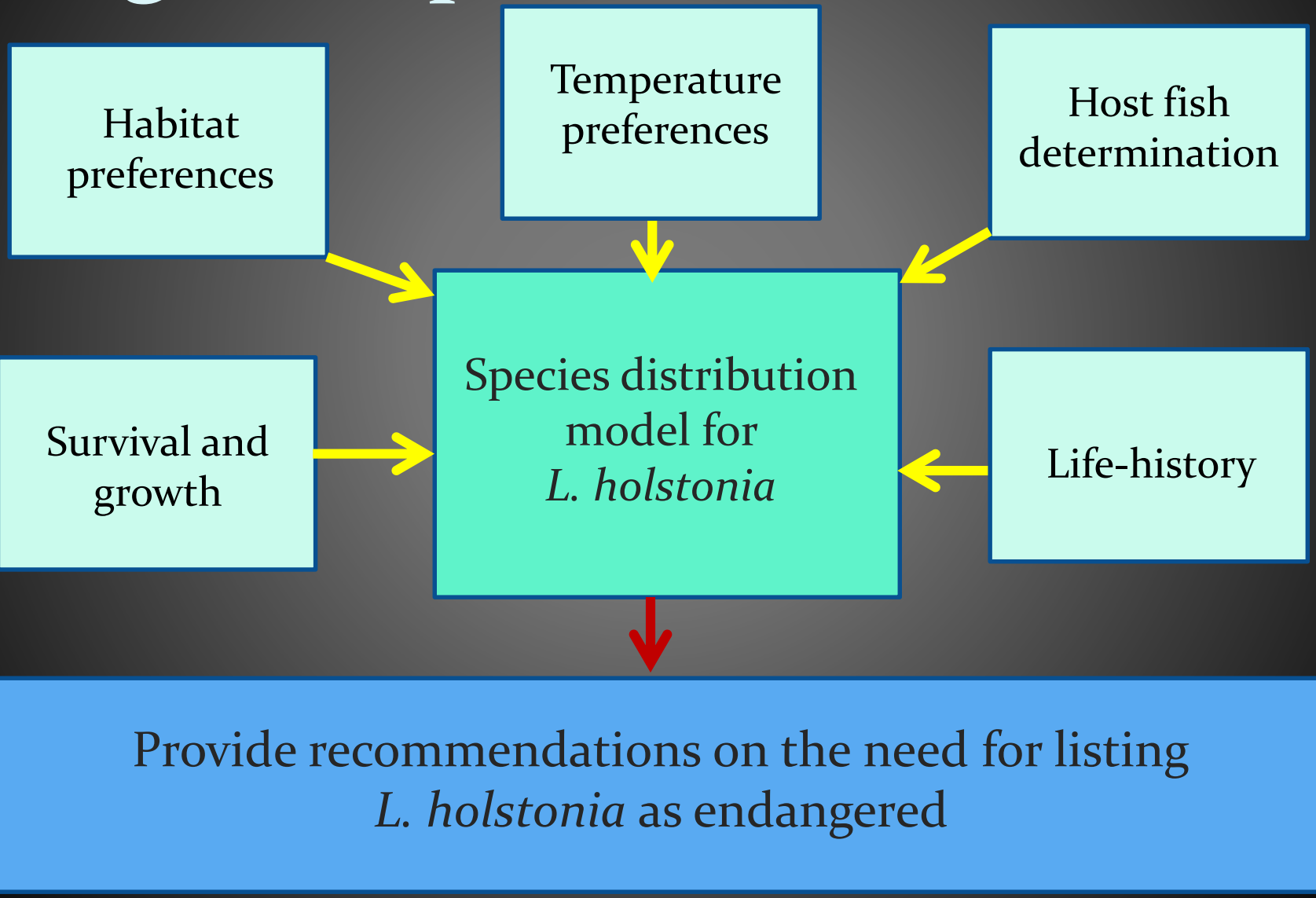
- *Lasmigona holstonia*…
  - Prefers streams with a cold ground-water inflow
  - Likely buries during warm months to find cold water and returns to sediment surface to reproduce in the fall
    - Records of *L. holstonia* burrowing 30+ cm into substrate

- But…what range of temperatures are mussels experiencing? Where do mussels occur?
  - Mussels are ectotherms and are regulated by temperature
  - Geographic locations determined by temperature
  - **Need to know temperature preference to determine where this species occurs**

Importance of temperature

- Cold water species likely to be affected by rising water temperatures
  - Climate change
  - Deforestation
  - Urbanization (pavement run-off)
- Establishing a temperature range likely important for conservation

Larger scope

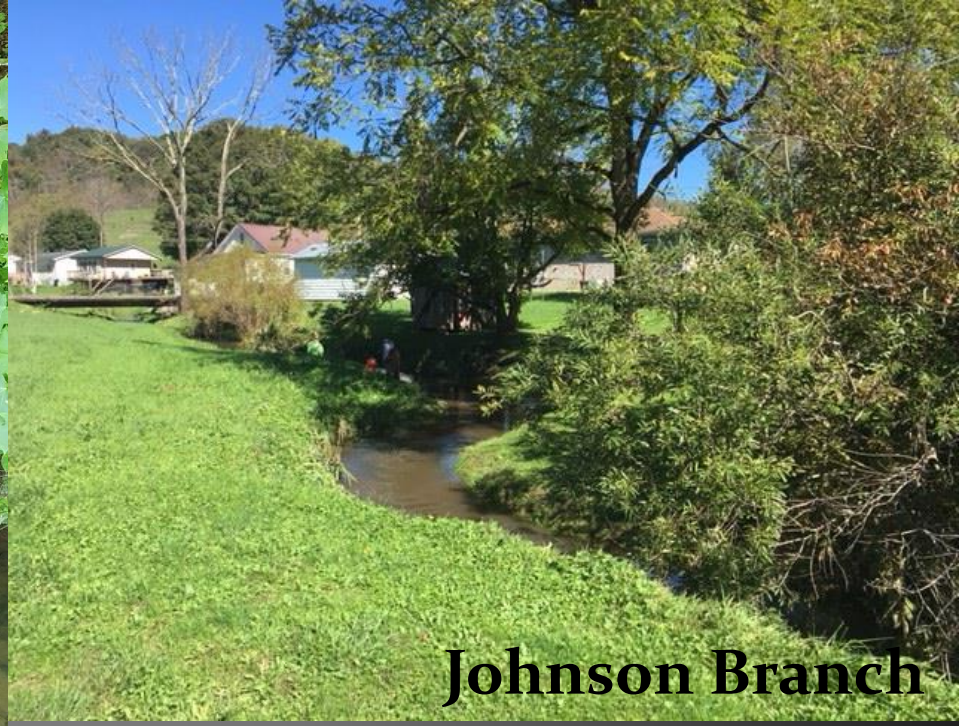


Site selection

- Five sites total, four VA and one TN
  - All VA sites active *L. holstonia* monitoring sites
  - TN site recently discovered

Site	River system
NF Clinch	North Fork Clinch, VA
Johnson Branch	Clinch, VA
Crab Orchard Creek	New, VA
Dunford Park	South Fork Clinch, VA
Cloud Branch	Ocoee, TN


North Fork Clinch


Johnson Branch


Crab Orchard Creek

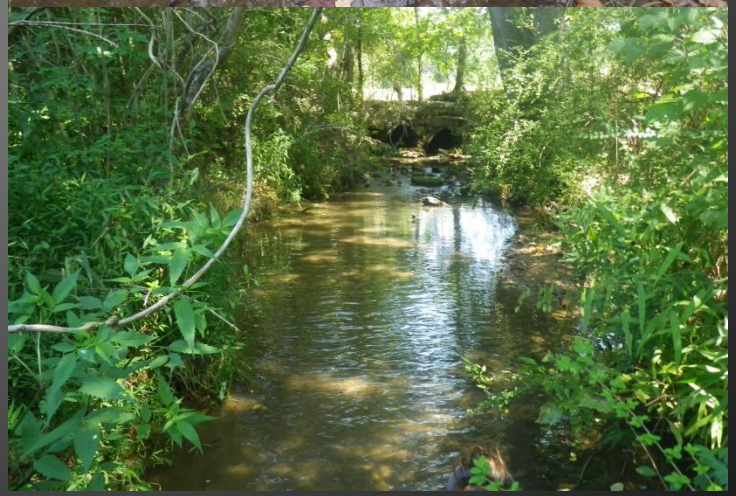
- Loose sand, silt, and bedrock substrate
- Fairly consistent tree cover
- All pretty shallow

Dunford Park – South Fork Clinch

- Meanders through flat plain
  - Little to no tree cover
- Prone to quick increases in water depth and flow during rain events
- Riparian enhancement ongoing
  - Prevent bank erosion
  - Increase cover
  - Improve habitat

Cloud Branch – Ocoee River

- Small, straight stream
- Heavily shaded
- Silt banks
- Agricultural area



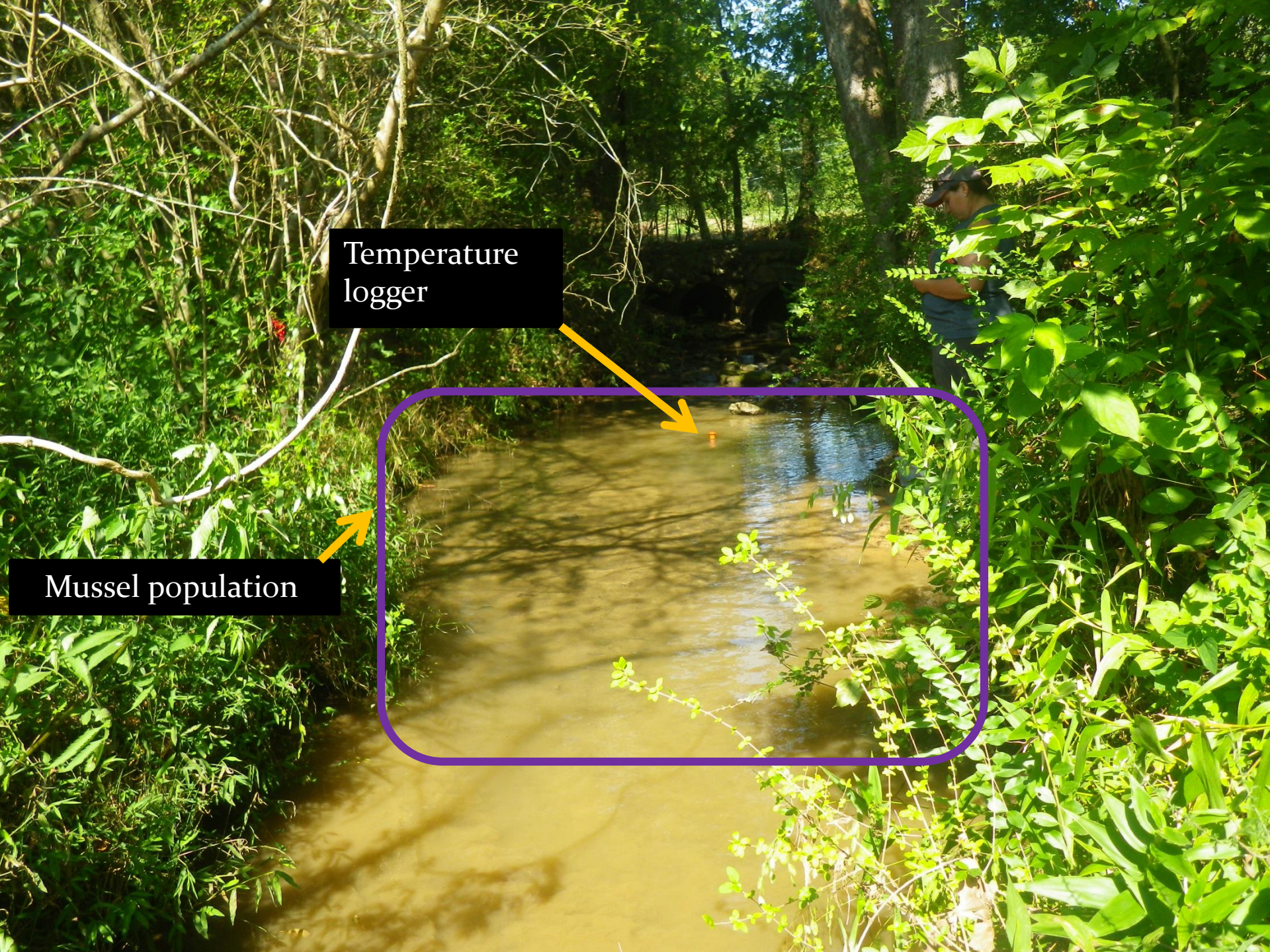
Temperature Assessment

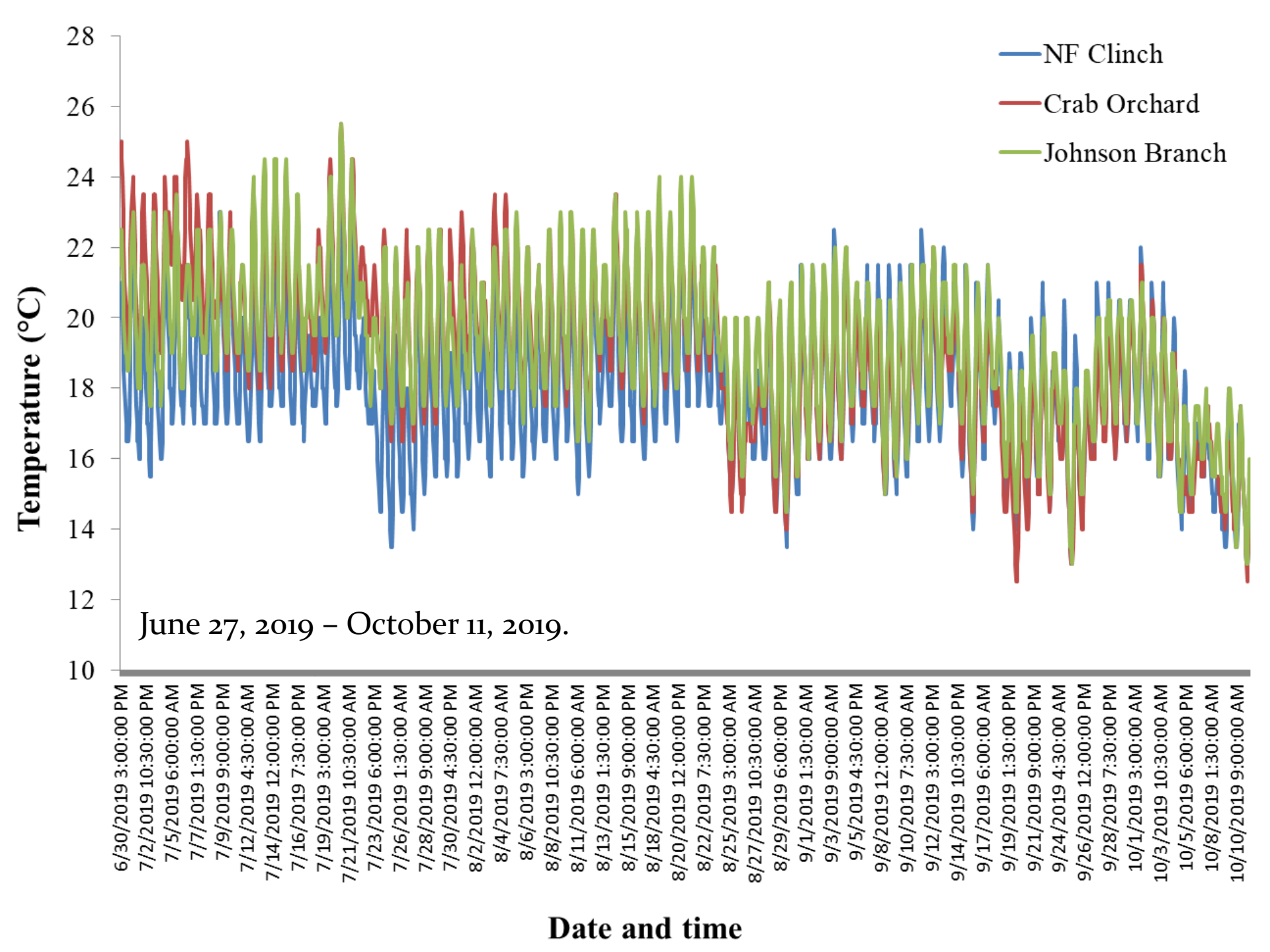
- Ibutton temperature loggers
  - Contained in PVC chambers affixed to rebar
- Temperature recording every 90 minutes
  - Data downloaded and replaced every 128 days

Temperature assessment

- Loggers placed 20 cm above sediment-water interface
  - Difference between above sediment and below sediment temperatures?
    - Loggers buried ≥30 cm at two sites

Site	River system	Logger location(s)	Start date
NF Clinch 1	NF Clinch, VA	In-stream (1)	June 27, 2019
Johnson Branch	Clinch, VA	In-stream (1)	June 27, 2019
Crab Orchard Creek	New, VA	In-stream (1)	June 27, 2019
Dunford Park	SF Clinch, VA	In-stream (1), buried (1)	June 26, 2019
Cloud Branch	Ocoee, TN	In-stream (1), buried (1)	July 16, 2019


Temperature logger
Mussel population

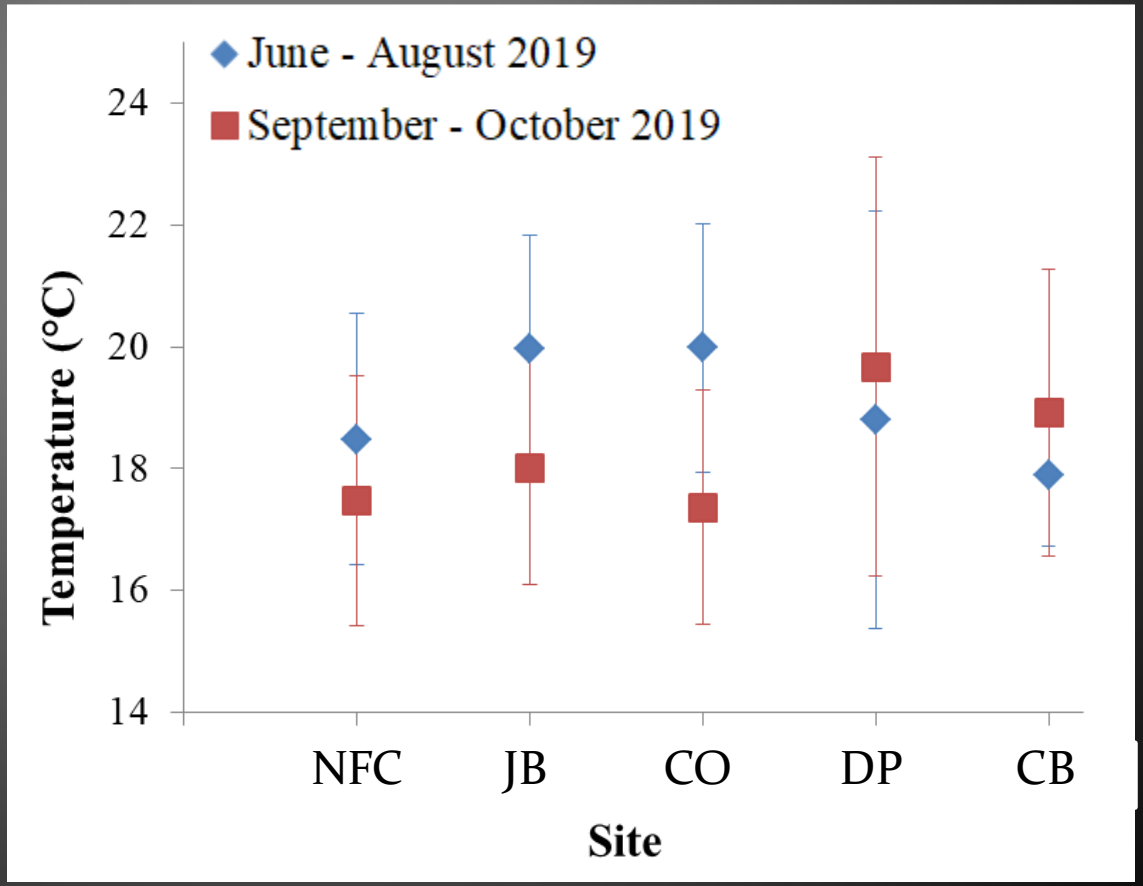

NF Clinch
Crab Orchard
Johnson Branch
Temperature (°C)
28
26
24
22
20
18
16
14
12
10
June 27, 2019 – October 11, 2019.
6/30/2019 3:00:00 PM
7/2/2019 10:30:00 PM
7/5/2019 6:00:00 AM
7/7/2019 1:30:00 PM
7/9/2019 9:00:00 PM
7/12/2019 4:30:00 AM
7/14/2019 12:00:00 PM
7/16/2019 7:30:00 PM
7/19/2019 3:00:00 AM
7/21/2019 10:30:00 AM
7/23/2019 6:00:00 PM
7/26/2019 1:30:00 AM
7/28/2019 9:00:00 AM
7/30/2019 4:30:00 PM
8/2/2019 12:00:00 AM
8/4/2019 7:30:00 AM
8/6/2019 3:00:00 PM
8/8/2019 10:30:00 PM
8/11/2019 6:00:00 AM
8/13/2019 1:30:00 PM
8/15/2019 9:00:00 PM
8/18/2019 4:30:00 AM
8/20/2019 12:00:00 PM
8/22/2019 7:30:00 PM
8/25/2019 3:00:00 AM
8/27/2019 10:30:00 AM
8/29/2019 6:00:00 PM
9/1/2019 1:30:00 AM
9/3/2019 9:00:00 AM
9/5/2019 4:30:00 PM
9/8/2019 12:00:00 AM
9/10/2019 7:30:00 AM
9/12/2019 3:00:00 PM
9/14/2019 10:30:00 PM
9/17/2019 6:00:00 AM
9/19/2019 1:30:00 PM
9/21/2019 9:00:00 PM
9/24/2019 4:30:00 AM
9/26/2019 12:00:00 PM
9/28/2019 7:30:00 PM
10/1/2019 3:00:00 AM
10/3/2019 10:30:00 AM
10/5/2019 6:00:00 PM
10/8/2019 1:30:00 AM
10/10/2019 9:00:00 AM
Date and time

		June – August 2019			September – October 2019		
Site	**River system**	**Average (°C) ± SE**	**Min (°C)**	**Max (°C)**	**Average (°C) ± SE**	**Min (°C)**	**Max (°C)**
NF Clinch	North Fork Clinch, VA	18.5 (±2.1)	13.5	24	17.5 (±2.0)	13.5	24
Johnson Branch	Clinch, VA	20.0 (±1.9)	14.5	25.5	18.0 (±1.9)	14.5	25.5
Crab Orchard Creek	New, VA	20.0 (±2.0)	14.0	25.5	17.3 (±1.9)	14.0	25.5
Dunford Park	South Fork Clinch	18.8 (±3.4)	12.5	28.5	19.7 (±3.4)	12	28
Cloud Branch	Ocoee	17.9 (±1.2)	15	21	18.9 (±2.4)	15	27

Temperature assessment

- Average daily water temperatures

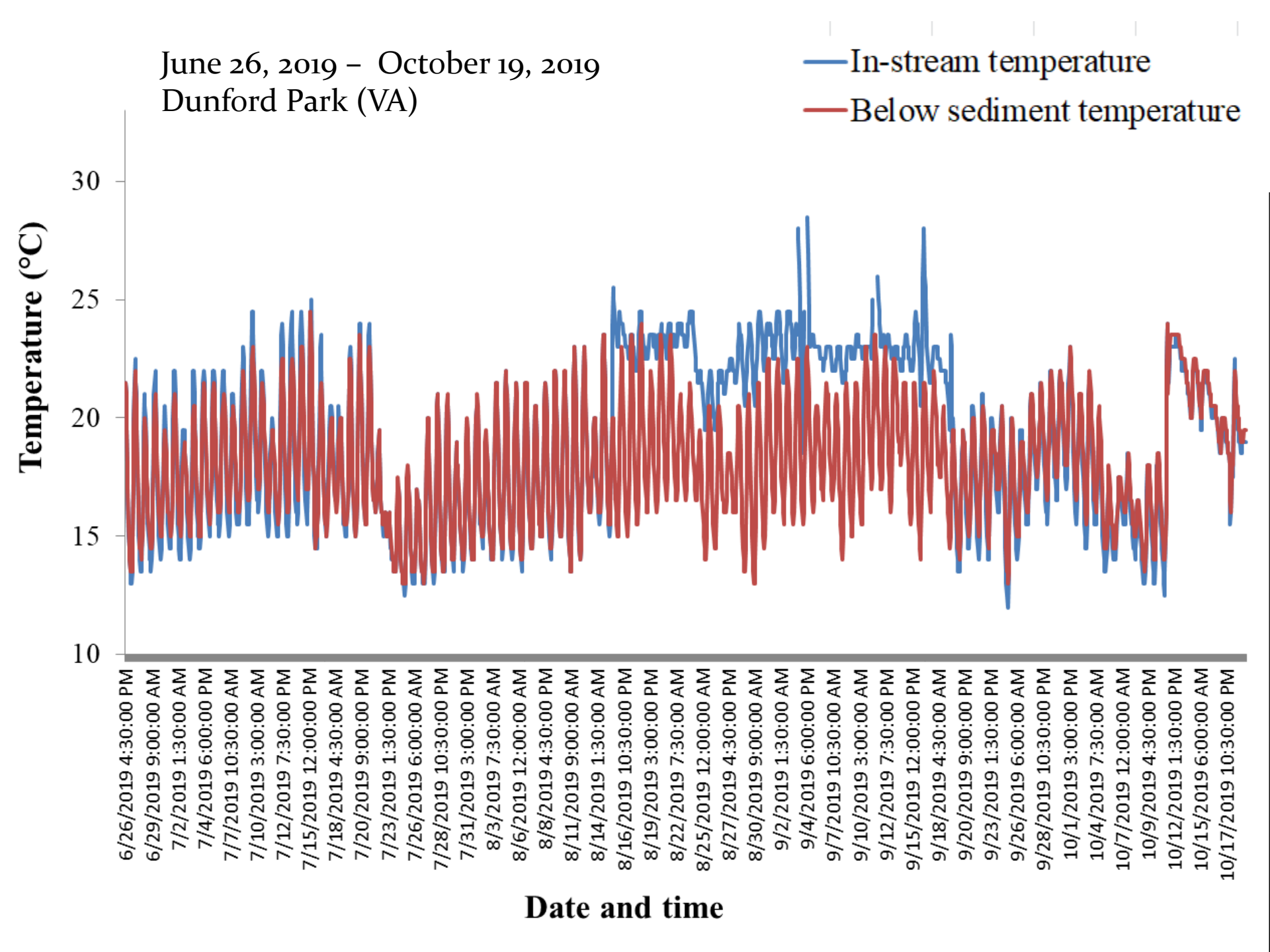
NFC = North Fork Clinch
JB = Johnson Branch
CO = Crab Orchard Creek
DP = Dunford Park
CB = Cloud Branch



Temperature assessment

- Mussels experienced a range of water temperatures from 12 – 28.5°C in summer through fall 2019
- Mussels frequently experience a 5 – 7°C change in water temperature over a 24 h period
- Drought conditions plus low water levels could have contributed to higher average fall water temperatures

- Is there any difference between above sediment and below sediment temperatures?


June 26, 2019 – October 19, 2019
Dunford Park (VA)
In-stream temperature
Below sediment temperature
Temperature (°C)
30
25
20
15
10
6/26/2019 4:30:00 PM
6/29/2019 9:00:00 AM
7/2/2019 1:30:00 AM
7/4/2019 6:00:00 PM
7/7/2019 10:30:00 AM
7/10/2019 3:00:00 AM
7/12/2019 7:30:00 PM
7/15/2019 12:00:00 PM
7/18/2019 4:30:00 AM
7/20/2019 9:00:00 PM
7/23/2019 1:30:00 PM
7/26/2019 6:00:00 AM
7/28/2019 10:30:00 PM
7/31/2019 3:00:00 PM
8/3/2019 7:30:00 AM
8/6/2019 12:00:00 AM
8/8/2019 4:30:00 PM
8/11/2019 9:00:00 AM
8/14/2019 1:30:00 AM
8/16/2019 10:30:00 PM
8/19/2019 3:00:00 PM
8/22/2019 7:30:00 AM
8/25/2019 12:00:00 AM
8/27/2019 4:30:00 PM
8/30/2019 9:00:00 AM
9/2/2019 1:30:00 AM
9/4/2019 6:00:00 PM
9/7/2019 10:30:00 AM
9/10/2019 3:00:00 AM
9/12/2019 7:30:00 PM
9/15/2019 12:00:00 PM
9/18/2019 4:30:00 AM
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9/26/2019 6:00:00 AM
9/28/2019 10:30:00 PM
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10/4/2019 7:30:00 AM
10/7/2019 12:00:00 AM
10/9/2019 4:30:00 PM
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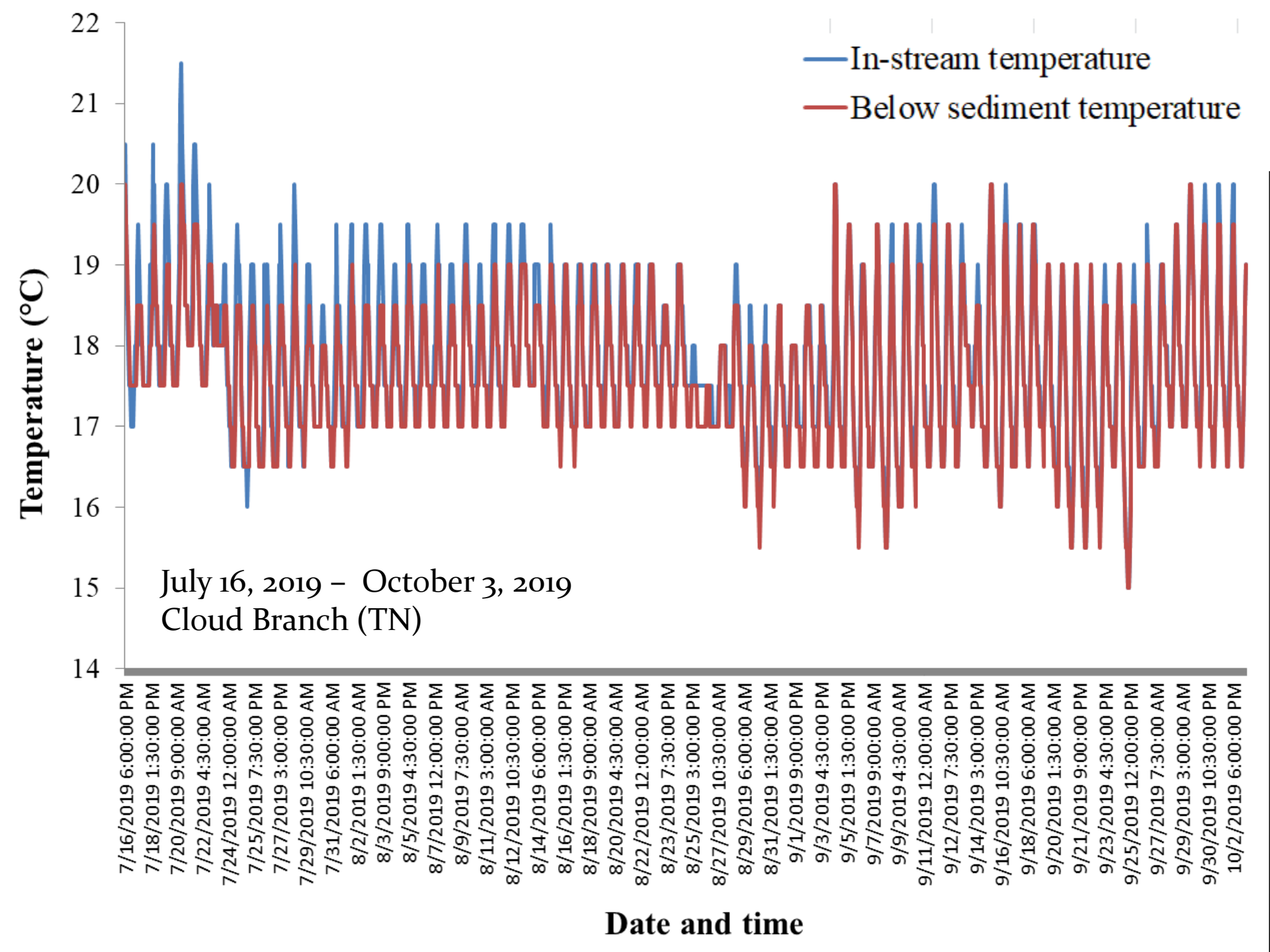
10/15/2019 6:00:00 AM
10/17/2019 10:30:00 PM
Date and time


In-stream temperature
Below sediment temperature
July 16, 2019 – October 3, 2019
Cloud Branch (TN)
Temperature (°C)
Date and time
22
21
20
19
18
17
16
15
14
7/16/2019 6:00:00 PM
7/18/2019 1:30:00 PM
7/20/2019 9:00:00 AM
7/22/2019 4:30:00 AM
7/24/2019 12:00:00 AM
7/25/2019 7:30:00 PM
7/27/2019 3:00:00 PM
7/29/2019 10:30:00 AM
7/31/2019 6:00:00 AM
8/2/2019 1:30:00 AM
8/3/2019 9:00:00 PM
8/5/2019 4:30:00 PM
8/7/2019 12:00:00 PM
8/9/2019 7:30:00 AM
8/11/2019 3:00:00 AM
8/12/2019 10:30:00 PM
8/14/2019 6:00:00 PM
8/16/2019 1:30:00 PM
8/18/2019 9:00:00 AM
8/20/2019 4:30:00 AM
8/22/2019 12:00:00 AM
8/23/2019 7:30:00 PM
8/25/2019 3:00:00 PM
8/27/2019 10:30:00 AM
8/29/2019 6:00:00 AM
8/31/2019 1:30:00 AM
9/1/2019 9:00:00 PM
9/3/2019 4:30:00 PM
9/5/2019 1:30:00 PM
9/7/2019 9:00:00 AM
9/9/2019 4:30:00 AM
9/11/2019 12:00:00 AM
9/12/2019 7:30:00 PM
9/14/2019 3:00:00 PM
9/16/2019 10:30:00 AM
9/18/2019 6:00:00 AM
9/20/2019 1:30:00 AM
9/21/2019 9:00:00 PM
9/23/2019 4:30:00 PM
9/25/2019 12:00:00 PM
9/27/2019 7:30:00 AM
9/29/2019 3:00:00 AM
9/30/2019 10:30:00 PM
10/2/2019 6:00:00 PM

Results

- Sediments generally between cooler than in-stream water temperature
  - 1 – 8°C cooler in Dunford Park
  - 0.5°C – 3°C in Cloud Branch
- Sediments may act as a thermal buffer during warm months
  - Similar results observed in the Upper Mississippi River
    - Observed up to 7.5°C cooler in sediments

Points to consider

- 2019 was a drought year
  - Average daily water temperatures may have been higher than non-drought years
  - October 3, 2019…97°F at Cloud Branch (TN)
- Hope to continue this project for at least another year

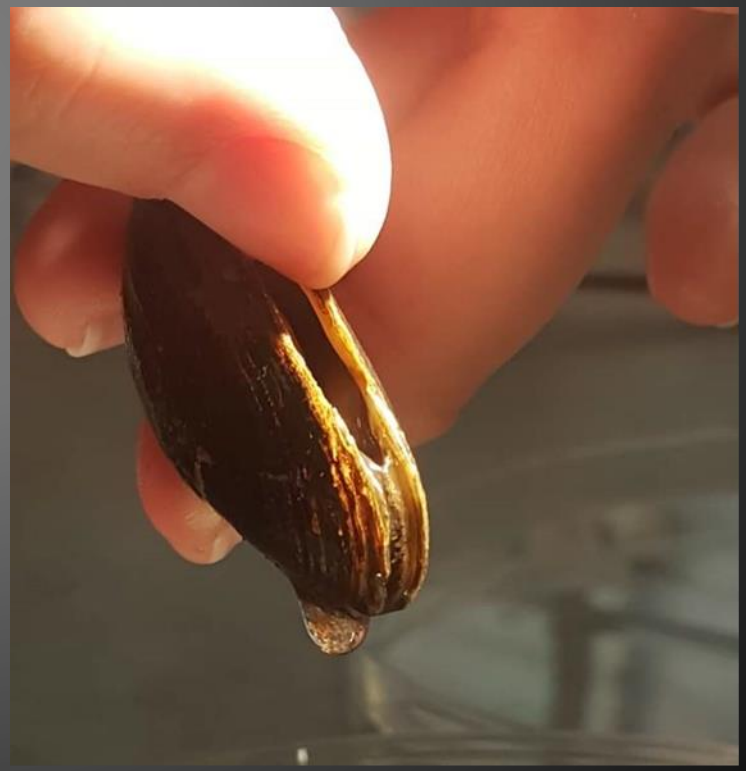


Photo by Tiffany Leach

Take-away

- Mussel location depends on temperature
- Temperature data will help pinpoint possible *L. holstonia* streams
- Data will be used to provide recommendations on the need for listing *L. holstonia*

- VDGIF
  - Brian Watson
  - Tim Lane (AWCC)
  - Sarah Colletti (AWCC)
  - Tiffany Leach (AWCC)
  - Joe Ferraro (AWCC)
- Ocoee Mist owners, residents, and staff

- Rose Agbalog (FWS)
- Braven Beaty (Nature Conservancy)
- Gerry Dinkins (UT)
- Barb Dinkins (DBC)
- Steve Ahlstedt
- Don Hubbs (TWRA)
- Kristen Irwin (UT)
- Andrew Henderson (FWS)

- VT/ FMCC
  - Katie Ortiz
  - Emanuel Frimpong
  - Meryl Mims
  - Drew Phipps
  - Rebecca Belcher
  - Dawn Mercer
  - Caitlin Cary (CMI)
  - Bill Henley
  - Zach Taylor
  - Jeremy Jenrette
  - Athan Anderson

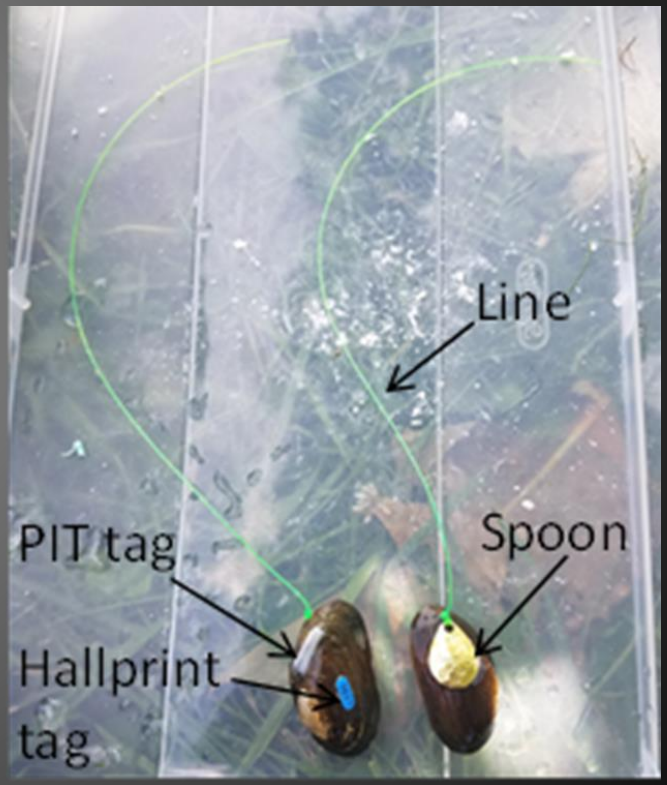
Sponsor: VDGIF

Questions?

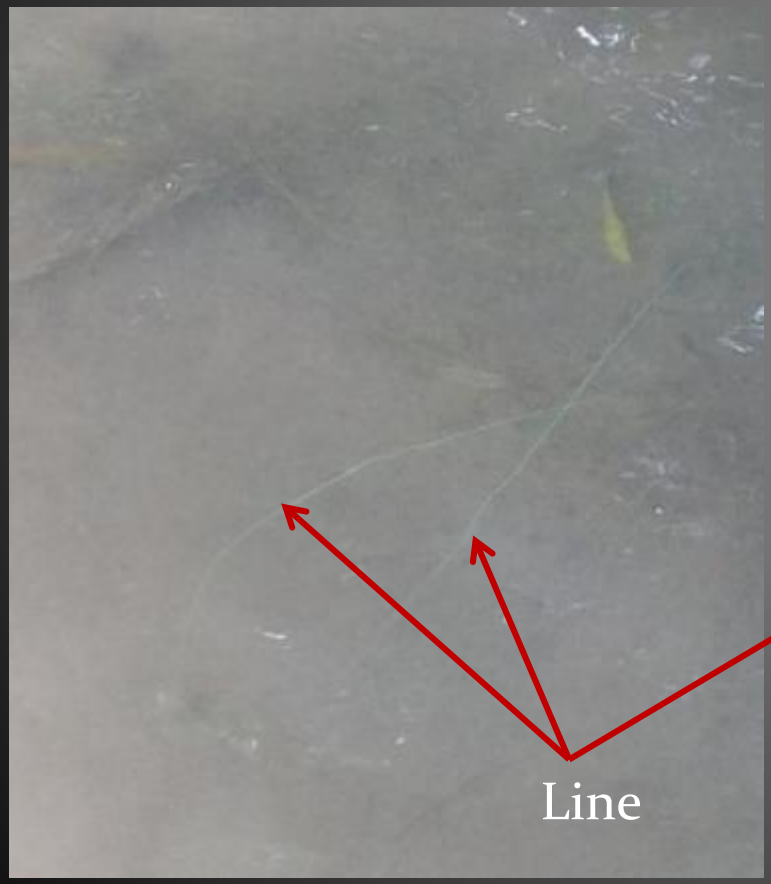

DANG, THAT FISH HAS SOME MUSCLE !
HA HA HA
WWW.FISHEADTACKLE.COM

Ongoing mark-recapture study

- Dunford Park study – June 26, 2019
  - 60 mussels collected
    - Hallprint and PIT tagged
    - 30 individuals affixed with 30 cm line
- Cloud Branch study – July 16, 2019
  - 43 mussels collected
    - Hallprint and PIT tagged
    - 8 individuals affixed with 30 cm line



Lined mussels



Mark-recapture: Dunford Park

	8/15/19	9/19/19	10/11/19	11/11/19
Buried <5 cm	7	2	2	3
Buried 5 – 10 cm	3	0	2	0
Buried 10 - 15	0	0	0	0
Buried > 15 cm	0	0	0	0

Mark-recapture: Cloud Branch

	9/4/19	10/3/19	11/21/19
Buried <5 cm	3	5	2
Buried 5 – 10 cm	1	0	1
Buried 10 - 15	0	0	0
Buried > 15 cm	3	0	2

Functional Roles of Mussels

Remove large amounts of particles from the water column

Excrete nutrients back to the water column

Provide nutrients for primary producers

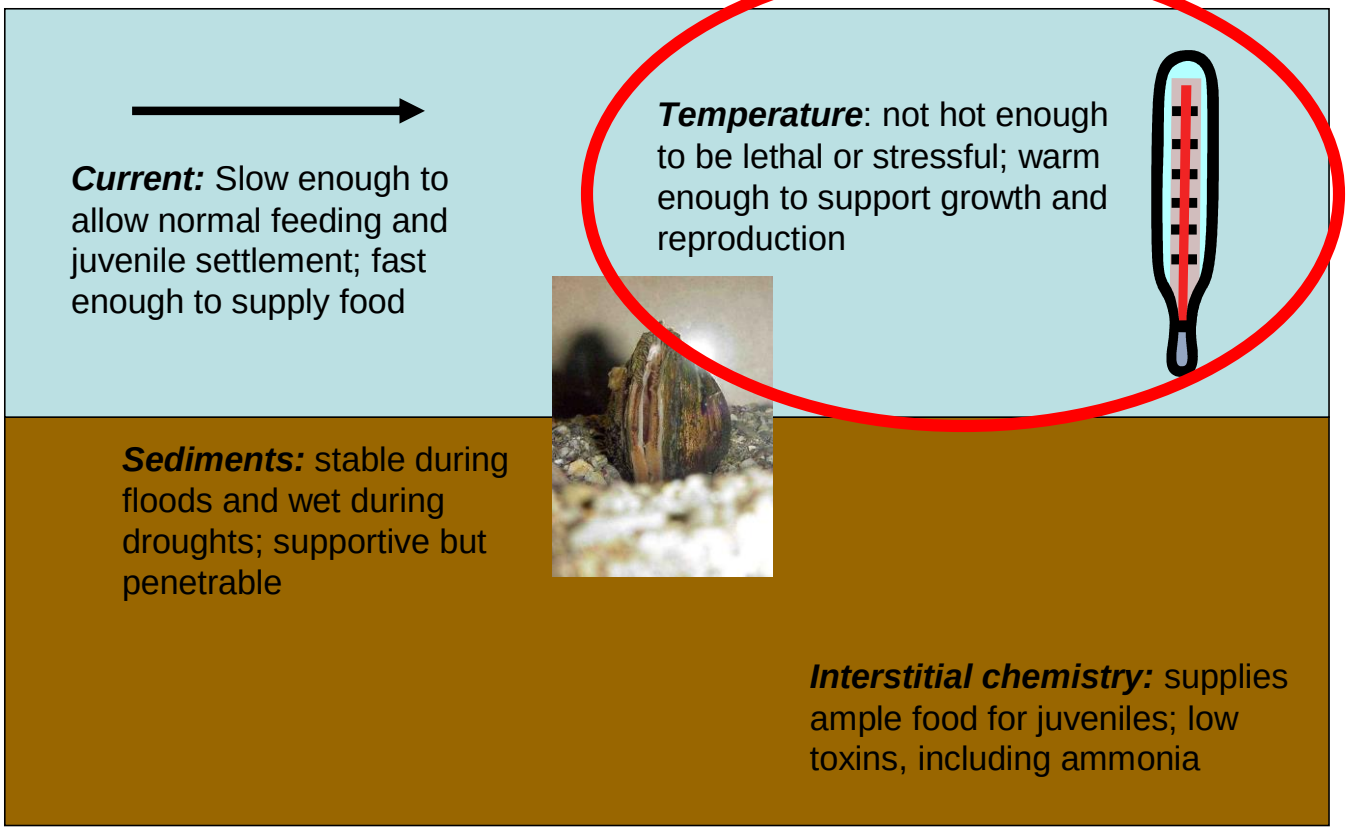
Biodeposit organic material to the sediment as feces and pseudofeces

Stimulate benthic productivity

Increased benthic macroinvertebrate assemblages *(Howard & Cuffey 2006, Vaughn & Spooner 2006)*

Slide by Teresa Newton 2009

Importance of Temperature



from Strayer 2008


L143
L145
L130
L118
L147