Hyde's Quarry Zebra/Quagga Mussel Eradication Effort

Response and Treatment: May 2018 – November 2019

Routine Monitoring: November 2019 – August 2021

Today's Agenda

Overview on zebra and quagga mussels and associated environmental and economic consequences

Background

County Response

County actions following finding of invasive mussels in Hyde's

(~15-month process)

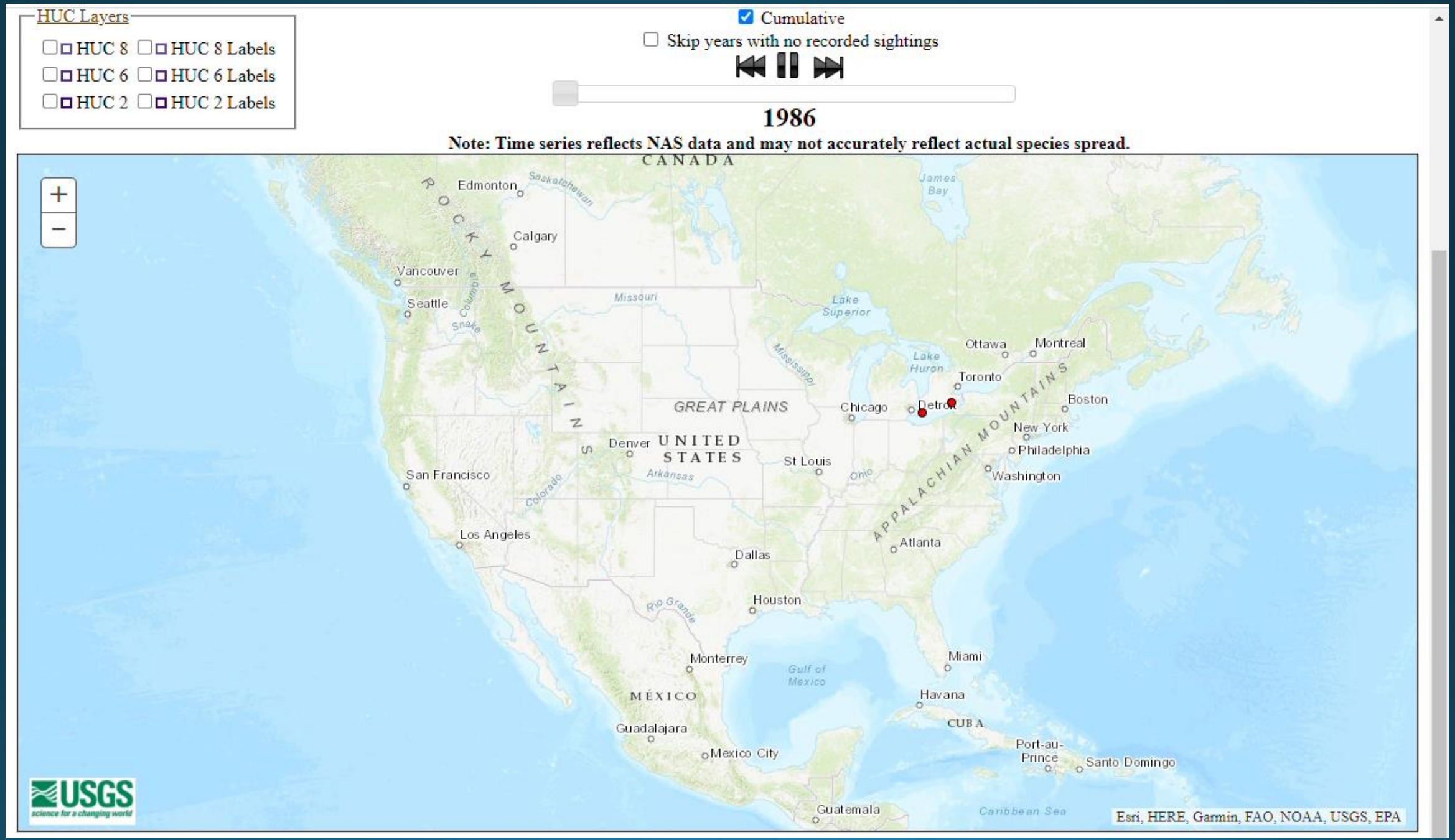
Where we are, post-treatment & post 2-year monitoring

Current Status

Zebra Mussel Quick Facts

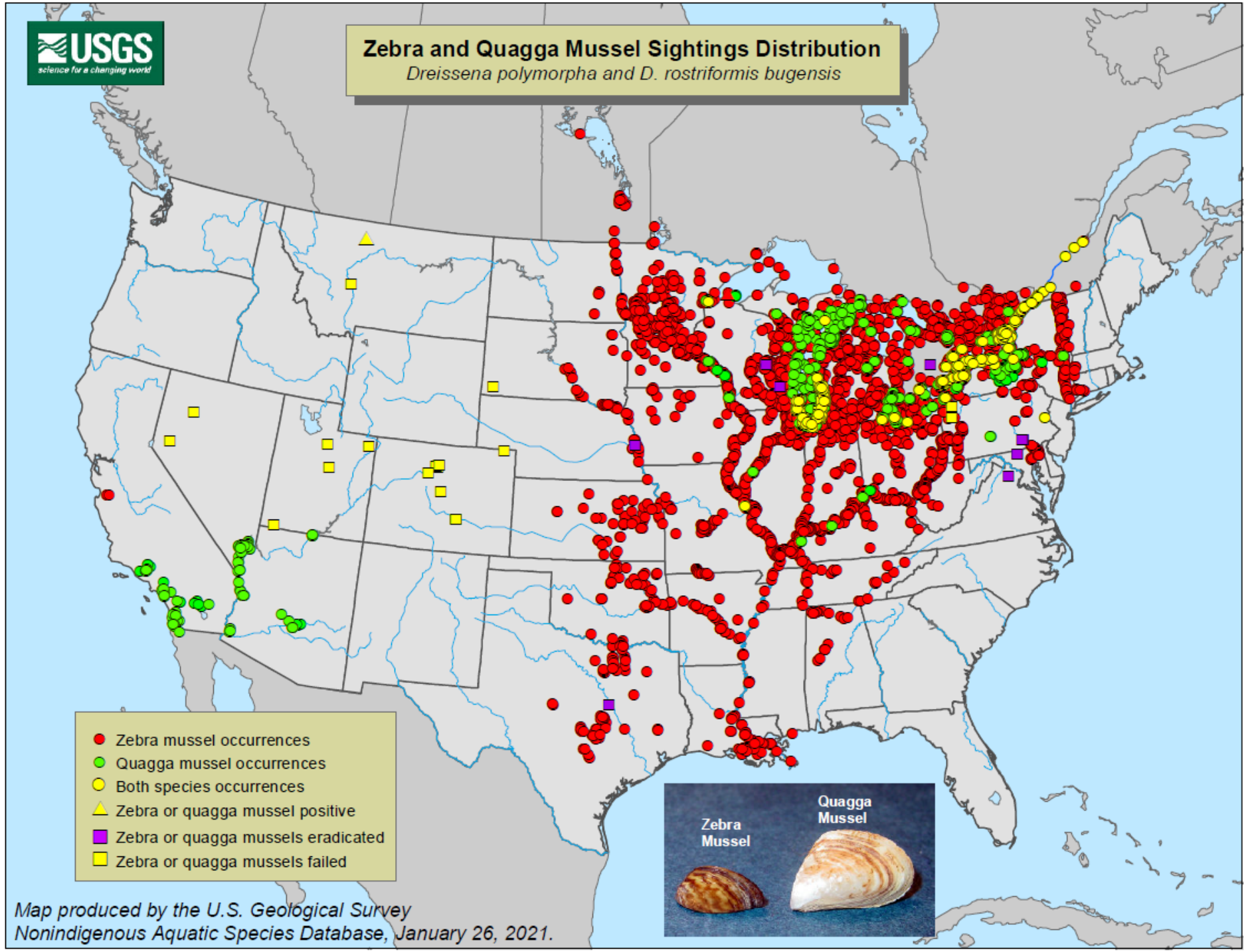
- Native to Black, Caspian and Azov Seas (Eastern Europe/Western Asia)
- Introduced into Great Lakes via ballast water discharge of veliger's
- Veliger – Free-floating/drifting microscopic larval stage of mussel (one-month period)
  - Settles and seeks hard surfaces
- Size: < 2 inches
- Lifespan: 3 – 9 years
- Reproduction – occurs in water column
  - 40,000 eggs laid per reproductive cycle (**1,000,000** in a spawning season!!!)
- Can survive out of water for **7 days**

The Outbreak



What about Quagga Mussels?

- Same genus, different species.
  - Considered close cousin of zebra mussel
- Native to Ukraine (Dnieper River Basin). Spread to Caspian.
- Similar method of introduction – arrived more recently than zebra mussel
- Unlike zebra mussel, can also inhabit soft substrates (sand/mud) and substantial depths
  - Is outcompeting/displacing zebra mussels under suitable conditions (off-shore) in Great Lakes
  - Can co-exist in shallow, productive systems


USGS
science for a changing world
Zebra and Quagga Mussel Sightings Distribution
Dreissena polymorpha and D. rostriformis bugensis
Zebra mussel occurrences
Quagga mussel occurrences
Both species occurrences
Zebra or quagga mussel positive
Zebra or quagga mussels eradicated
Zebra or quagga mussels failed
Zebra Mussel
Quagga Mussel
Map produced by the U.S. Geological Survey
Nonindigenous Aquatic Species Database, January 26, 2021.

Why the fuss?

[redacted] For just zebra mussels??? There's gotta be more to the story 🤔

[redacted] The water at Dutch has been getting better and better every year, mostly because of zebra muscles and the associated increase in crayfish populations, and thus bass. If they do to Hydes what they did to Milbrook, that'll be a disaster. Letting nature take its course is the best solution in this case.

[redacted] I'm agreeing with [redacted] on this one. The ecosystem will acclimate to the presence of the zebra muscles as it has elsewhere.

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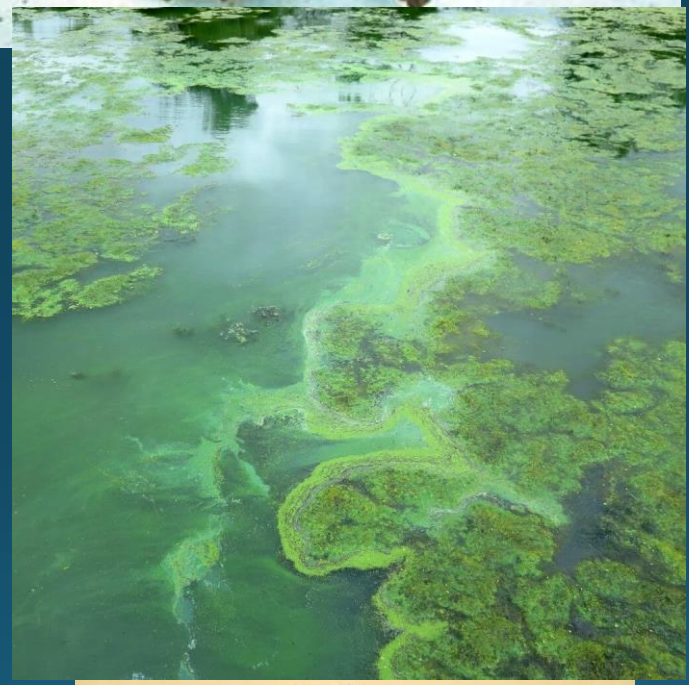
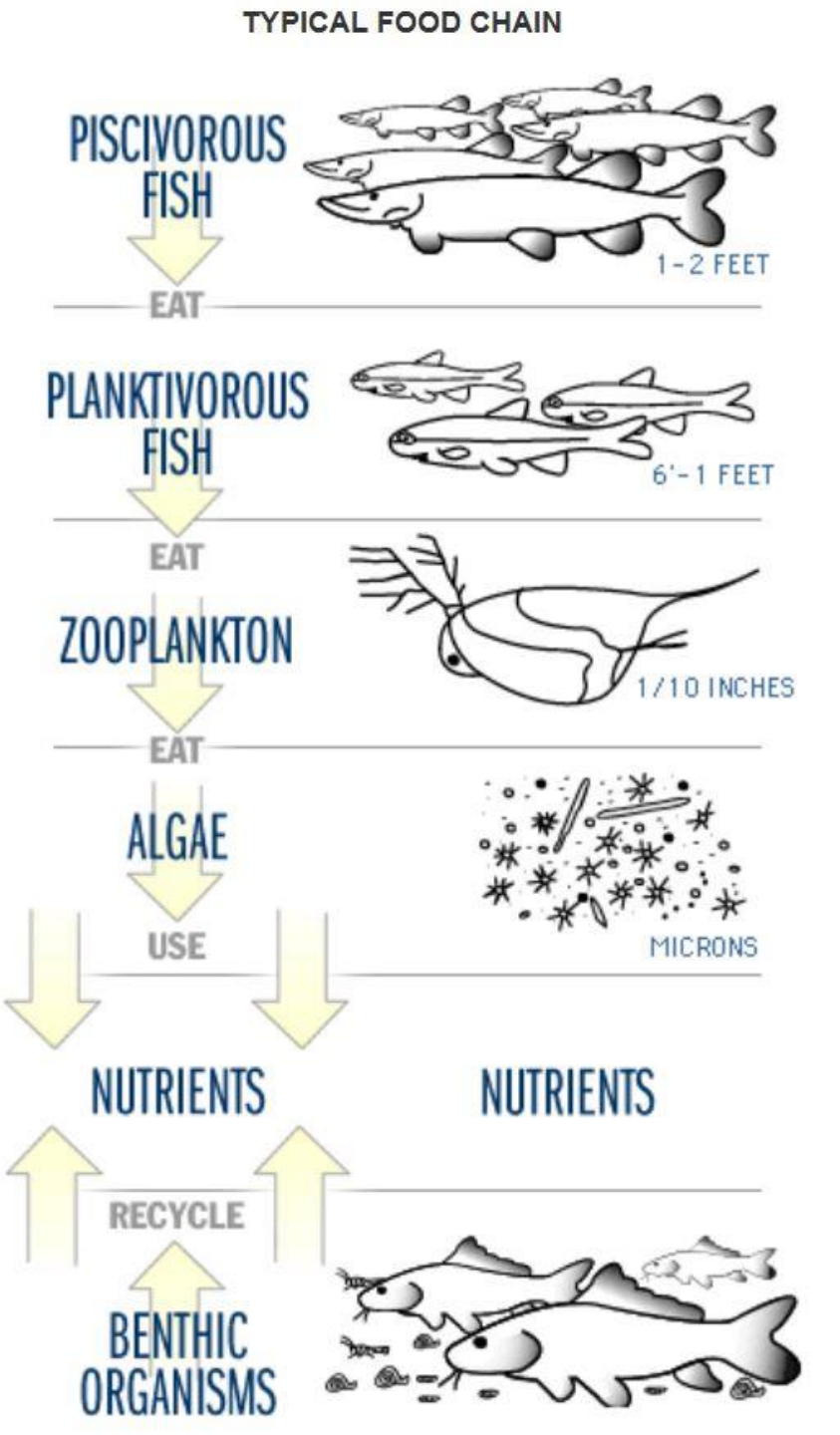
Environmental Impacts

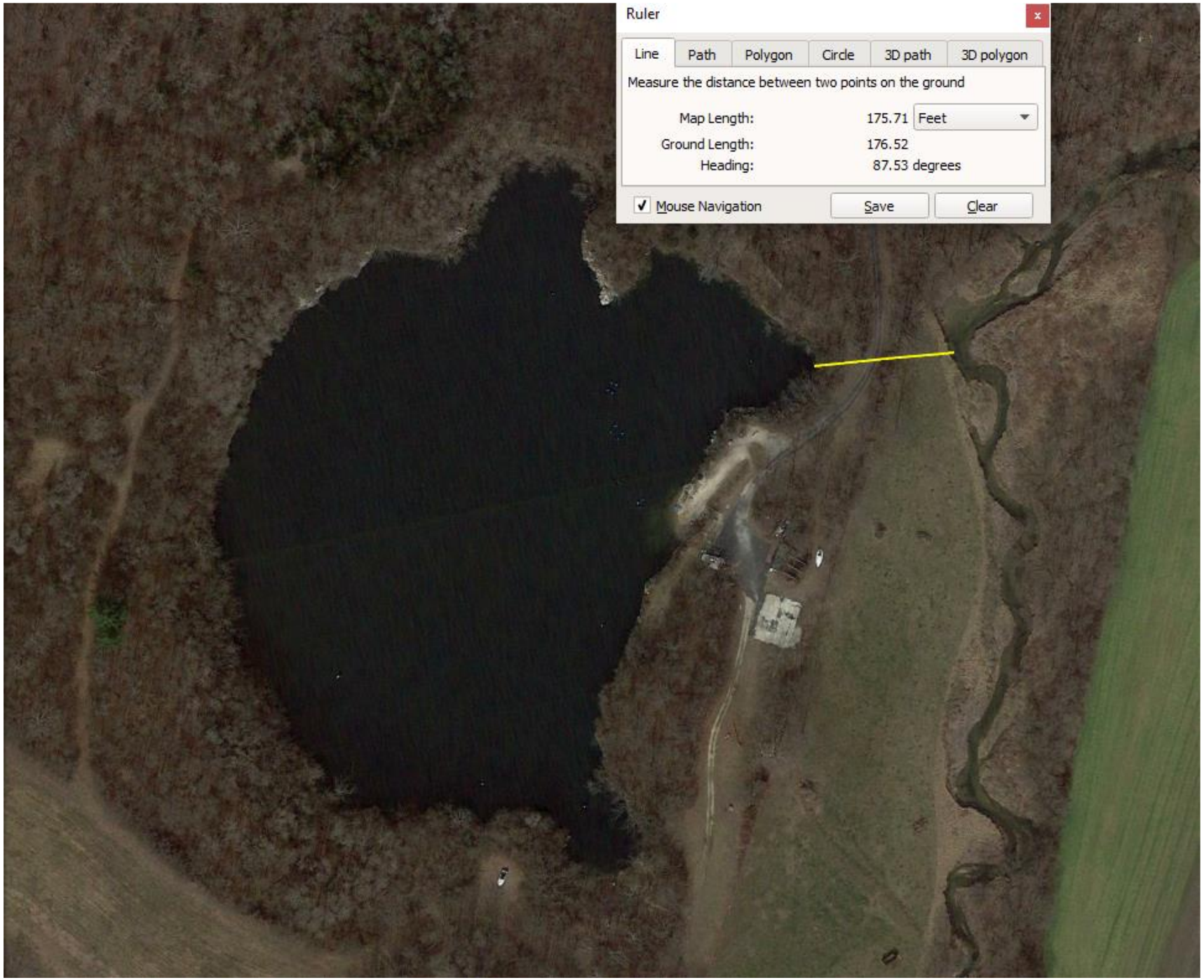
- Directly smother and outcompete native species (mussel and non-mussel)
- Significant alteration to food web and ecosystem
  - Feed on phytoplankton, decreasing food source for zooplankton (and higher tiers)
  - Can preferentially filter-feed on algal species, altering dominant species (blue-greens may dominate)
  - Increase water clarity, leading to establishment of different primary producers (vegetation)





Economic Impacts

- Biofouling of water intakes and pipes (industry, drinking water supply, power, etc.)
  - Mitigation (not permanent) estimated in the tens to hundreds of millions annually
- In addition to water lines/intakes, can get into engine cooling systems, etc.
- Deterioration of structures (wood, concrete, steel) in affected waters
- Decreased tourism/recreation (smell/sharp shells)
- Estimated cost to US Economy > $1 Billion annually


Ruler
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Measure the distance between two points on the ground
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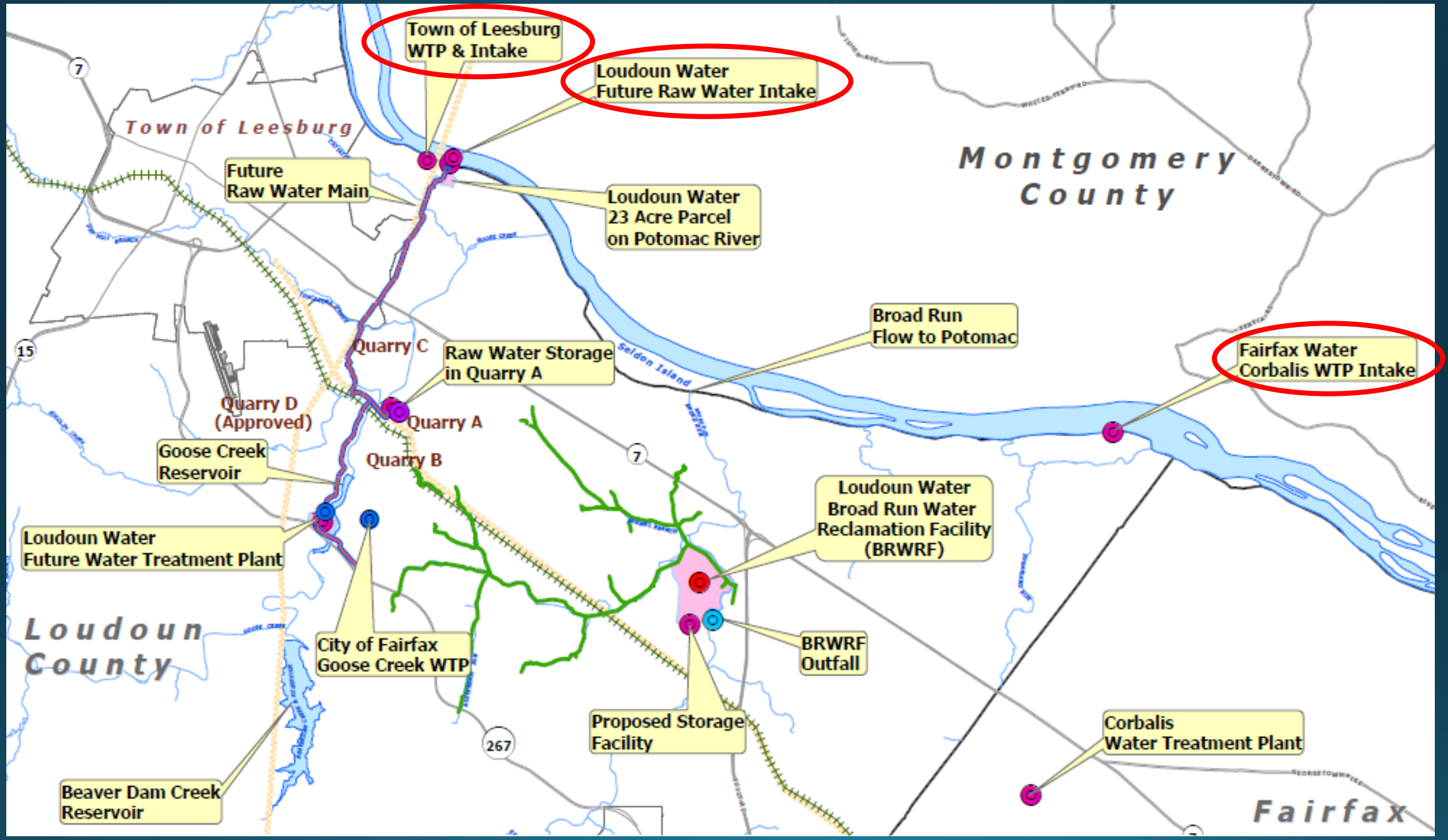


Drainage Network near Hyde's Quarry: Little Pipe Creek -> Double Pipe Creek -> Monocacy River -> Potomac River (upgradient of Leesburg, VA)

Early Chronology

April 2018

Maryland Department of Natural Resources (DNR) receives report of a possible zebra mussel population in Hyde's Quarry. Source was Matthew Petterson with U.S. Fish & Wildlife Service

May 24, 2018

DNR dive team confirms presence of zebra mussel population in Hyde's Quarry

Mussel age ~3-4 years

May 25, 2018

DNR staff inform Carroll County Bureau of Resource Management of zebra mussel population identified at Hyde's Quarry

May 29, 2018

Department of Land and Resource Management briefed on finding of zebra mussel at Hyde's Quarry.

Department staff begin assessing situation and putting together response plan

June 5, 2018

Department staff draft action plan for Commissioner review and approval. Action plan calls for the following:

- Implementing quarantine measures for Quarry
- Assessing degree of mussel establishment
- Compiling data and determining data needs
- Researching/assessing treatment strategies
- Assembling task force to review treatment strategies
- Acquiring competitive bids for eradication protocol strategy
- Conduct eradication protocol
- Mussel assessment and water quality monitoring post-treatment

Early Chronology Continued

June 7, 2018

Divers given 30-days to cease operations. Diving ends July 7, 2018.

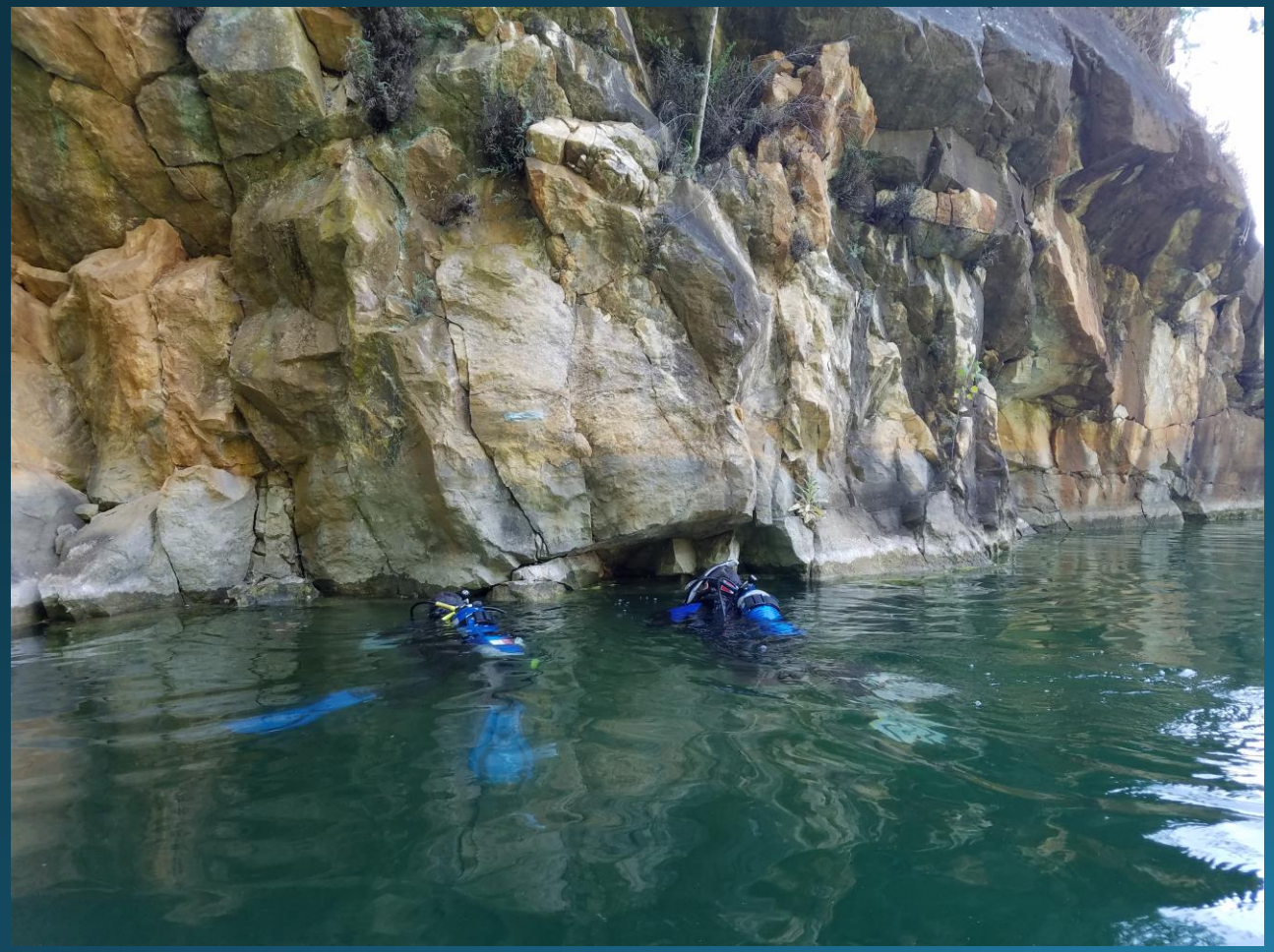
July 10, 2018

Water quality sampling performed at Hyde's Quarry to estimate dilution/flow-through vs. time

July 19, 2018

Land and Resource Management staff and MD DNR staff conduct zebra mussel count/density survey at Hyde's Quarry

~350 mussels collected over randomized 492 square foot area. Potential suitable habitat estimated in the hundreds of thousands of square feet



Invasive Mussel Task Force – 8/6/2018

- LRM staff coordinated task force meeting to determine best treatment protocol for Hyde's Quarry. Chemical treatment was previously determined to be most effective means of eradication.
- Attendees included:
  - County staff (multi-agency)
  - Maryland Department of Natural Resources
  - Maryland Department of the Environment
  - City of Westminster
  - Carroll County Health Department
  - Virginia Department of Games and Inland Fisheries (eradication using potash at Millbrook Quarry) – Now Virginia Department of Wildlife Resources.
  - Susquehanna River Basin Commission (eradication using EarthTecQZ at Billmeyer Quarry)
    - LRM staff visited by manufacturer of EarthTecQZ on 8/1/2018.
- Discussed Quarry history, future plans, distribution of zebra mussels, hydrogeology and limnology of Quarry, and open discussion of treatment options
  - **Task Force determined that eradication utilizing potash was most effective/practicable of available options**.
    - Potassium impacts integrity of and ability to transfer oxygen across mussel's gills, leading to asphyxiation

August – December 2018

- August 23, 2018 – DNR staff perform survey of 1.5 mile stretch of Little Pipe Creek adjacent to Hyde's – no invasive mussels found
- September & October – LRM staff undertake additional studies to gather information on Quarry and begin to draft a request for qualifications for zebra mussel eradication utilizing potash
- November
  - 1st – Carroll County releases LOI/RFI for zebra mussel eradication (potash treatment)
  - 15th – Carroll County receives 2 responses which are then evaluated. Only one determined to be qualified to perform the work
  - 27th – LRM staff meets with qualified contractor for site visit to determine project scope and proposal cost
- December
  - 10th – LRM informs EarthTecQZ manufacturer that task force team decided on potash
  - 14th – Carroll County receives proposal from qualified contractor (ASI Group, Ltd.)

Meet ASI

ASI Proposal

- Mirrors the LOI/RFI
- Includes:
  - Mobilization of necessary equipment (boats, generators, pumps and tanks, site security)
  - Review of County collected data (volume, thermal profiles, water quality, etc.)
  - Background sampling (Quarry and off-site surface water and groundwater)
  - Establishment of bioassay (LRM to collect mussels, ASI to keep mussels alive in biobox until "charging" with potash complete, at which time mussels placed at multiple locations and depths
  - Introduction of liquid potash (410 metric tonnes of 20% KCl planned)
  - Periodic water quality sampling to ensure KCl diffusion in Quarry and no off-site impacts
  - Bioassay to assess mortality

January & February 2019 – Permitting Party

- Now that we know the treatment method and have identified a contractor, we can apply for requisite permits:
  - Collection permit – Permit from DNR to collect zebra mussels for bioassay
  - Water appropriation permit – permit to withdraw water from LPC to keep mussels alive during "charging" of Quarry and post-treatment recovery box
  - Toxic Materials Permit – MDE permit to introduce pesticide to a water body
  - Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) Section 18 Quarantine Exemption
    - Potash is not a regulated pesticide. Need federal approval to utilize
    - Only a state agency can secure FIFRA Section 18 (Maryland Department of Agriculture)
    - LRM submits application to MDA on 2/19/19. MDA submits to EPA on 2/27/2019
- State permits submitted by March 2019 (awaited commissioner approval for project)

March and April 2019

- Open Session – LRM presents request to engage ASI for zebra mussel eradication services to Commissioners
  - Commissioners approve. Article in CC Times
- LRM staff submit requisite state permits (all under review)

- Commissioners contacted by Manufacturer of EarthTecQZ to utilize their product instead
- Manufacturer appeals to MDE, MDA, and finally EPA. Seeks rejection of potash permitting in favor of EarthTec

Spring –Summer 2019

- April 2019 – Executed contract sent from CC Government to ASI Group, Ltd.
- May 2019 – All requisite state and federal permits supporting project are received
- June 2019 – LRM meets with ASI and chemical supplier to work on site access and staging
- August 2019 – ASI ready to perform eradication services

Pool Party – Collection for Bioassay

- August 12, 2019
- ASI mobilizes set-up team
- CC LRM staff and DNR staff collect zebra mussels for bioassay
  - DNR divers scrape mussels from walls and bring to surface
  - LRM staff count mussels and ferry to ASI on shore
- >4,800 mussels collected
  - ASI finds many to be quagga, but zebra also present
- Mussels then kept alive in tank with water from LPC until potash treatment completed

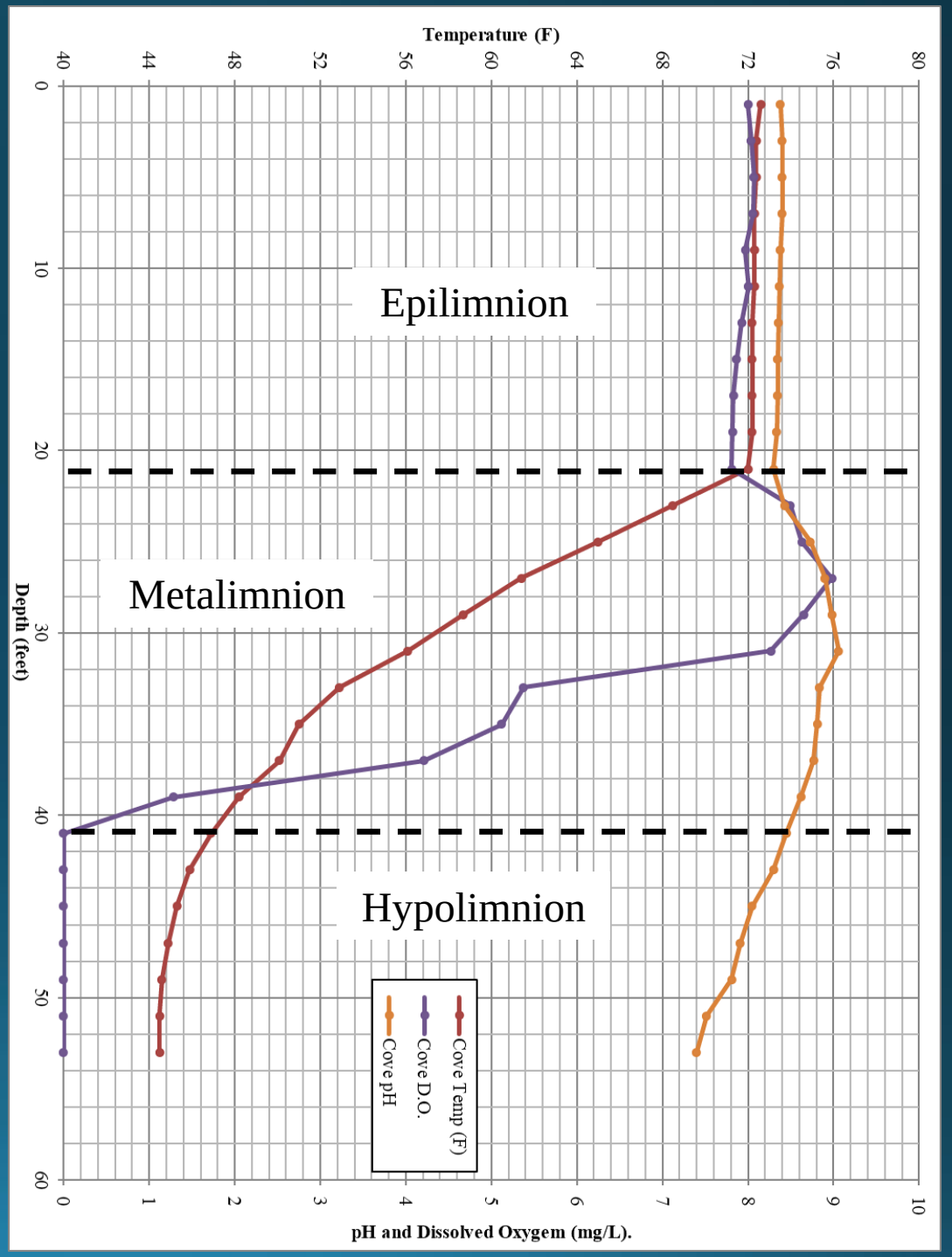
August 15, 2019 – Treatment Finally Begins!

~ 14.5 months after notification of finding of mussels in Quarry

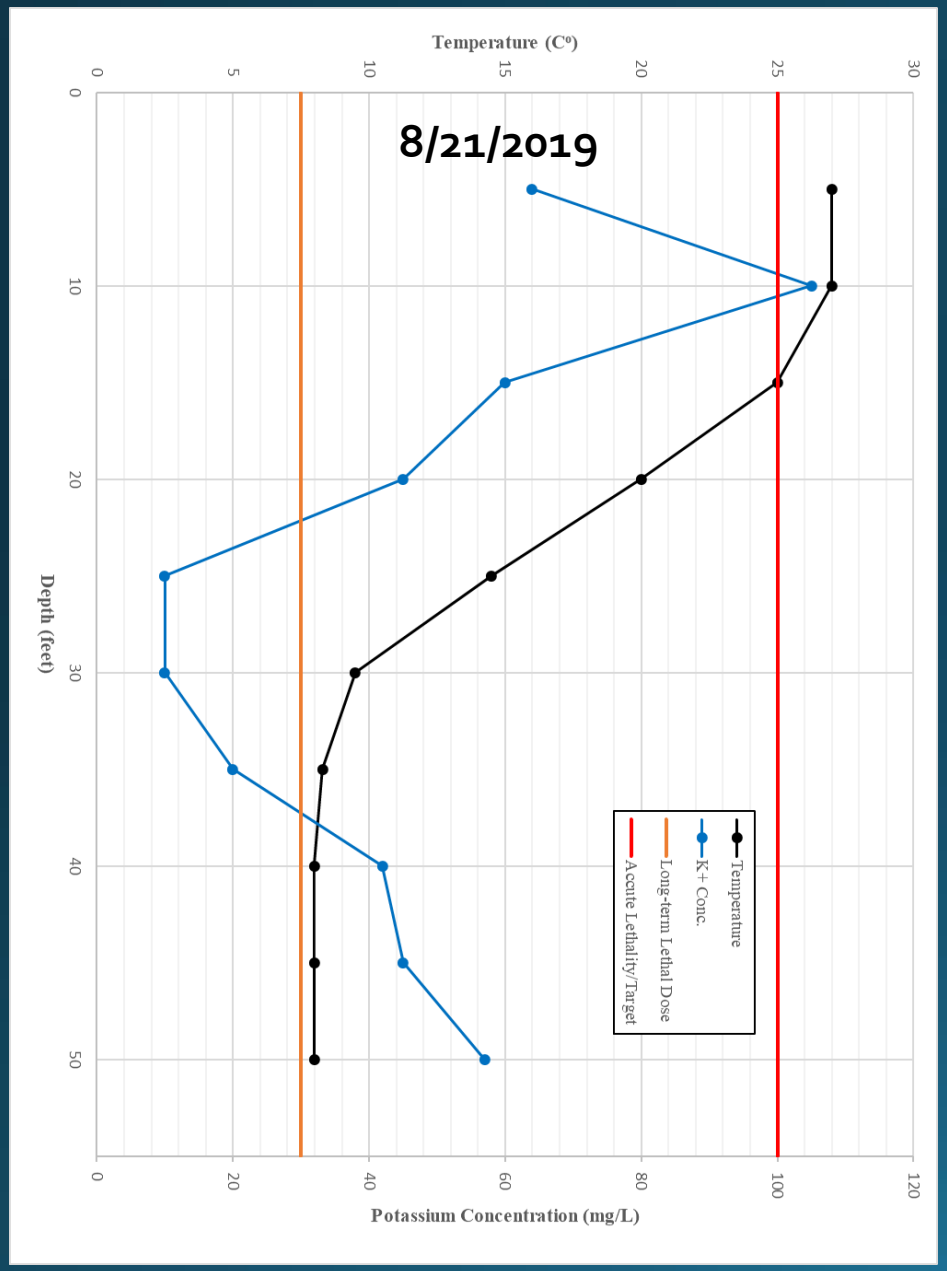
470 metric tonnes of liquid potash introduced over an 8-day period (410 tonnes initially planned)

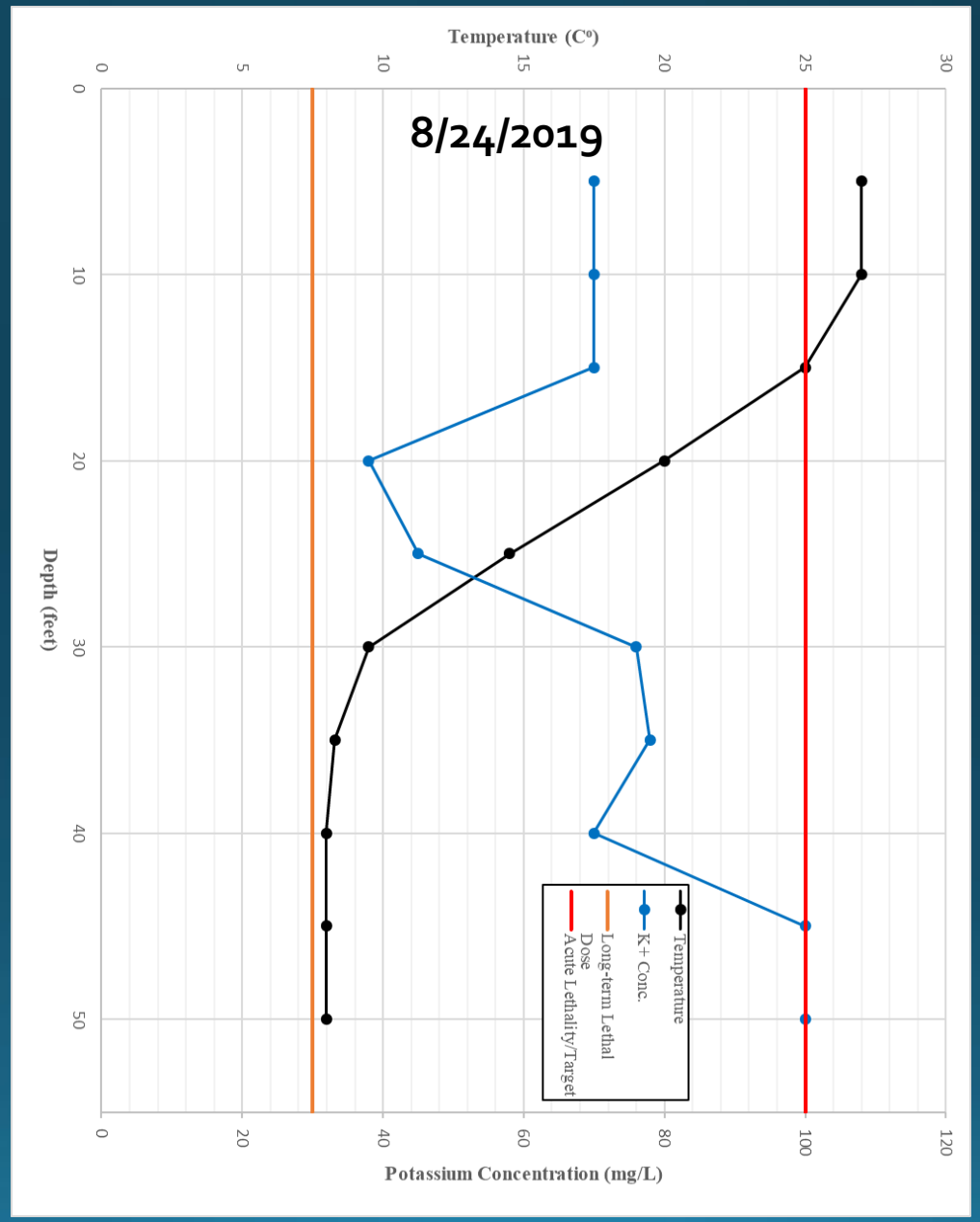
Treatment Considerations (Seasonal)

- Not as simple as batch dumping liquid potash
- Pontoon boat slowly introduced potash across the Quarry using diffuser and hanging lines, which could target different depths
- Limnology Lesson:
  - As spring/summer progresses, lakes differentially heat (more at surface, less light penetration & therefore heat at depth)
  - As temperature increases, density decreases
  - As temperature/density difference increases, resistance to mixing increases, and distinct layers form, inhibiting vertical exchange
  - Water is unique – most dense at 4°C
- Since treatment occurred in summer, we had to target different thermal layers
  - Less of a concern come fall/winter, when Quarry experiences turnover
  - Approach ensured quicker contact time for kill



Potash Management (Product vs Layers)





Focused on epilimnion from 8/15 to 8/18

Targeted hypolimnion from 8/19-8/21

Began targeting metalimnion on 8/21
Opted to add additional day of charging to metalimnion

Wanted to ensure that at least a long-term lethal dose was achieved at all sampling depths

Post-Treatment

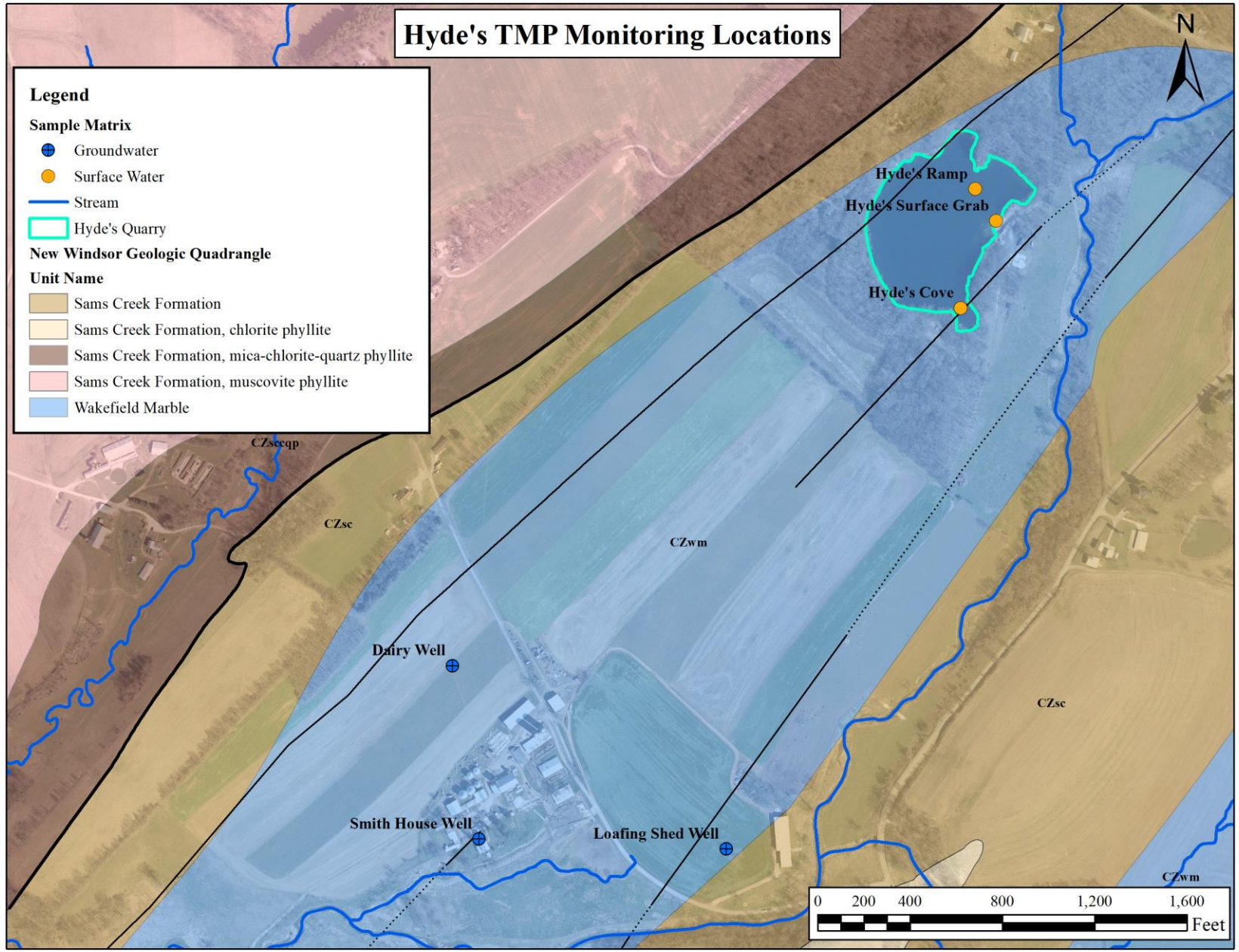
- Treatment ends at end of day on 8/23/2019
- Sampling completed 8/24/2019
- Mussels placed at multiple depths (different thermal layers) at 15 different sampling stations for bioassay on 8/25/19
- ASI demobilizes from site
- Since observed concentration in metalimnion < acutely lethal dose, bioassay planned for mid-November

Bioassay & Final Sampling – 11/20/19

- ASI remobilizes for:
  - Completion of bioassay
  - Water quality sampling/profiling of Quarry
  - Off-site water quality sampling
- After pulling mussels from all stations, no living mussels found (none contained flesh/organs)
  - Suggests complete eradication achieved
- Quarry potassium concentrations were between 70 and 120 mg/L
- No off-site impacts were identified

September 2020 DNR Follow-Up Dive: No living invasive mussels found!

Photo Credit: Michael Eversmier
Aqua Ventures, Inc.



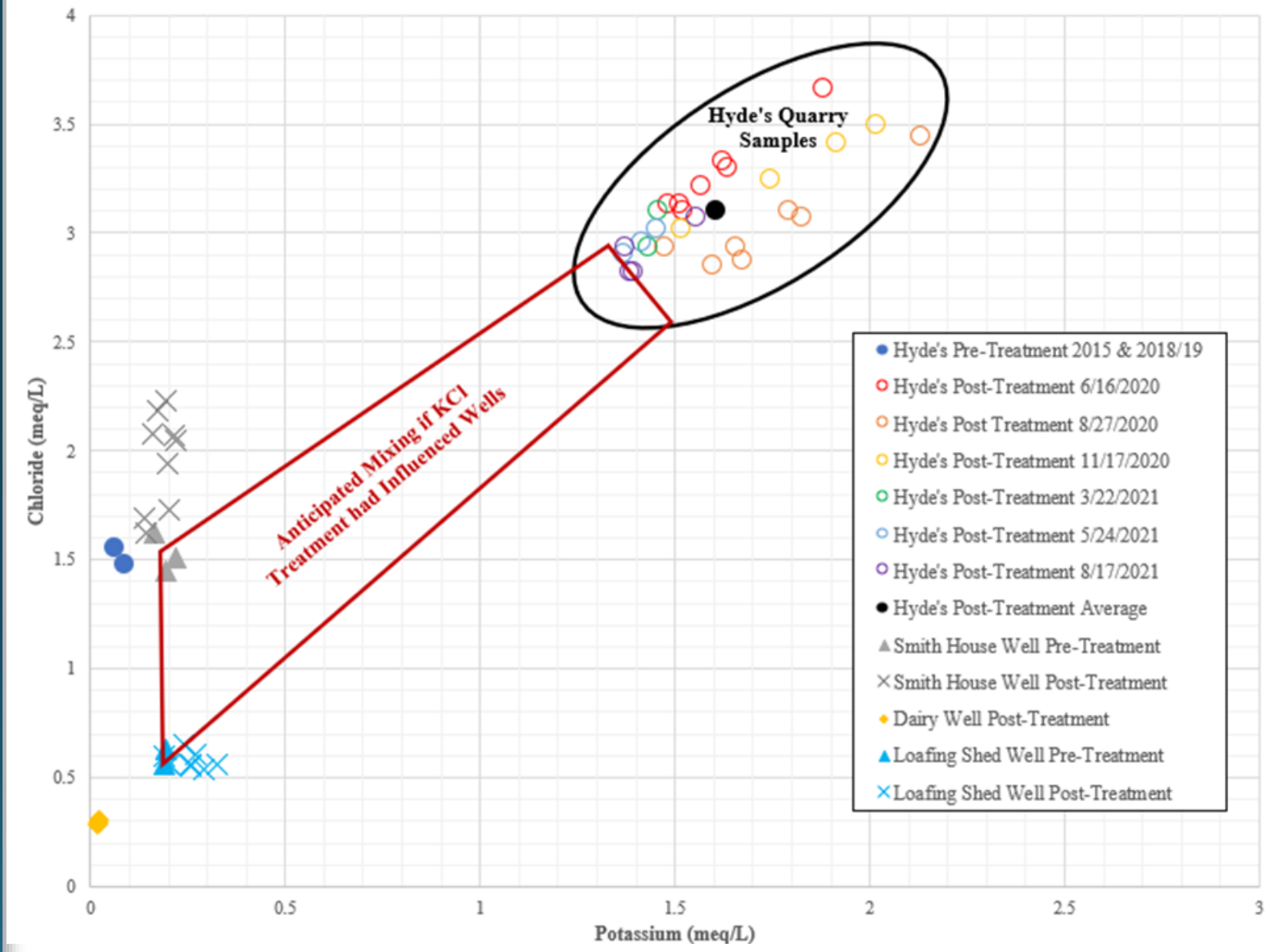
Two Year Post-Treatment Monitoring Period

- Monitored potassium and chloride concentrations in three downgradient groundwater wells on a quarterly basis through August 2021
- Monitored potassium and chloride concentrations in Hyde's Quarry on concurrent quarterly basis
  - Completed vertical profiles to assess degree of stratification and determine sampling depths
  - Due to non-uniform distribution following treatment, profiled and sampled in at least two locations (Ramp and Cove)

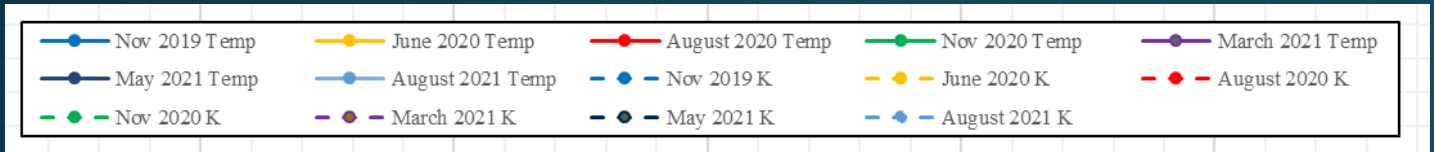
No Adverse Groundwater Impact

- Potassium concentrations remained below threshold established by MDE for this project (20 mg/L) in downgradient wells

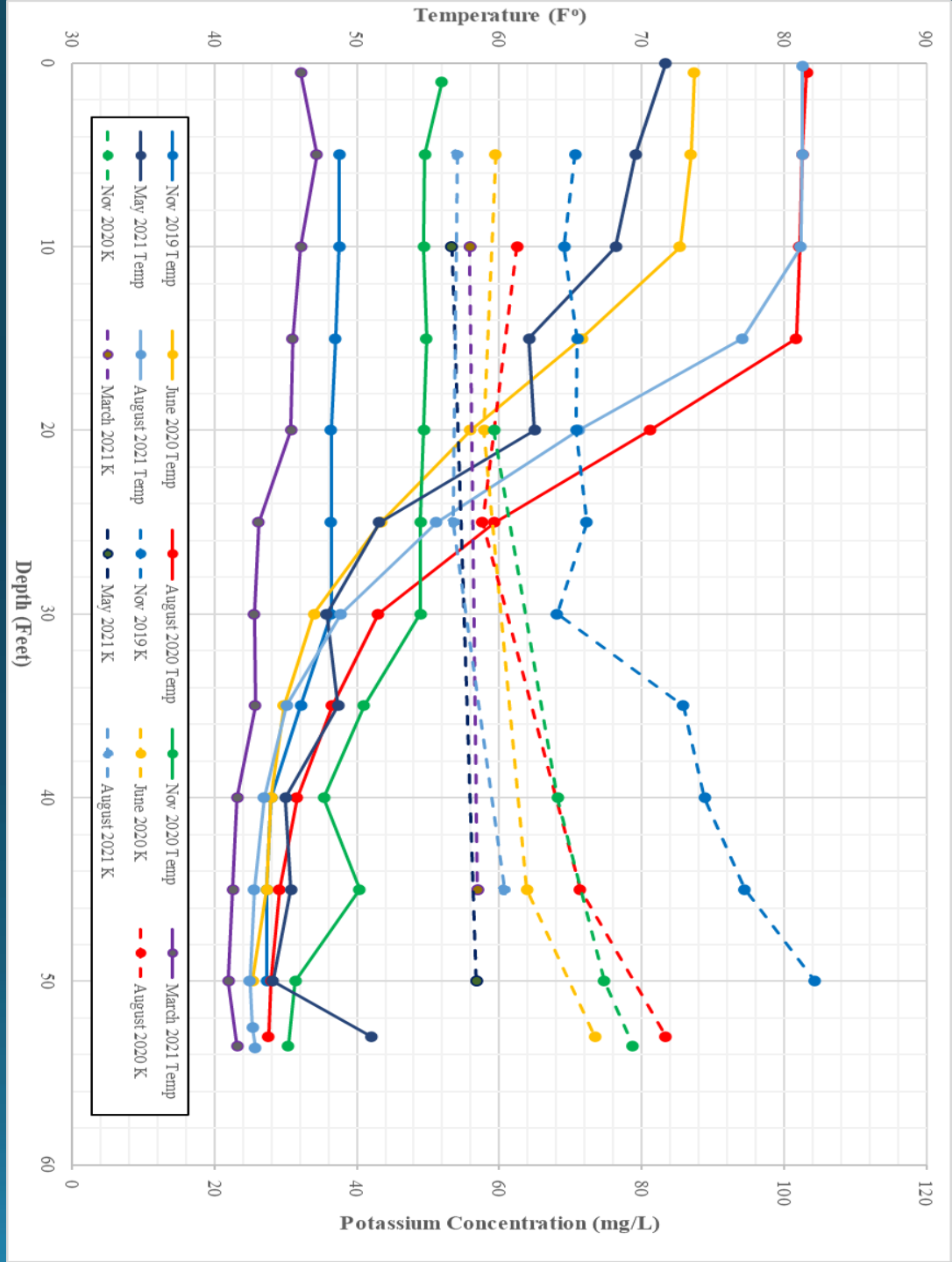
- While potassium and chloride concentrations did fluctuate, changes were determined not to be result of treatment, but likely proximal, anthropogenic influences, including agricultural and animal husbandry practices.



Quarry Monitoring



- As time passed and turnover events occurred, observed more uniform distribution of potassium and chloride
- Post-turnover average concentration lower than projected from November 2019 data
- Potassium concentrations remain lethal to zebra/quagga mussels at this time
- No adverse impacts to non-target biota observed during or following treatment



Where do we go from here?

- Continue to periodically profile and sample Quarry to monitor potassium concentrations
  - Currently anticipating lethal potassium residual for up to about 12 years
  - Re-evaluate as additional data becomes available
- Continue stewardship of Quarry - No public/3rd party access
  - While protected from invasive mussels, not protected from other aquatic invasive species
- Continue discussions with City about use of Quarry as water supply source
  - Options for primary or backup source
  - Quarry would be purged and allowed to refill before use

Questions?

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