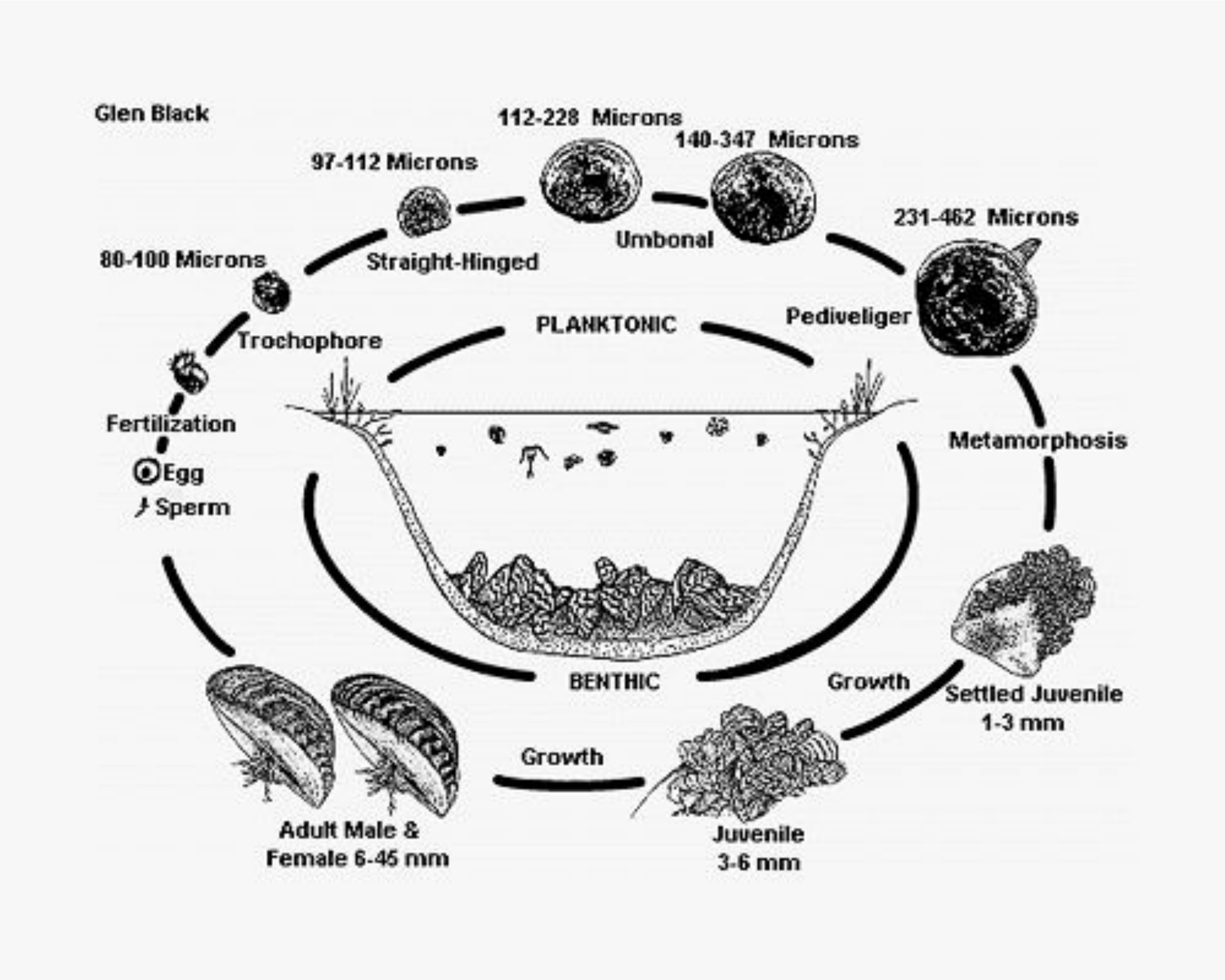
ZEBRA MUSSELS

SABRINA GROVES

MANAGERS: ZACHARY NEAL, ERIC SAKOWS

LIFE HISTORY STRATEGY

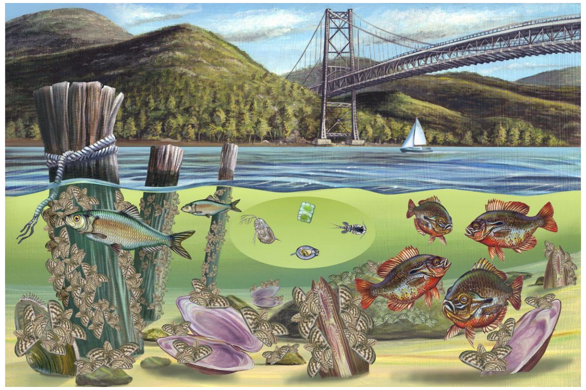
- Species: *Dreissena polymorpha*
- Lifespan: 3-9 years
- Minimum Spawning Temperature: 54 degrees Fahrenheit
- Reproductive Cycle: 30,000-40,000 eggs (R Type III)
- Cycles per Season: ~25 >> one million eggs per spawning season!!!
- Veliger (Seed, Spat) – free swimming microscopic larvae (~1month)
- Adult Max Size: ~2 inches
- Desiccation Period: up to 7 days
- Environmental Stressors: High salinity, high particulates, low hard substrate, predation (limited)



IMPACTS OF ZEBRA MUSSELS

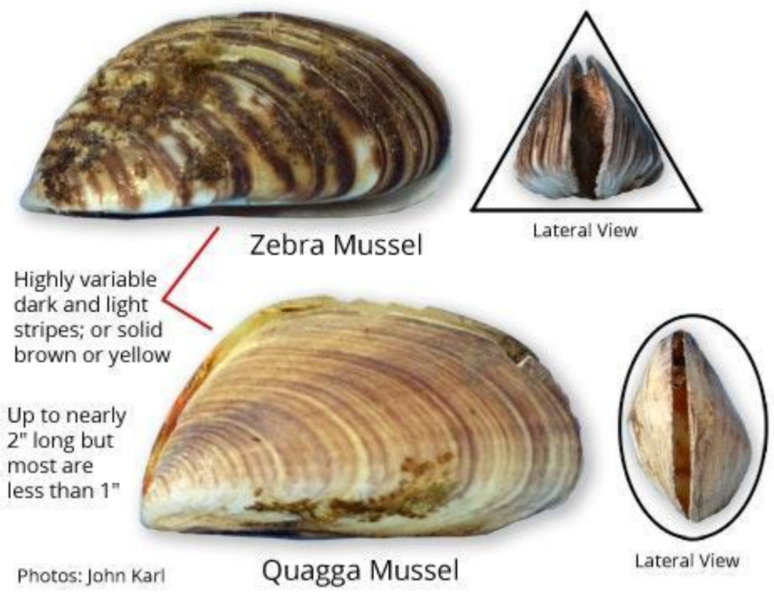
Originally thought to assist in water quality through filter feeding. In actuality, hyperfiltration is harmful:

- Deplete low trophic organisms
- High substrate recruitment >> restructured aquatic communities
- Biofouling (recreation, industry, pipes)
- Compete with native species
- Biomagnification of harmful substances (selective shell composition)
- Selective filtration & high sunlight (due to water clarity) lead to blue-green algae blooms and eutrophication
- Health hazards (direct: cuts; indirect: water quality)



IDENTIFYING ZEBRA MUSSELS: COMMON MISTAKES

Species Misidentification



Invasives Confusion

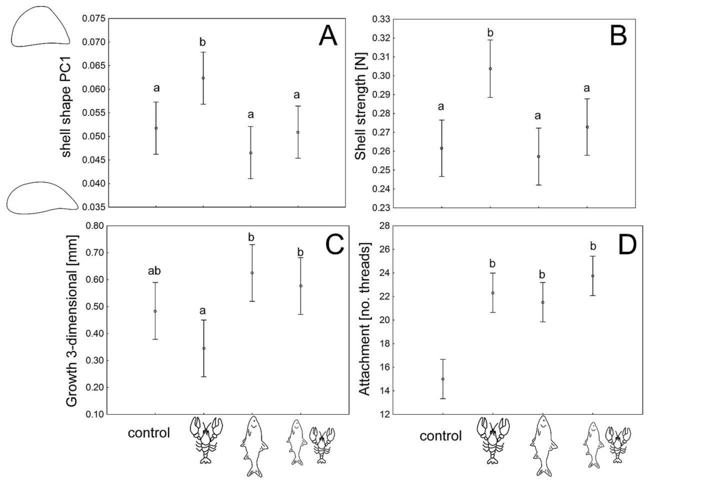


Fig. 2. Zebra mussels' phenotype expression changes with predation risk. Anti-predator responses of zebra mussels from the four experimental treatments: either a single crayfish (crayfish symbol), a single roach (fish symbol), both predators combined (both symbols next to each other) or no predator at all (minus symbol). Different lower case a and b letters denote significant differences for $p<0.05$ after post-hoc tests. Error bars denote 95% confidence intervals **A**: shell shape expressed as a principal component PC1 explaining 77% of the total variation in the contour shape of all analyzed mussels (the contours on the y-axis depict $\pm 2SD$ of the mean of PC1). **B**: shell strength as resistance to crushing in the form of the residuals from the correlation between mussel size and strength. **C**: growth measured in mm increase in the three shell dimensions length, height, and width compared to the start of experiment. **D**: Attachment strength as inferred from the number of byssus threads with which individual zebra mussels were attached to the surface.

Phenotypic Differences

INVASION TIMELINE

1900s

Native to Eurasia

Black, Caspian, Azov Seas

1988:

Introduced to US through ballast water discharge in Great Lakes

2006:

First successful 100% eradication in Millbrook Quarry, Virginia (20% KCL)

2008:

Discovered in Chesapeake Bay

2010:

Copper sulfate treatment eradicates mussels at Offutt Air Force Base, NE and 21 unintended species

2010:

Ionic copper EarthTec QZ shown effective against adults and veligers in Lake Mead, NV

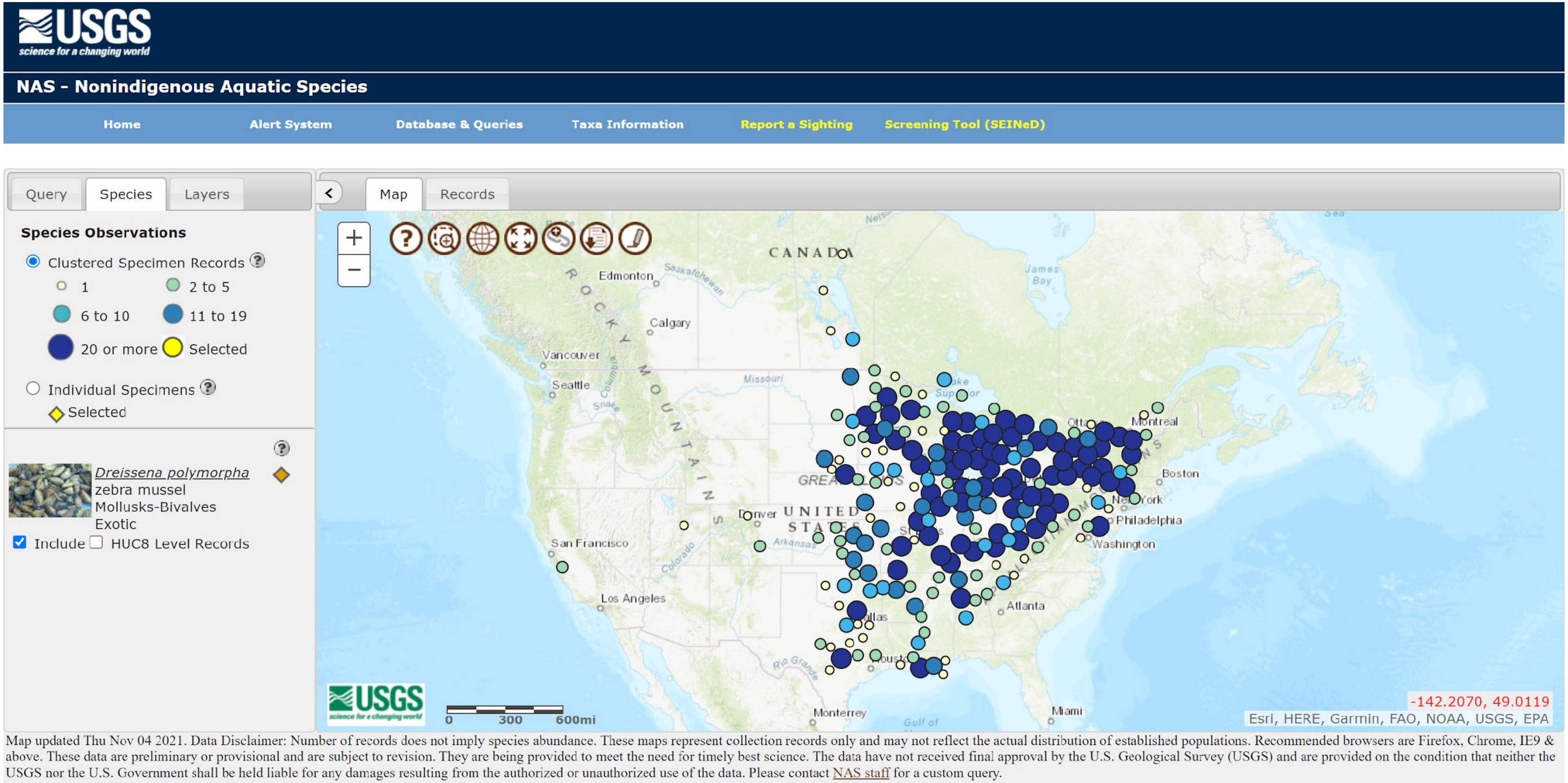
2019:

Replication of Millbrook method leads to 100% eradication in Hyde’s Quarry, Maryland

2021:

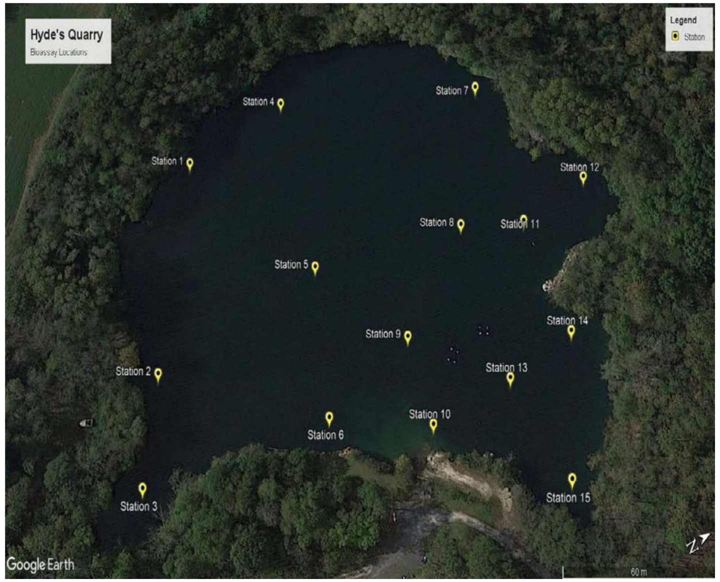
Lingering high copper and potassium levels prompt research in treated areas

RANGE TRACKING: [HTTPS://NAS.ER.USGS.GOV/VIEWER/OMAP.ASPX?SPECIESID=5](https://nas.er.usgs.gov/viewer/omap.aspx?SpeciesID=5)



LOCAL MANAGEMENT: ZACHARY NEAL

- Hydrogeologist by trade
- Called in following 2018 Hyde's Quarry discovery by Matthew Peterson (no prior management plan)
- Suspected contaminant: recreational diving equipment
- Environment: unique low-outflow system
- Goal: preserve groundwater resources for potential use
- Eradication 2019: Potash (active ingredient: 20% Potassium Chloride)
- Post-treatment: bioassays, thermocline tests, off-site groundwater supply tests
- Outcome: 100% adult mortality; ongoing high potassium levels
- Resource requirements: 470 metric tonnes of potash ($369,000), ongoing personnel and research costs
- Financially-dependent upon emergency county budget approvals



LOCAL RESEARCH: ERIC SAKOWSKI

- Microbial ecologist by trade
- Became interested in dynamics of high copper & potassium ecosystems (2020)
- Sites: Hyde's Quarry, MD (potassium chloride) & Billmeyer Quarry in Bainbridge, PA (ionic copper)
- Environment: both low-outflow system
- How do acute eradications fair in the long-term?
  - Billmeyer Quarry in Bainbridge, PA (2018)
  - Hyde's Quarry, MD (2019)
- Research Goals:
  - Identify thermocline changes
  - Track microbial diversity & compare to regional communiti
  - Determine impacts of chemical treatments

Advertising looks great when there are no studies to suggest otherwise

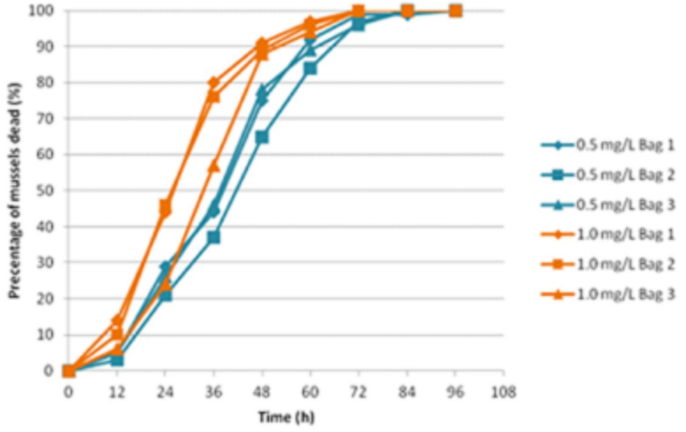


Figure 22. Zebra mussel mortality when exposed to EarthTec QZ for 96 hours.

BLEAK OUTLOOK

- County management is largely reactive or falsely proactive (expectations are not mandated)
- Mitigation strategy depends on ecosystem structure (especially isolated vs free-flowing)
- Current options are financially inaccessible
- Need researchers to create opensource or low-cost treatment methods (alternatively need ample funding)
- 2021 literature is helpful for education, but not for mitigation
- Monitoring programs struggle due to phenotypic variation and species misidentification
- eDNA is flawed by accumulation in soft substrate (hard substrate species) and dead material after eradication
- High salinity, high temperature, lack of hard substrate, and chemical treatments appear best at limiting ranges
- It is difficult to engage public due to long boat/gear quarantine times (7+ days and/or 2% bleach treatment to be effective) and no national policies (scraping is often ineffective)
- Climate change holds some promise in decreasing abundance (high temperature specifically)
- Quagga mussels appear to be better competitors in soft substrate environments (positive invasion treadmill)
- Successful management depends on early detection & prompt treatment

HEADLINES TO FOLLOW

Zebra mussel (*Dreissena polymorpha*) eradication efforts in Christmas Lake, Minnesota

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INVASIVESNET

Management of Biological Invasions (2018) Volume 9, Issue 4: 439–450

DOI: https://doi.org/10.3391/mbi.2018.9.4.07

Proceedings of the 20th International Conference on Aquatic Invasive Species

Research Article

Use of carbon dioxide in zebra mussel (*Dreissena polymorpha*) control and safety to a native freshwater mussel (Fatmucket, *Lampsilis siliquoidea*)

INVASIVESNET

Management of Biological Invasions (2019) Volume 10, Issue 1: 96–110

Research Article

Environmental DNA as a tool to help inform zebra mussel, *Dreissena polymorpha*, management in inland lakes

Jon J. Amberg[1,*], Christopher M. Merkes[1], Wendylee Stott[2], Christopher B. Rees[3] and Richard A. Erickson[1]

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ELSEVIER

Concentration addition and independent action assessments of the binary mixtures of four toxicants on zebra mussel (*Dreissena polymorpha*) mortality

Matthew T. Barbour[*], Justin R. Schueller, Todd J. Severson, Jeremy K. Wise, Matthew J. Meulemans, James A. Luoma, Diane L. Waller


QUESTIONS?

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