Using Resurrection Ecology of Freshwater Zooplankton to Understand Evolutionary Responses to Nutrient Pollution

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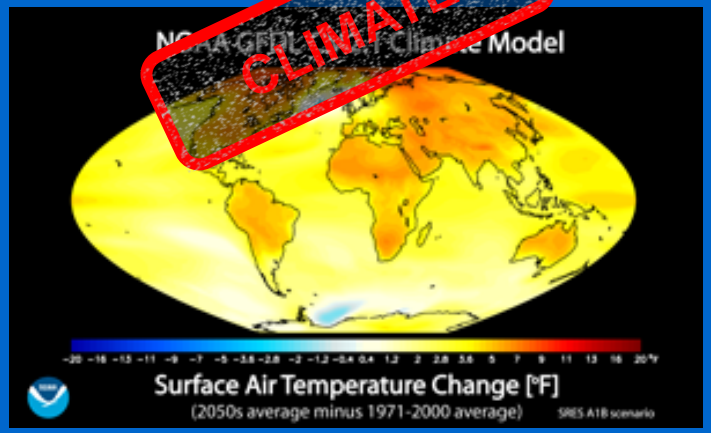
Global environmental change is more than climate change:



Cyanobacteria bloom in Shaokotan Lake, MN
July 2010

Resurrection Ecology (RE) – the study of long-dormant propagules in seed and eggbanks

A recent special issue of the journal *Evolutionary Applications* is devoted to this burgeoning research field.

Weider et al. 2018. Evolutionary aspects of resurrection ecology: Progress, scope, and applications – an overview. Evolutionary Applications 11:3-10; DOI: 10.1111/eva.12563

Model Organism - *Daphnia*

Small (~1-5 mm)

Short-generation times (i.e. mature ~7-10 days at 20^{o}C)

Easily cultured

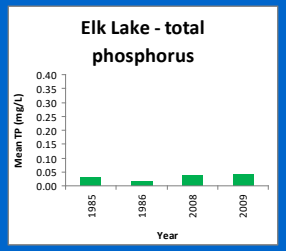
Clonal reproduction

Produce diapausing eggs

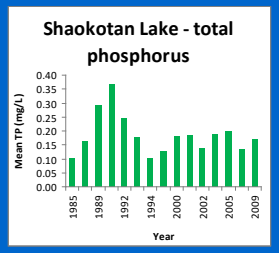
Whole genomes for several *Daphnia* species have been sequenced.

Used extensively in ecotoxicology

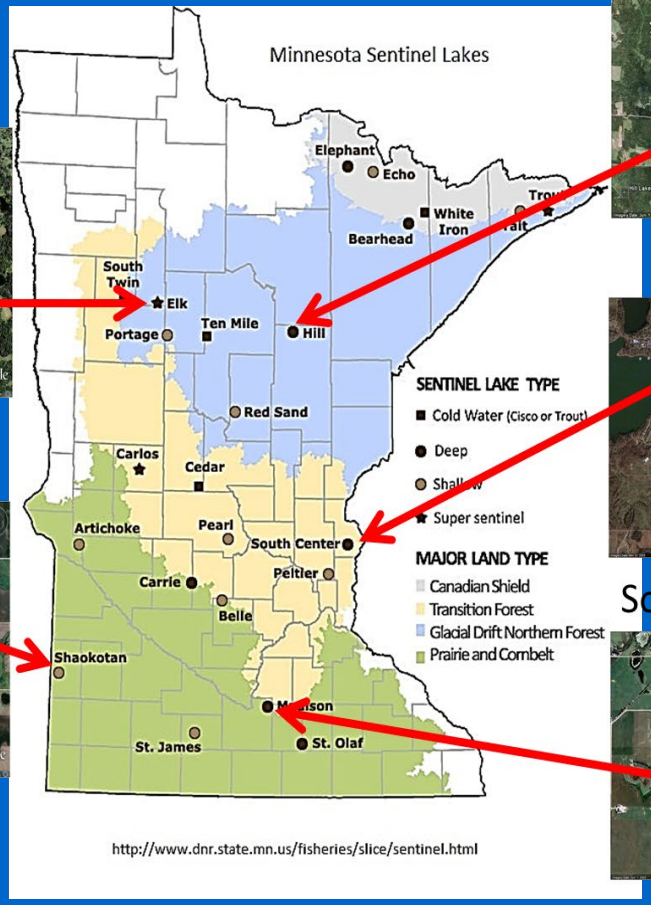
Study Sites – MN DNR
Minnesota Sentinel Lakes and P-histories

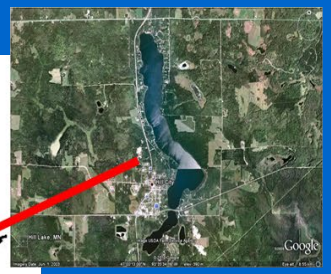


Elk Lake

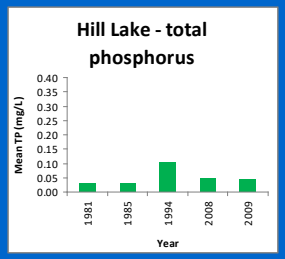


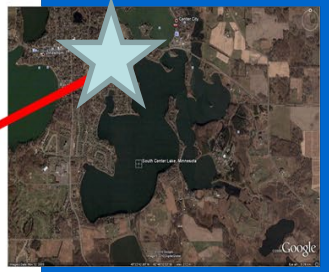
Shaokotan Lake



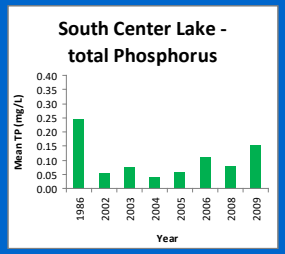


Hill Lake

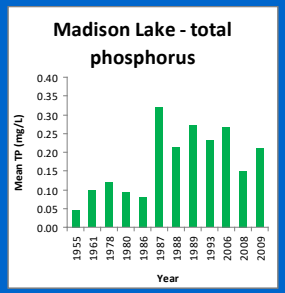




South Center Lake

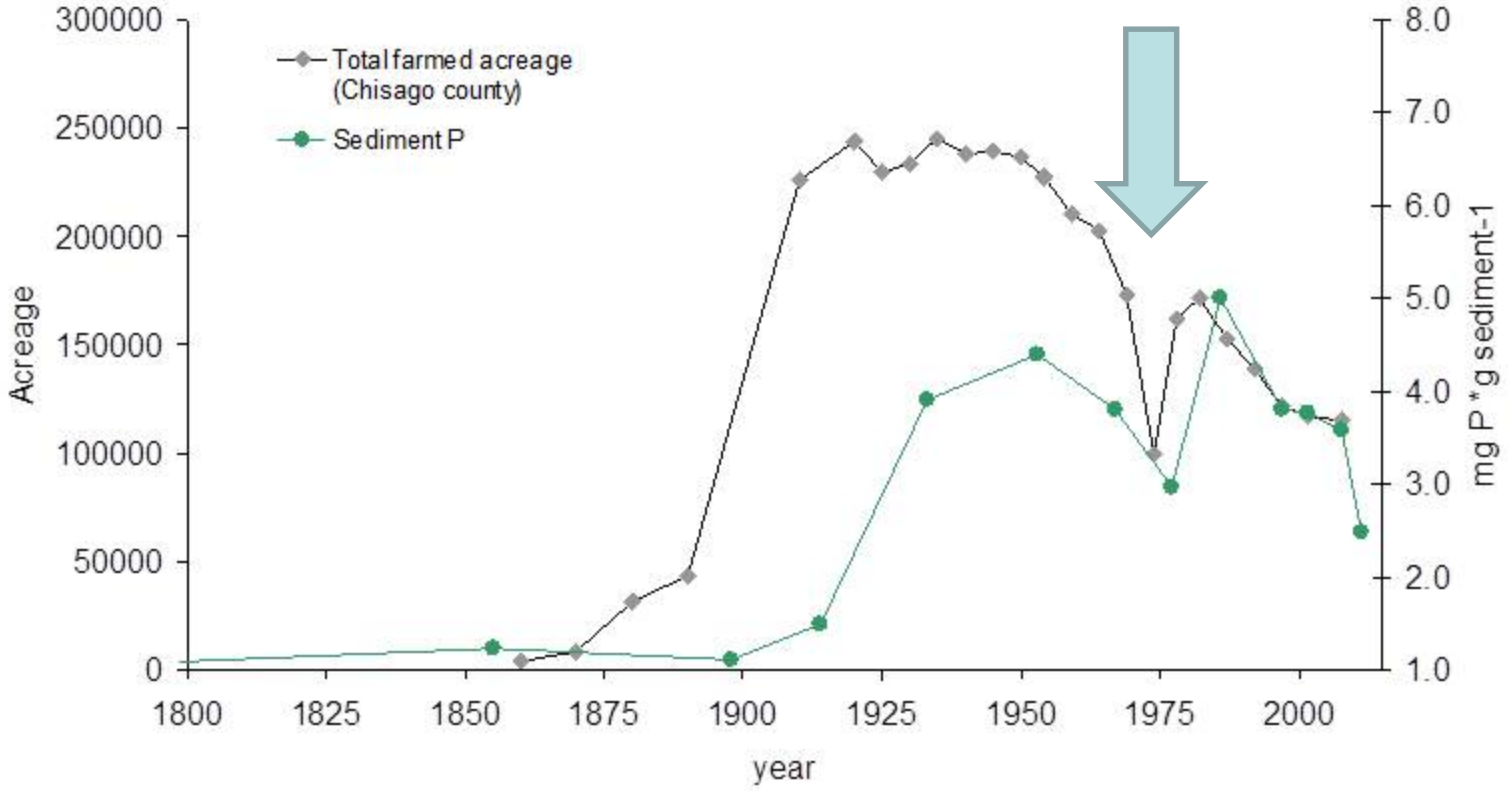


Madison Lake



https://www.dnr.state.mn.us/fisheries/slice/sentinel.html

Farm Acreage in Chisago County, MN and S. Center Lake Sediment P



Frisch et al. (2014). Ecol. Lett.

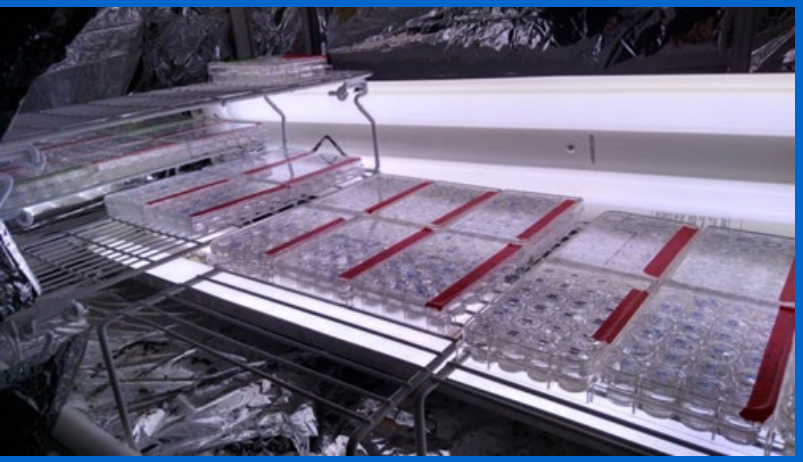
Methodology

Collection & Processing of *D. pulicaria* Ephippia

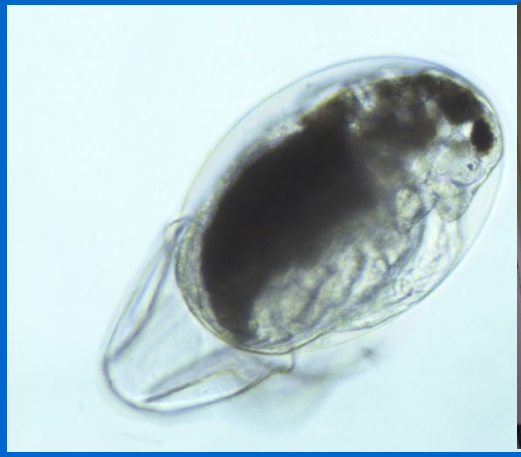
Coring of S. Center Lake

Nested Metal Sieves

Daphnia ephippium



Cell culture plates with *Daphnia* eggs

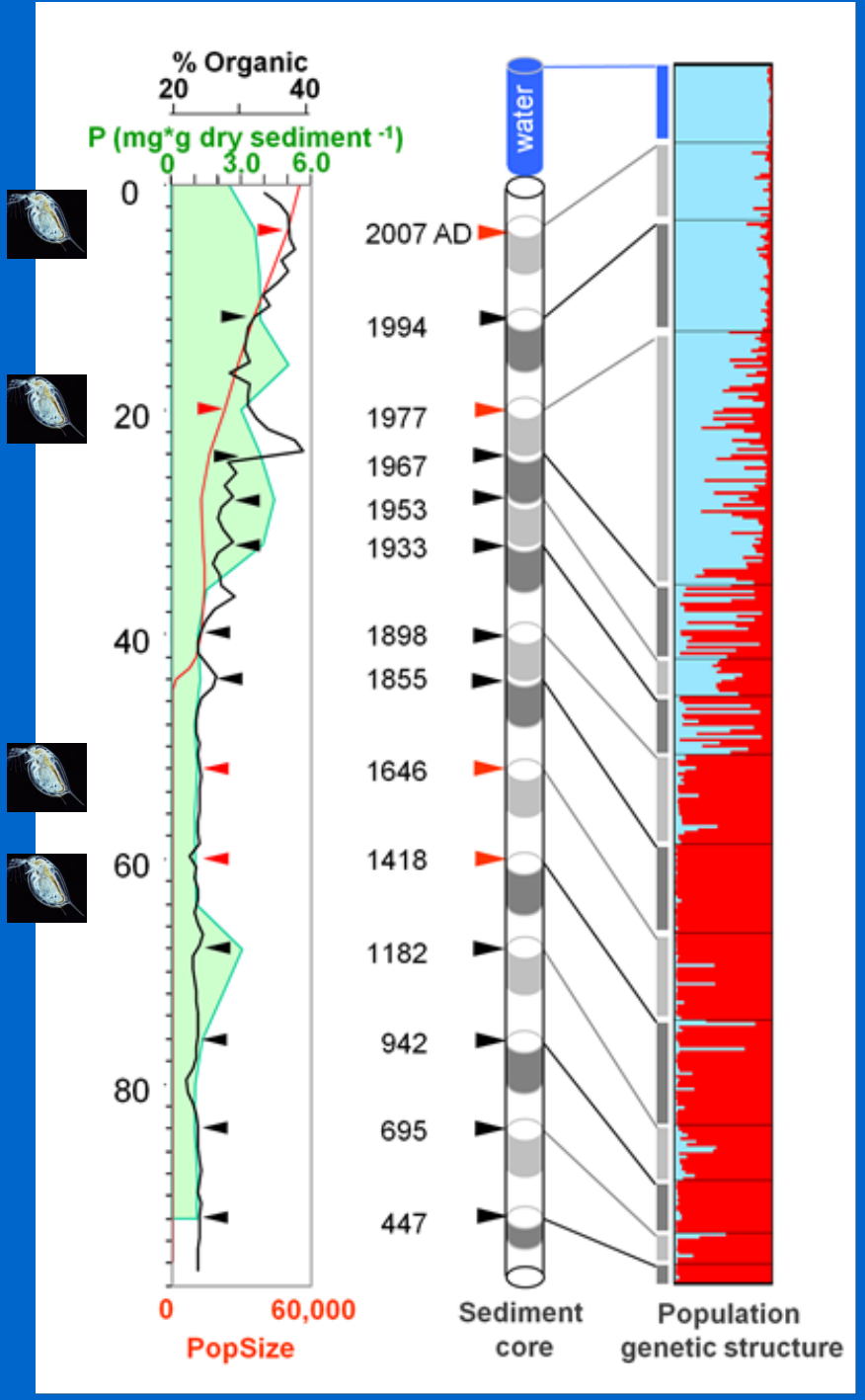


Daphnia hatchling

Daphnia culturing

Fig. 1 Eutrophication history and *Daphnia pulicaria* population genetic structure of the past ~1600 years, in South Center Lake (Chisago County, MN). Results indicate an increase of organic matter, and P concentrations in the lake with the growing human population size. In parallel to these environmental changes, shifts in population genetic structure were detected.

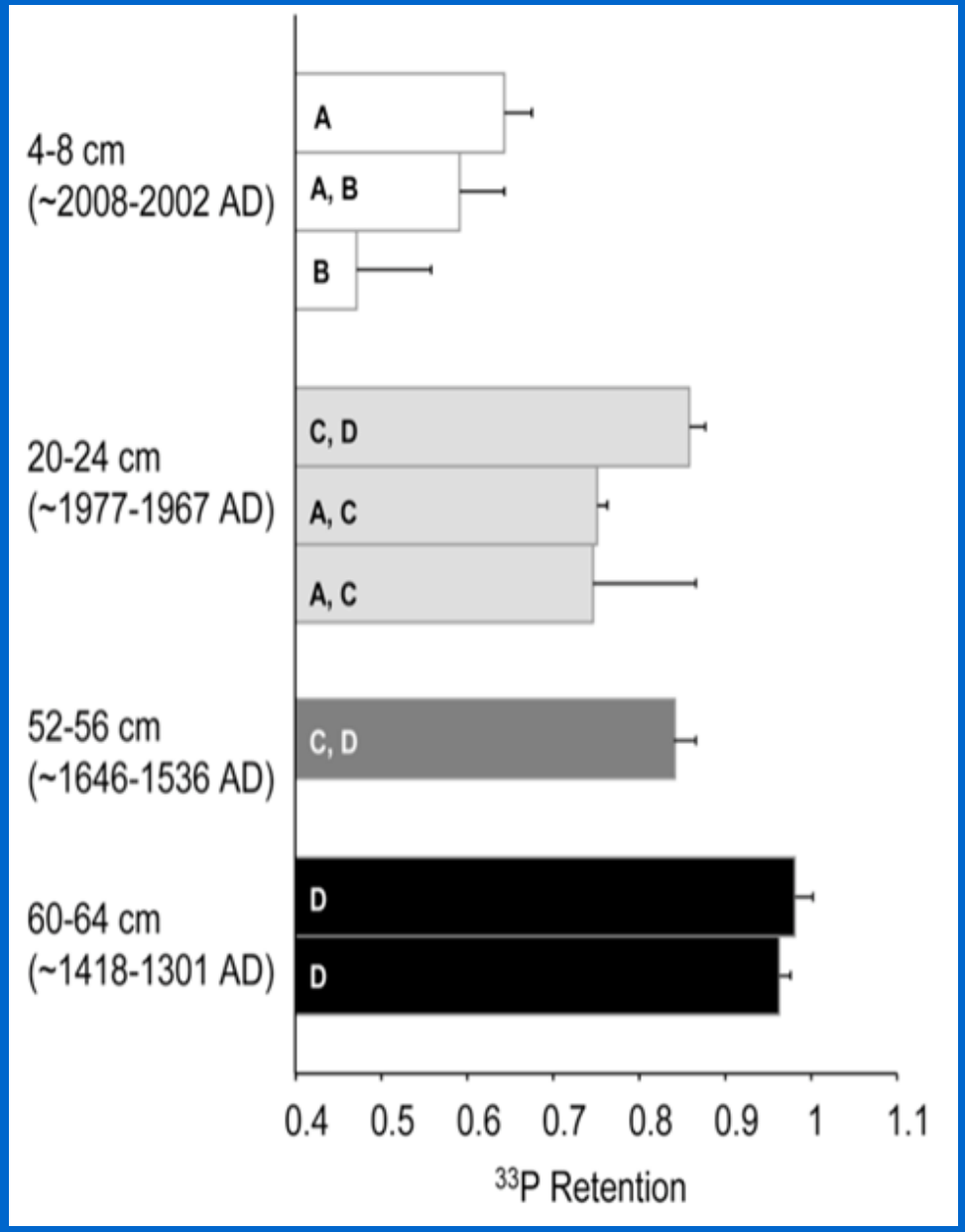
Frisch et al. 2014. Ecology Letters



These “ancient” and “modern” genotypes differ in P retention, with the ancient genotypes being more P efficient than their extant descendants.

“MODERN”

“ANCIENT”



Summary & Conclusions

- Diapausing seed, egg, cyst “banks” - repositories of genetic and ecological information;
- “Resurrection ecology” & long-term monitoring of ecological/environmental parameters - allow tracking of how organisms respond to environmental changes.
- Can examine a variety of environmental stressors (e.g. shifts in nutrients, eutrophication, toxic chemicals) through time.

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