Climate Change, Water Levels and the Ecology of Northern Wisconsin Lakes

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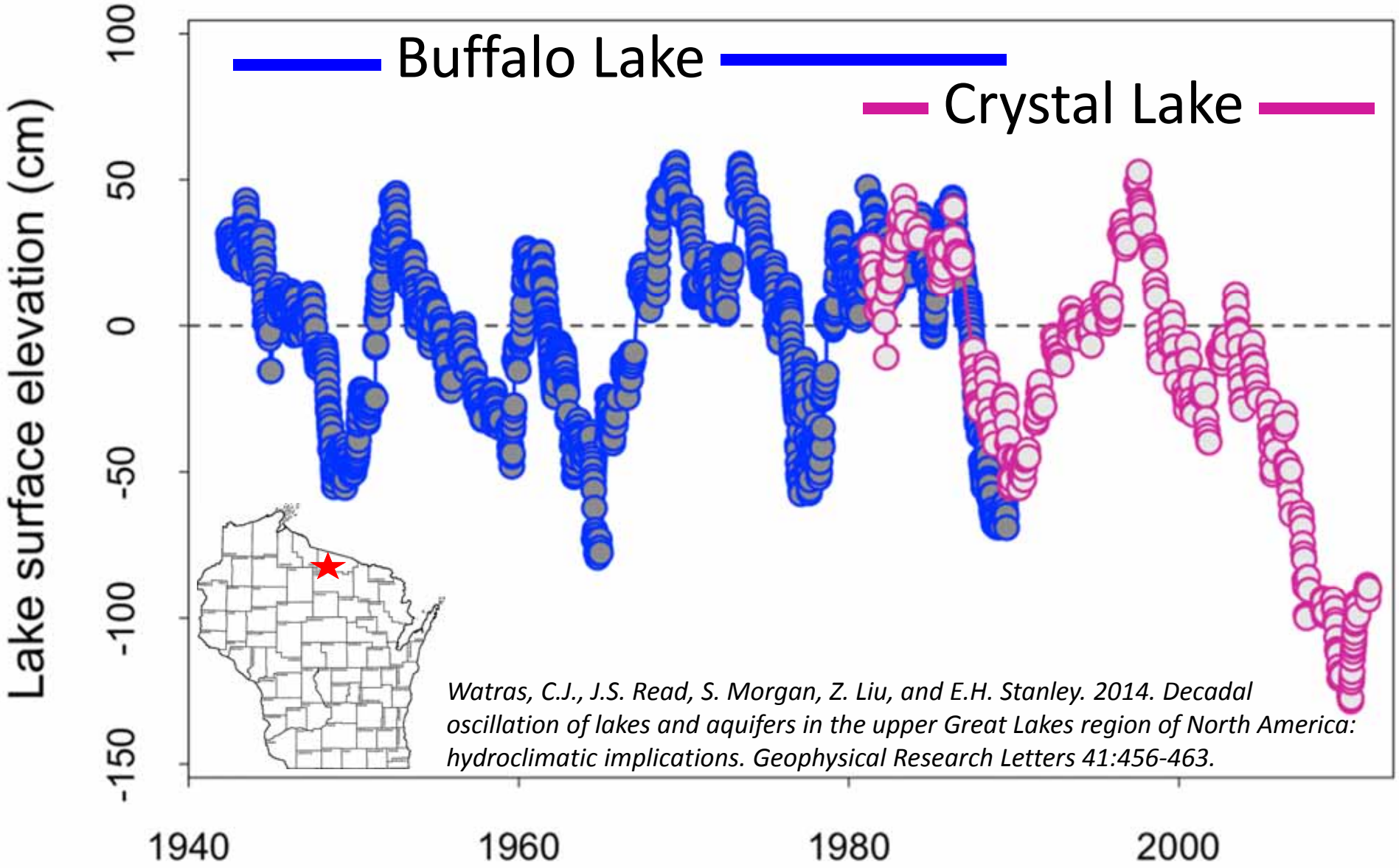
- Wisconsin Initiative on Climate Change Impacts
- Wisconsin Valley Improvement Company
- National Science Foundation
- Co-authors:

Outline

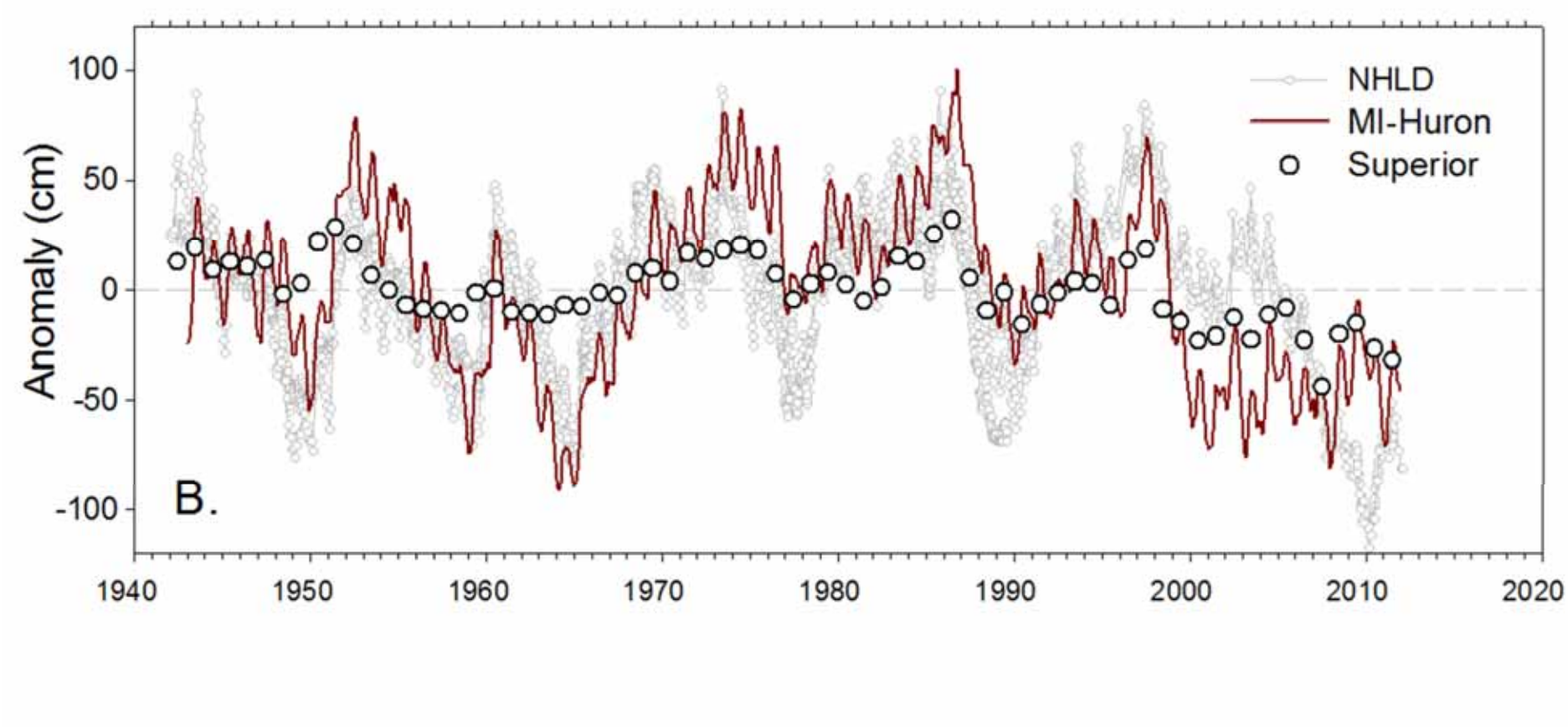
- Dynamics of lake levels
- Ecological response to changes in lake levels
  - Crayfish and cobble
  - Fish and dead trees
- Projections of future lake level change

Historic Lake Levels: Vilas and Oneida Counties



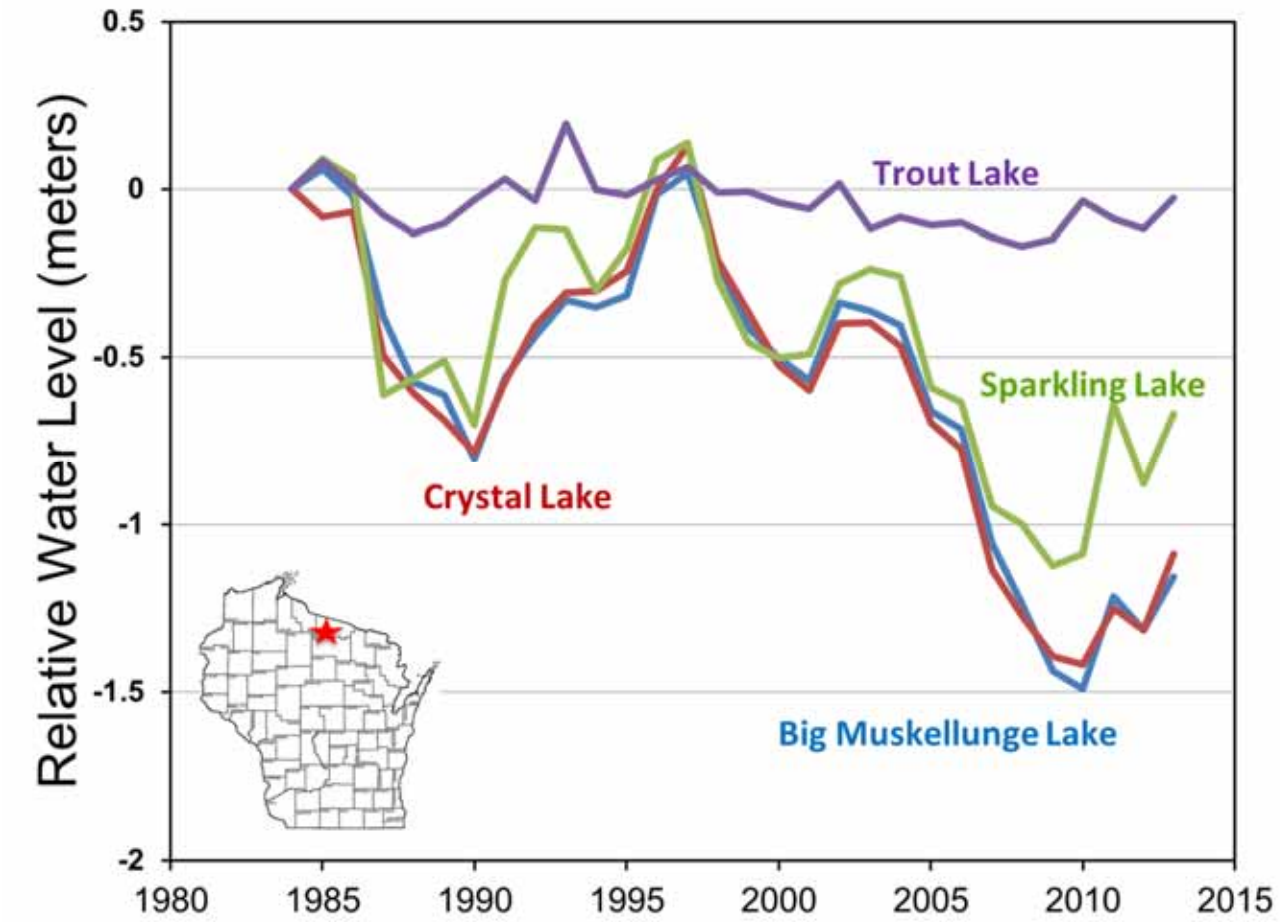
Watras, C.J., J.S. Read, S. Morgan, Z. Liu, and E.H. Stanley. 2014. Decadal oscillation of lakes and aquifers in the upper Great Lakes region of North America: hydroclimatic implications. Geophysical Research Letters 41:456-463.

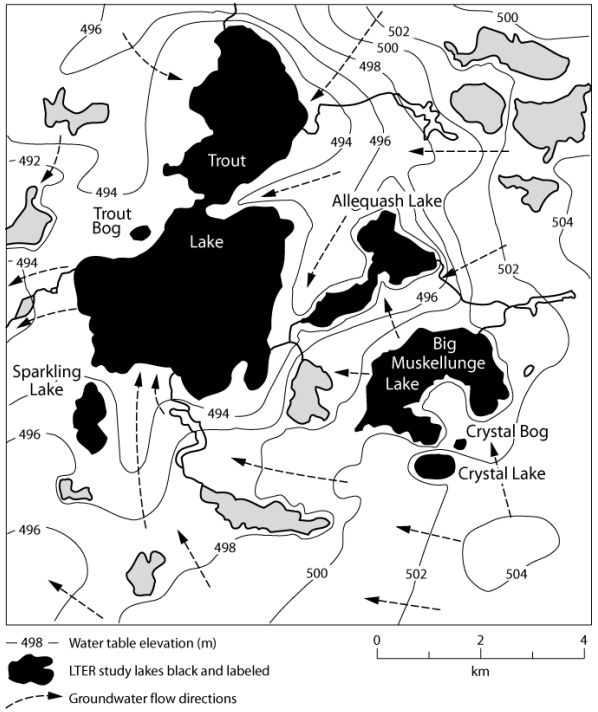
Lakes Michigan/Huron and Superior show similar patterns



Lake Level Response to Drought

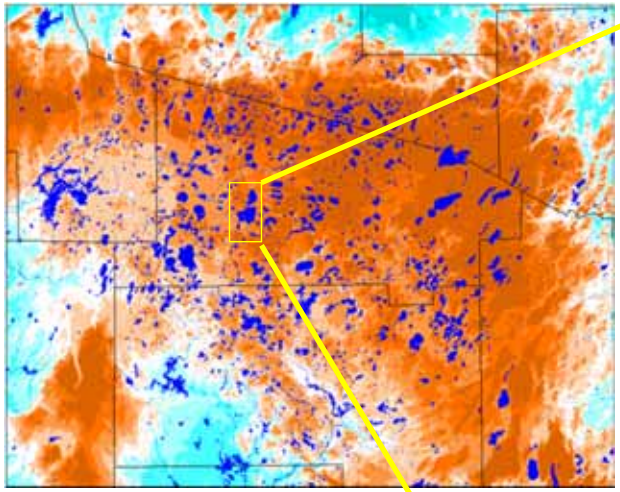
Seepage lakes have larger response than drainage lakes





Data courtesy of North Temperate Lakes Long-Term Ecological Research project; UW-Madison

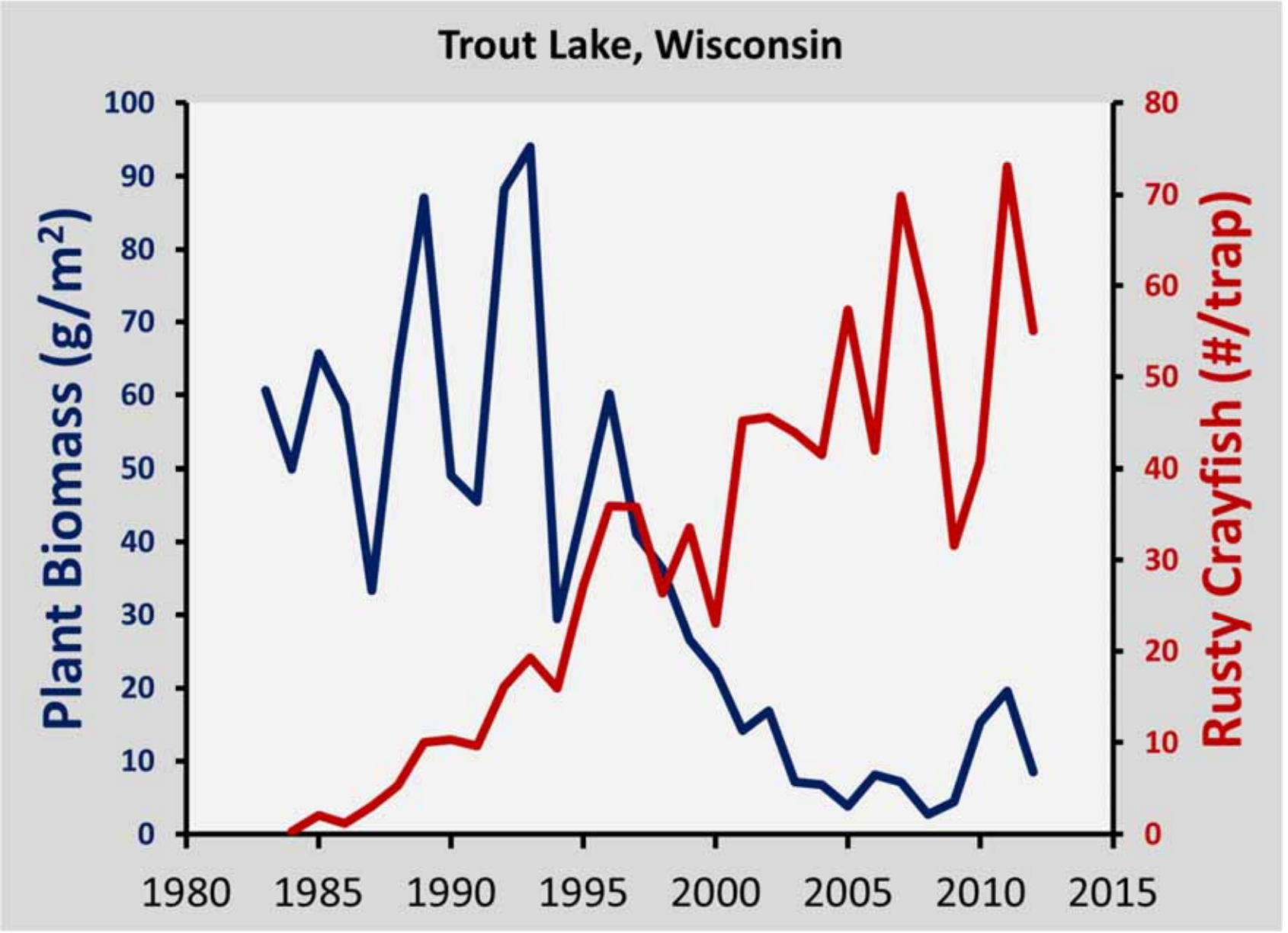
Rusty Crayfish: a story from two lakes



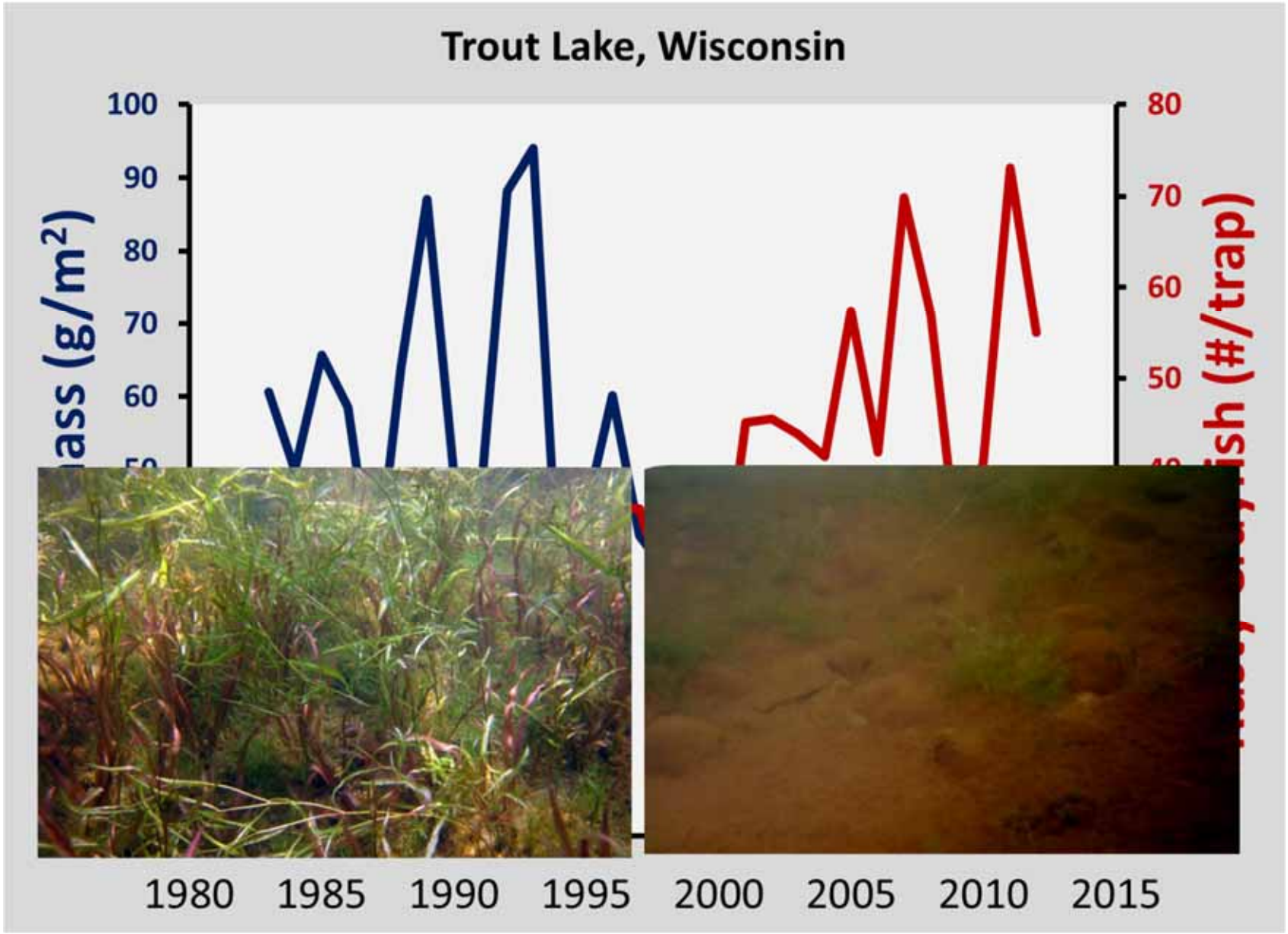
Rusty Crayfish

Hansen, G.J.A., A.R. Ives, M.J. Vander Zanden, and S.R. Carpenter. 2013c. Are rapid transitions between invasive and native species caused by alternative stable states, and does it matter? Ecology 94:2207-2219

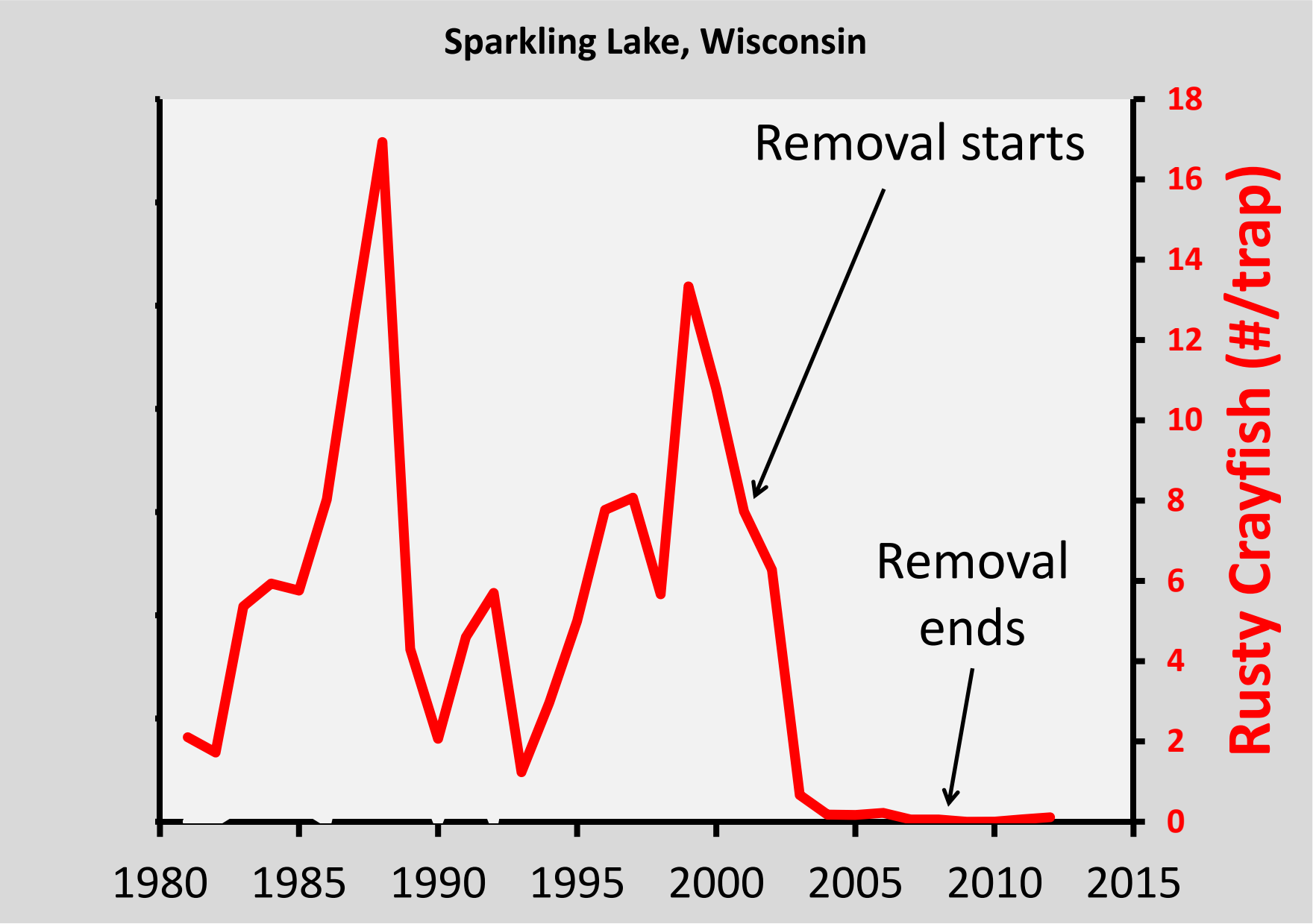
Rusty crayfish cause decline in aquatic plants



Rusty crayfish cause decline in aquatic plants

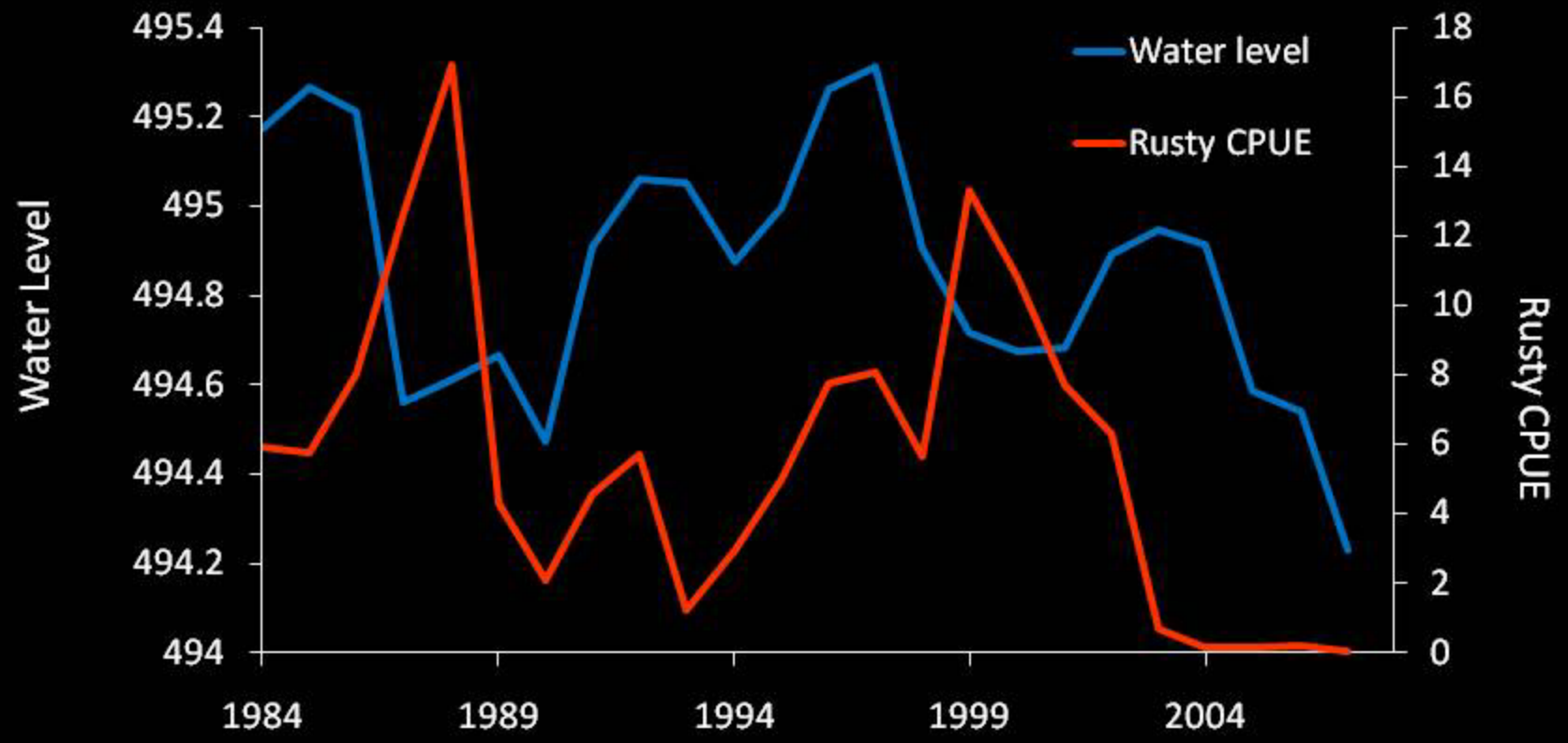


Rusty crayfish abundance in a seepage lake

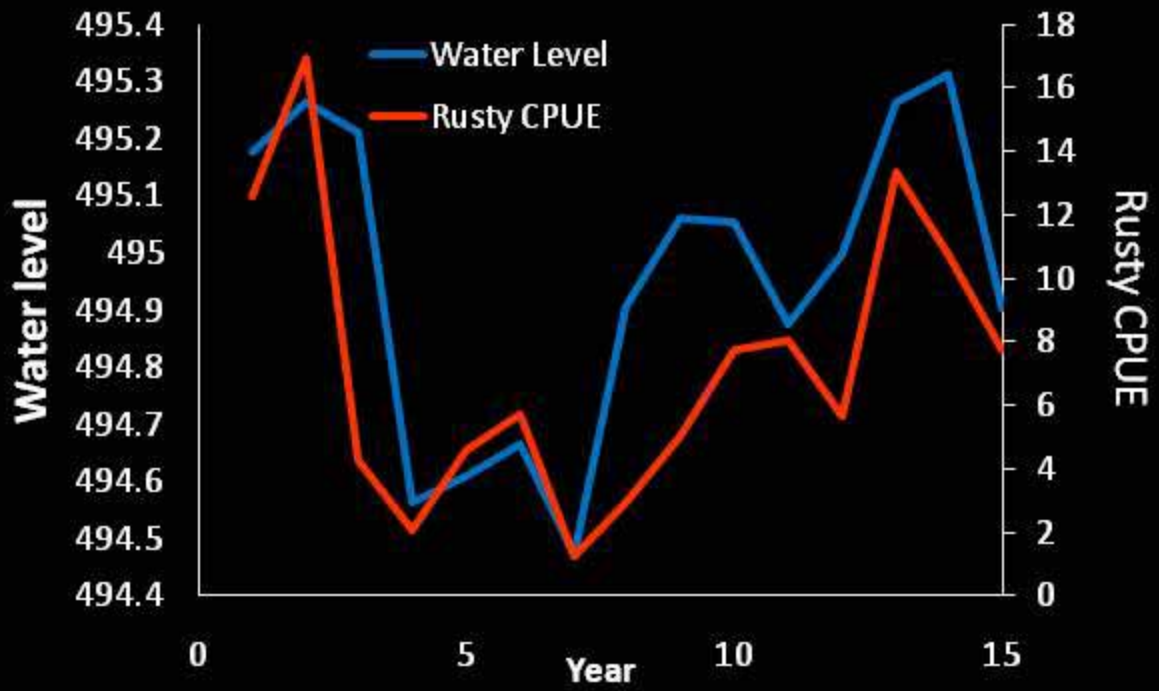


Drought conditions reduce cobble habitat

Crayfish Capture and Water Levels



Water Level - 3 year lag

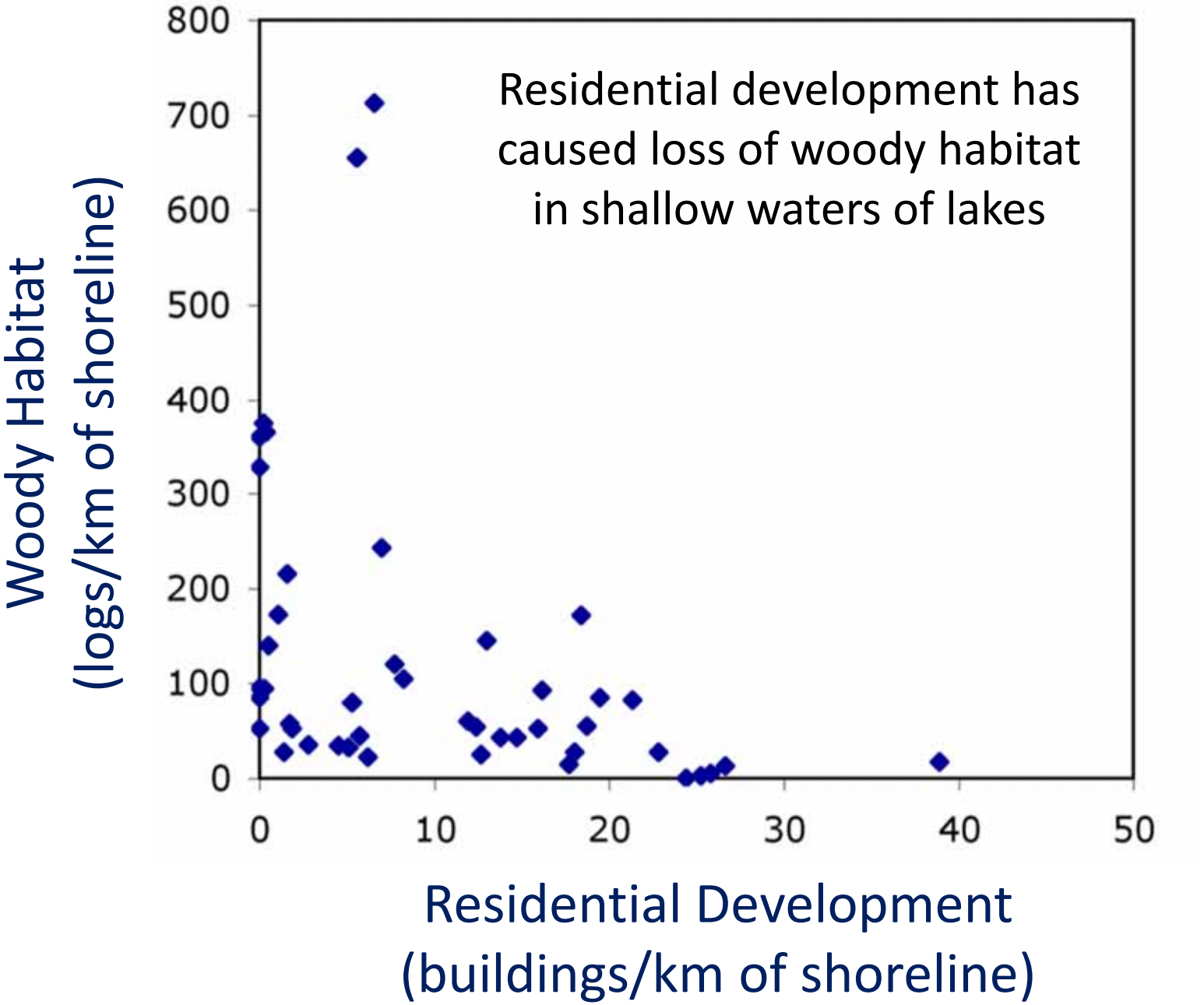


- Very young crayfish prefer cobble (in very shallow water)
- As water level drops, cobble exposed
- Young crayfish cannot escape predation
- Traps catch mostly 3+ year-old crayfish
- Three years after low water, see lower catch because young crayfish did not survive

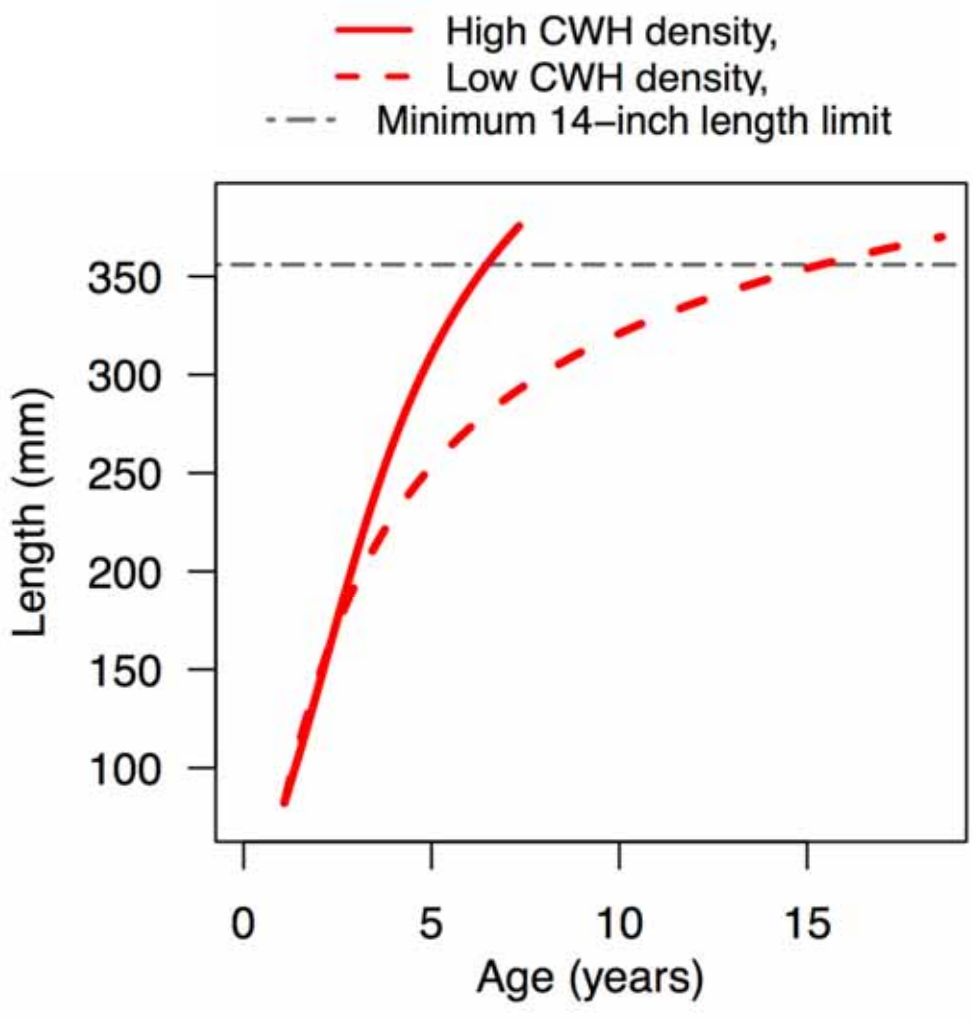
Fish, woody habitat, people and climate

Photo: Michele Woodford

Gaeta, J.W., G.G. Sass, and S.R. Carpenter. 2014. Drought-driven lake level decline: effects on coarse woody habitat and fishes. Canadian Journal of Fisheries and Aquatic Sciences 71:315-325.


Residential development has caused loss of woody habitat in shallow waters of lakes
Woody Habitat (logs/km of shoreline)
800
700
600
500
400
300
200
100
0
0
10
20
30
40
50
Residential Development (buildings/km of shoreline)

Woody habitat influences growth and composition of fish communities



Largemouth bass

Lower water levels effectively remove woody habitat from lakes

Photo by Dick Lathrop

Photo by Jereme Gaeta

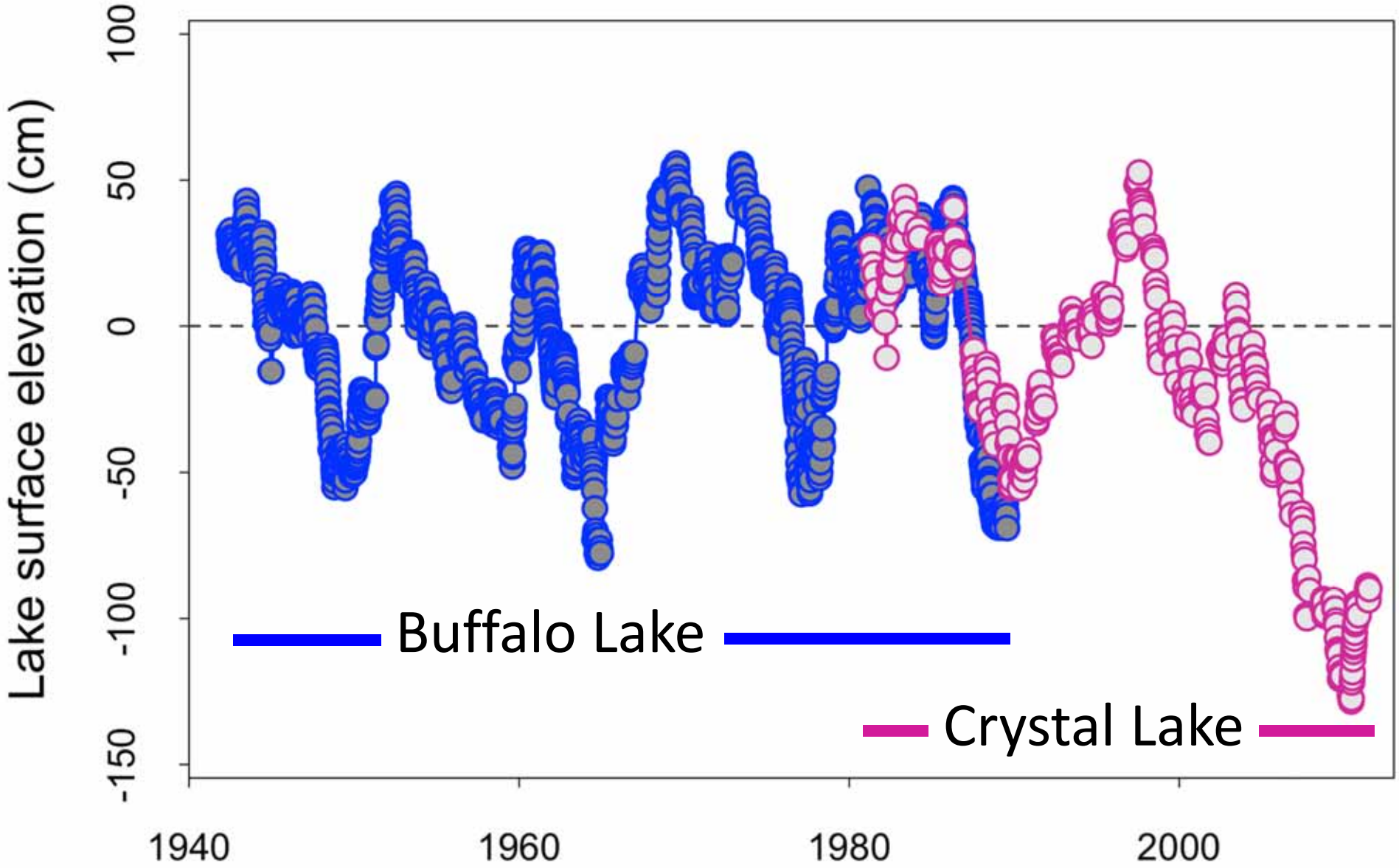
Modeling Future Lake Level Dynamics

- Scenarios A1, A1b, and B2 from IPCC 4th Assessment
- Downscaled using WICCI protocols*
- Average of 6 GCM outputs
- Coupled with regional hydrologic model for northern Wisconsin

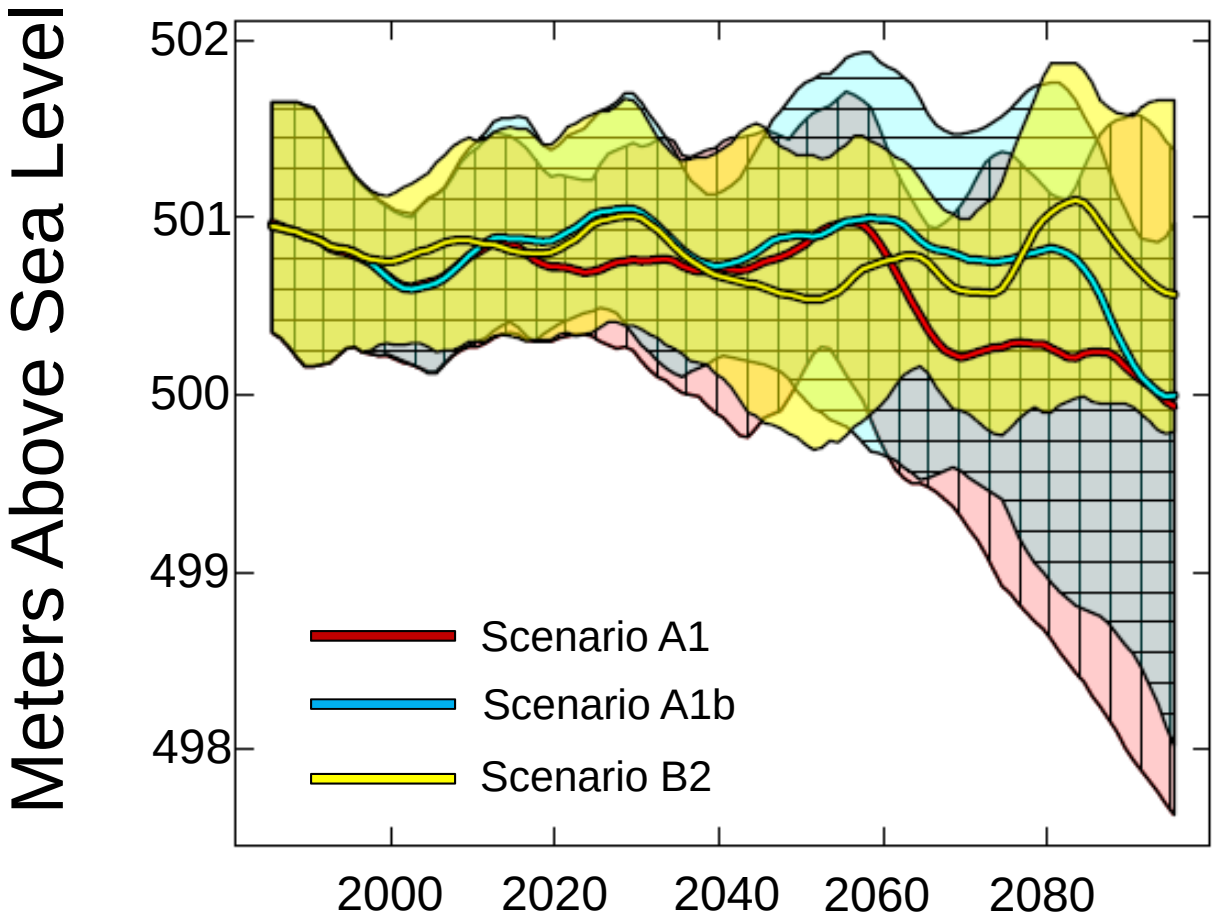
- Predicts:
  - Regional temperature, precipitation, evapotranspiration
  - Lake specific groundwater, surface water and lake stage

**WICCI. 2011. Wisconsin's Changing Climate: Impacts and Adaptation. Wisconsin Initiative on Climate Change Impacts. Nelson Institute for Environmental Studies, University of Wisconsin-Madison and the Wisconsin Department of Natural Resources. Madison, Wisconsin. 217 p.*

Historic Lake Levels: Upper Midwest



Modeled Water Level
Crystal Lake, WI

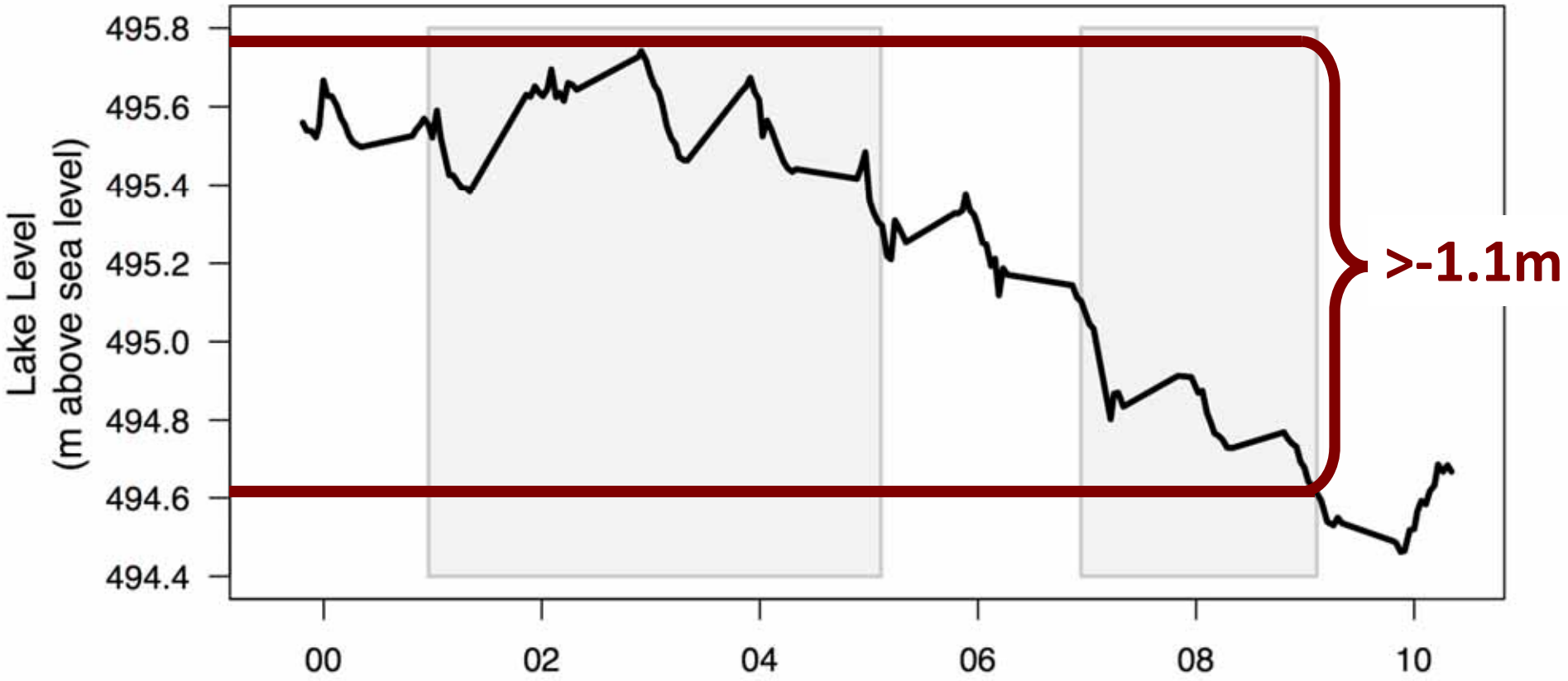


Summary

- Lake levels show significant decadal-scale variability.
- Quality of shallow water habitat important for aquatic organisms is affected by lake level change.
- Lake level changes are likely to have ecological consequences such as reduced growth or abundance of key species.
- Climate projections predict lower lake levels, but not until end of this century.

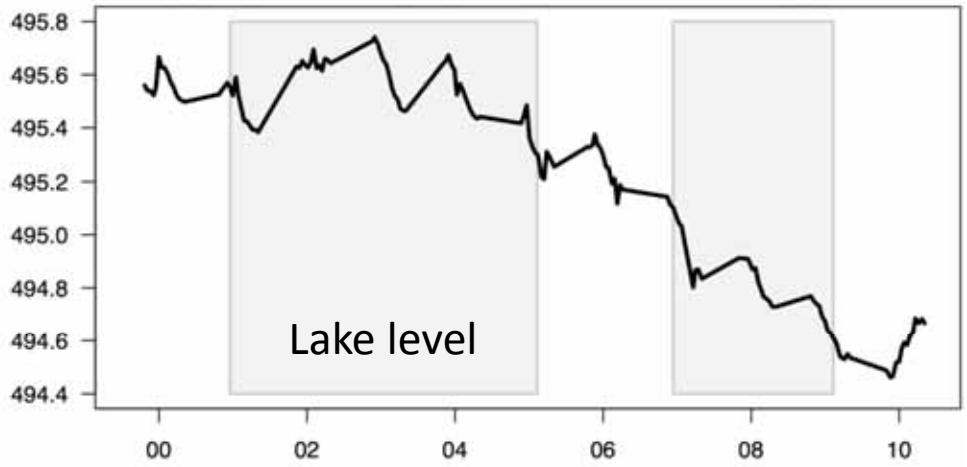
Lake level over time

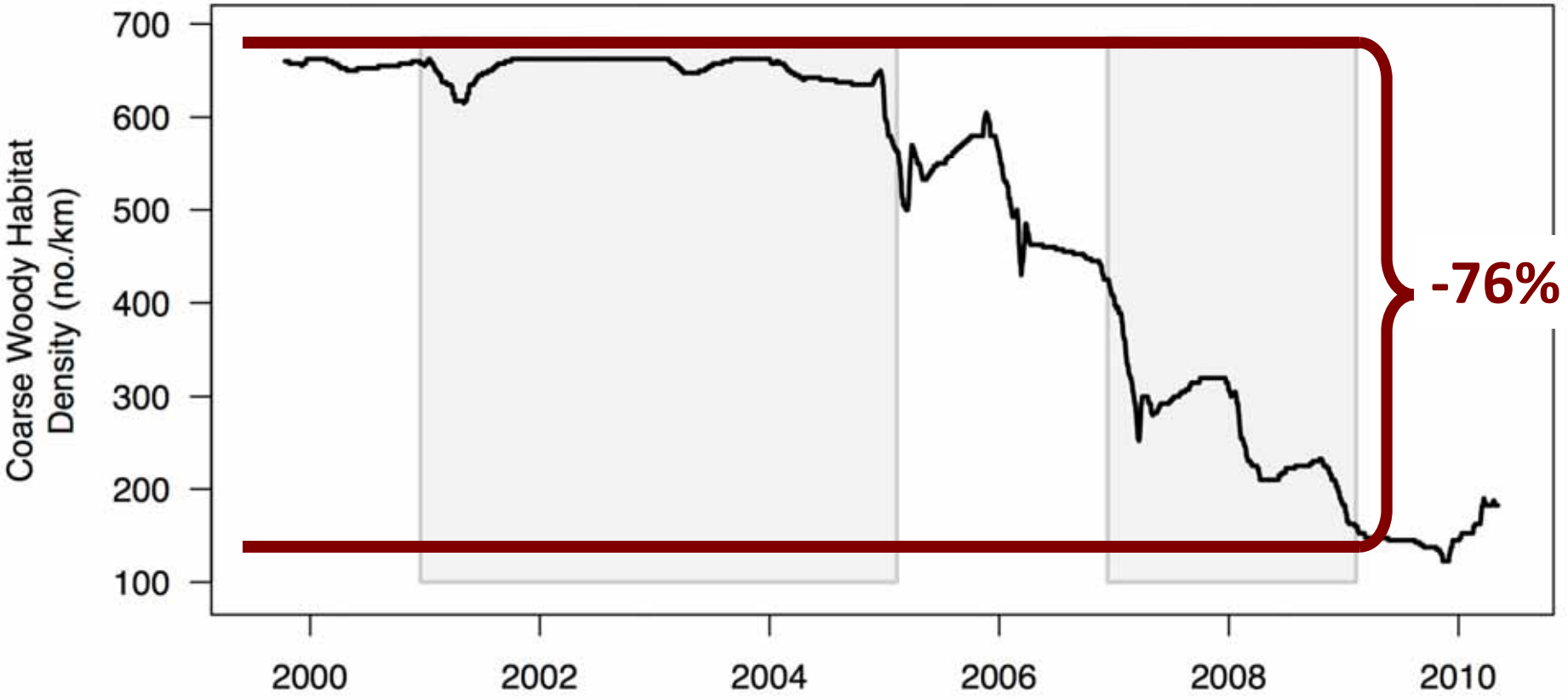
Little Rock Lake, WI



Gaeta, J.W. et al. *in review*

Corresponding change in woody habitat





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Modeled Net Precipitation (P-E)

Northern Wisconsin