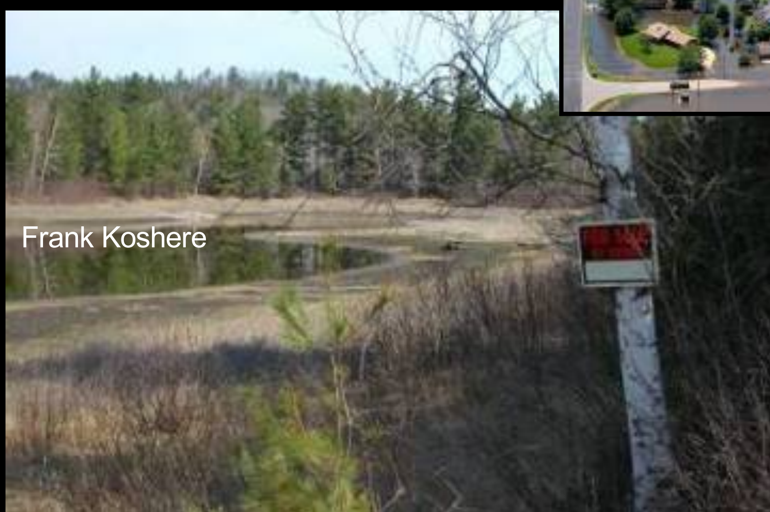
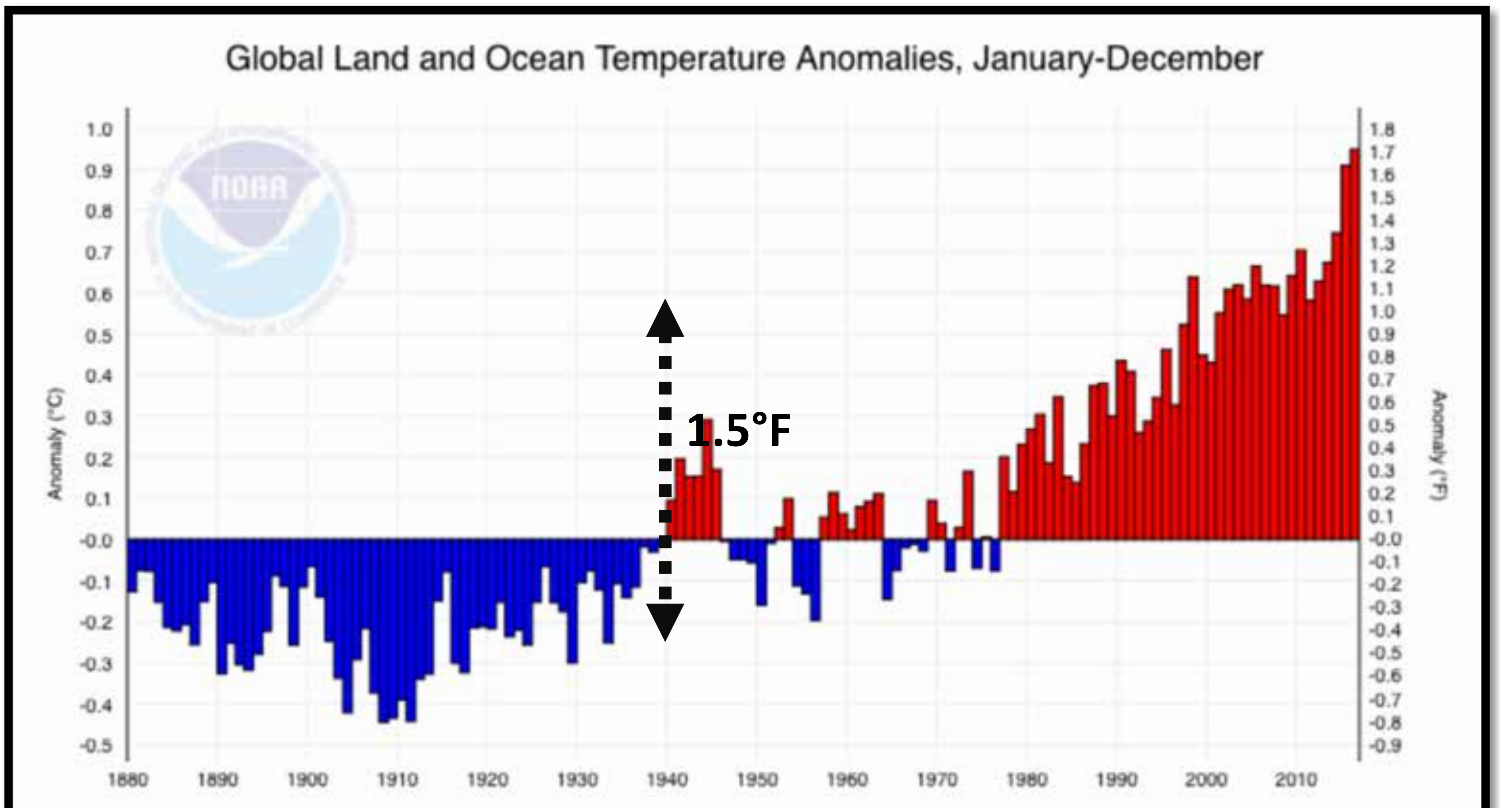
Adapting to Wisconsin's Changing Climate



Katie Hein, WDNR, Monitoring Section

Global Climate Change

Global temperature is increasing

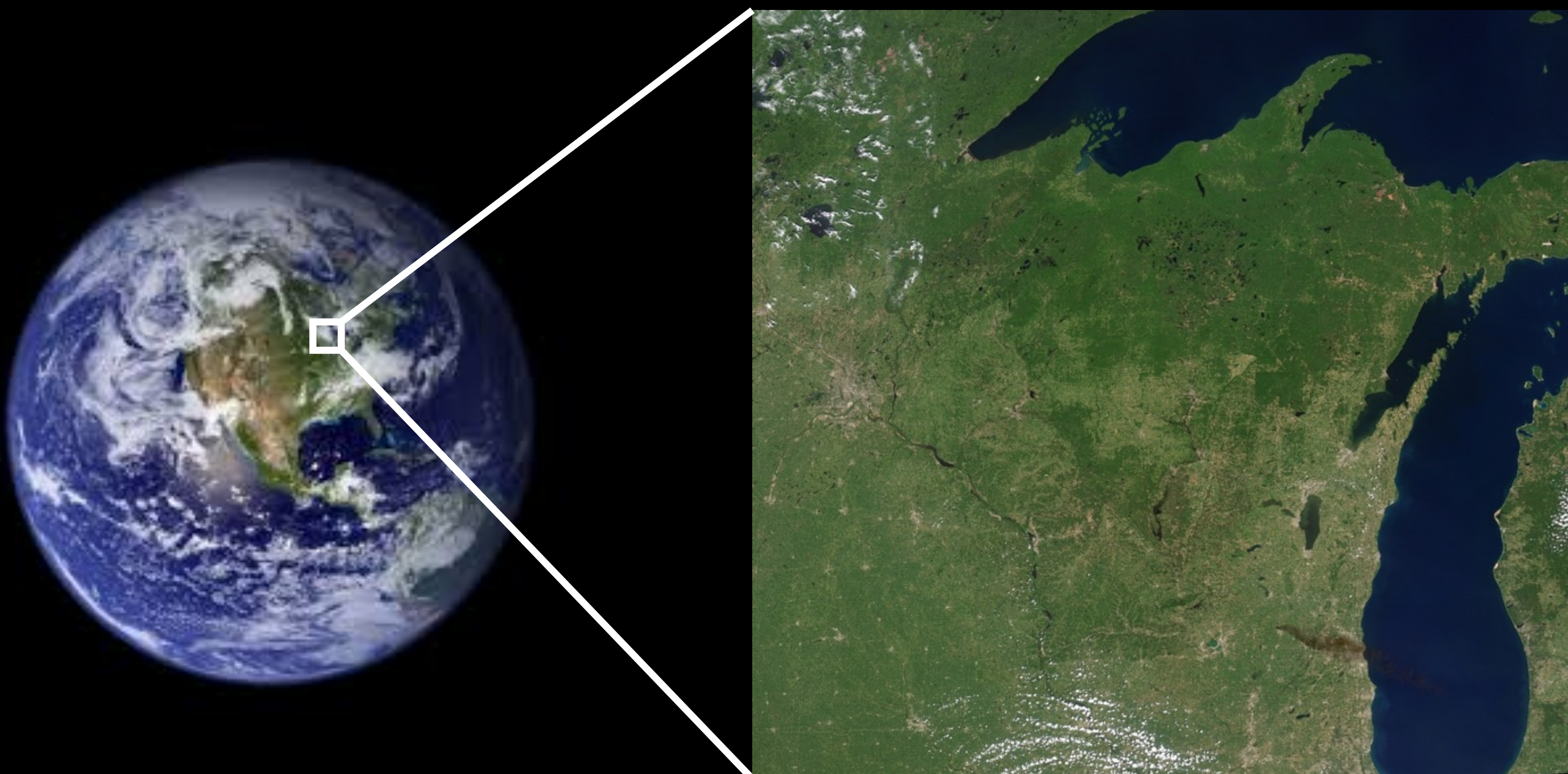


Global temperature has warmed by about 1.5°F since 1900.

Slide from Dan Vimont

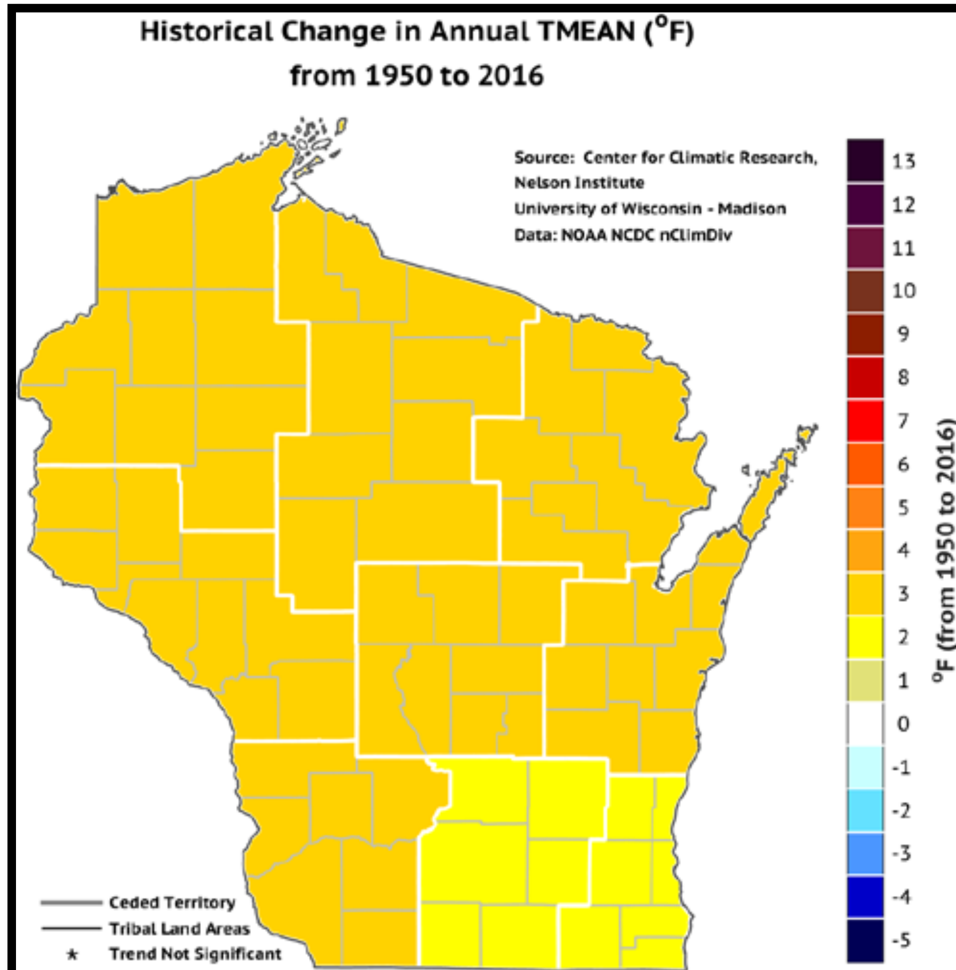
NOAA: https://www.ncdc.noaa.gov/cag/time-series/global/globe/land_ocean/ytd/12/1880-2016

Climate Change in Wisconsin



Historic Annual Temperature Change

Wisconsin has warmed by about 2°– 3°F since the mid 20th Century



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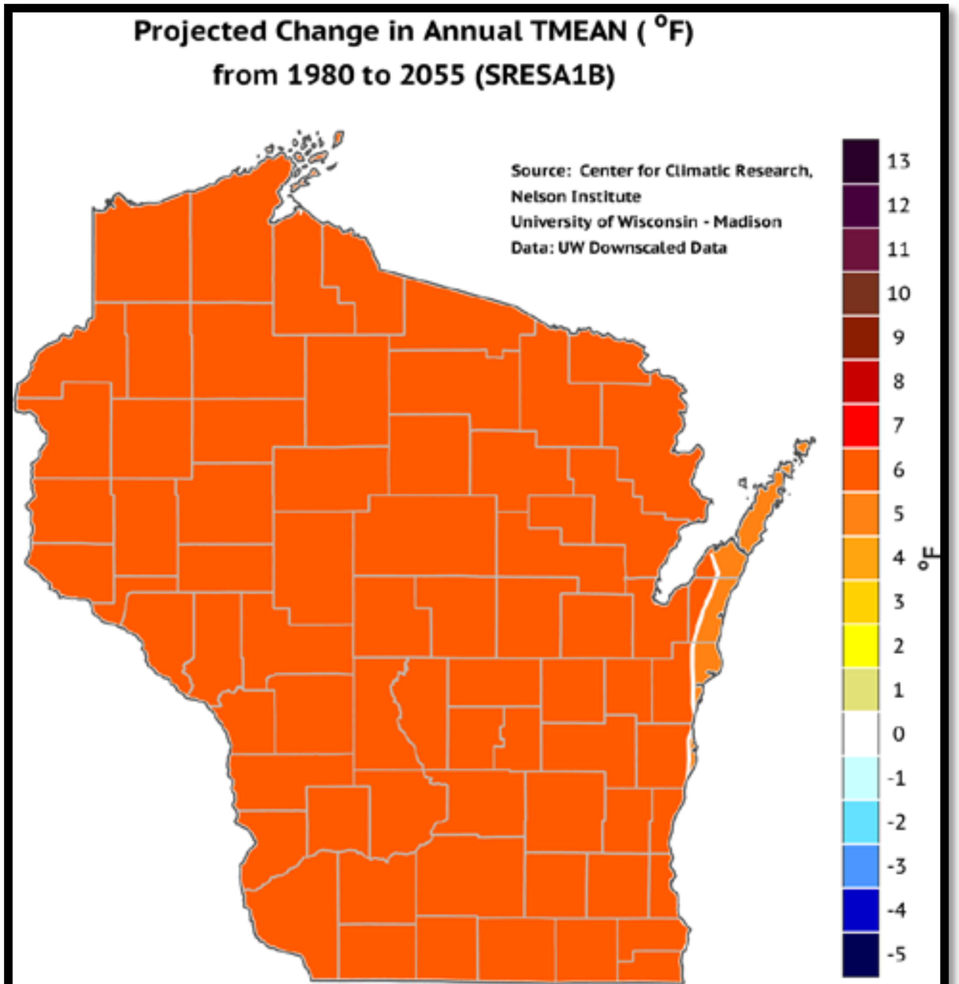
Future Annual Temperature Change



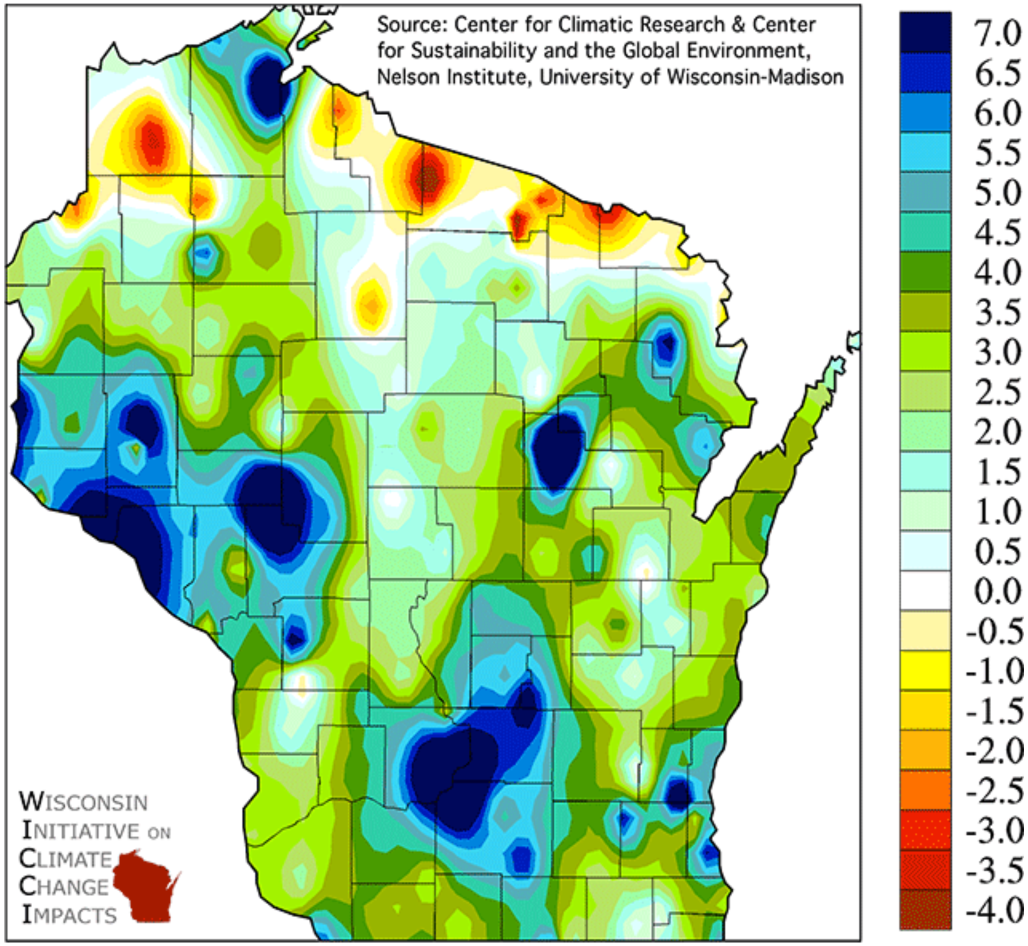
Wisconsin is expected to warm by 3°– 9°F by mid-21st century

Slide from Dan Vimont

Summary of recent historic climate

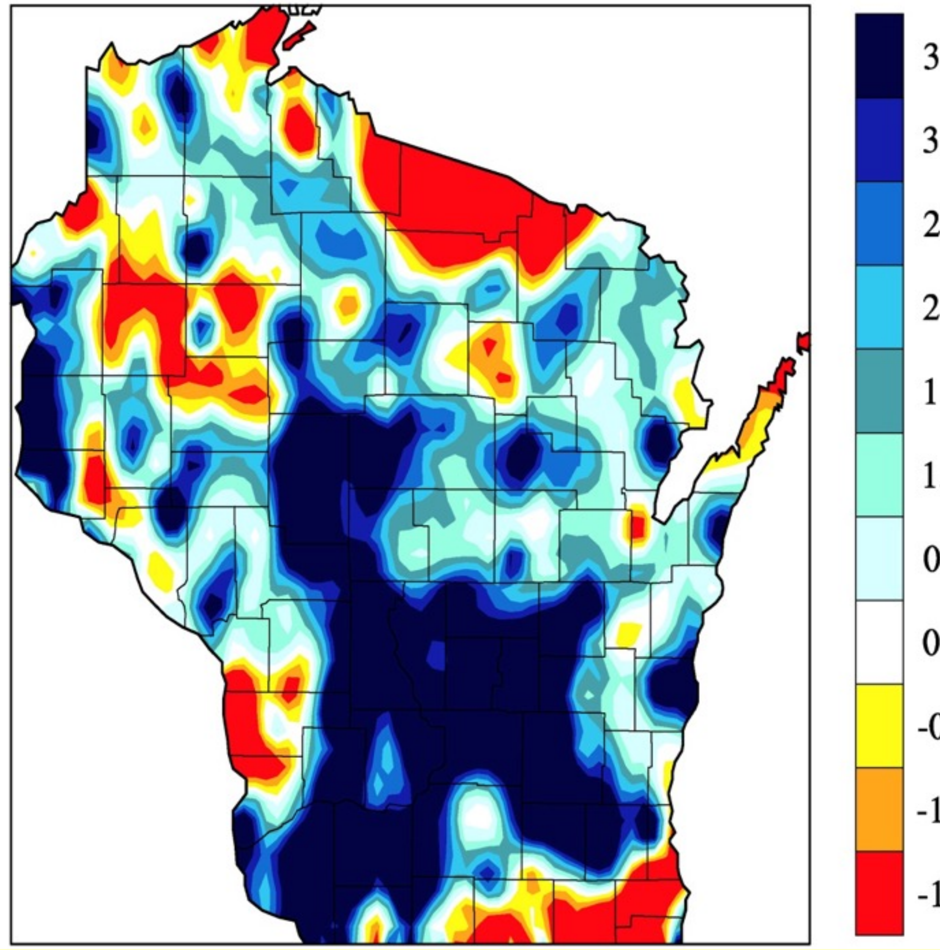
1950-2006 (based on NWS records)

Change in annual average precipitation (inches) 1950 to 2006



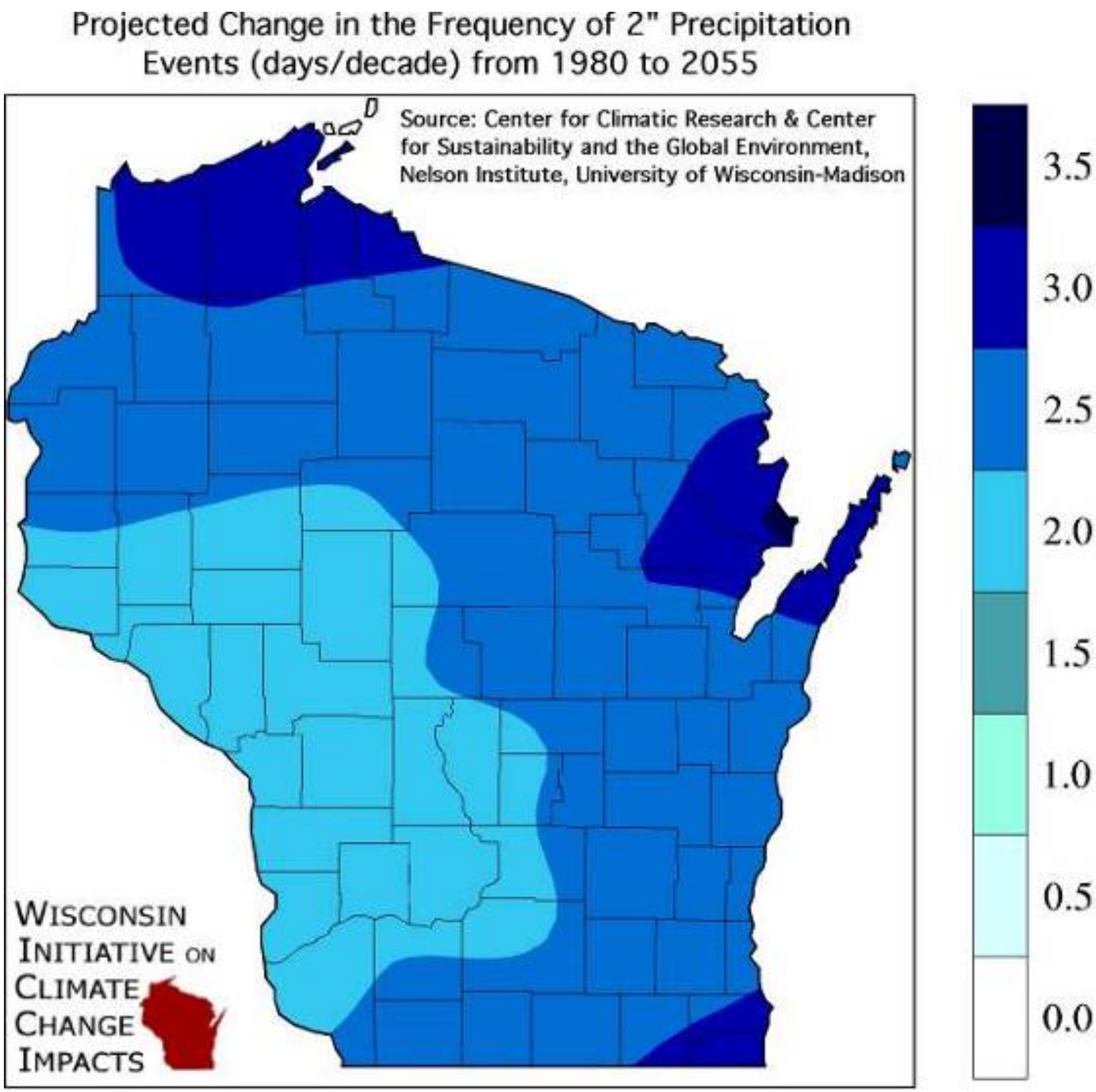
↑7” to ↓4” (drought)

Increase in 2” rainfalls (days/decade) 1950 to 2006



↑3.5 days to ↓1.5 days (regionally variable)

Future Increase in Extreme Precipitation Events



SUMMARY

- **Global climate is changing**
  - There is no going back → question is how much, and how fast?
- **Local climate change → look for robust changes**
  - Winter (4° – 11°F) warms more than summer (2° – 8°F)
  - More extreme temperature events are likely (3-fold increase in freq.)
  - Winter / spring precipitation increases, summer will vary
  - Extreme precipitation becomes more frequent
  - Evaporation is likely to increase

Slide from Dan Vimont

WICCI Water Resources Workshop
Winter 2018

Wisconsin
Initiative on
Climate
Change
Impacts

Climate Change Impacts and Adaptation Strategies for Inland Lakes

- Temperature
- Lake Levels
- Water Quality
- Fisheries
- Aquatic Invasive Species

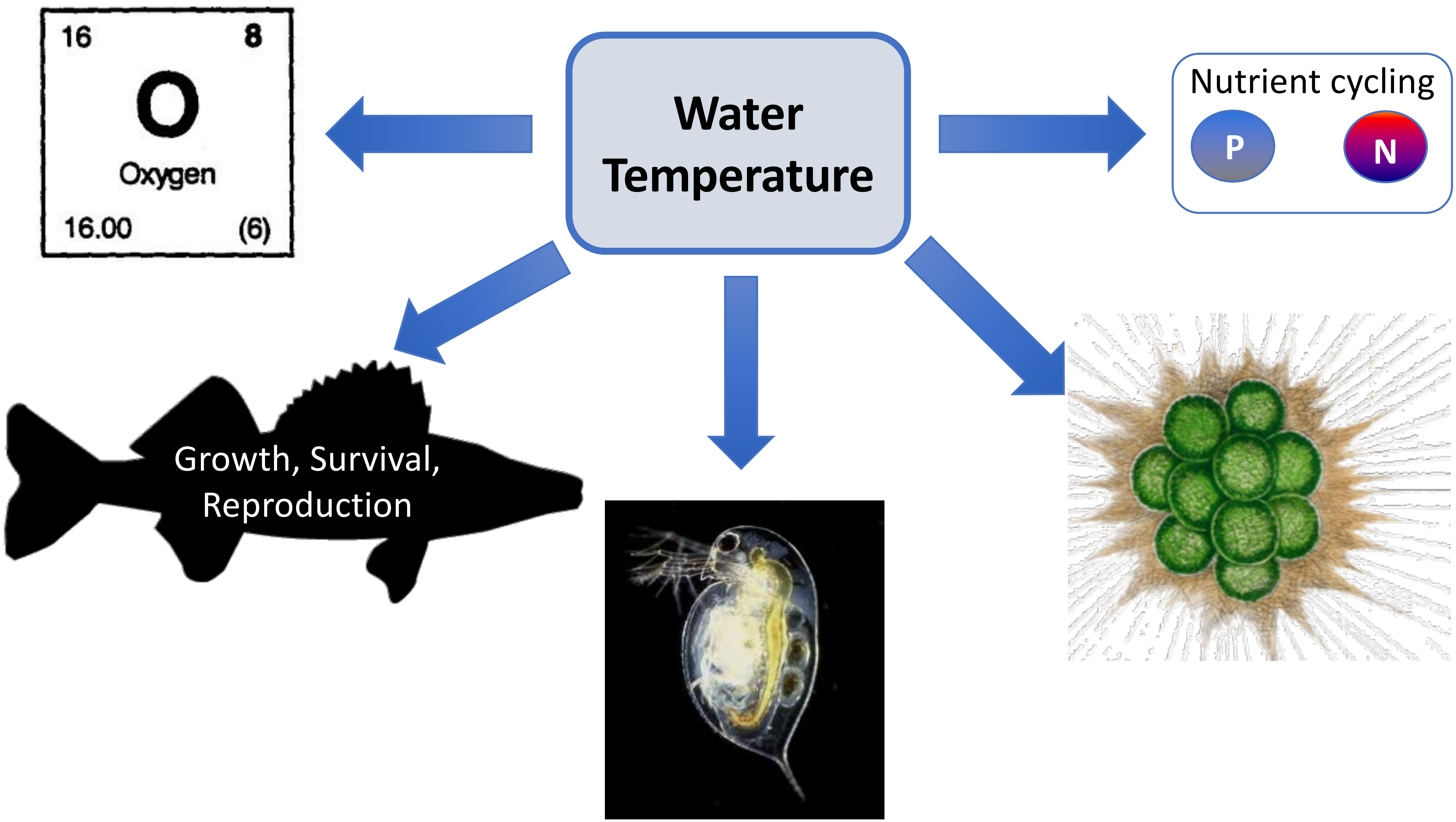
Adaptation Strategies

Resistance – defend high value lakes against changes caused by climate

Resilience – improve the capacity of the lake to return to prior conditions; reduce stress and minimize vulnerabilities

Response – intentionally accommodate change; minimizing undesired outcomes

Temperature is an ecological “master factor”



Globally lakes are warming at 0.34°C/decade

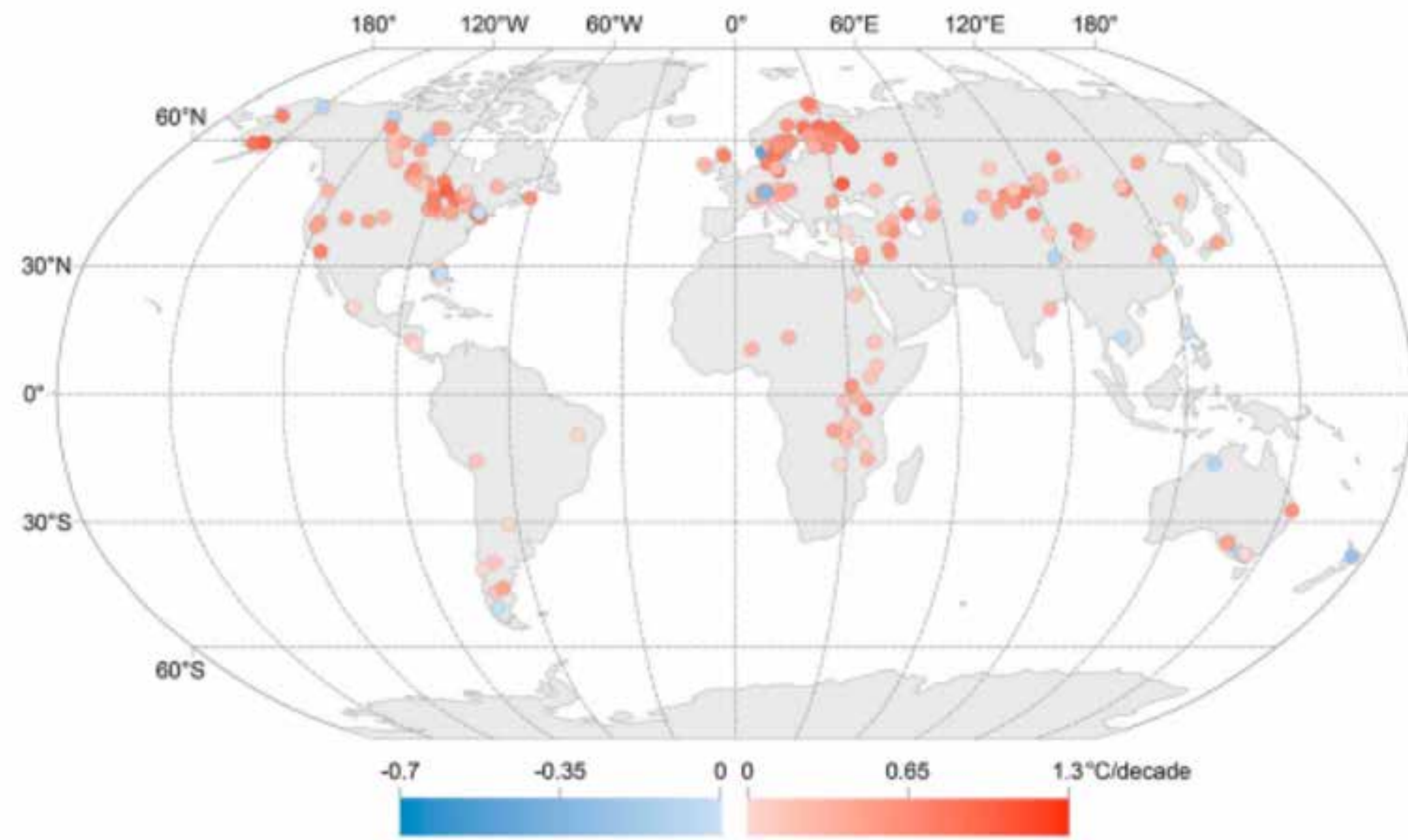
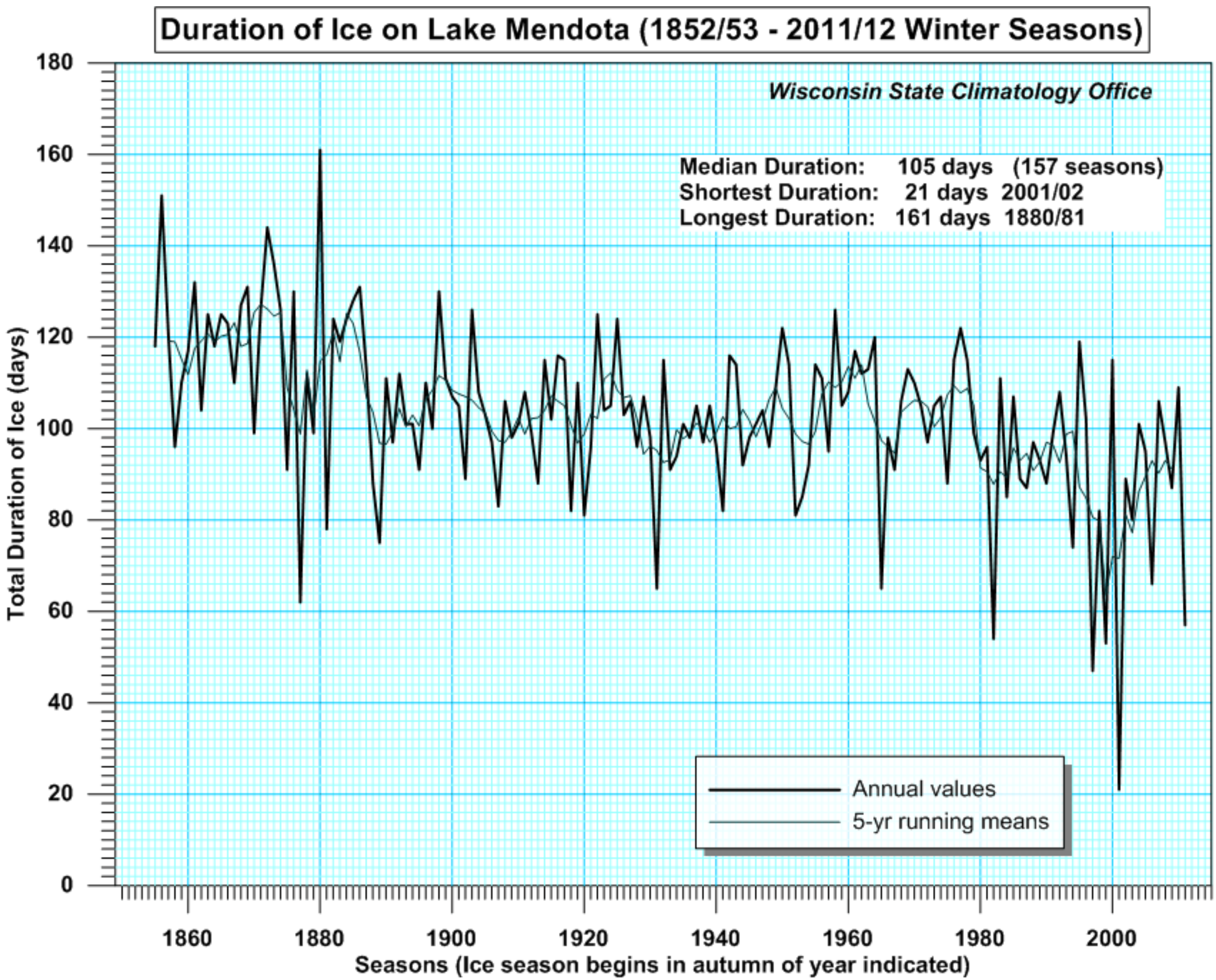


Figure 1. Map of trends in lake summer surface temperatures from 1985 to 2009. Most lakes are warming, and there is large spatial heterogeneity in lake trends. Note that the magnitudes of cooling and warming are not the same.

(O'Reilly et al. 2016)

Shorter periods of ice cover on lakes

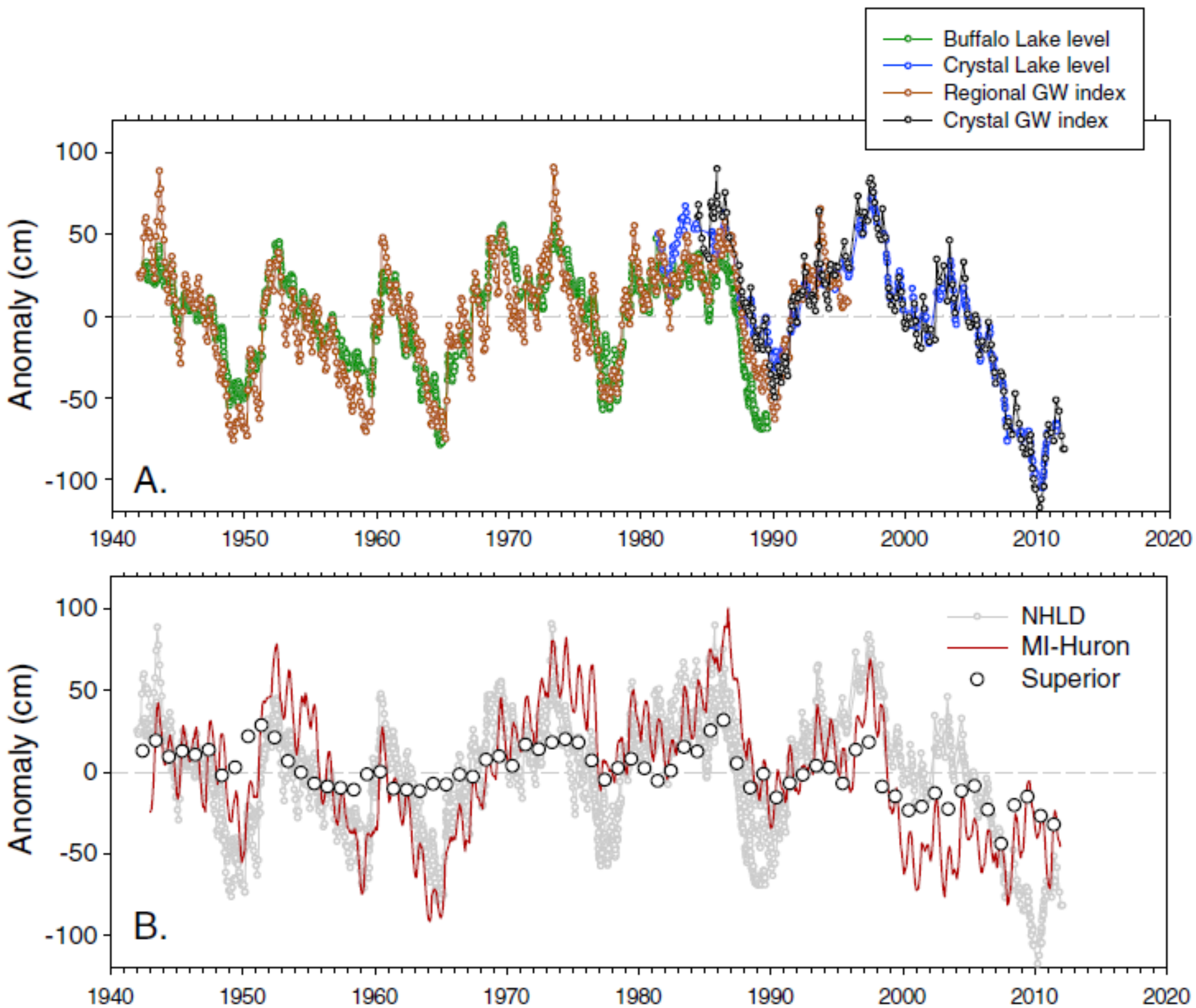


Lake Levels

Changing water levels due to variable precipitation, recharge, and increased evaporation

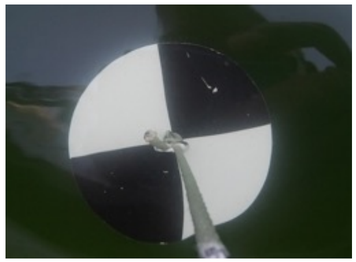
From Robertson et al. 2009 USGS Report 2009–5077

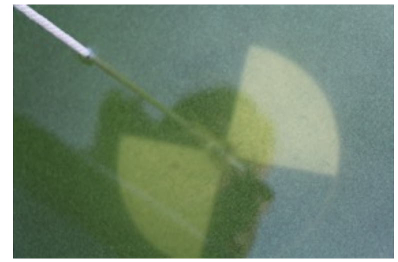
Coherent, near decadal cycle in lake and groundwater levels



Watras et al. 2014 Geophysical Research Letters

Influence of drought on water clarity

More Clear 

Less Clear 

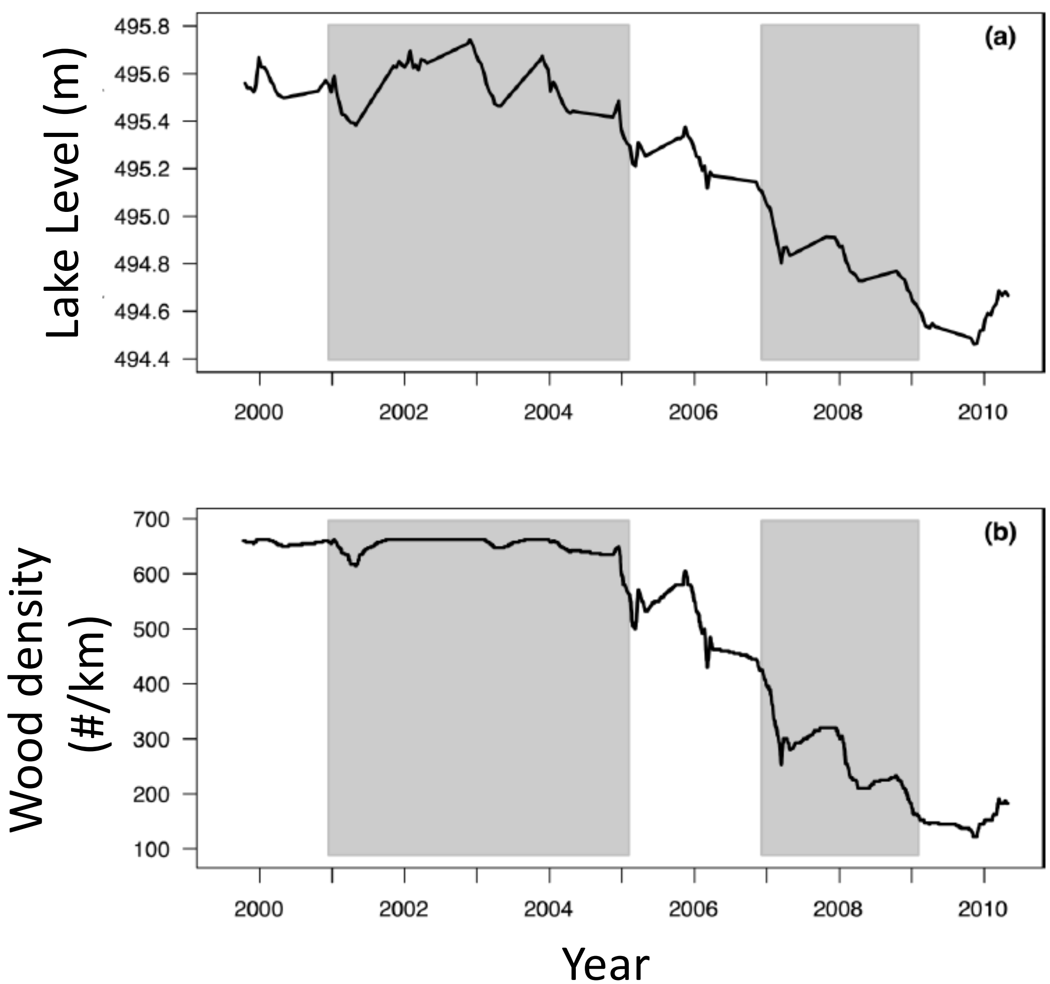
- Reduced phosphorus loads
- Reduced shoreline erosion
- Ultraviolet bleaching
- Dimictic, Oligotrophic lake
- Ex. Silver Lake

- Warmer surface water
- Internal nutrient loading
- Concentration of nutrients
- Polymictic, eutrophic lakes
- Ex. Shell Lake, Anvil Lake

Juckem & Robertson 2013 USGS 2013-5181

Mosley 2015 Earth Science Reviews

Low lake levels decrease available coarse woody habitat and impact fisheries

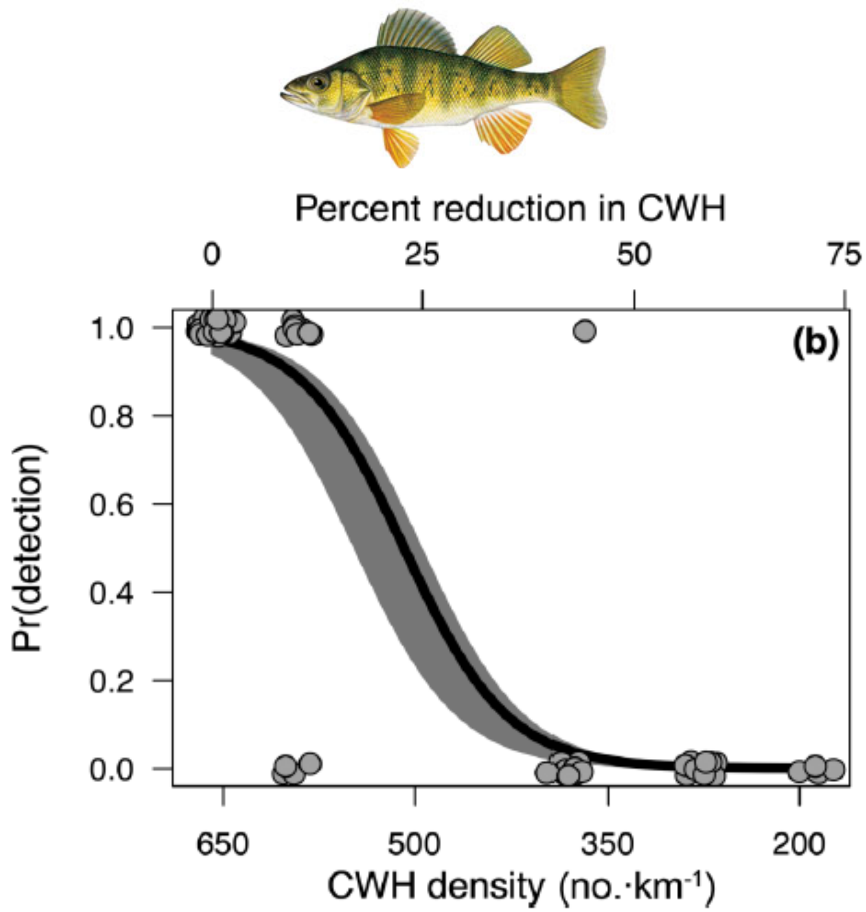


Lake levels in Little Rock Lake declined by >1.1 m and 76% of coarse woody habitat became inaccessible to fish.

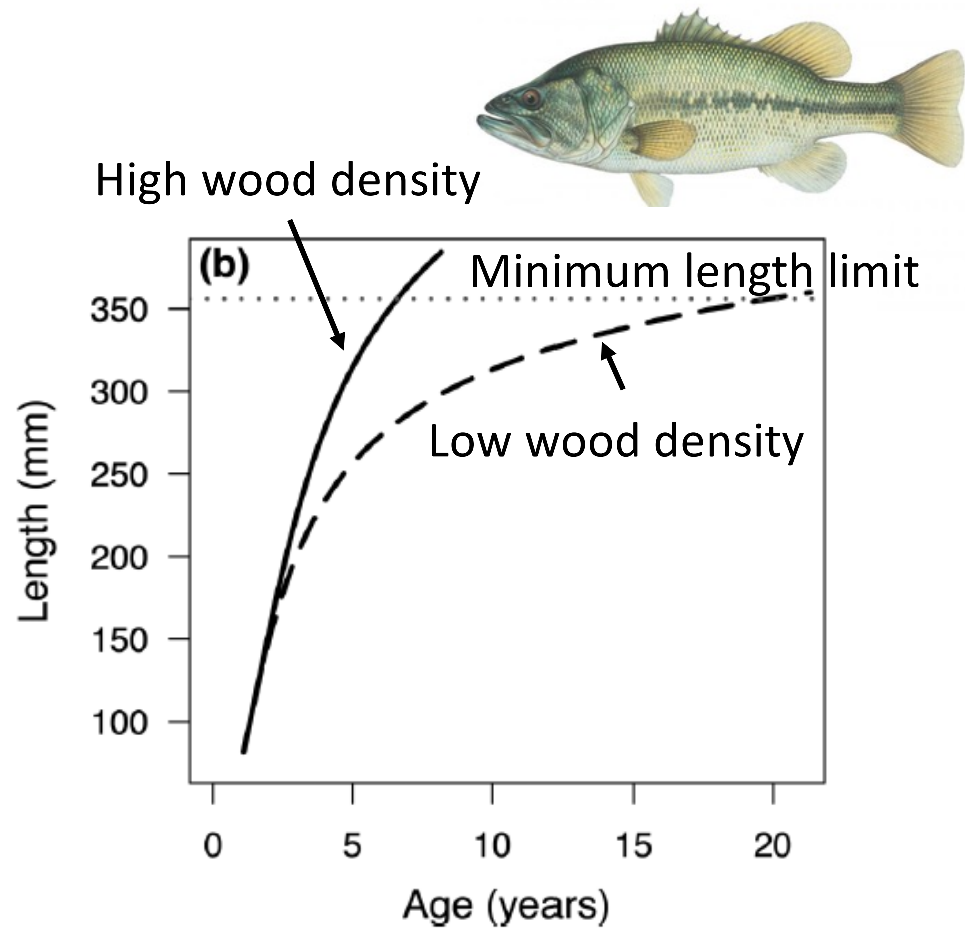
Gaeta et al. 2014 CJFAS v.71

Reduced fish abundance and growth rates

Yellow Perch Abundance



Largemouth Bass Growth



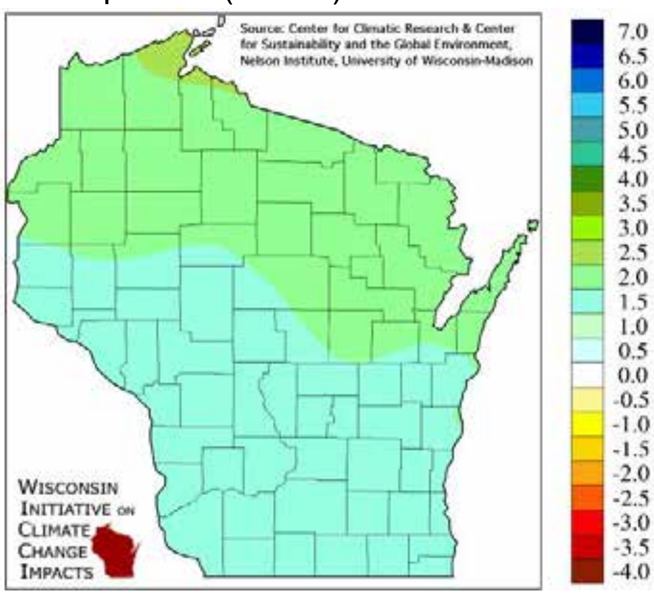
Gaeta et al. 2014 CJFAS v.71


How can we adapt to warmer lakes
and changing lake level regimes?

Water Quality

precipitation → water clarity harmful algal blooms

Projected Change in Annual Average Precipitation (inches) from 1980 to 2055

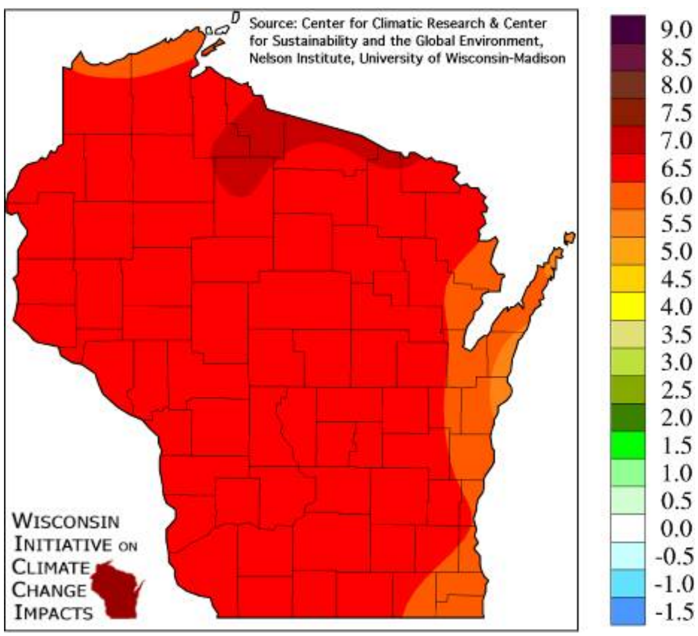


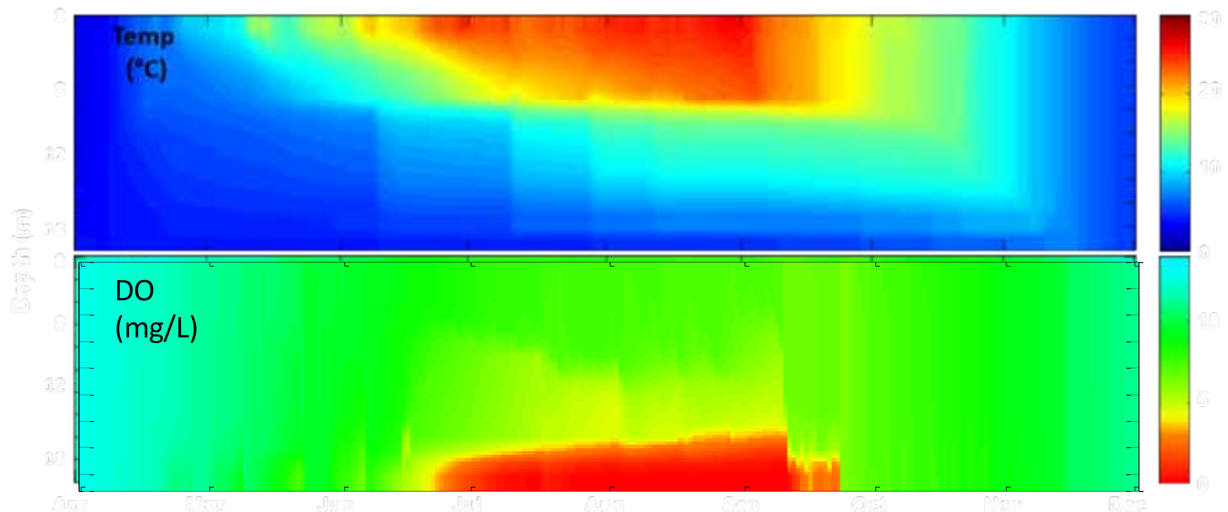
Slide from Madeline Magee

Water Quality

↑ temperatures → ↓ dissolved oxygen

Projected Change in Annual Average Temperature (°F) from 1980 to 2055



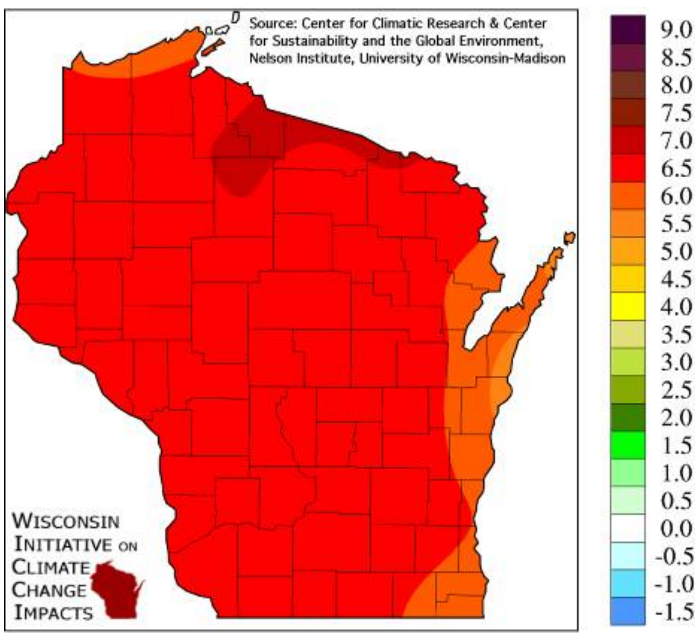


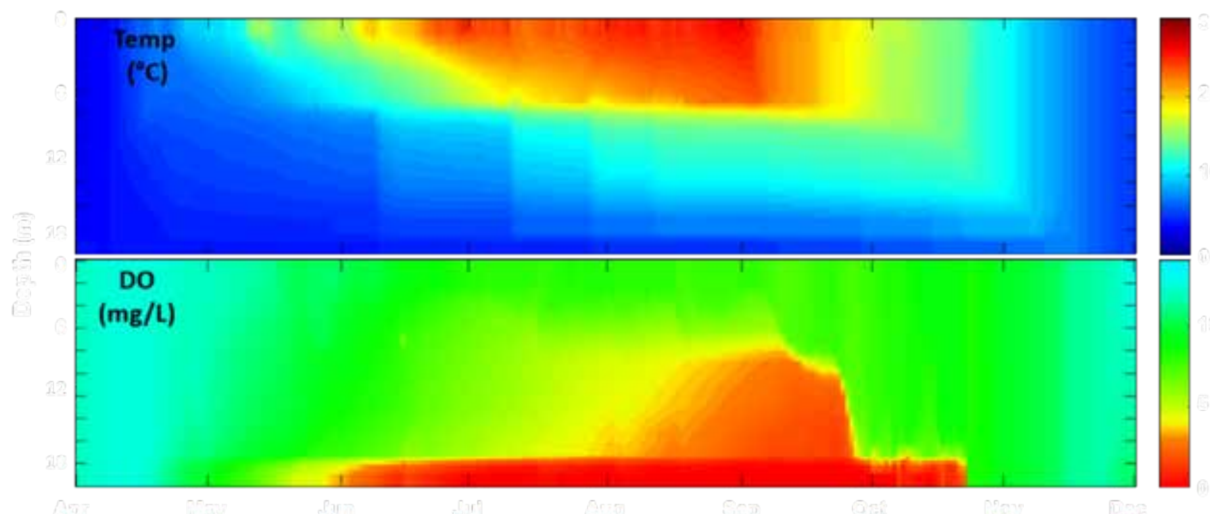
Slide from Madeline Magee

Water Quality

temperatures → dissolved oxygen

Projected Change in Annual Average Temperature (°F) from 1980 to 2055

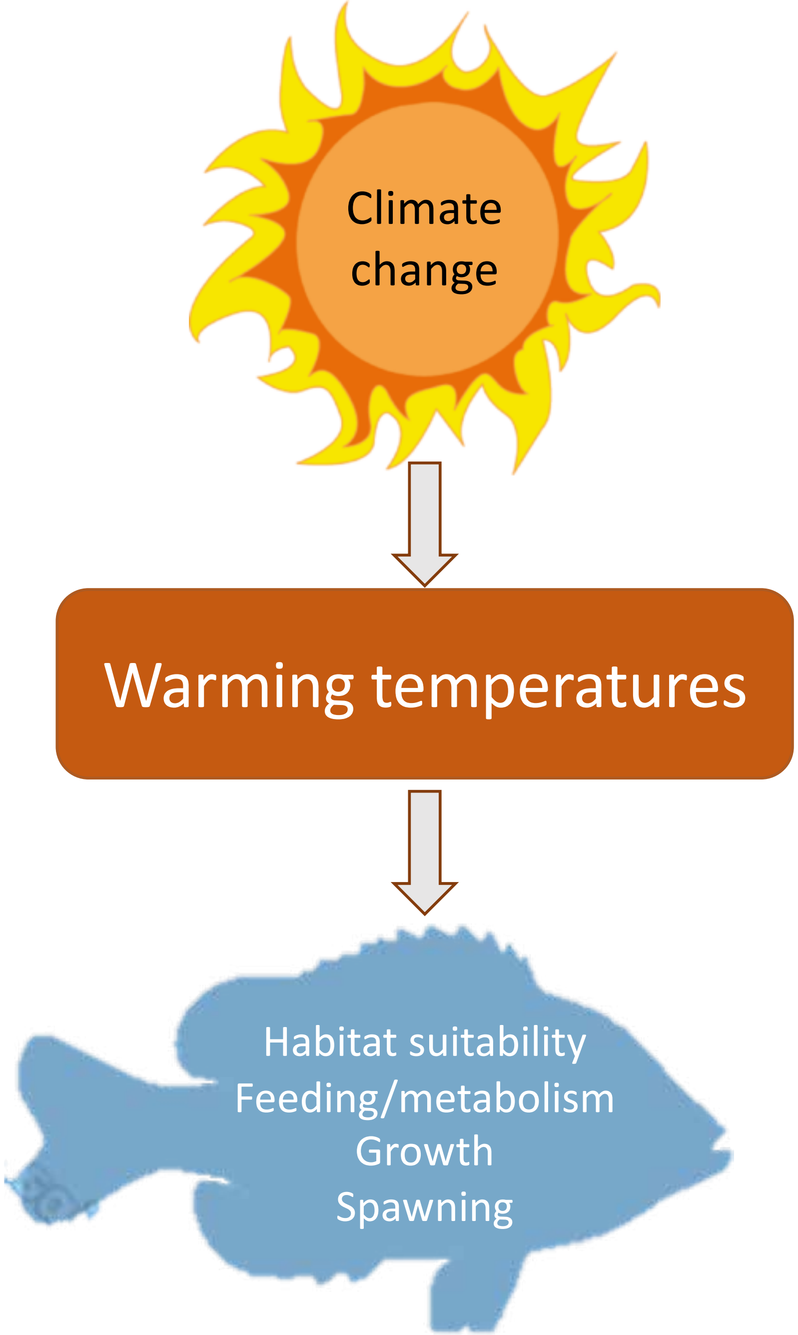


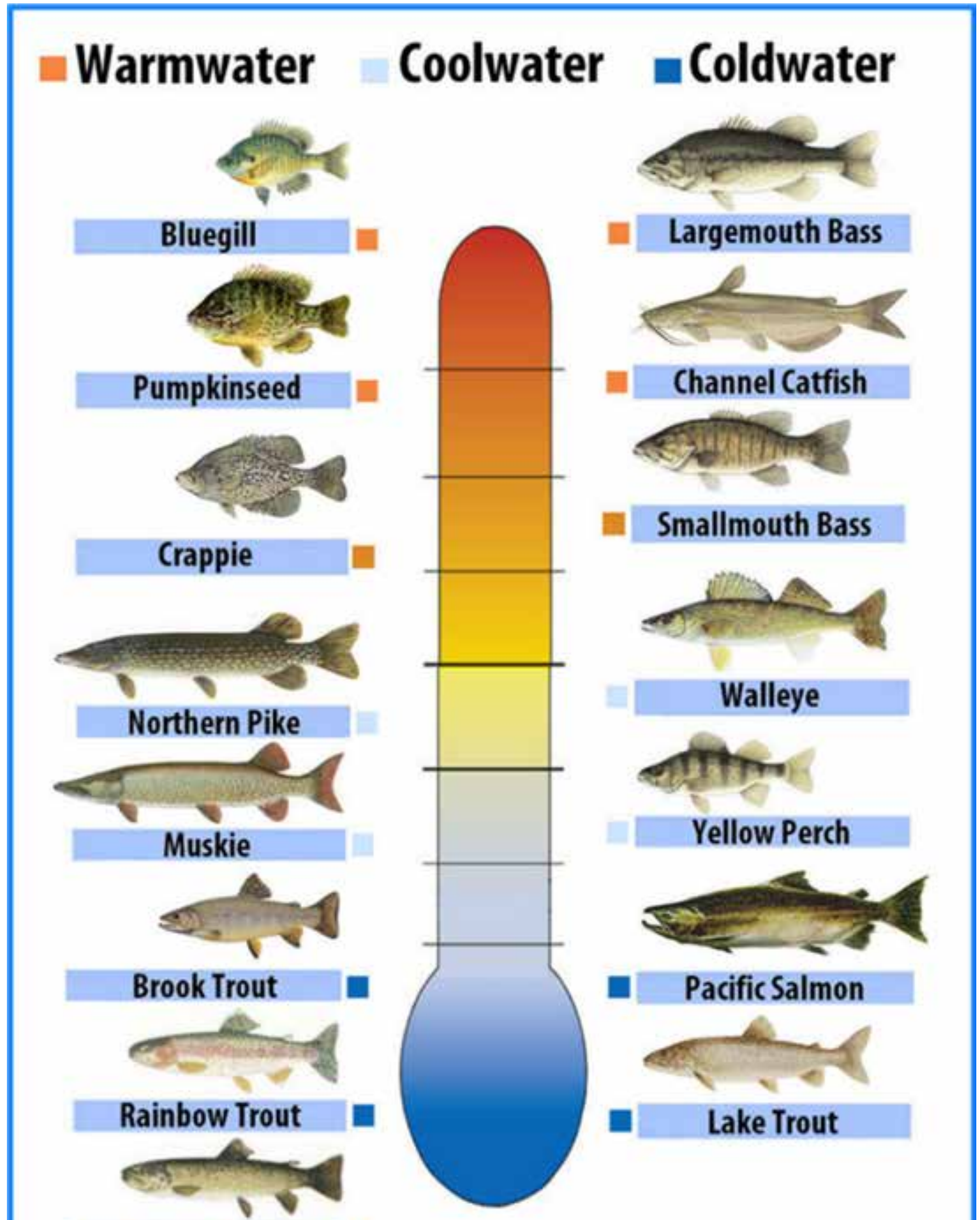


Slide from Madeline Magee


What are water quality adaptations to climate change?
Photo: Melvin McCartney, Lake Monona, Ju

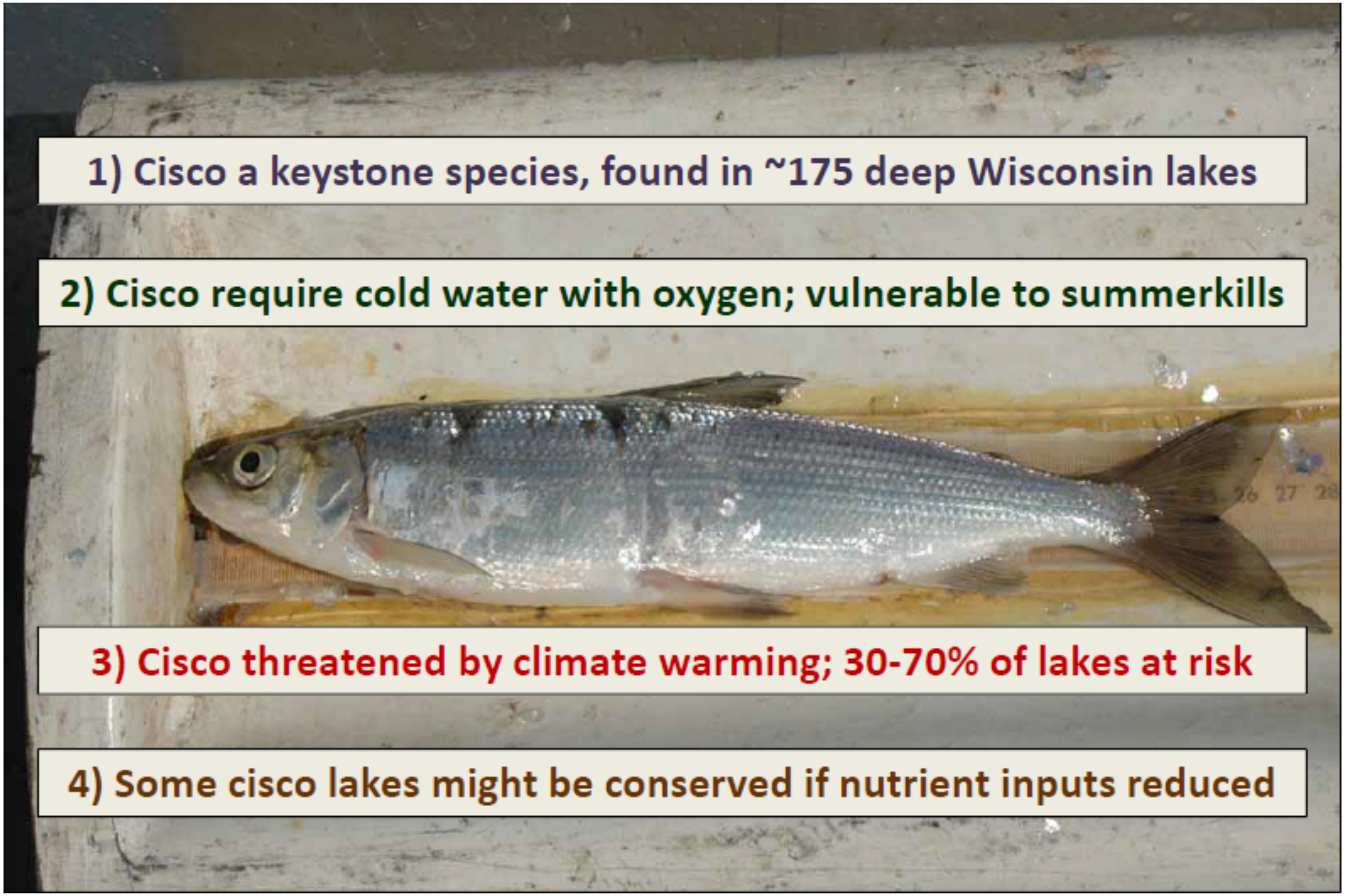
Fisheries





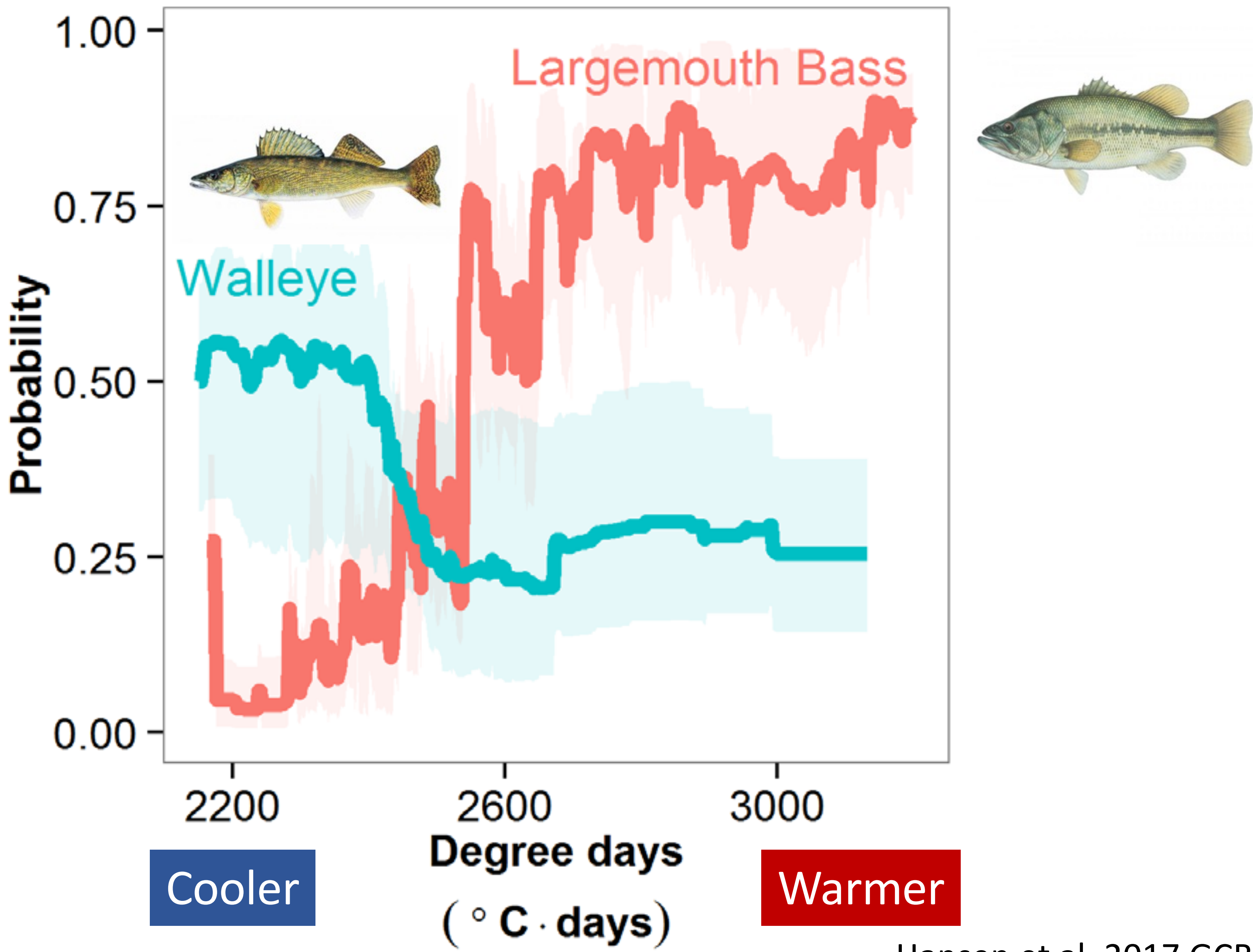
Slide from Gretchen Hansen

Warm water and low DO threaten cisco



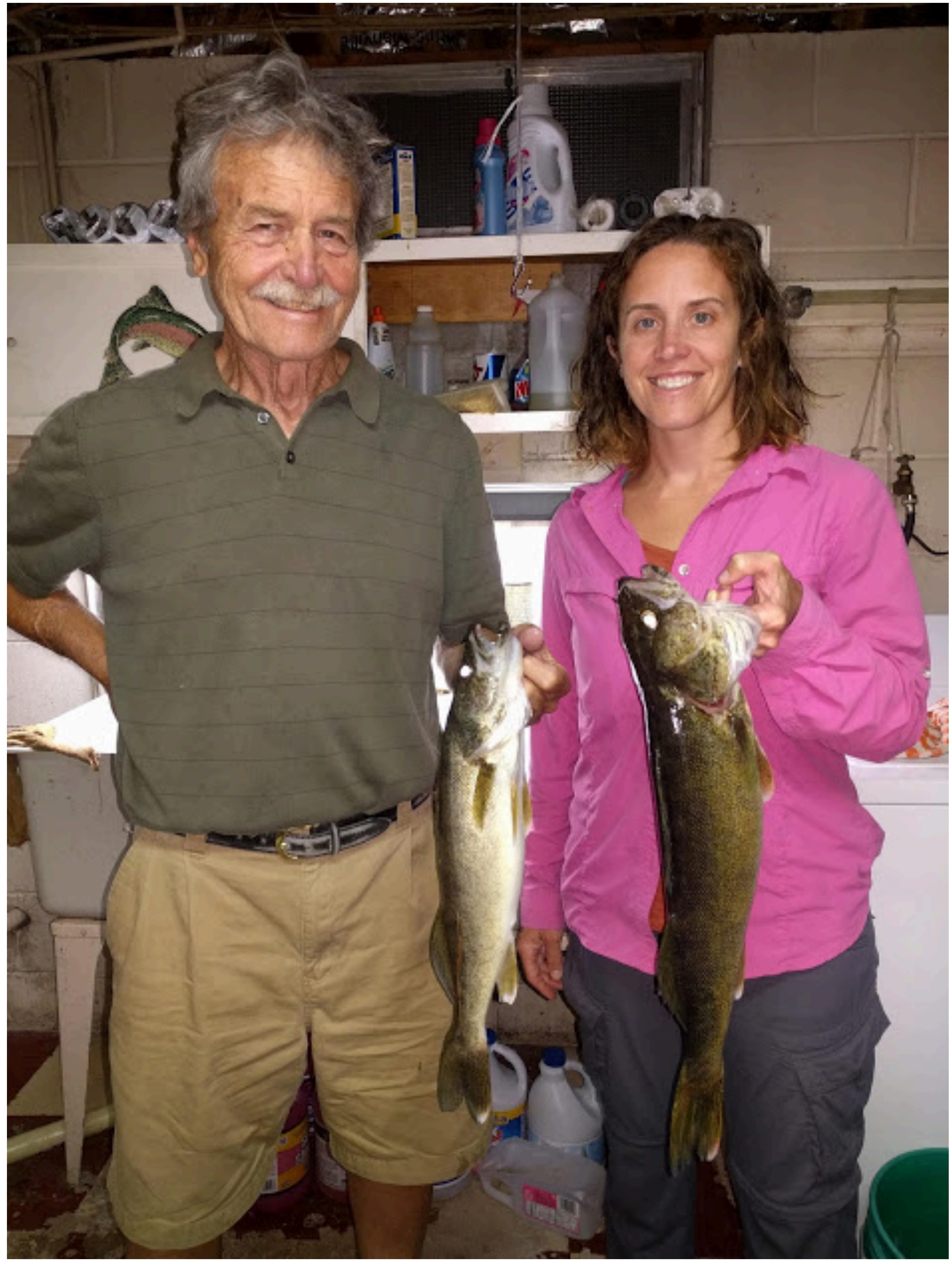
Courtesy of John Lyons

Water temperature affects multiple species

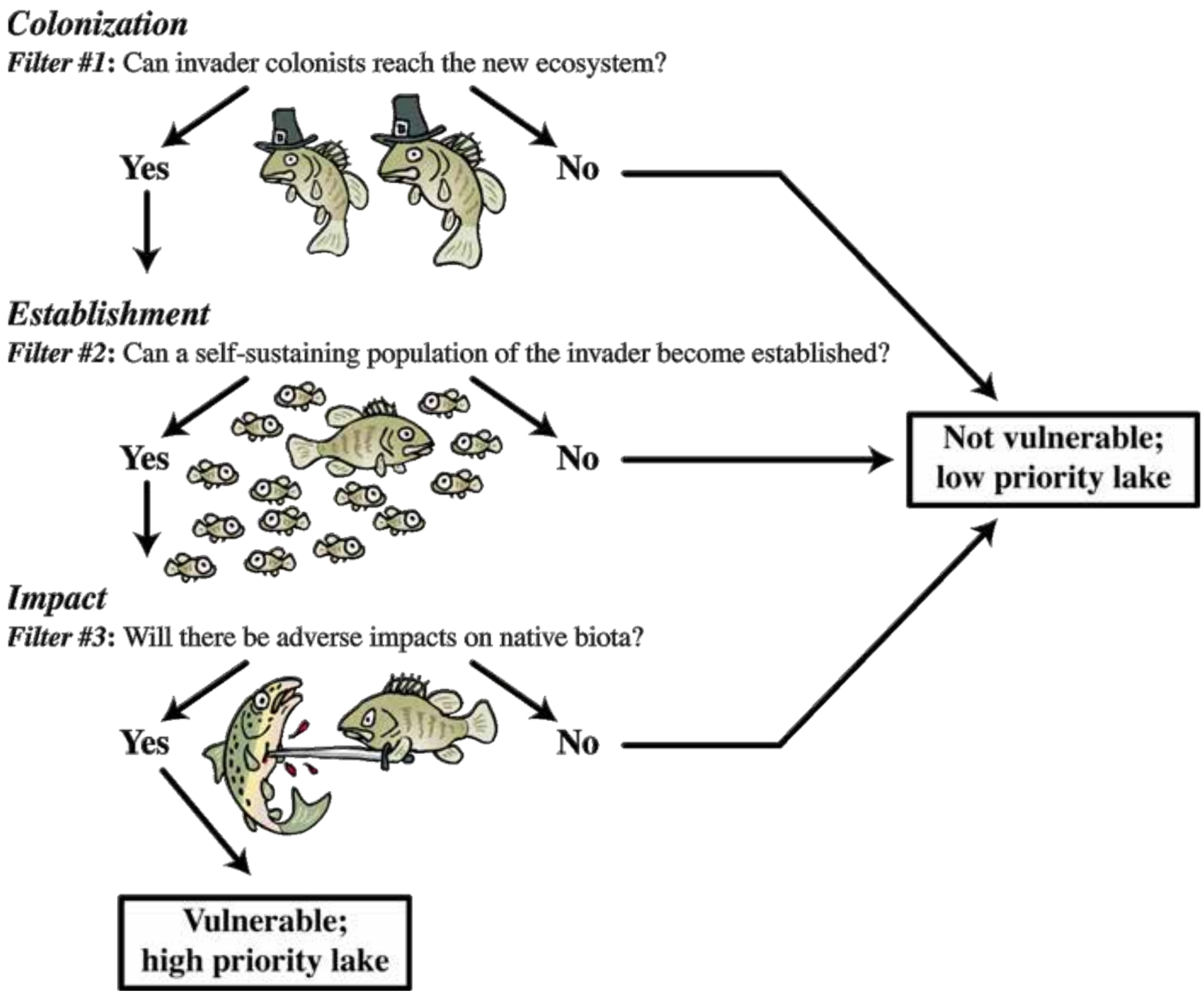


Hansen et al. 2017 GCB

What are climate adaptations for fisheries?



Effects of climate change on aquatic invasive species



1. Climate change will affect human activities, altering vectors and pathways

2. Climate change will alter physio-chemical conditions

3. Climate change will alter species/biotic interactions

Slide from Jake Vander Zanden

Vander Zanden et al. 2004 Ecological Applications 14: 132-148

How can we adapt to climate impacts on invasive species?

Olden (2006)

Resources

http://www.wicci.wisc.edu/

http://www.ipcc.ch/index.htm