

# Adapting to Wisconsin's Changing Climate



Frank Koshere

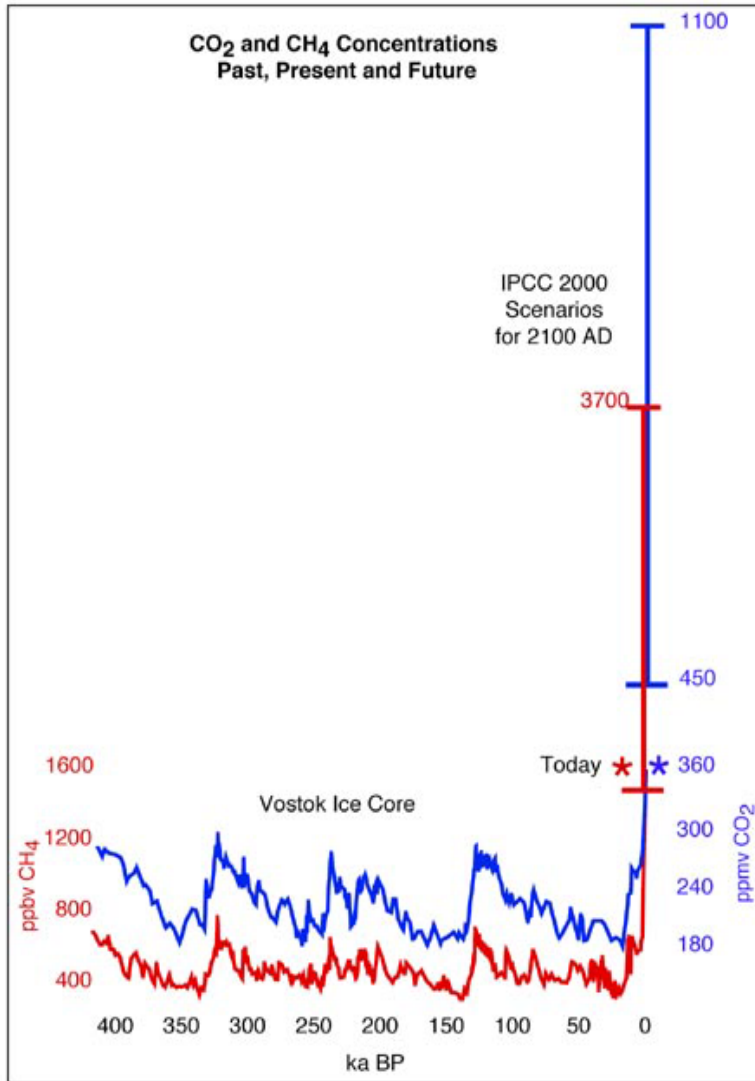


FEMA

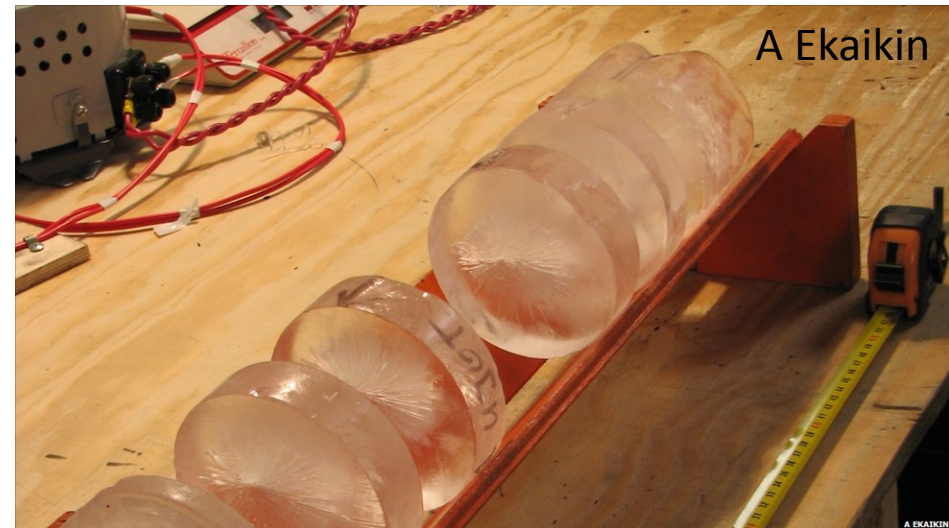
Anvil Lake Association

Katie Hein, WDNR, Monitoring Section

## Greenhouse Trace Gas: Past Changes from Vostok and IPCC Estimates



- The concentration of CO<sub>2</sub> is at a record high compared to the past 650,000 years.
- The rate of increase in CO<sub>2</sub> is faster than before at 80ppm over the past 100 years compared to 80 ppm over 5,000 years following previous ice ages.



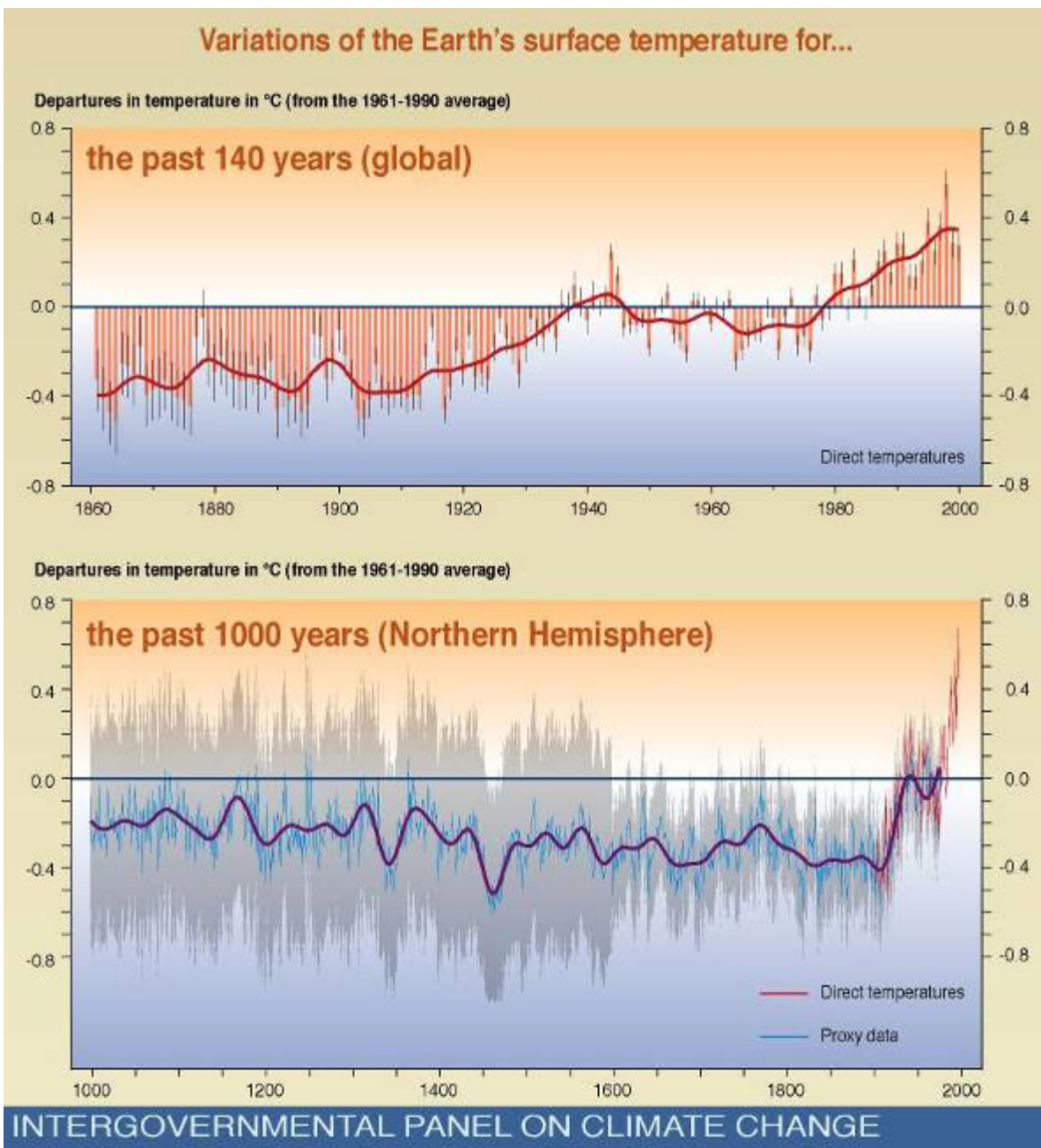
Paleoclimate, Global Change and the Future

Alverson, Bradley and Pederson eds., 2002

Chapter 1: F. Oldfield, K. Alverson, fig. 1.6, p. 6

“Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level.”

*IPCC, 2007*

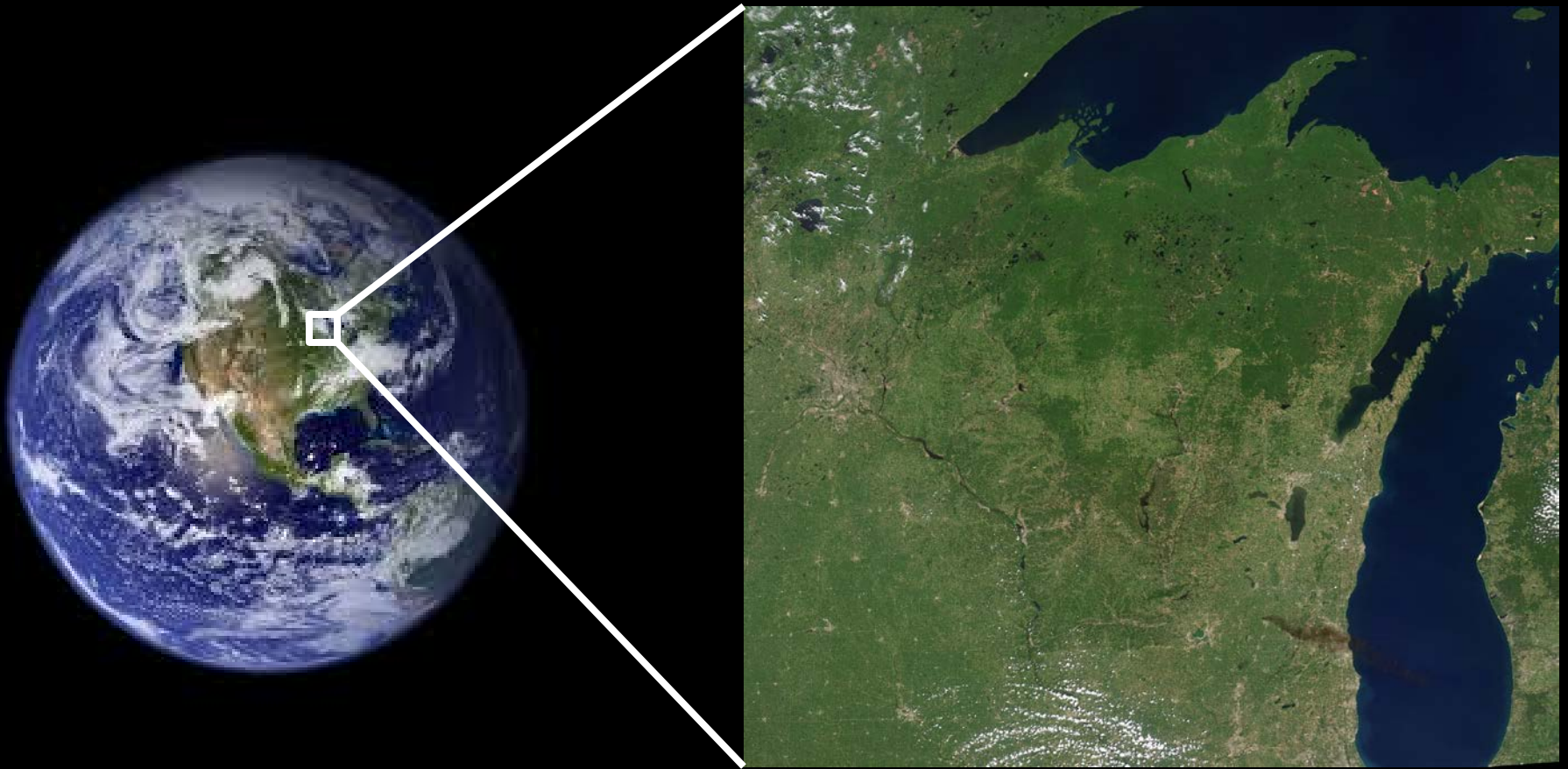


# Global Climate Change

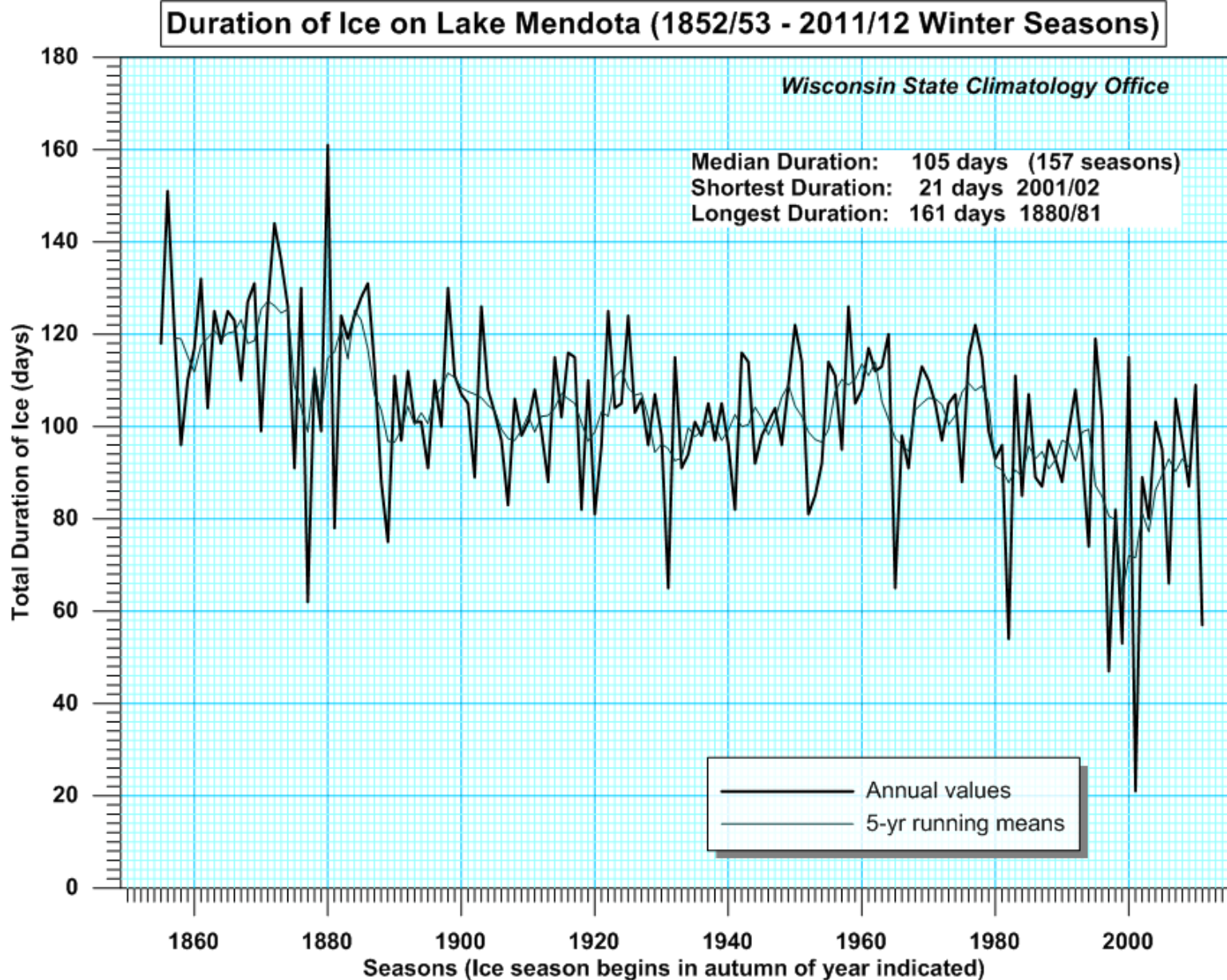
- Rate of warming is faster than any known period in the past 650,000 years
- Broad perspective in space and time
- Projected temperature change greatest near the poles
- The past century is no longer a reasonable guide to the future for water management



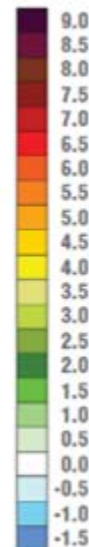
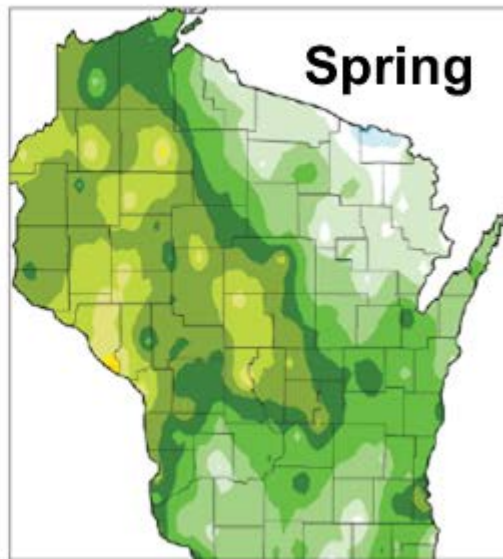
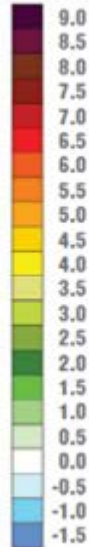
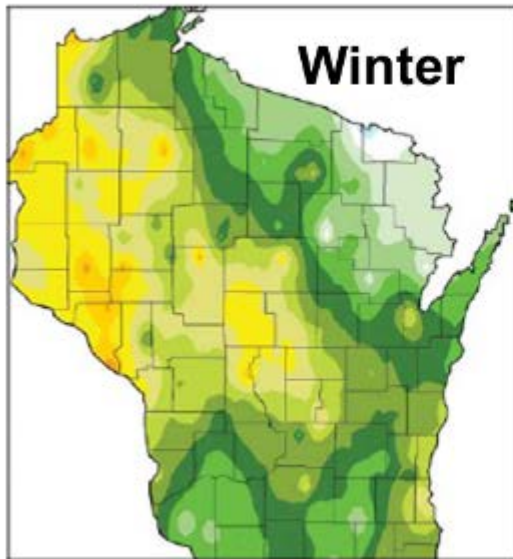
# Climate Change in Wisconsin



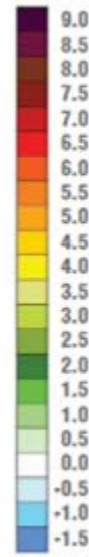
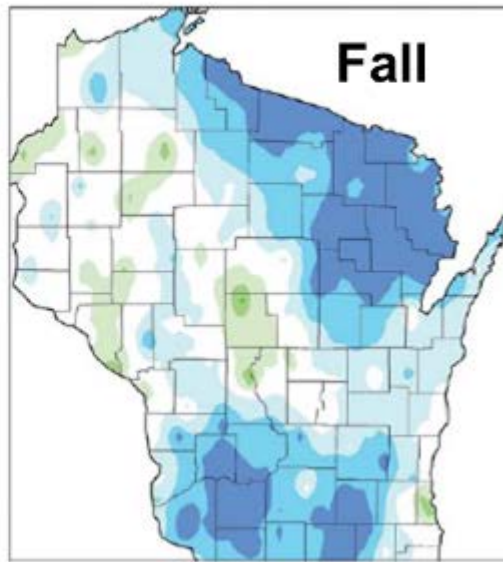
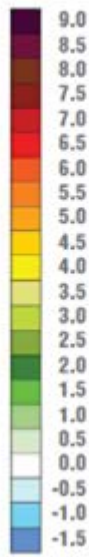
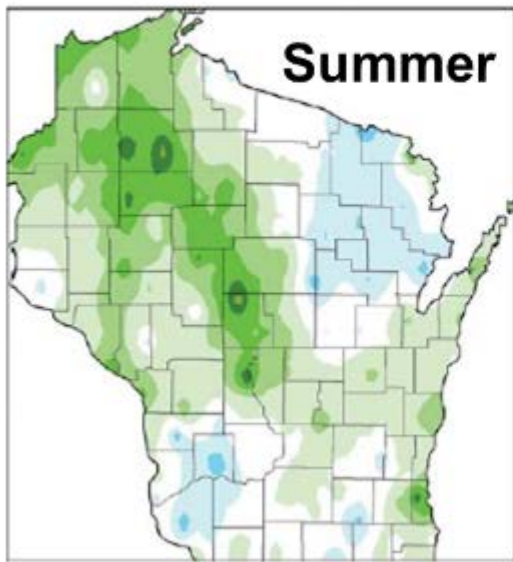
# Shorter periods of ice cover on lakes



# Observed Change in Average Temperatures °F from 1950 to 2006



**Winter temperatures have warmed more than any other season in recent decades, especially in northwestern Wisconsin.**

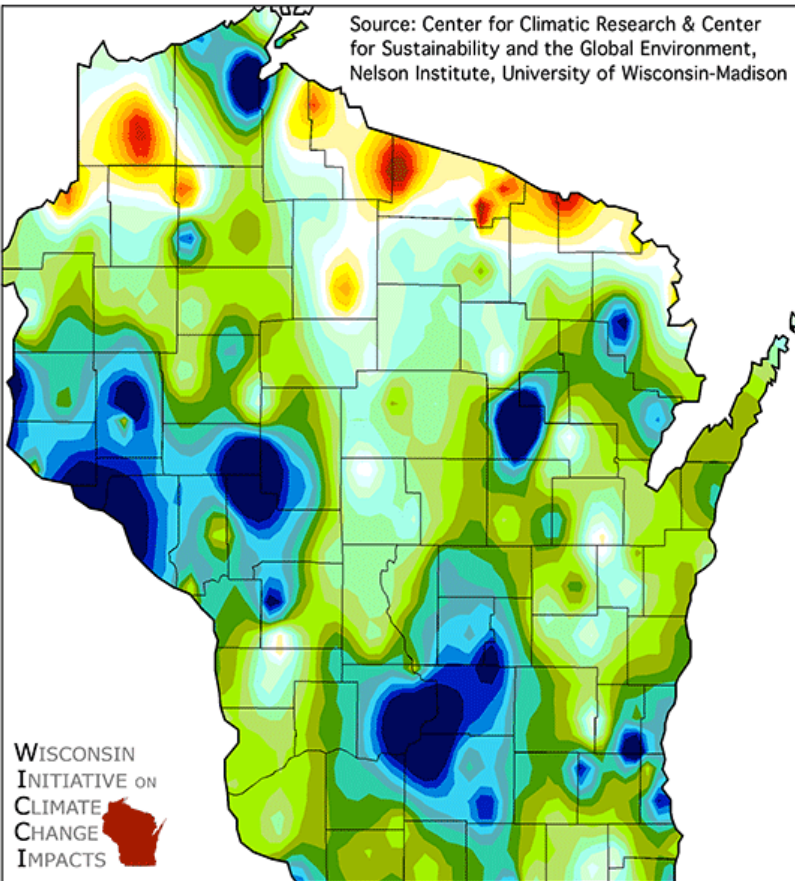


(from Serbin and Kucharik 2009)

# Summary of recent historic climate

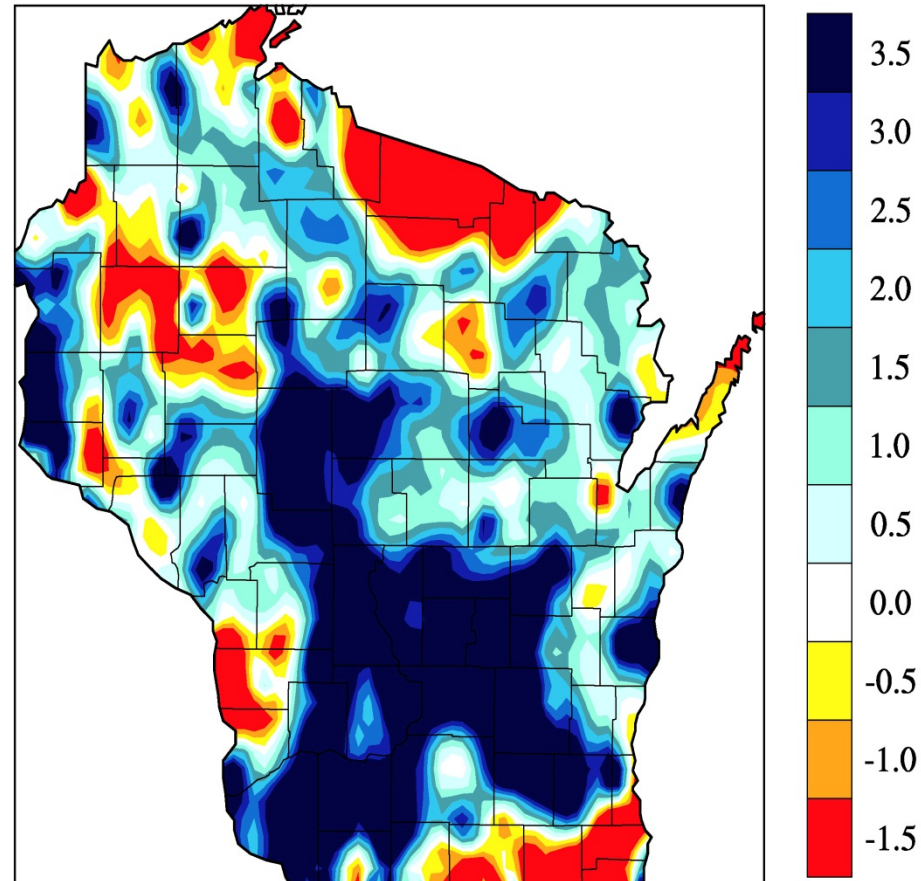
1950-2006 (based on NWS records)

**Change in annual average precipitation (inches) 1950 to 2006**



↑7" to ↓4" (drought)

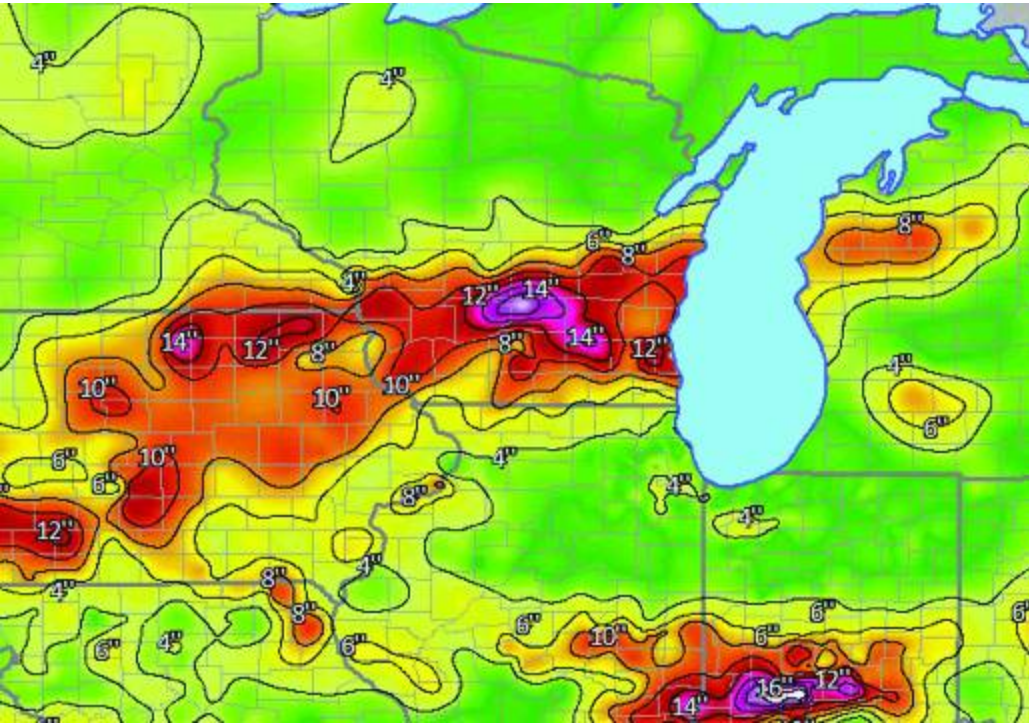
**Increase in 2" rainfalls (days/decade) 1950 to 2006**





# Extreme events: June 2008 storms

Total Precipitation (inches), June 1-15, 2008



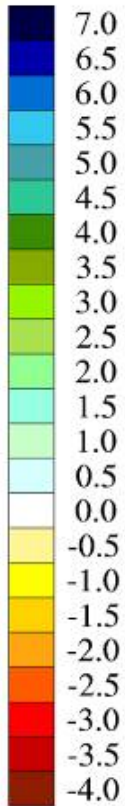
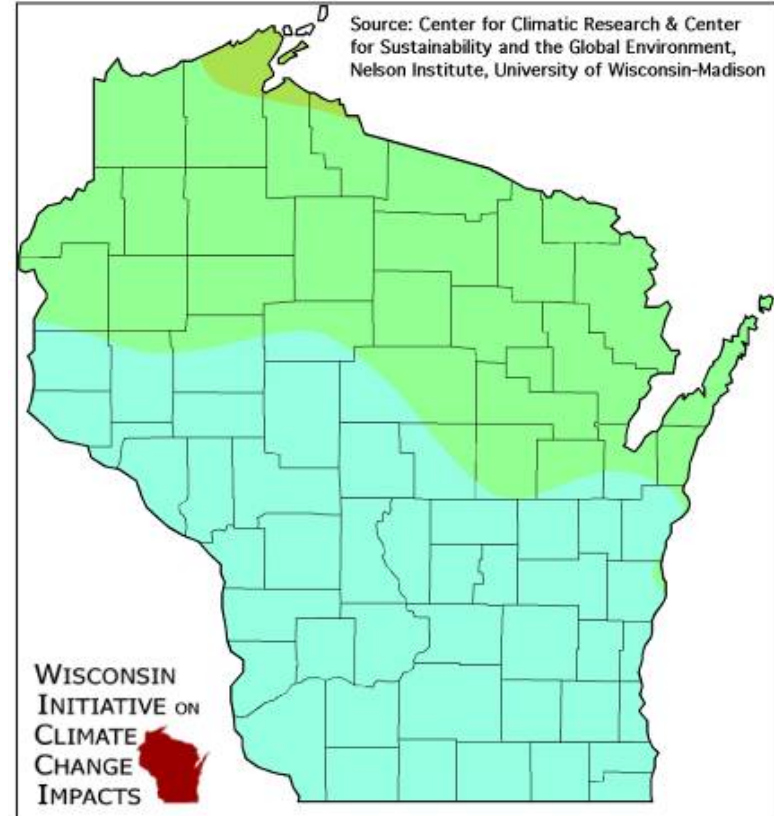
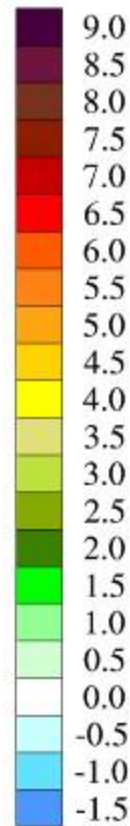
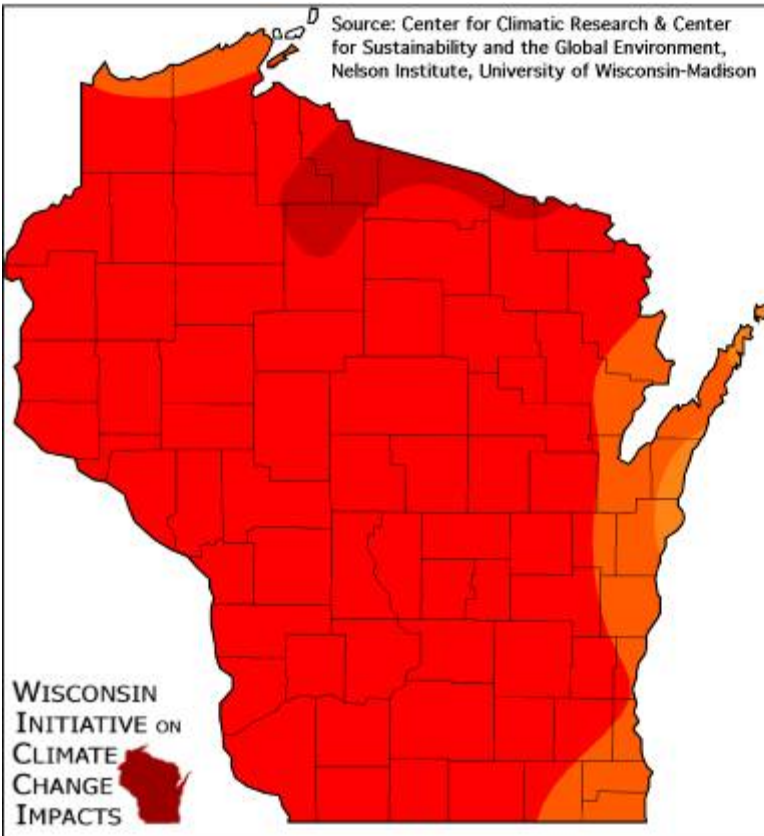
- Stormwater infrastructure was overwhelmed
- Massive flooding (810 sq. mi)
- Water from private wells contaminated (28%)
- Raw sewage overflows (90 million gallons from 161 wastewater treatment plants)
- FEMA paid \$34 million in flood damage claims

**Few communities even today can handle these kinds of extreme events!**

# Future Climate

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

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

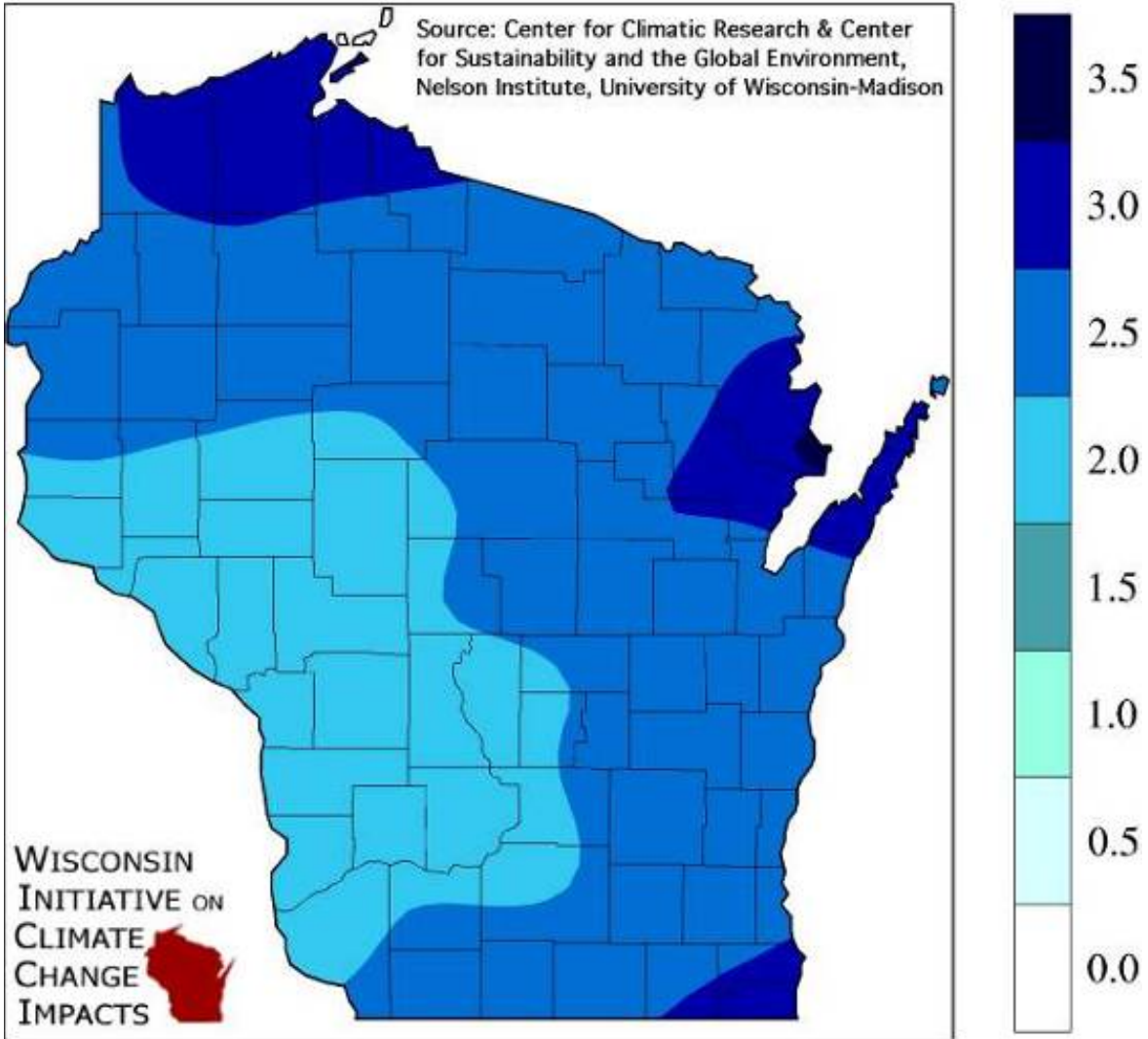


**Wisconsin will warm by 5.5 – 7.5 °F by mid-21<sup>st</sup> century**

**Wetter winters and early springs (0-40% increase), but summer rainfall uncertain**

# Future Increase in Extreme Precipitation Events

Projected Change in the Frequency of 2" Precipitation Events (days/decade) from 1980 to 2055



# “Stationarity is dead.” Science 2008

“Traditionally, hydrologic design rules have been based on the assumption of stationary hydrology, tantamount to the principle that the past is the key to the future...

...This assumption is no longer valid.”




Joe Koshollek, Milwaukee Journal Sentinel



Kundzewicz et al 2007. Contribution of Working Group II to IPCC

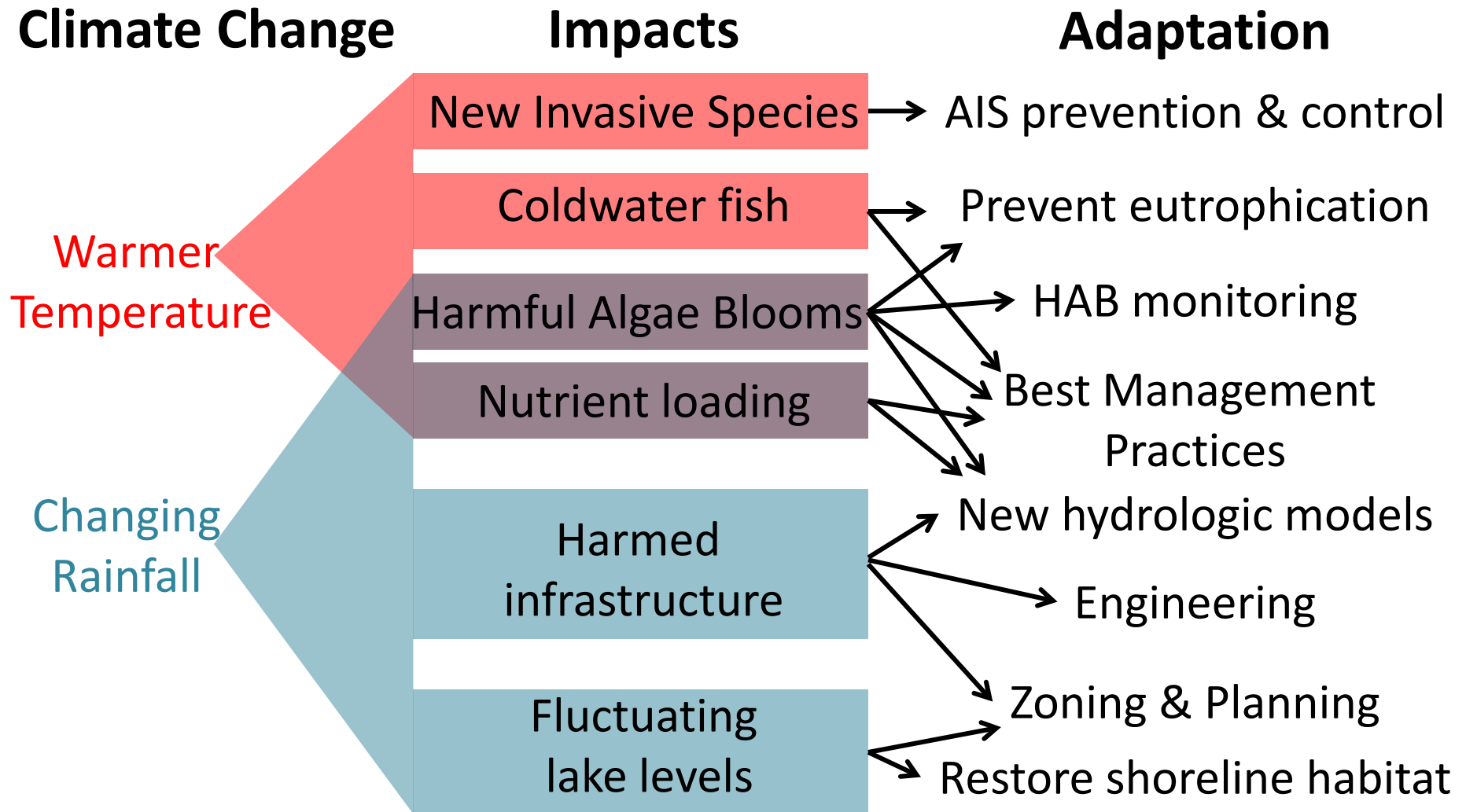
# Adaptation!



WICCI: How humans will respond to climate change in a way that will make our natural and human systems more resilient.

So where do we go from here?

# Impacts of Climate Change to Wisconsin Lakes & Adaptation Strategies



# Aquatic Invasive Species

**Impact:** Increased threat due to warmer temperatures and flooding

**Adaptation:** prevent spread, regulation, education

## Regulated Aquatic Invasive Plants in WI

Please report any **prohibited** species (as indicated by the red frame box) to the WDNR.

Report by email to: [Invasive.Species@wi.gov](mailto:Invasive.Species@wi.gov) or by phone at: (608) 266-6437

OR to find out more information, for information on reporting restricted species and whom to contact go to:

<http://dnr.wi.gov/invasives/aquatic/whattodo/>



Flowering rush  
(*Butomus umbellatus*)



Purple loosestrife  
(*Lythrum salicaria*)



Curly-leaf pondweed  
(*Potamogeton crispus*)



Eurasian water milfoil  
(*Myriophyllum spicatum*)



Australian swamp  
stonecrop (*Crassula helmsii*)



Brazilian waterweed  
(*Egeria densa*)



Hydrilla  
(*Hydrilla verticillata*)



European frog-bit  
(*Hydrocharis morsus-ranae*)

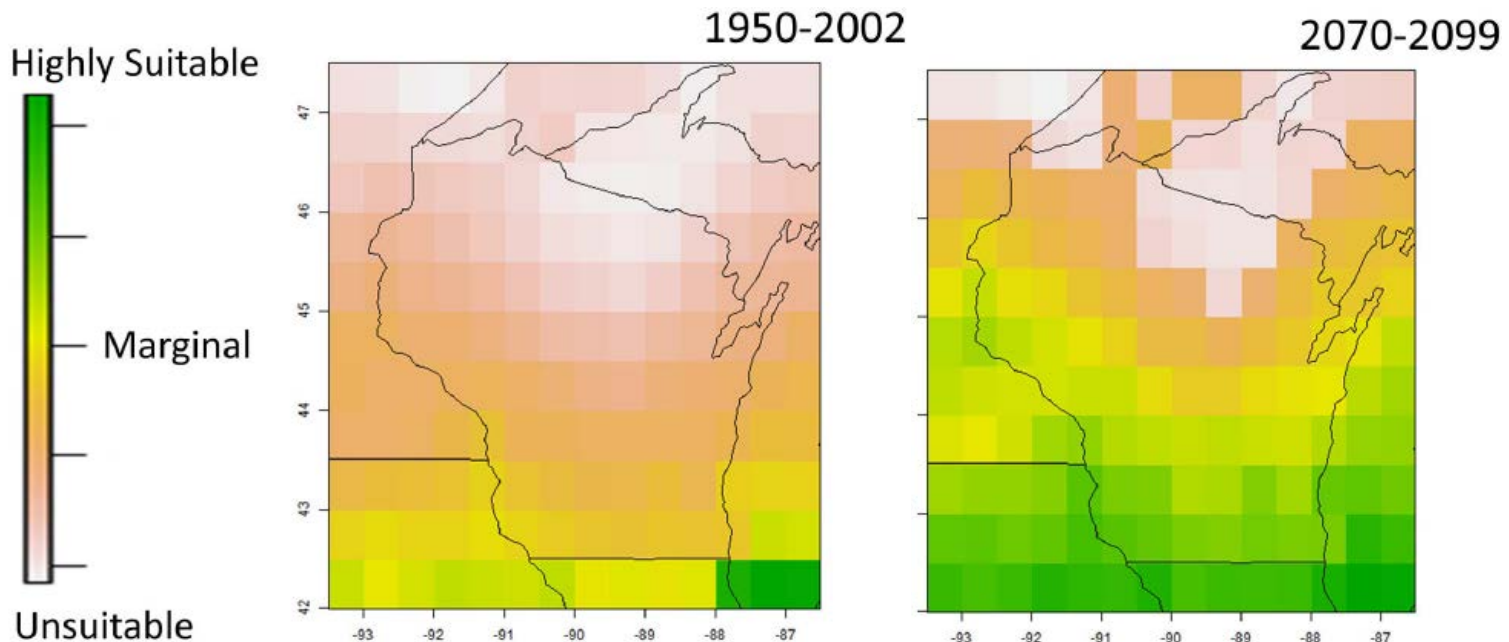


NR40 Invasive Species Identification,  
Classification, and Control Rule

# Anticipate Future Invaders Given Climate Change



Example:  
Wisconsin's climate is not suitable for Water Hyacinth today, but models predict that it will be in the future.



Courtesy of Ali Mikulyuk



# Coldwater Fish

**Impact:** Cisco extinctions in some lakes due to warming

**Adaptation:** Reduce nutrient inputs

1) Cisco a keystone species, found in ~175 deep Wisconsin lakes

2) Cisco require cold water with oxygen; vulnerable to summerkills

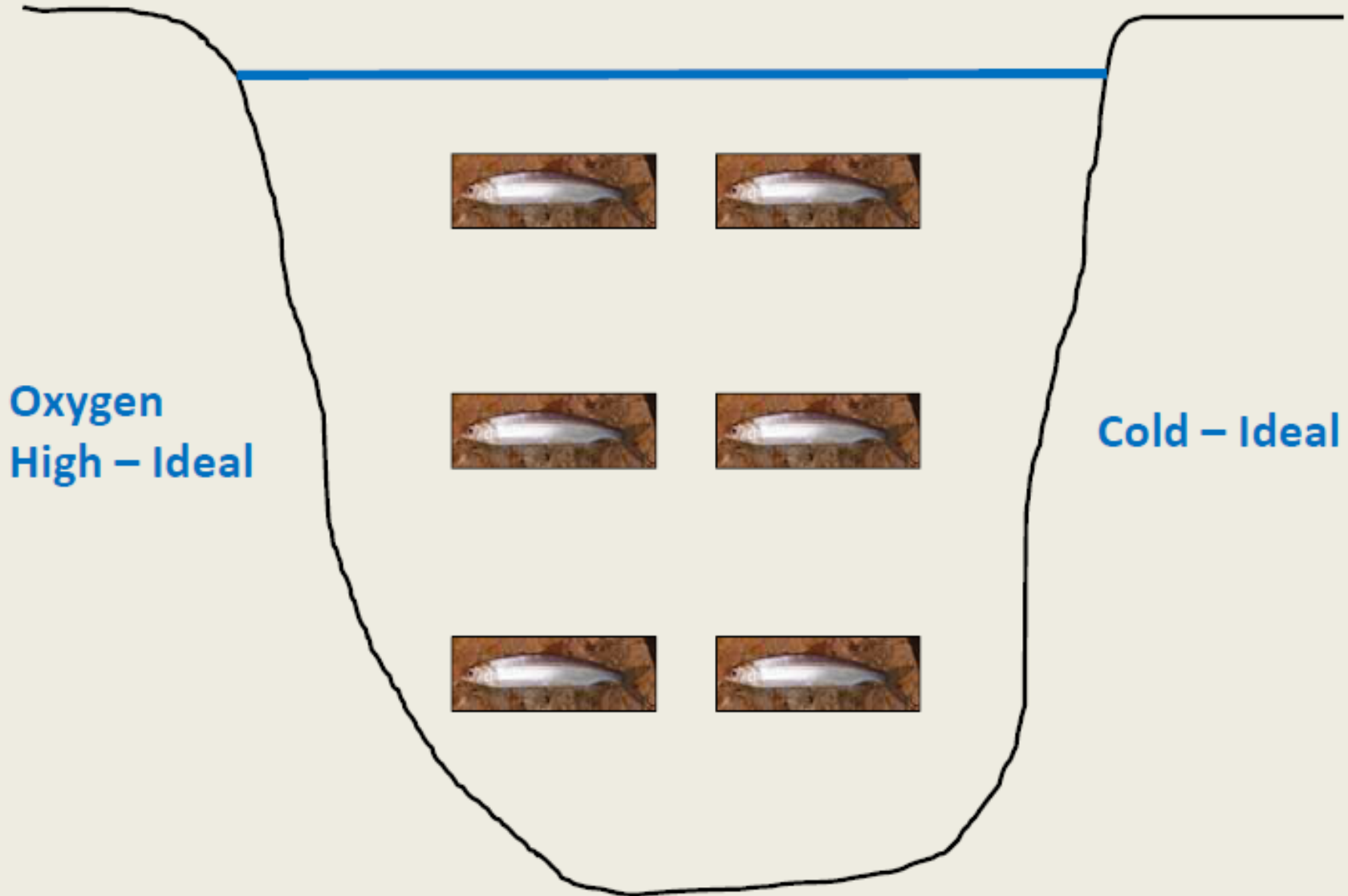
3) Cisco threatened by climate warming; 30-70% of lakes at risk

4) Some cisco lakes might be conserved if nutrient inputs reduced

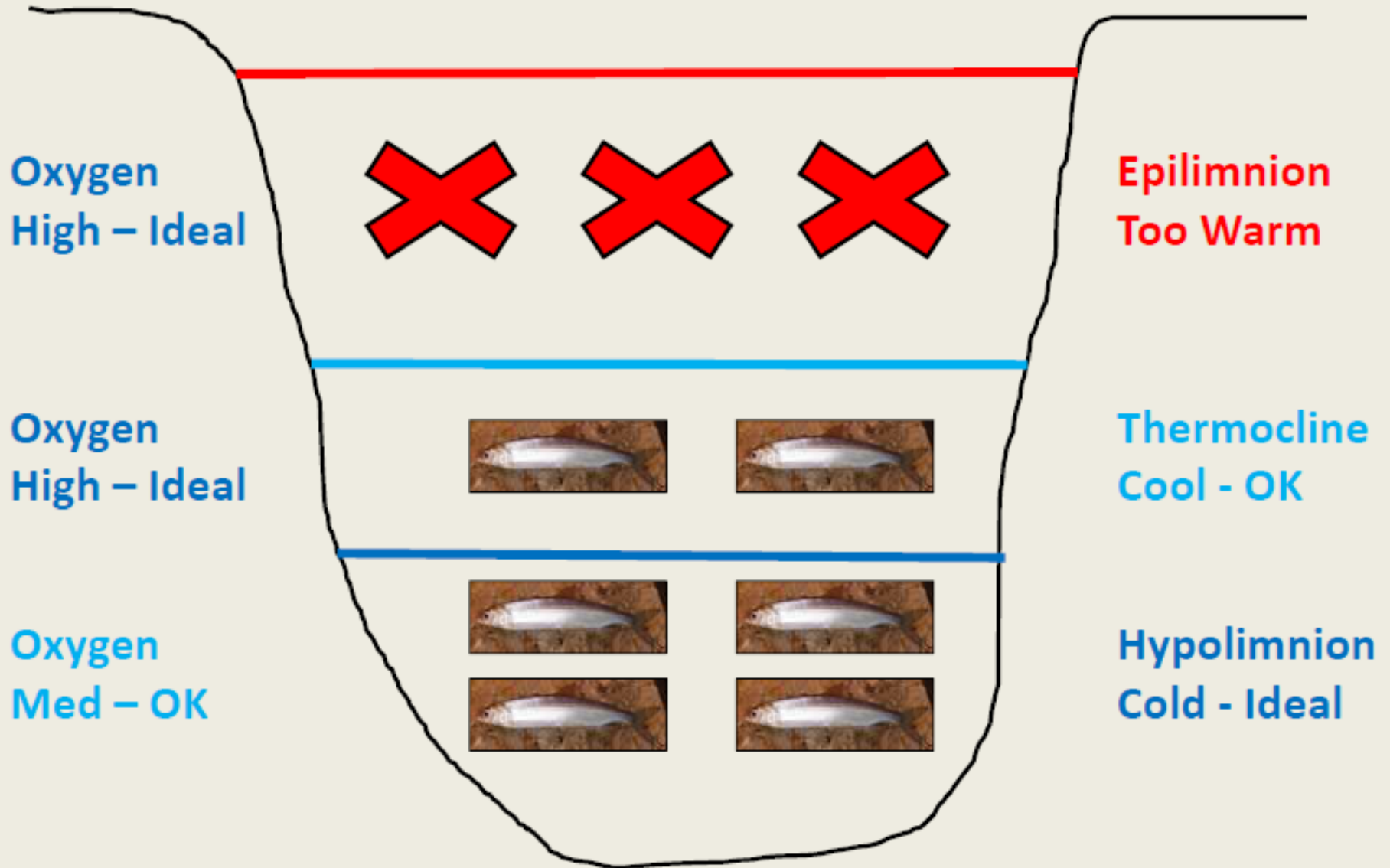


# Where Do Cisco Live in Lakes?

## Fall, Winter, and Spring

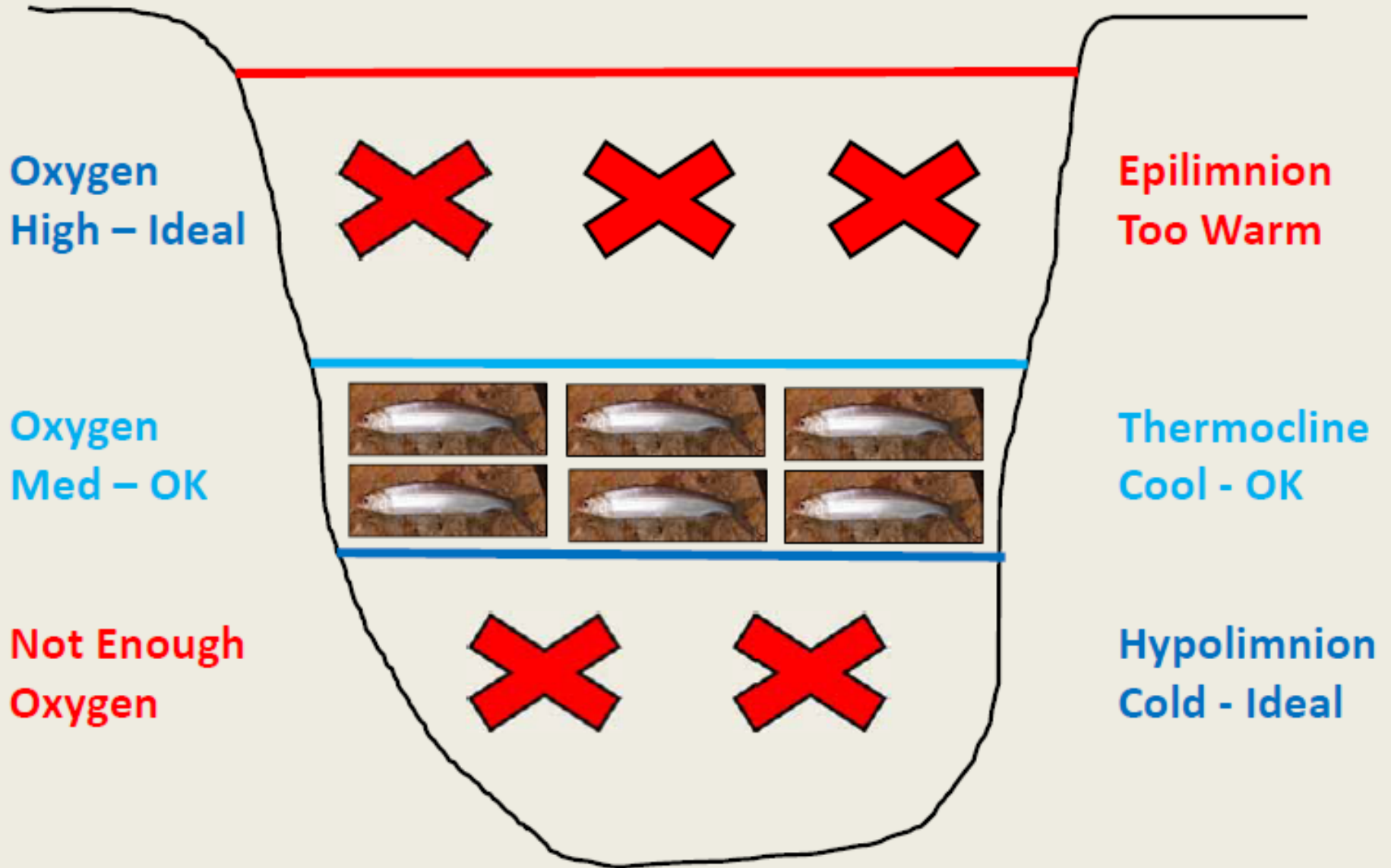


# Where Do Cisco Live in Lakes? Early Summer



# Where Do Cisco Live in Lakes?

Late Summer



# Where Do Cisco Live in Lakes?

Late Summer – Hot Year



Oxygen  
High – Ideal



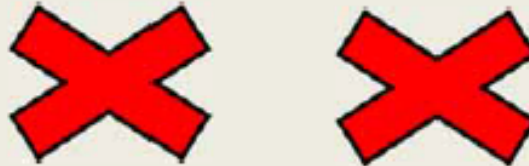
Epilimnion  
Too Warm

Not Enough  
Oxygen



Thermocline  
Cool - OK

Not Enough  
Oxygen



Hypolimnion  
Cold - Ideal

**SUMMER FISH KILL!**

# Climate Change Adaptation: Reduce Nutrient Inputs



**Improve  
Watershed  
Land Use**



**Protect  
Natural  
Shorelines**



# Harmful Algae Blooms

**Impact:** more HABs due to warming and increased runoff

**Adaptation:** Reduce nutrient inputs  
Create a HAB surveillance program  
Improve predictive capacity  
Develop statewide standards for blue-green algae



Photo: R. Lathrop



Photos: R. Lathrop, WDNR

Photos: R. Lathrop, WDNR



Photo: Melvin McCartney, Lake Monona, June 2006

# Nutrient Loading

**Impact:** Greater nutrient loading due to increased runoff

**Adaptation:** Improve hydrologic models  
Agricultural Best Management Practices  
Rain gardens, Riparian buffers  
Stormwater retention ponds

$$P = \frac{L(1-R)}{zp}$$

$$P = \frac{L}{z(0.162(L/z)^{0.458} + p)}$$





# Infrastructure

**Impact:** Buildings, roads, and water/sewer systems not designed for future precipitation patterns

**Adaptation:** Update hydrologic models  
Improve predictive capacity  
Redesign/Rebuild infrastructure  
Zoning and planning



# Lake Levels

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

**Adaptation:** Restore shoreline habitat  
Enhance infiltration  
Planning and zoning

Anvil Lake Stages 1936-2010

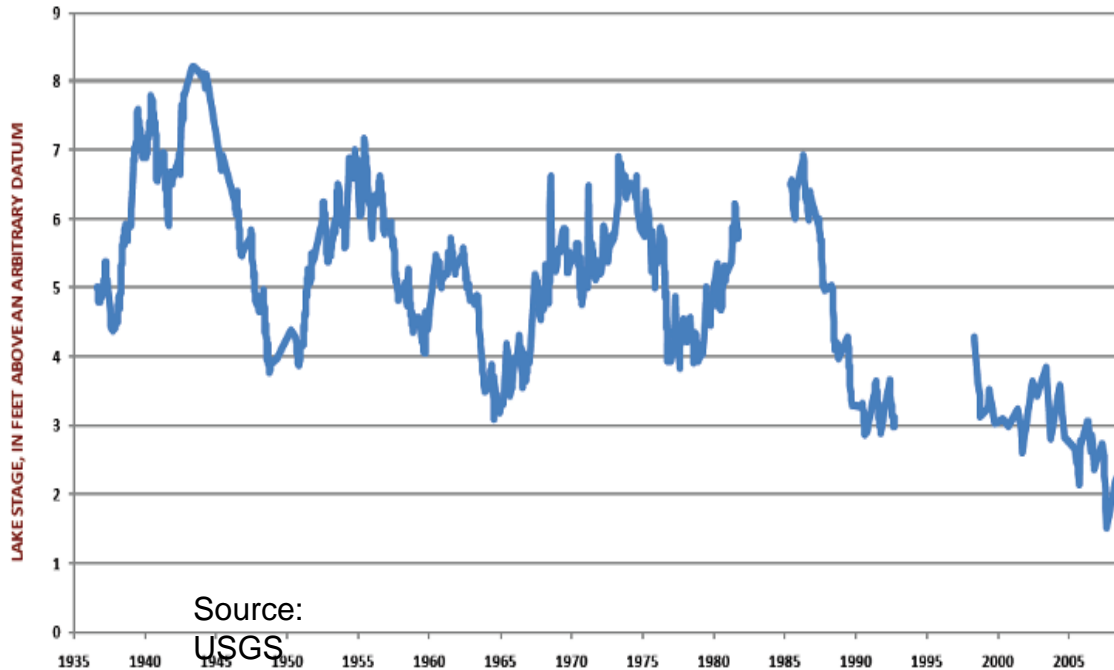
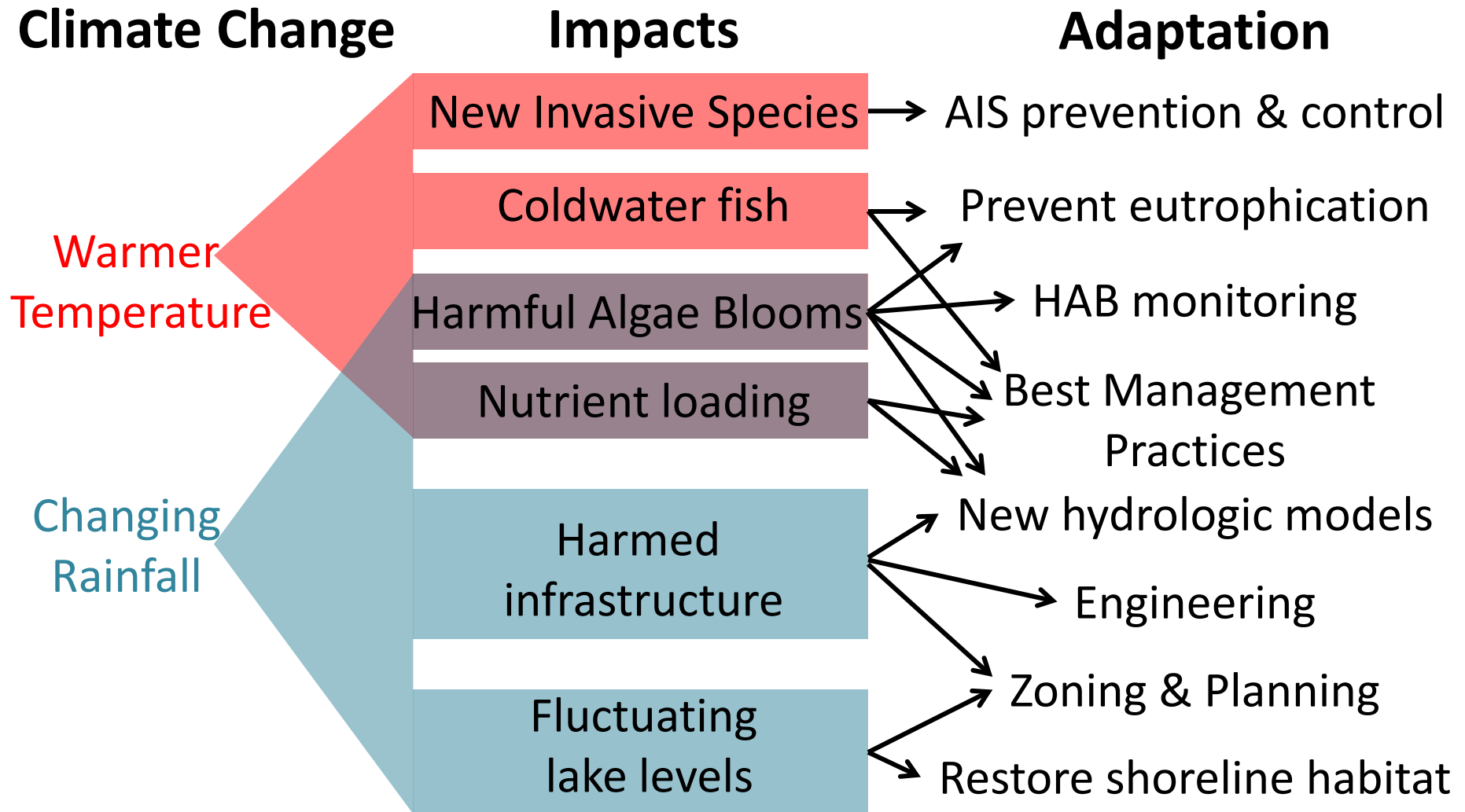


Photo - WDNR



Photo - Janesville Gazette

# Impacts of Climate Change to Wisconsin Lakes & Adaptation Strategies



# Resources



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



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