Richard C. Lathrop
Co-Chair
WICCI Science Council

presented at
UW-Stevens Point
Aug. 18, 2011

UWSP Environmental Forum
sponsored by:

Central Wisconsin Chapter of Wild Ones:
Native Plants, Natural Landscapes

Interfaith Community for the Earth (ICE)

Aldo Leopold Audubon Society
Weather is the set of conditions happening at any specific time, or over relatively short periods such as days or weeks. Weather is typically measured by instruments that record temperature, precipitation (rain or snow), humidity, wind, etc.

Climate is the long-term average of weather conditions measured over long periods of time (usually decades or more) for a specific location. Climate trends are determined by statistical analyses of long-term weather data.
Global Land–Ocean Temperature Index
1880-2010

Source: NASA Goddard Institute for Space Studies
Loss of sea ice in the Arctic is one of many signs of warming
One of many signs of warming in Wisconsin...

Lake Mendota

Decrease in duration of ice cover on lakes

Source: J. Magnuson, UW-Madison
## Earlier arrival of spring in Wisconsin

<table>
<thead>
<tr>
<th>Bird migration</th>
<th>Vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geese Arrival: 29 days earlier</td>
<td><em>Baptista</em> first bloom: 18 days earlier</td>
</tr>
<tr>
<td>Cardinal first song: 22 days earlier</td>
<td><em>Butterfly weed</em> first bloom: 18 days earlier</td>
</tr>
<tr>
<td>Robin arrival: 9 days earlier</td>
<td><em>Marsh milkweed</em> first bloom: 13 days earlier</td>
</tr>
</tbody>
</table>


Of 55 ecological indicators of spring, 37 advanced and 18 showed no shift between 1935-47 and 1976-98.

Leopold Shack
Photo: Aldo Leopold Foundation

Nina Leopold Bradley
Photo: Jeffrey Phelps, Milw. Journal Sentinel

Slide adapted from C. Kucharik, UW-Madison
THERE WERE PATTERNS

• Early spring events seemed to show the most pronounced advances

Pasque flower blooms 9 days earlier, on average

Bloodroot blooms 14 days earlier, on average

Source: Stan Temple, UW-Madison
LONG-DISTANCE MIGRANTS

WOOD THRUSHES ARRIVE
1935-1947: mean=MAY 8
1976-1998: mean=MAY 5

Source: Stan Temple, UW-Madison

SHORT-DISTANCE MIGRANTS

AMERICAN ROBINS ARRIVE
1935-1947: mean=MARCH 19
1976-1998: mean=MARCH 5
Wisconsin Initiative on Climate Change Impacts (WICCI)

Objectives:
Assess and anticipate climate change impacts on specific Wisconsin natural resources, ecosystems and regions

Evaluate potential effects on industry, agriculture, tourism, and other human activities

Develop and recommend adaptation strategies
# WICCI Collaborators

## Federal
- U.S. Department of Agriculture
- U.S.D.A. Natural Resources Conservation Service
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- U.S. Geological Survey

## State
- State of Wisconsin Commissioner of Insurance
- Wisconsin Coastal Management Program
- Wisconsin Conservation Congress
- Wisconsin Council on Forestry
- Wisconsin Department of Transportation
- Wisconsin Department of Agriculture, Trade and Consumer Protection
- Wisconsin Department of Health and Family Services
- Wisconsin Department of Natural Resources
- Wisconsin Emergency Management
- Wisconsin Geological and Natural History Survey
- Wisconsin Public Service Commission
- Wisconsin State Climatology Office
- Wisconsin State Legislature

## Tribal Groups
- Great Lakes Indian Fish & Wildlife Commission

## Local/Municipal
- City of Fitchburg Engineering
- City of Madison Storm Water Utility
- City of Racine Water & Wastewater Utility
- Columbia County Land & Water Conservation
- Dane County Land Conservation Division
- Greater Milwaukee Committee
- League of Wisconsin Municipalities
- Madison & Dane County Public Health Department
- Madison Metropolitan Sewerage District
- Milwaukee Metropolitan Sewerage District
- Southeast Wisconsin Regional Planning Commission
- Wisconsin Towns Association

## Universities
- Lakehead University
- UW Extension
- UW Sea Grant
- UW-Engineering Professional Development
- UW-Green Bay
- UW-La Crosse
- UW-Madison
- UW-Milwaukee
- UW-Milwaukee Great Lakes WATeR Institute
- UW-Stevens Point

## NGO's
- 1000 Friends of Wisconsin
- American Birkebeiner Ski Foundation
- Clean Wisconsin
- Education Communications Board
- Fox-Wolf Rivers Environmental History Project
- Grow North Regional Economic Development Corporation, Inc.
- Natural Areas Preservation Council
- Nature Net
- New North, Inc.
- Professional Dairy Producers of Wisconsin
- Second Look Holsteins
- The Association of State Floodplain Managers
- The Nature Conservancy
- Trout Unlimited
- Wisconsin Citizen-Based Monitoring Network
- Wisconsin Environmental Initiative
- Wisconsin River Alliance
- Wisconsin Wetlands Association
- Wisconsin Wildlife Federation

## Private Sector
- AECOM
- Alliant Energy
- HNTB Corporation
- Montgomery Associates-Resource Solutions
- MSA Professional Services, Inc.
- S.C. Johnson
- Short Elliott Hendrickson, Inc.
- We Energies
Working Groups

Working Groups are a statewide mix of researchers, managers, and practitioners with expertise in the topic area or geographic region being assessed. Members come from WDNR, other state and federal agencies, UW system, non-profit organizations, and private sector.

Working Group Objectives:

- Identify potential risks and vulnerabilities pertinent to working group topic area or geographic region
- Summarize existing information on climate change impacts
- Identify data and research needed to assess future impacts
- Recommend adaptation strategies
Working Groups (Feb. 2011)
Climate Change in Wisconsin: Historical Trends
Weather Station Network for Wisconsin
(Daily temperature and precipitation data since 1950)

Source: Map from Serbin and Kucharik (2009); photos from C. Kucharik, UW-Madison
Greatest warming occurred in central to northwest Wisconsin.
Most warming occurred in winter followed by spring.
Winter and summer nighttime low temperatures warmed more than daytime high temperatures.
Extreme Temperature Trends

Change in the frequency of 
<0°F nights per year 
from 1950 to 2006

Decline in extreme cold winter nights, especially in northwest Wisconsin

Change in the frequency of 
≥90°F days per year 
from 1950 to 2006

Little change in hot summer days across Wisconsin

(from Serbin and Kucharik 2009)
Change in the Length of the Growing Season
In Days from 1950 to 2006

Growing season increased 1 to 4 weeks in much of Wisconsin

(from Serbin and Kucharik 2009)
Change in Annual Average Precipitation (inches) from 1950 to 2006

Average increase of 15%, but highly variable across Wisconsin

(from Serbin and Kucharik 2009)
Northern and Southern Wisconsin Precipitation Trends

3 stations each region, 1950-2010

Source: Chris Kucharik, UW-Madison
Climate Change in Wisconsin: Future Projections
**Climate Modeling:**

Used 14 Global Climate Models (GCM’s) having daily data in IPCC 2007 assessment

Downscaling verified using same Wisconsin weather station data analyzed for historical climate trends

Provides a range of probable climate changes (probability distribution) essential for impact assessments

**Downscaling:**

Focus global projections to a scale relevant to climate impacts in Wisconsin

Source: Adapted from D. Vimont, UW-Madison

IPCC 2007
Annual Temperature Change

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

Wisconsin will warm by 4 – 9 °F by mid-21st Century

Source: Adapted from D. Vimont, UW-Madison
Projected Change in Seasonal Temperatures
1980 to 2055 (°F)

Winter

Source: Center for Climatic Research & Center for Sustainability and the Global Environment, Nelson Institute, University of Wisconsin-Madison

Summer

Source: Center for Climatic Research & Center for Sustainability and the Global Environment, Nelson Institute, University of Wisconsin-Madison

Fall

Source: Center for Climatic Research & Center for Sustainability and the Global Environment, Nelson Institute, University of Wisconsin-Madison

Spring

Source: Center for Climatic Research & Center for Sustainability and the Global Environment, Nelson Institute, University of Wisconsin-Madison
Extreme Temperature Projections

Projected change in the frequency of <0°F nights per year from 1980 to 2055

Projected change in the frequency of ≥90°F days per year from 1980 to 2055

Fewer extremely cold winter nights

More hot summer days
Projected Change in Precipitation from 1980 to 2055

Change in Annual Average (inches)

Probability Distributions of 14 Climate Model Projections by Month

Models predict winter and early spring will be wetter
Models uncertain about amount of summer rainfall

Source: Adapted from D. Vimont, UW-Madison
Winter Precipitation Projections for mid-21\textsuperscript{st} Century

- Precipitation statewide is projected to increase about 25%.
- Snow depth and snow cover are projected to decline due to warmer temperatures causing more melting as well as increased proportion of precipitation falling as rain rather than snow.

Source: WICCI Climate Working Group

Source: Notaro, et al. 2010
Monthly Frequency of >3-inch Rainstorms in 24 hr
Green Bay, Wisconsin
(Predictions averaged for 14 GCM's)

Predicted increase in large rainstorms during spring & fall

Source: Z. Schuster & K. Potter, UW-Madison;
Analyses based on statistically downscaled data developed by Center for Climate Research, UW-Madison
Water Resources
Trends in observed stream flows generally corresponded to changes in precipitation across Wisconsin.

Source: Greb et al., WICCI Water Resources & Climate Working Groups
Wisconsin Precipitation Trends: 1950-2006

Anvil Lake (Vilas Co.)
Water loss through increased evaporation and transpiration associated with warmer temperatures could exacerbate recurring drought effects in the future, especially in lakes and wetland systems high in the landscape.

Source: USGS
High Capacity Wells in the Central Sands Region, 2010

Source: George Kraft, UW-Stevens Point
Three Central Counties Groundwater Pumping (USGS 2009)

78 Billion gallons per year

Source: George Kraft, UW-Stevens Point
Lakes and streams in the Central Sands region are drying up due to lower groundwater levels from increased pumping; climate change is expected to “pile on” these impacts.

Source: George Kraft, UW-Stevens Point
Wisconsin Precipitation Trends: 1950-2006

Annual

Summer

Devil’s Lake (Sauk Co.)
Water Levels in Devil's Lake
1922 to winter 2011

Source: R. Lathrop, WDNR from USGS data
but groundwater flooding can also occur as water tables rise following prolonged periods of excessive precipitation.

Flooding can occur not only when streams and rivers overtop their banks when extreme precipitation events occur…
Case Study: June 2008 storms

- 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!

... and such events are projected to become more frequent in a warming climate.

Map: NOAA Midwestern Regional Climate Center

WICCI Stormwater Working Group
Natural Habitats & Biodiversity
There are many phenology impacts...

Arrival of the American robin in southern Wisconsin is earlier when spring temperatures are warmer

\[ y = -1.5132x + 142.49 \]

\[ R^2 = 0.4943 \]

Source: Stan Temple, UW-Madison
Wisconsin’s Tension Zone is projected to move north due to a warming climate.

As a result, many northern plant and animal species could be severely impacted while more southern species could benefit.
Projected changes in stream temperatures by mid-century affect fish under 3 climate warming scenarios.

Response of 50 Common Stream Fishes to Highest Temperature Scenario:

- All 3 coldwater species decline
- All 16 coolwater species decline
- 4 warmwater species decline
- 23 warmwater species increase

WICCI Coldwater Fisheries Working Group
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Possible Winners</th>
<th>Possible Losers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short generation times</td>
<td></td>
<td>Long generation times</td>
</tr>
<tr>
<td>Wide distributions</td>
<td></td>
<td>Narrow/restricted distributions</td>
</tr>
<tr>
<td>Move easily across landscape</td>
<td></td>
<td>Poor dispersal ability</td>
</tr>
<tr>
<td>Habitat generalists</td>
<td></td>
<td>Habitat specialists</td>
</tr>
<tr>
<td>Not sensitive to human activity</td>
<td></td>
<td>Sensitive to human activity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Examples</th>
<th></th>
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<tbody>
<tr>
<td>Gray squirrel</td>
<td>American marten</td>
<td></td>
</tr>
<tr>
<td>White-tailed deer</td>
<td>Red-backed salamander</td>
<td></td>
</tr>
<tr>
<td>European starling</td>
<td>Spruce grouse</td>
<td></td>
</tr>
<tr>
<td>Canada goose</td>
<td>Common loon</td>
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</table>
Agriculture and the Soil Resource

Photo: Wisconsin DNR
For every 2º F of summer warming, corn and soybean yields could potentially decrease by 13 and 16 percent, respectively.
Results reinforce expected northward movement of Tension Zone.

Projections for northward movement of plant hardiness zones due to climate change

Source: Notaro, Lorenz & Vimont, UW-Madison
Soil Erosion:
A loss in “natural capital” of Wisconsin’s agriculture

- Soil losses in Wisconsin are increasing due to cropping system changes, erodible land returned to cultivation, and changing precipitation patterns.

- Small number of intense precipitation events cause most of annual soil loss from agricultural fields.

- Future precipitation patterns could cause soil erosion in Wisconsin to double by 2050 from 1990 rates.

- And loss of soil and nutrients causes downstream water quality problems.
People and their Environment
More challenges to public health are anticipated due to climate change.
Human Health Working Group

Increase in waterborne infectious diseases due to more intense storms

Urban stormwater runoff from Milwaukee entering Lake Michigan

Photo: Milwaukee Metropolitan Sewerage Dist

Increase in vector-borne infectious diseases

Photo: Gary Braasch

Increase in respiratory health problems from air pollution and climate change

Photo: www.topnews.in
Buildings, roads and water/sewer systems are not currently designed for challenges from future climate changes.
Adaptation: Principles & Implementation
Mitigation vs. Adaptation

**Mitigation:**
Decrease the amount of warming by reducing GHG emissions

- Very little
- Minor
- Major

**Adaptation to a warmer climate required even with GHG reductions**

*Scenarios from IPCC 2007

Modified from: IPCC 2007
Adaptation: “- adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.” IPCC

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

Risk management is the framework to discuss adaptation to climate change impacts.

Risk = (probability of impact occurring) X (degree of harm or benefit)
Principles for Adaptation

• **Triage Approach**
  
  *Determine which actions to implement first*

  Dealing with the most vulnerable species or habitat is likely less fruitful than dealing with the ones that can be preserved for the longest time into the future (e.g., brook trout streams).

• **Adaptive Management**
  
  *Build flexibility into management practices*

  Where uncertainties are high but the need is real, we may have to learn as we go or learn by doing (e.g., nonpoint pollution practices and water quality).

• **“No Regrets” Strategies**
  
  *Choose strategies that increase resilience and provide benefits across all future climate scenarios*

  Encouraging water conservation and implementing polluted runoff controls make sense under any climate scenario (e.g., enhance infiltration in headwater areas).
Principles for Adaptation (cont’d)

• **Precautionary Principle**
  
  *Where vulnerability is high, it is better to be safe than sorry*

  Serious flood damages to homes and other facilities catalyze relocation and/or altered engineering designs (e.g., move existing neighborhoods out of the flood prone areas before they flood).

• **Adapting to Variability in a Changing Climate**
  
  *Expect variability and work within it*

  Even though climate change is occurring, unusually warm and cold years and wet and dry years will continue to occur (e.g., hold Birkebeiner ski race or ice festivals on the cold and snowy winters, do not plan for them on warm or dry winters).
Principles for Adaptation (cont’d)

• **Place-Based Considerations**
  
  *Consider the restrictions and special circumstances of place-based impacts*

  All of Wisconsin’s human and natural systems are “place-based.” But some may have less flexibility to change functions or locations (e.g., Native American cultural resources such as wild rice).

• **Adaptation Compliments Mitigation**

  *Recognize the place of adaptation in the bigger picture*

  Co-benefits for mitigation and adaptation occur for some actions (e.g., innovations in mass transit and vehicle technologies both improve air quality and reduce ozone and greenhouse gases).
Road to Implementation

• **Taking Action**
  - Undertake activities to offset some of the negative impacts of climate change on specific resources.
  - Direct management efforts to locations where the actions provide greatest benefit.

• **Building Capacity**
  - Create better understanding of climate science, impacts and adaptation strategies along with tools for resource managers and other decision makers.

• **Communicating**
  - Establish dialog with public, decision makers, community groups, local governments, nonprofits, and others about impacts of climate change and benefits of adaptation.

• **Filling Gaps**
  - Expand our knowledge about how natural and human system will respond to climate change.
“Wisconsin’s Changing Climate: Impacts and Adaptation” is the first in an ongoing WICCI assessment of climate change impacts and adaptation strategies in Wisconsin!
“Working to fix your local environment has another benefit besides making your own life more pleasant. It also sets an example to others… We would be more effective in persuading people to adopt environmental policies good for the rest of humanity if we ourselves were seen to be pursuing such policies.”

(Jared Diamond, 2005. *Collapse: How Societies Choose to Fail or Succeed*)
“Are these the shadows of the things that Will be, or are they shadows of things that May be, only? … Men’s courses will foreshadow certain ends … but if the courses be departed from, the ends will change. Say it is thus with what you show me!”

(Ebenezer Scrooge in Charles Dickens’ A Christmas Carol)
WICCI was created from a partnership between the UW-Madison Nelson Institute for Environmental Studies and the Wisconsin Department of Natural Resources.

www.wicci.wisc.edu