

# Not-So-Early Worries About Climate Change

## Adapting to Climate Change Around Lake Superior



Bob Krumenaker  
Superintendent  
Apostle Islands National Lakeshore  
Bayfield, Wisconsin



# It's Not Just the Mountains and Coasts

The Middle of the Country is Affected by Climate Change\*



The Appalachians, e.g.  
Great Smoky Mountains  
National Park



The Great Plains, e.g.  
Badlands National Park



The Deserts, e.g.  
Big Bend National Park



The Heartland, e.g.  
Buffalo National River

The Great Lakes, e.g.  
Isle Royale National Park



\* Even if you don't hear about it in the media



# Case in Point

## Lake Superior and Apostle Islands National Lakeshore

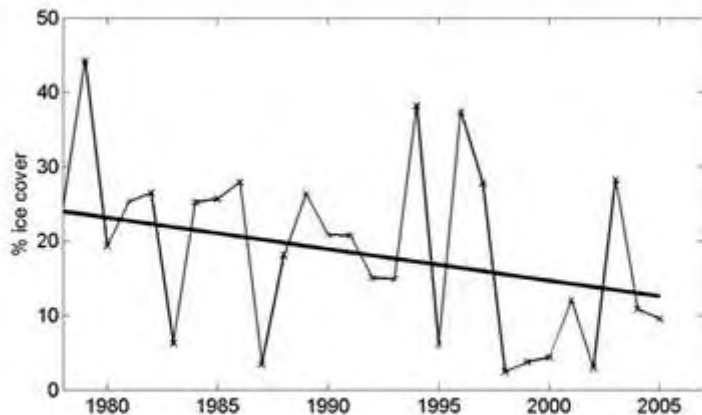
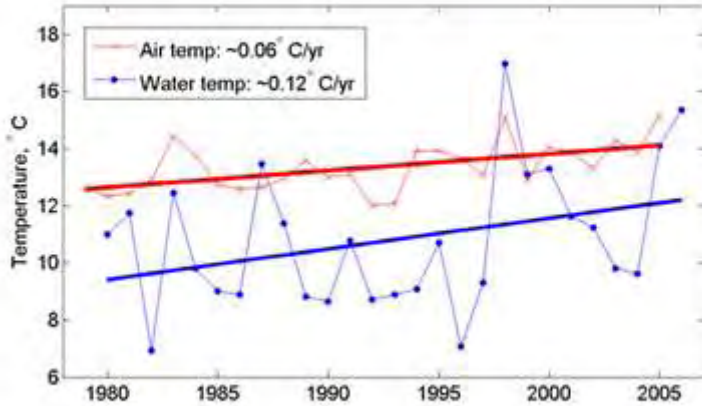


# Today's Plan

- What we know
- What will this mean for our area
- So what do we do now?



# Lake Superior is Warming Rapidly



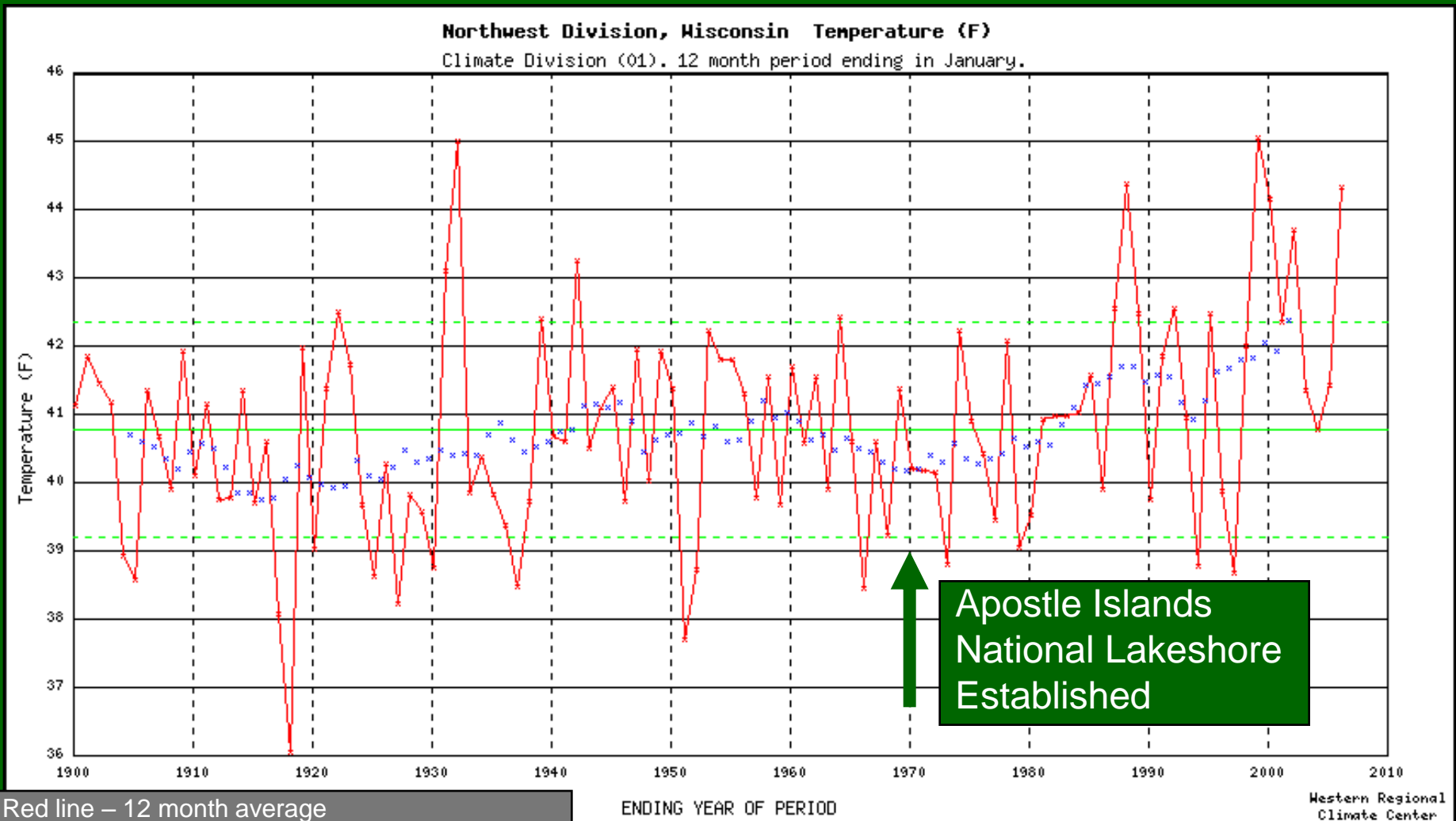
- Water temperatures are rising at twice the rate of air temperatures since 1980
- This correlates with decreasing ice cover over the same period
- Research is by Jay Austin and Steve Colman of the Univ. of Minnesota Large Lakes Observatory (Duluth)

From <http://www.d.umn.edu/~jaustin/ICE.html>

To be published shortly in *Geophysical Research Letters*



# Temperatures in Northwest Wisconsin



Red line – 12 month average  
Blue line – 10 year running mean  
Green lines – Average (solid), sigma (dashed)

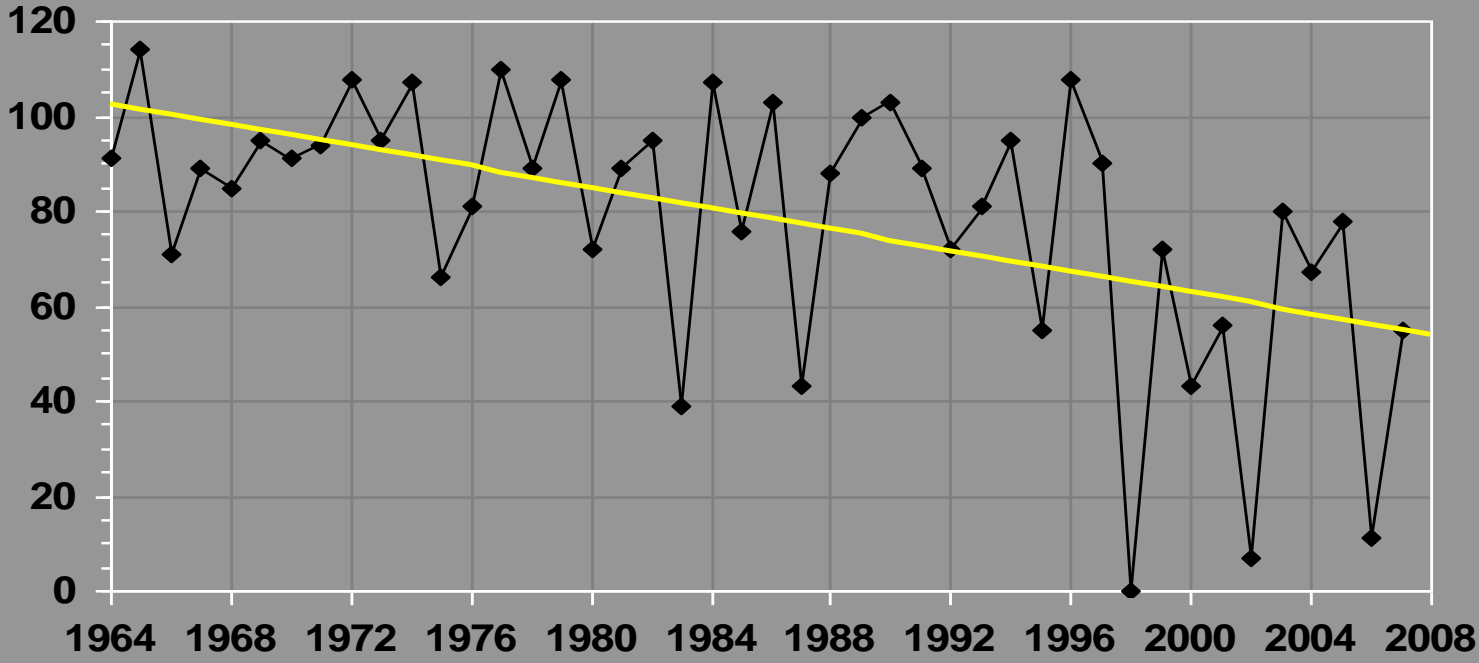
From <http://www.wrcc.dri.edu/spi/divplot1map.html>



# Madeline Island Ice Road

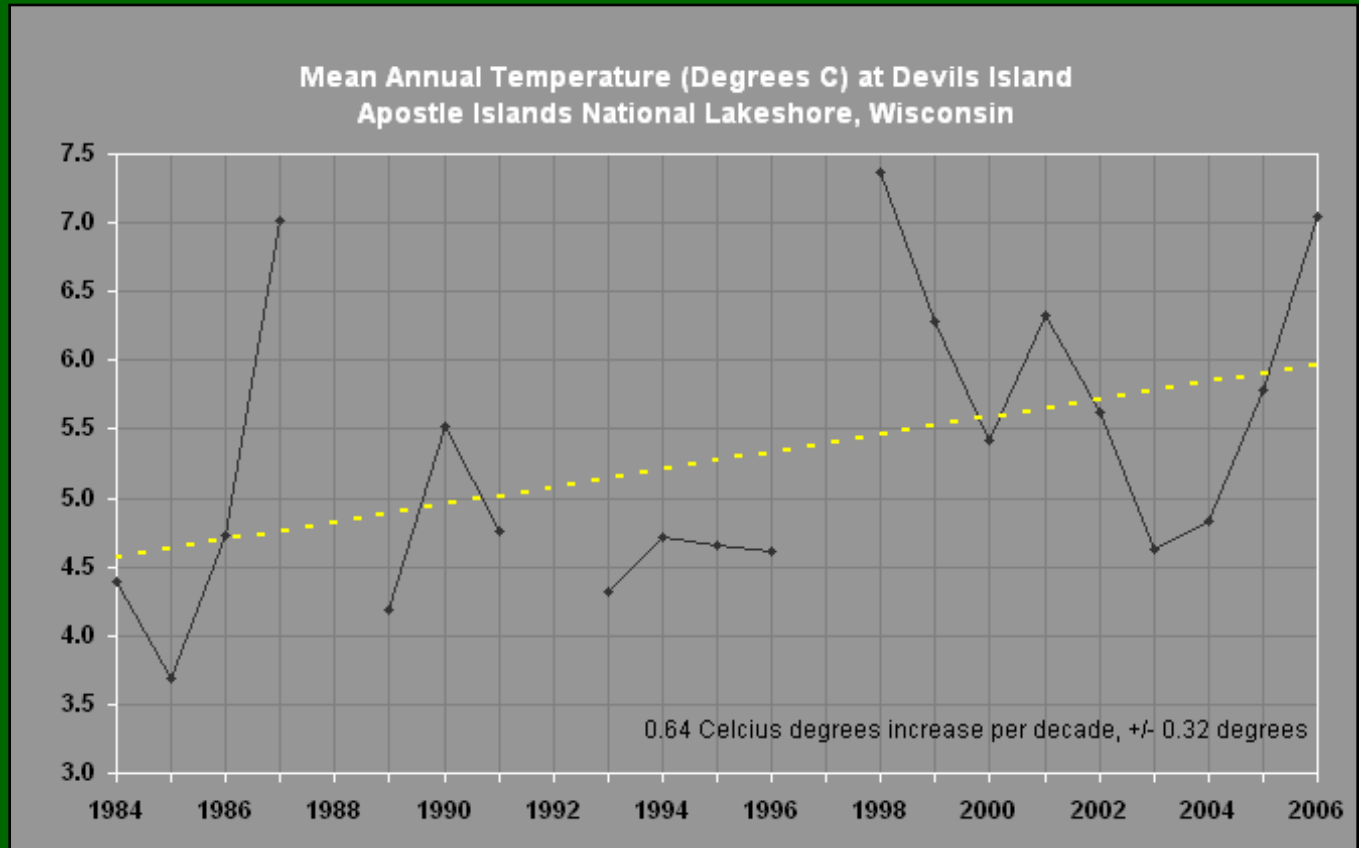


La Pointe Winter History  
Total Ice Transportation Days  
Chart by Burke Henry - Data from Evan Erickson



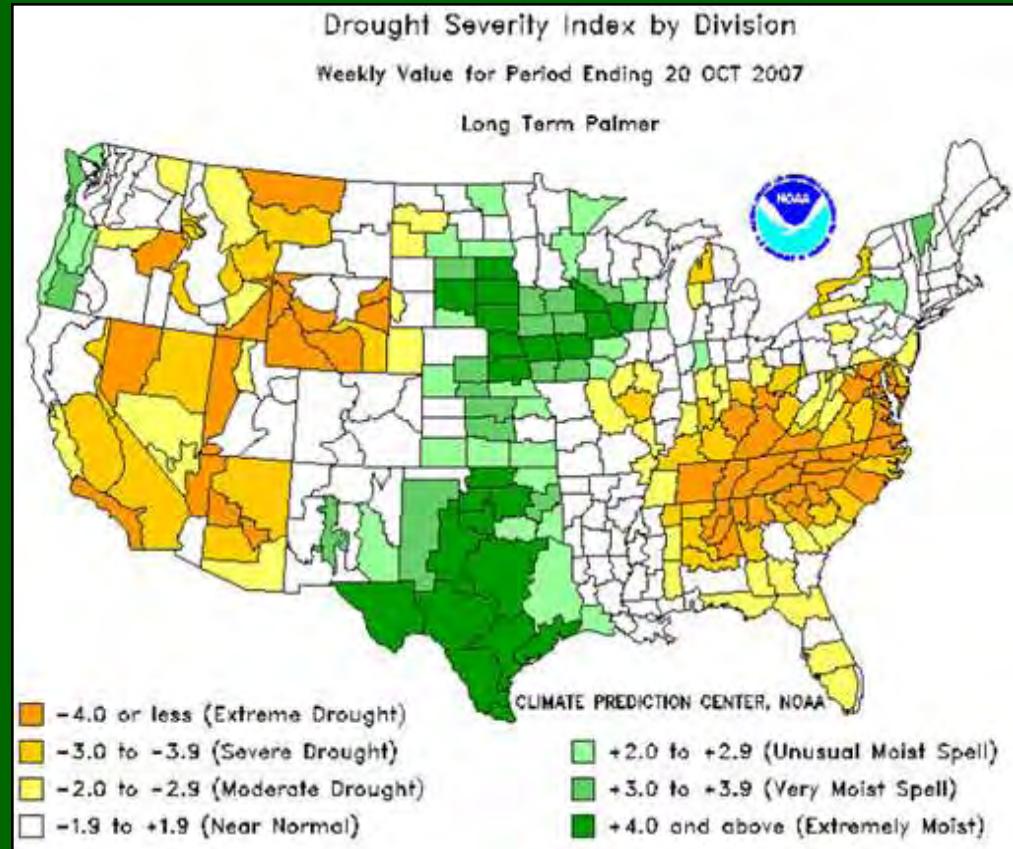
# Temperatures at Devils Island

Apostle Islands National Lakeshore, Wisconsin



# The (Very Recent) Drought in the Upper Midwest

- Warmer, drier summers
- Warmer winters
- Shorter cold season
- More winter precipitation as rain
- Warmer water
- Less ice
- Later freeze-up, earlier ice-out
- More evaporation from lakes
- Lower lake levels



# Climate Change Projections for the Great Lakes

- Warmer, drier summers
- Warmer winters
- Shorter cold season
- More winter precipitation as rain
- Warmer water
- Less ice
- Later freeze-up, earlier ice-out
- More evaporation from lakes
- Lower lake levels
- Irregular, higher intensity storms
- More flooding, esp. in spring



# Climate Change Projections for the Great Lakes

- Warmer, drier summers (IPCC, 2001)
- Warmer winters (IPCC, 2001)
- Shorter cold season (International Joint Commission, 2003)
- More winter precipitation as rain (Wuebbles and Hayhoe, 2004)
- Warmer water (Lehman, 2002)
- Less ice (International Joint Commission, 2003)
- Later freeze-up, earlier ice-out (International Joint Commission, 2003)
- More evaporation from lakes (Nat'l Assessment Synthesis Team, 2000)
- Lower lake levels (Nat'l Assessment Synthesis Team, 2000)
- Irregular, higher intensity storms (International Joint Commission, 2003)
- More flooding, esp. in spring (Kling et. al, 2003)



# Lake Superior Water Level - Observed

## LAKE SUPERIOR WATER LEVELS - OCTOBER 2007

washingtonpost.com

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### Lake Superior Sets Record for Low Water

By JOHN FLESHER  
The Associated Press  
Monday, October 1, 2007; 6:24 AM

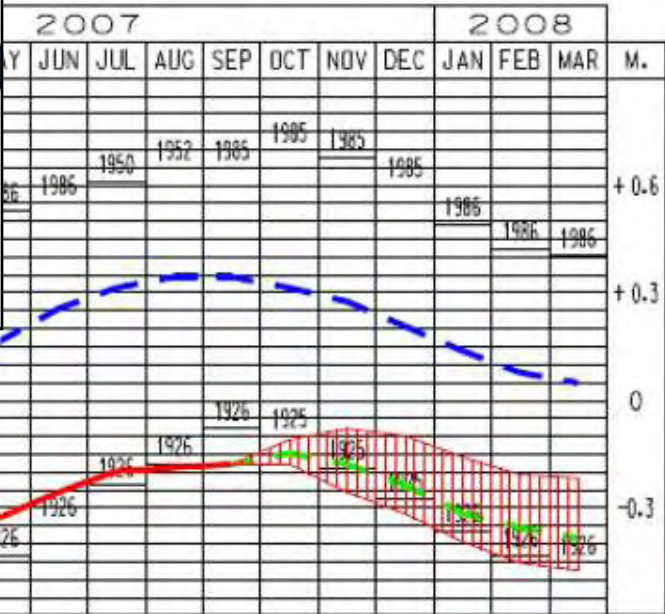
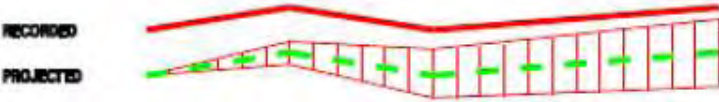


CHART DATUM 801.1 FEET (103.2 METERS)

### LAKE SUPERIOR

#### LEGEND LAKE LEVELS



AVERAGE **	[Dashed blue line]			
MAXIMUM **	1985	1985	1973	1973
MINIMUM **	1936	1934	1926	1934

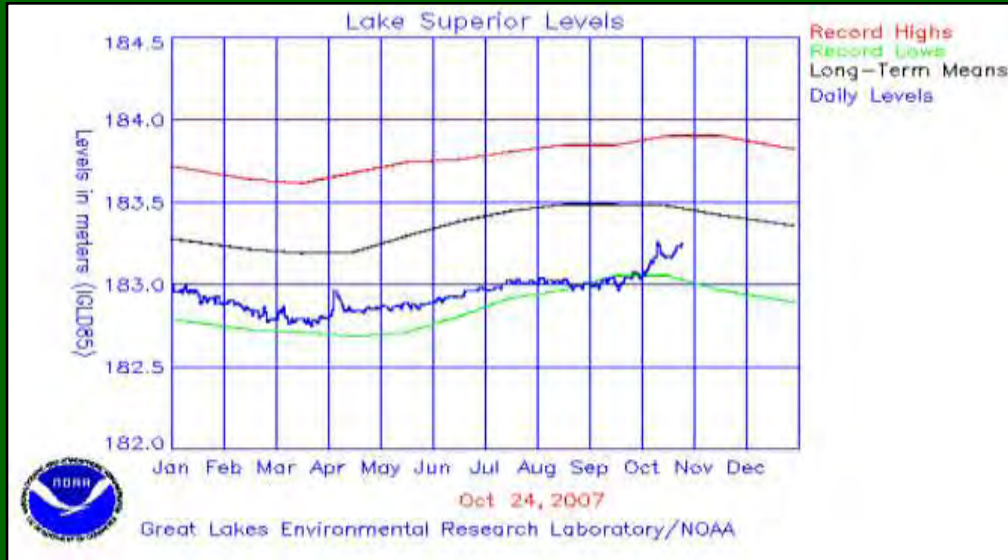
\*\* Average, Maximum and Minimum for period 1918-2006

From <http://www.lre.usace.army.mil/greatlakes/hh/greatlakeswaterlevels/waterlevelforecasts/monthlybulletinofgreatlakeswaterlevels>

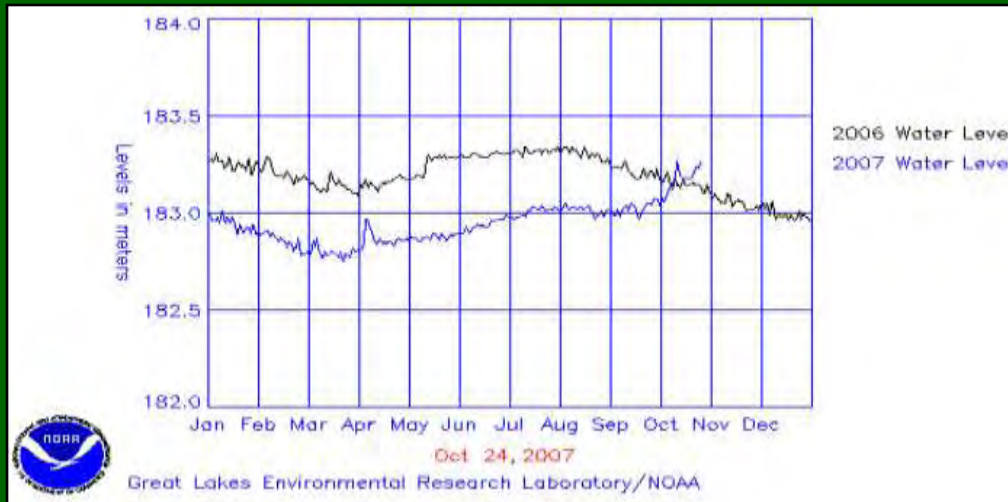


# The *Current* Lake Superior Water Level

As of October 24, 2007



- Recent heavy rains have raised the lake level significantly, and rapidly
- Nonetheless, the lake remains well below normal level
- *Normally*, the lake drops in fall and winter
- Do we even know what *normal* is any more?



# Today's Plan

- What we know
- What will this mean for our area
- So what do we do now?



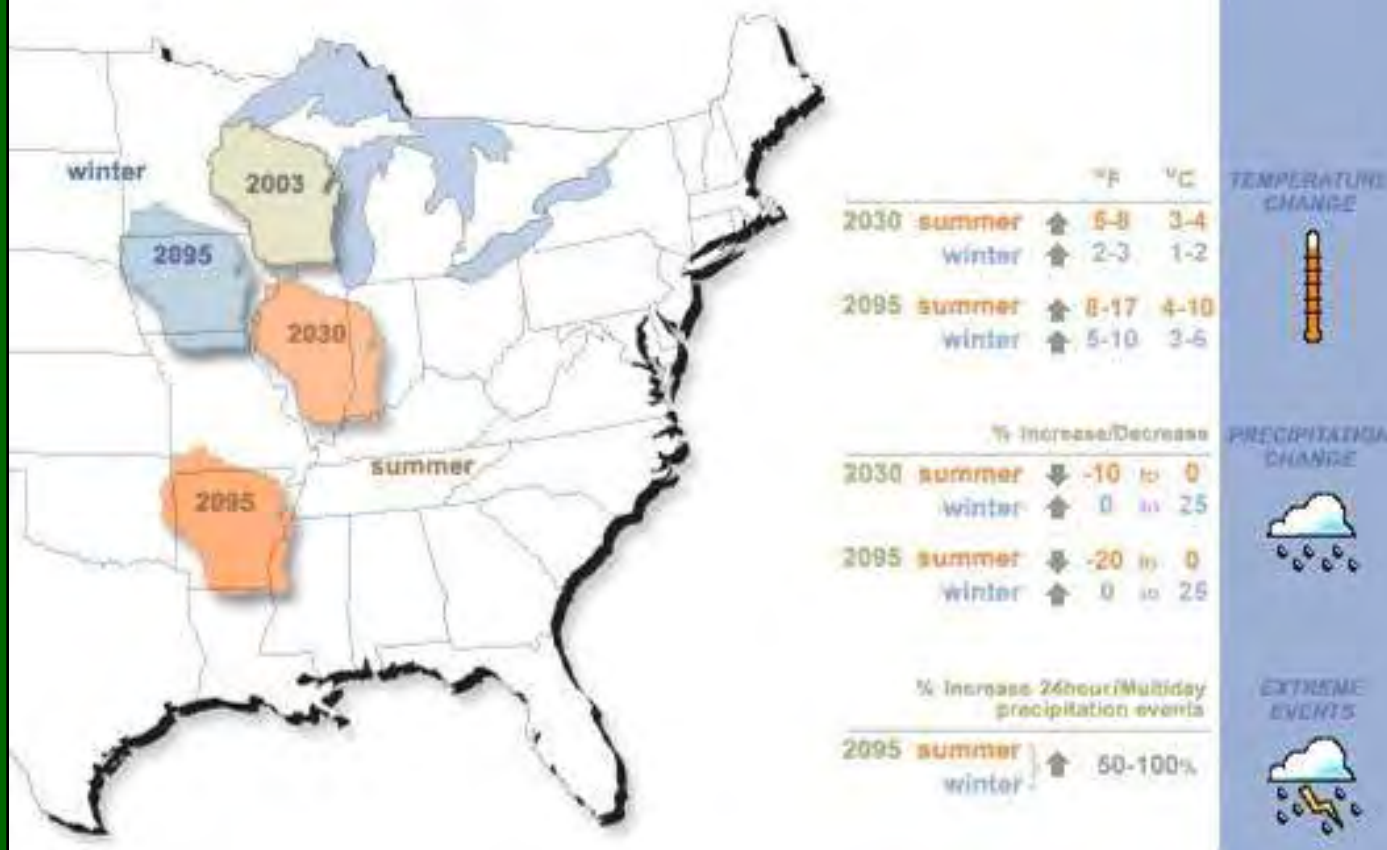
# Great Lakes Water Levels – Projections Vary

- Models have inherent scientific uncertainty but are limited by non-scientific uncertainty over future emissions, making it seem like the models are more imprecise than they are. (Pollack, 2007)
- Ice cover drives lake level models since winter evaporation affects lake levels more than precipitation. (Lofgren et al. 2002)
- 11 of 12 models project significant reductions in levels of the Great Lakes, ranging up to 5 feet. (National Assessment Synthesis Team, 2000)
- Evaporation from Lake Superior will increase by 7-17% by 2030 and 19-39% by 2090. Ice cover will decrease by 2090 to only 2-11% of current February average levels. (Lofgren et al. 2002)
- The 2 most recent major models differ: one has Lake Superior levels decreasing from long term averages by 9” by 2030 and 17” by 2090; the other has levels stable to rising by 4.” (Lofgren et al. 2002)



# Climates Will Migrate South

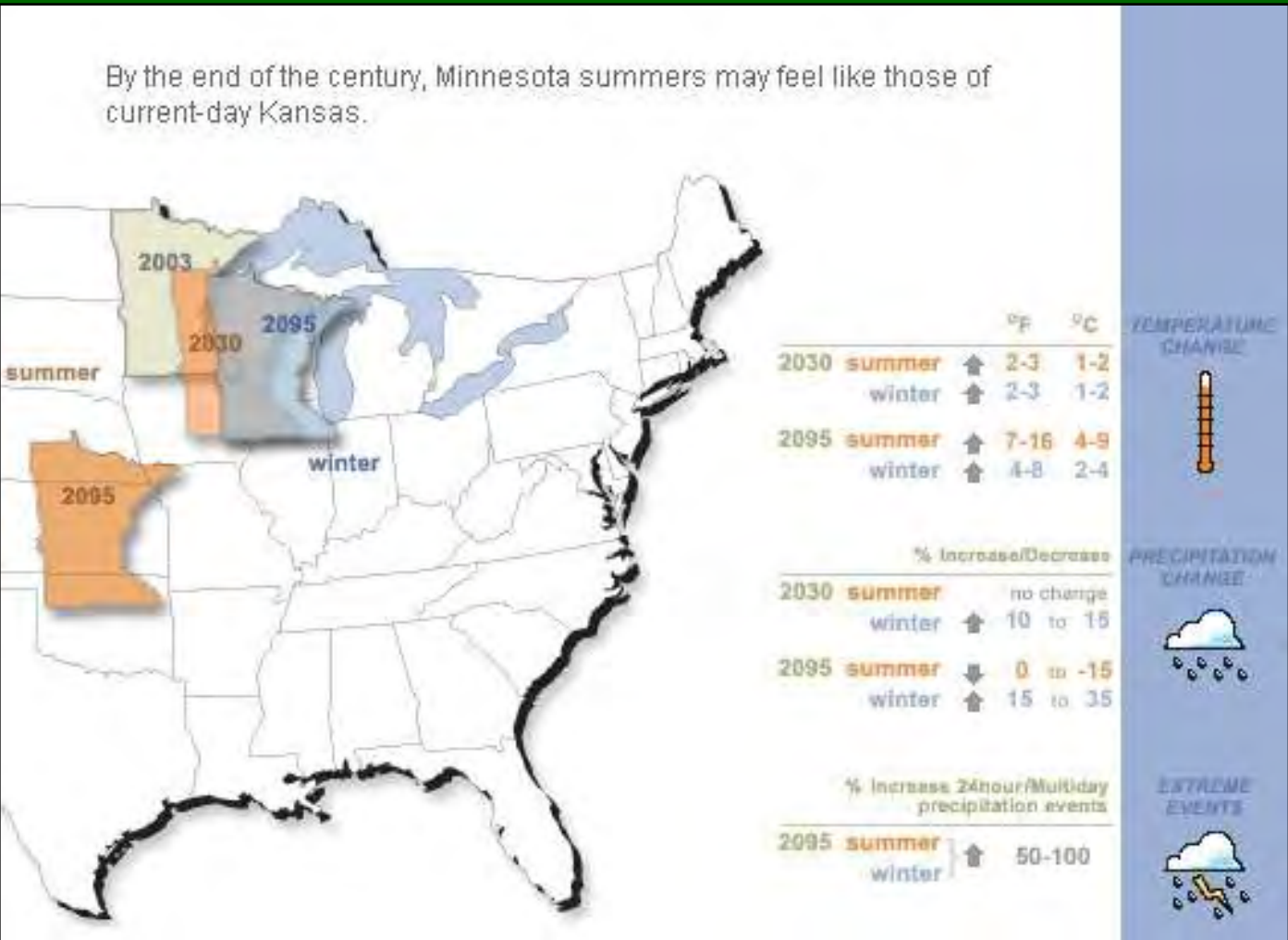
By the end of the century, Wisconsin summers may feel like those of current-day Arkansas.



From <http://www.ucsusa.org/greatlakes/glimpactmigrating.html>



# Climates Will Migrate South



From <http://www.ucsusa.org/greatlakes/glimpactmigrating.html>



# Lower Water Levels in Lake Superior

We've Seen it Lately – This Is Not Just Some “Possible” Future



- Recreational infrastructure: fixed docks will be too high, ramps will need to be extended, more navigational hazards will be exposed.
- Commercial shipping: locks and berths will be too shallow. Ships will have to carry less to float higher.
- Ephemeral wetlands (e.g. the Kakagon Sloughs south of the Apostle Islands), hugely important biological areas, may dry up, affecting wild rice beds, fisheries, and possibly tribal communities.

# Lower Water Levels in Lake Superior

We've Seen it Lately – This Is Not Just Some “Possible” Future

## Bad River wild rice harvest cancelled

By Chad Dally

Thursday, August 09th, 2007 10:36:05 AM



*Leah Gibala/Submitted Photo*

Bad River tribal members Donald Corbine and his son, Justin, harvest wild rice in the Kakagon Slough in August, 2006.

The fears of many Bad River tribal members have been realized: For the first time in history, there will be no harvest of wild rice this year within tribal boundaries.

The Bad River Tribal Council announced on Wednesday that, due to extremely low water levels, a one-year hiatus is in place for rice beds in the 12,000-acre Kakagon, Bad River and Bad River Slough complexes, as well as Honest John Lake and the Sand Cut Sloughs off of Oak Point.

"This is something we have to do as a people," said Matt O'Claire, a game warden with Bad River's Natural Resources Department (NRD). "...It's something that we share with everybody, but we also talk about looking ahead seven generations and the need to protect it for our children and grandchildren."

- Ephemeral wetlands (e.g. the Kakagon Sloughs south of the Apostle Islands), hugely important biological areas, may dry up, affecting wild rice beds, fisheries, and possibly tribal communities.

# Warmer and Longer Summers



- More boats ill suited for the cold, treacherous waters of Lake Superior, e.g. jet skis, pontoon boats.
- “Shoulder” seasons will begin earlier, end later, and see more activity.
- Warm waters will change the cold water fishery.
- Increased turbidity and algae in the Lake.
- Shipwrecks and other submerged cultural resources will deteriorate faster.

# More Intensive Storms

Coupled with warmer temperatures, there will likely be more boaters unprepared for storms on the lake, leading to more groundings, capsizings, and more need for rescues.



# More Dangerous Boating



# More Need For Rescues on Lake Superior?



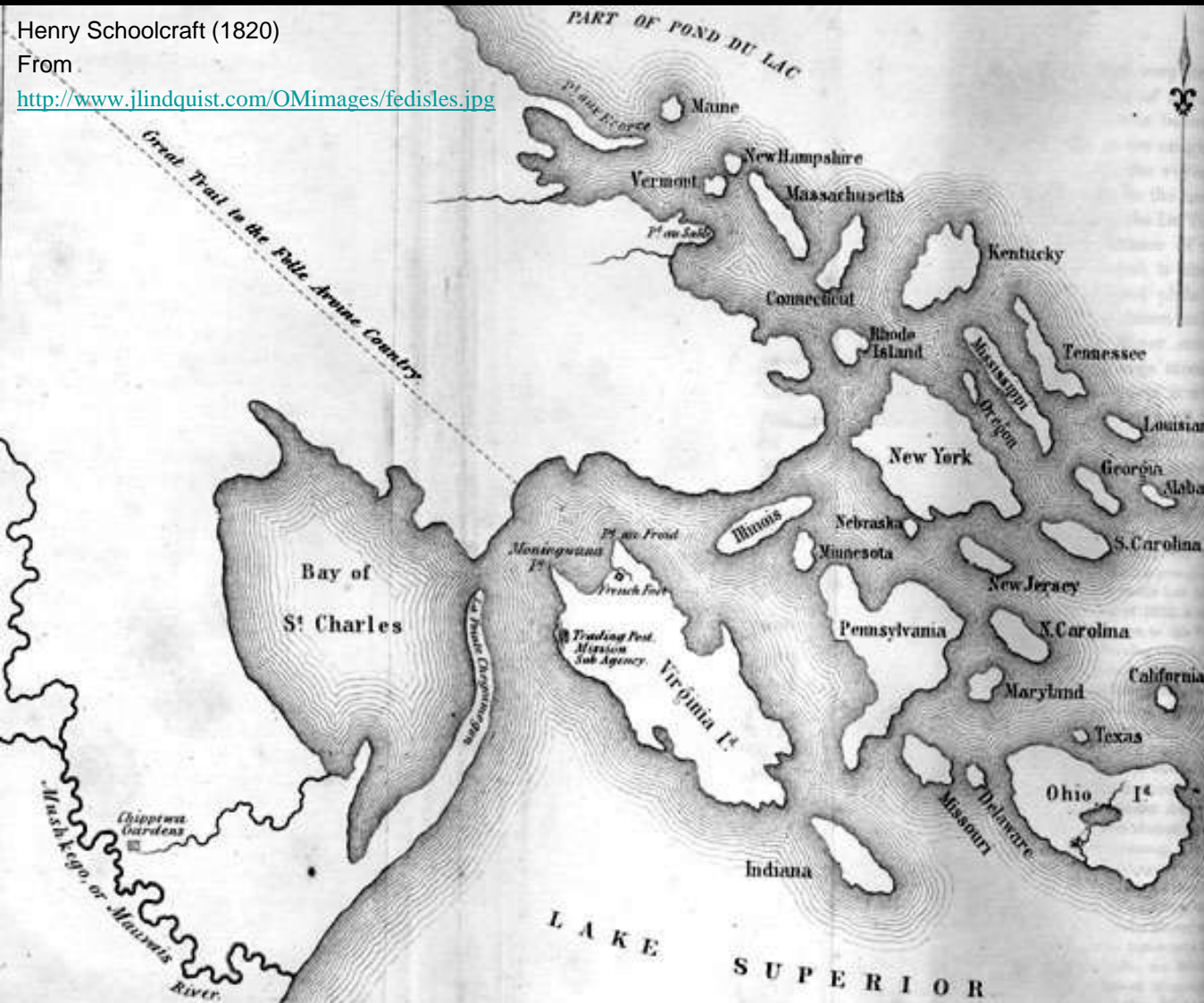


# Whither the Apostle Islands?

Henry Schoolcraft (1820)

From

<http://www.jlindquist.com/OMimages/fedisles.jpg>



“The [Apostle] Islands are simply a phase in the history of the lake, their existence or their obliteration depending on relatively slight fluctuations of the lake level.”

-- George Lucius Collie, “Wisconsin Shore of Lake Superior” (1901)



# Public Health Issues

- Temperature Stress
- Insects and Disease
- Respiratory Problems
- Extreme Weather



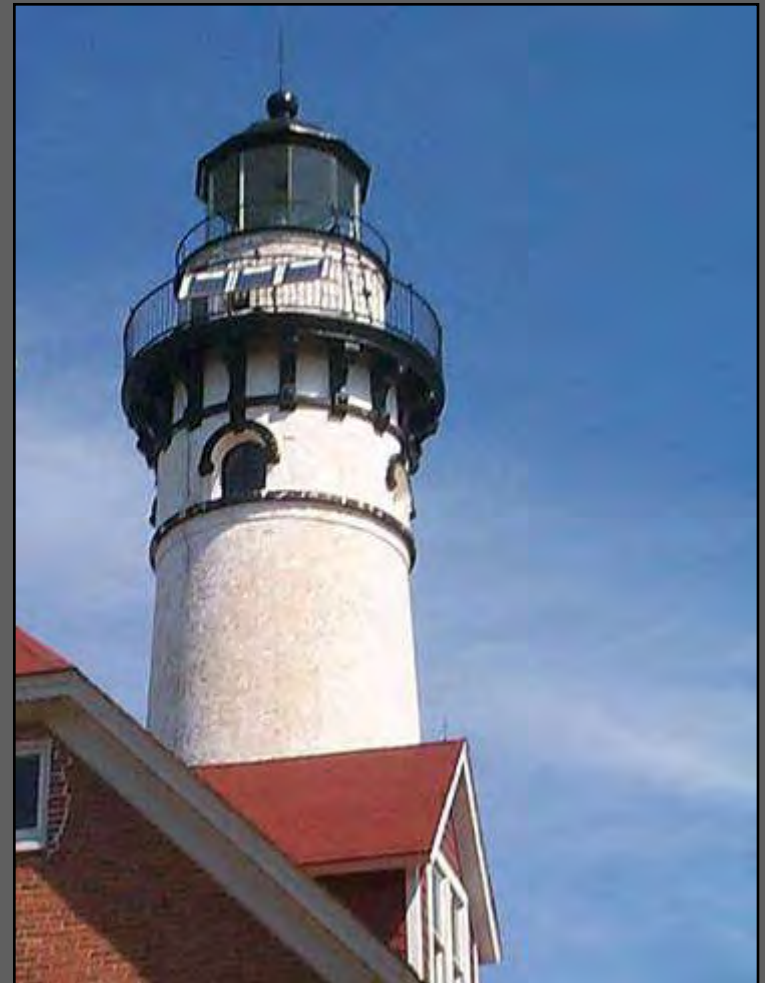
[http://www.jhsph.edu/nationalassessment-health/health\\_final.pdf](http://www.jhsph.edu/nationalassessment-health/health_final.pdf)

- Higher temperatures & heat waves are likely to cause more heat-related illnesses (and fewer cold-induced illnesses). (Martens, 1998)
- Survival of ticks, mosquitoes, and other disease vectors will be enhanced with higher temperatures and longer periods of heavy rainfall. (Yoganathan, 2001)
- Spread of West Nile Virus may have been enhanced by recent climate change. (Epstein, 2001)
- SW air flows (often associated with high ozone and poor air quality) are predicted to increase over the Midwest with implications for respiratory health. (Sousounis et al., 2002)



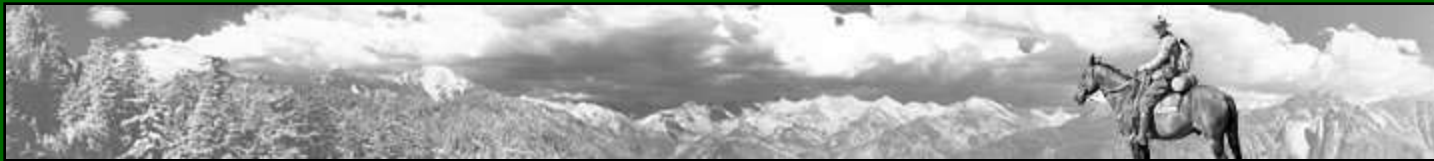
# Today's Plan

- What we know
- What will this mean for our area
- So what do we do now?



# The National Park Service Mandate

- The National Park Service was established by an Act of Congress in 1916 (16 US Code 1)
- “... to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.”
- What are the roles of the national parks and other protected areas in the face of climate change?
- What can and should the NPS do?





# Increase Commitment to Sustainability

## and then Lead By Example



**Apostle Islands National Lakeshore**  
 Superintendent's Order # 31

National Park Service  
 U.S. Department of the Interior

**Safety and Sustainability**

Effective Date of this Order: February 12, 2007

**Apostle Islands National Lakeshore**  
**Sustainability Best Management Practices**  
**July, 2007**

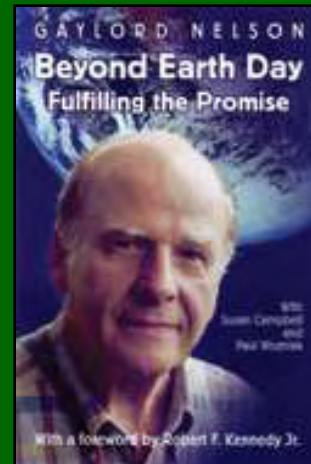


# Increase Commitment to Sustainability

## and then Lead By Example



“Without vigorous and persistent leadership ...the goal of sustainability can not be achieved... A way to make environmental problems appear to be less daunting is to relate them to our communities and convey their relevance to our daily lives – as they unquestionably are relevant.”



-- Gaylord Nelson  
Beyond Earth Day  
2002



# Educate Ourselves and Others



### Climate Change in National Parks

National Park Service  
U.S. Department of the Interior

"Earth's climate is changing with global temperatures now rising at a rate unprecedented in the past 100 years."  
—World Meteorological Organization, 2007

**Climate Change is Happening**

Scientists have observed a wide range of changes in the natural world, including shifts in the timing of seasonal events, changes in the distribution of plants and animals, and changes in the frequency and intensity of extreme weather events. These changes are consistent with the predictions of climate change models.

**Changes Have Consequences**

As the climate continues to warm, the effects will become more pronounced. This includes more frequent and severe droughts, floods, and wildfires, as well as the loss of habitat for many species. These changes will have significant impacts on the natural resources and ecosystems of our national parks.

### Climate Change

David Miller King  
National Park Service  
U.S. Department of the Interior

**Impact of Midwest Warming**

Living birch trees, minimal snowpack, and ice-free lakes are just some...  
Impacts of Midwest Warming

**The Science is In**

Recent reports by the U.S. Global Change Research Program, the National Academy of Sciences, and the United States Intergovernmental Panel on Climate Change, give a clear indication of a warming world and scaled changes in our global climate system. The climate is changing, and there is little scientific doubt that most of the temperature increases since the mid 20th century are due to greenhouse gases produced by human activities. Taking action now will diminish the risks associated with climate change, and reduce the likelihood of catastrophic and far more expensive consequences.

**A Changing Climate**

Change has a way of coming in a powerful form of nature. National parks help us understand how much change influences our lives by illustrating how interconnected we are with our environment.

**Temperatures and Precipitation**

The Northern Plains, including the upper Great Lakes region, has warmed by almost 7°F (4°C) in the last century.

Due to late Michigan, Illinois and Indiana, there that summer water temperatures are increasing. Lake Superior's summer surface water temperatures have increased by 4.2°F (2.3°C) since 1980.

The timing of Lake Superior's summer ice-out is now two weeks earlier than reported in 1980.

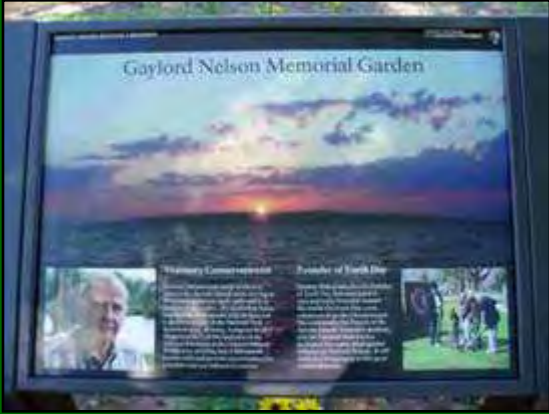
As it warms, less and melting earlier in the spring, the snowpack in the Great Lakes region. The reduction in snowpack and melting the lakes in the Great Lakes.

**Consequences of a Warming World**

Warmer temperatures in the Great Lakes region are projected to rise by at least 1.4°F (0.8°C) and as much as 10°F (5.6°C) by 2050. Projected temperature changes vary depending on the model and scenario, however all projections indicate warming for the region. Extreme weather events such as heat waves, drought, tornadoes, and flash-floods will also become more frequent.

Ice is melting later and melting earlier on lakes and streams in the Great Lakes region. Two-thirds of the winters between 1980 and 2000 in the Midwestern states were above the long-term average. Winters are getting shorter in the Great Lakes region. The late spring is coming earlier and the late summer is coming later. Snow cover in the northern hemisphere has declined about 4% since 1970.

The combination of reduced winter ice, warmer lake temperatures, and greater precipitation leads according to scientists that the Great Lakes region will see an increase in the amount of algae growth and significant changes in species composition.



Determine the message and deliver it consistently!



# Educate Ourselves and Others

Climate Friendly Park Workshop July 16-17, 2007



## Other Climate Friendly National Parks:

- Everglades
- Gateway
- Glacier
- Glacier Bay
- Great Smoky Mtns
- Hawaii Volcanoes
- Pictured Rocks
- Point Reyes
- Rocky Mountain
- Yosemite
- Zion



## Apostle Islands develops action plan for climate change

By CHAD DALLY  
The Daily Press

Wednesday, July 18th, 2007 09:16:48 AM

For more information, see <http://www.nps.gov/climatefriendlyparks>



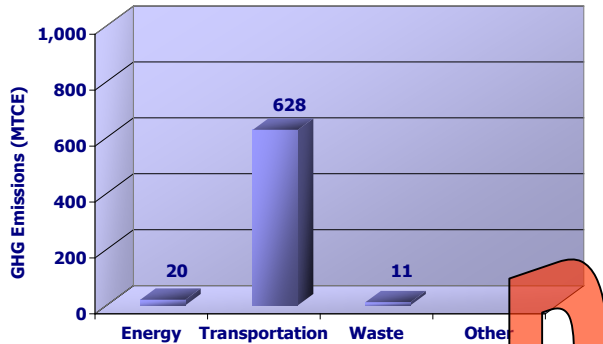
# Apostle Islands NL's: 2006 Emission Inventory Results

## Greenhouse Gas (GHG) Emissions

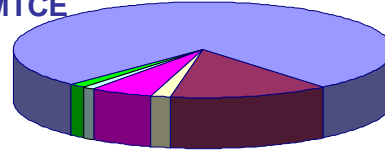
Total = 659 MTCE\*

\*Metric Tons Carbon Equivalent

### GHG Emission by Sector

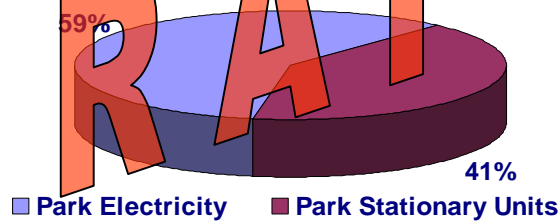


Transportation GHG Emissions = 628 MTCE

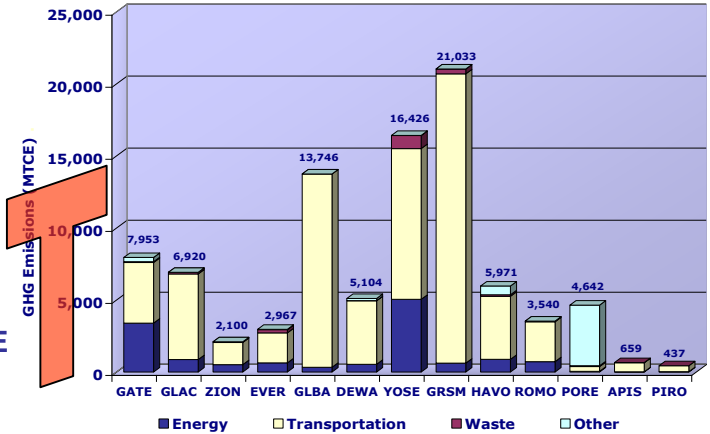


- Park Vehicles 2%
- Park Watercraft 5%
- Visitor Vehicles 1%
- Visitor Snowmobiles 1%
- Visitor Watercraft 77%
- AI Cruise Serv. Watercraft 14%

Energy GHG Emissions = 20 MTCE



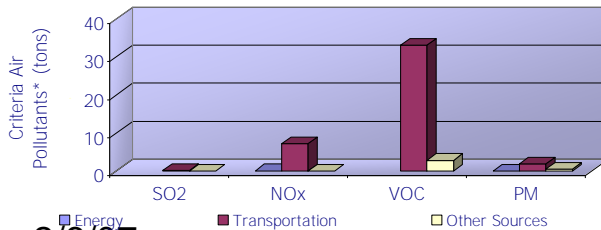
### Climate Friendly Park Comparison



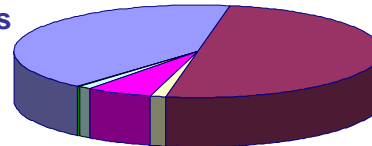
## Criteria Air Pollutants

### Criteria Air Pollutants by Sector

	CO tons	SO <sub>2</sub> tons	NO <sub>x</sub> tons	VOC tons	PM tons
Energy	0.0	0.0	0.0	0.0	0.0
Transportation	193.4	0.1	7.1	33.1	1.9
Campfires	3.1	0.0	0.0	2.8	0.4
<b>Total Emissions</b>	<b>196.5</b>	<b>0.1</b>	<b>7.2</b>	<b>35.9</b>	<b>2.3</b>



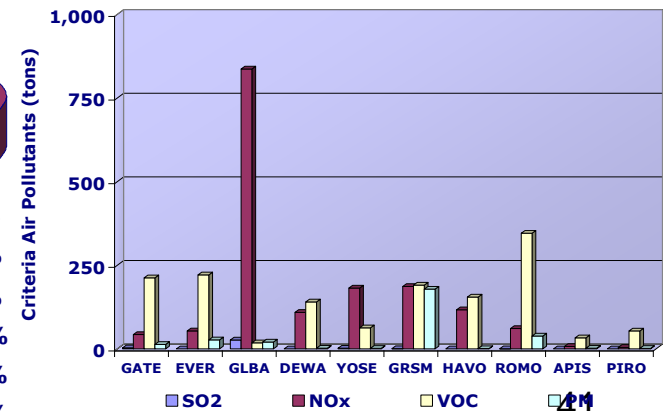
Transportation NOx Emissions = 7.1 tons



- Park Vehicles 1%
- Park Watercraft 6%
- Visitor Vehicles 1%
- Visitor Snowmobiles <1%
- Visitor Watercraft 41%
- AI Cruise Serv. Watercraft 51%

### Climate Friendly Park Comparison\*

\*CO excluded due to scale



# Plan for Change / Adapt Facilities as appropriate

APOSTLE ISLANDS NATIONAL LAKESHORE  
WISCONSIN

NATIONAL PARK SERVICE  
U.S. NATIONAL PARK SERVICE



## Options For Future Management

Dear Friend of Apostle Islands National Lakeshore:

A little more than a year ago, we held several meetings around Wisconsin and Minnesota to discuss the revision of the General Management Plan for Apostle Islands National Lakeshore. As you may recall, National Park Service (NPS) general management plans are very broad planning documents that create a vision for the park for the next 15 to 20 years. This new management plan will address wilderness issues for the first time because of the designation of the Gaylord Nelson Wilderness in late 2004.

We have learned a lot about the issues that are important to you, and we have given the issues a lot of thought ourselves. As we prepare to begin drafting this important plan for the park, we invite you to review the issues and some different options for addressing them. Once we have a complete list of issues, each with a broad range of options, we will define planning alternatives and prepare a Draft General Management Plan / Wilderness Management Plan / Environmental Impact Statement for your review.

This newsletter highlights several issues that we believe are appropriate for the general management plan to address, and outlines several different approaches to each of the issues. We want to hear from you! Is the list of issues complete? Is there a reasonable, legal option for approaching a particular issue that we have missed? Do you prefer any particular approach to an issue? Any thoughts that you can share with us along these lines could be extremely valuable to us.

We'll be hosting several meetings around the region this summer to listen to your views and gather input for the plan. (Please see page 22 for the schedule.) Help us decide what the Apostle Islands National Lakeshore will look like 20 years from now. We hope you'll stay engaged in this important planning process by reviewing this newsletter, attending a meeting, and sending us your comment.

Sincerely,

Bob Kronenaker  
Superintendent



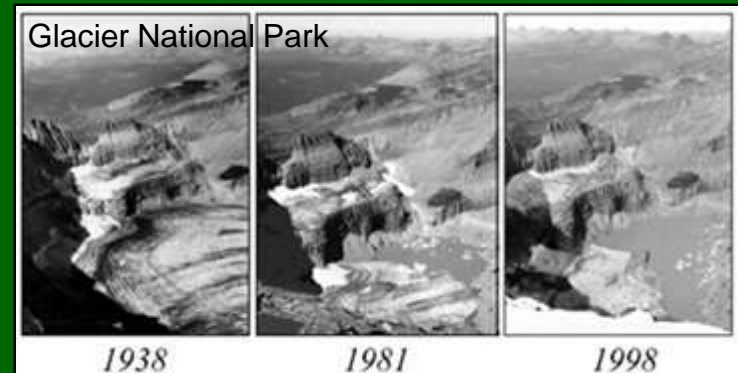
# Protect Species And Mitigate Ecological Changes

- This is the most difficult of the strategies.
- Do we know how? Can it be done?
- Should we even try?
- Should we create refugia in new habitats?
- If so, what's the impact on the “receiving” area”?
- A protected species in one area may look like an invasive species in another...
- Does “native” still have a meaning for protected area policy?
- We need to *manage for maximum resiliency...*



# Most Importantly: Change the Paradigm

- Climate change is not simply about the changes to park environments and regional ecosystems...
- We need to consider changes to, and rethinking of:
  - Experiences
  - Expectations
  - Safety
  - Facilities and access
  - Demands on management agencies
  - What it means to “conserve unimpaired”
- Climate change is not just a *resource* management issue; it’s a *protected area* management issue -- and one for our gateway communities and visitors.



# Climate Change and the National Parks

“For the past 25 years, I have been doing field work at high elevations in the ... premier national parks, including Glacier, Yellowstone, Mt. Rainier, Yosemite, and Sequoia. In all of these parks, we are seeing the fingerprint of global climate change. Glaciers are disappearing and plants, animals and insect pests are moving upslope at unprecedented rates.

“Our national parks can no longer be protected from human influence by building a fence or hiring park rangers. Recall that national parks are an American invention. In fact, the writer Wallace Stegner often remarked that the idea of national parks was the best idea that we ever had. *It’s my fervent hope that we find the will to address global climate change in order to ensure that the parks and wild places ... continue to delight and inspire future generations.* “



Lisa Graumlich  
Director, School of Natural Resources  
University of Arizona

From <http://www.earthsky.org/article/50989/20-scientists-speak>



# We've Got Some Work To Do...



Apostle Islands From Space

QUESTIONS? FOR MORE INFORMATION  
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