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](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

Apostle Islands National Lakeshore
Established
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

Mean Annual Temperature (Degrees C) at Devils Island
Apostle Islands National Lakeshore, Wisconsin

0.64 Celsius degrees increase per decade, +/- 0.32 degrees

From NOAA data records at http://www.ndbc.noaa.gov/station_history.php?station=disw3
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 Sets Record for Low Water

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

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

By the end of the century, Minnesota summers may feel like those of current-day Kansas.

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

• 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?
Vulnerability of Coastal Areas on the Great Lakes

- Relative Coastal Change Potential Assessment of Apostle Islands National Lakeshore (APIS) to Lake-Level Changes
- Elizabeth A. Pendleton, E. Robert Thieler, S. Jeffress Williams

Whither the Apostle Islands?

“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

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
Increase Commitment to Sustainability and then Lead By Example

“Without vigorous and persistent leadership … the goal of sustainability cannot 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

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

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

+ Energy
+ Transportation
+ Waste
+ Other

Transportation GHG Emissions = 628 MTCE

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>628</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

Criteria Air Pollutants

Criteria Air Pollutants by Sector

- Park Electricity
- Park Stationary Units

Energy GHG Emissions = 20 MTCE

Transportation NOx Emissions = 7.1 tons

Climate Friendly Park Comparison*

*CO excluded due to scale

<table>
<thead>
<tr>
<th>Park Vehicles</th>
<th>Park Watercraft</th>
<th>Visitor Vehicles</th>
<th>Visitor Snowmobiles</th>
<th>Visitor Watercraft</th>
<th>AI Cruise Serv. Watercraft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>6%</td>
<td>1%</td>
<td>&lt;1%</td>
<td>41%</td>
<td>51%</td>
</tr>
</tbody>
</table>

Climate Friendly Park Comparison

<table>
<thead>
<tr>
<th>Source</th>
<th>SO2</th>
<th>NOx</th>
<th>VOC</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation</td>
<td>GATE GLAC ZION EVER GLBA DEWA YOSE GRSM HAVO ROMO PORE APIS PIRO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Transportation NOx Emissions = 7.1 tons

Energy

Transportation

Waste

Other

0
5,000
10,000
15,000
20,000
25,000
GHG Emissions (MTCE)

59%
41%
0
250
500
750
1,000
Criteria Air Pollutants (tons)

GATE GLAC ZION EVER GLBA DEWA YOSE GRSM HAVO ROMO PORE APIS PIRO

SO2 NOx VOC PM

0
250
500
750
1,000 Criteria Air Pollutants (tons)

Energy
Transportation
Waste
Other

0
5,000
10,000
15,000
20,000
25,000
GHG Emissions (MTCE)

Climate Friendly Park Comparison

*CO excluded due to scale

Transportation NOx Emissions = 7.1 tons

Energy
Transportation
Waste
Other

0
5,000
10,000
15,000
20,000
25,000
GHG Emissions (MTCE)

Climate Friendly Park Comparison

*CO excluded due to scale

Transportation NOx Emissions = 7.1 tons

Energy
Transportation
Waste
Other

0
5,000
10,000
15,000
20,000
25,000
GHG Emissions (MTCE)

Climate Friendly Park Comparison

*CO excluded due to scale
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 would 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 23 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 comments.

Sincerely,

Bob Kromenaker
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

We’ve Got Some Work To Do…

Apostle Islands From Space

QUESTIONS? FOR MORE INFORMATION
B O B  K R U M E N A K E R  •  S U P E R I N T E N D E N T
415 WASHINGTON AVENUE • BAYFIELD WI 54814
(715) 779-3397 x101
bob_krumenaker@nps.gov