

Climate change and impacts to water resources

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FUTURE FORECAST FOR MIDWEST

- Likely increase in winter and spring precipitation, more heavy downpours, and greater evaporation in summer leading to more periods of both floods and water deficits.
- Longer growing season provides the potential for increased crop yields, but increases in heat waves, floods, droughts, insects, and weeds will present increasing challenges to managing crops, livestock, and forests.
- Native species are very likely to face increasing threats from rapidly changing climate conditions, pests, diseases, and invasive species moving in from warmer regions.

Global Climate Change Impacts in the United States
www.globalchange.gov/usimpacts



Challenge #1

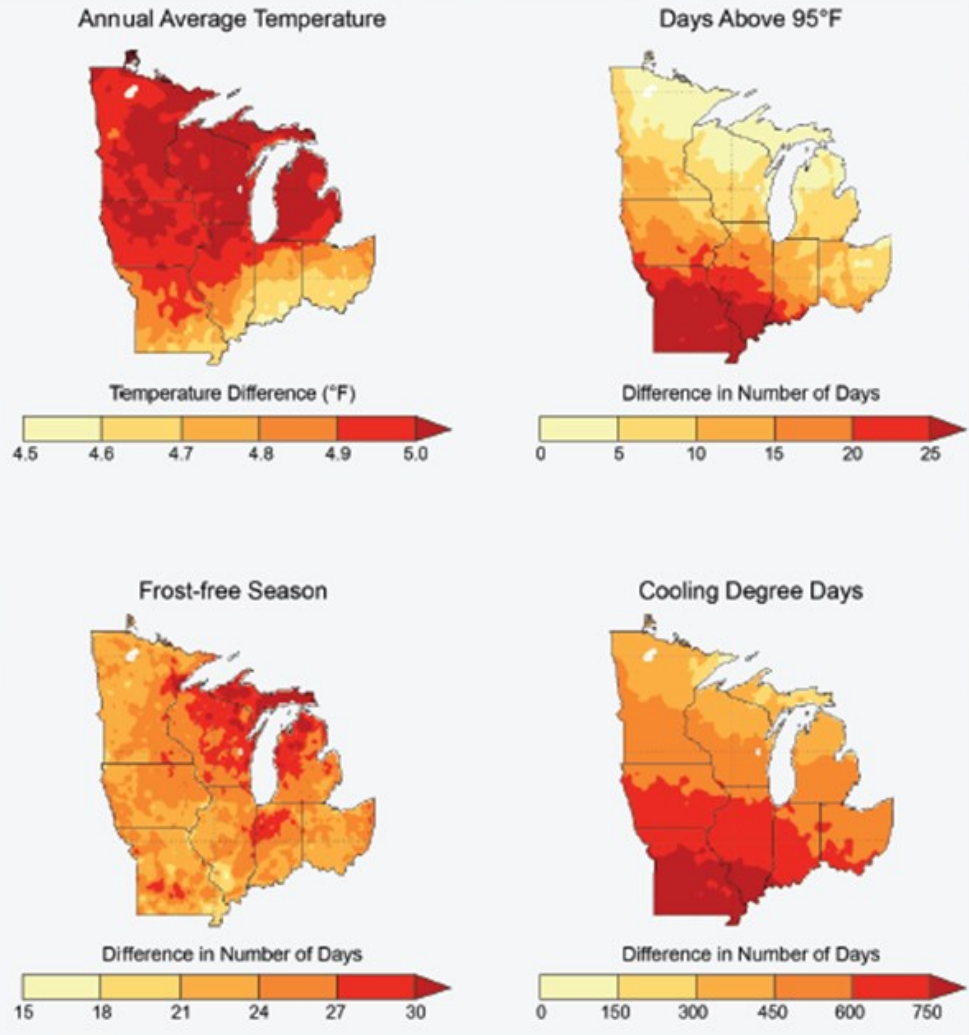
Less water



Climate Change: Temperatures

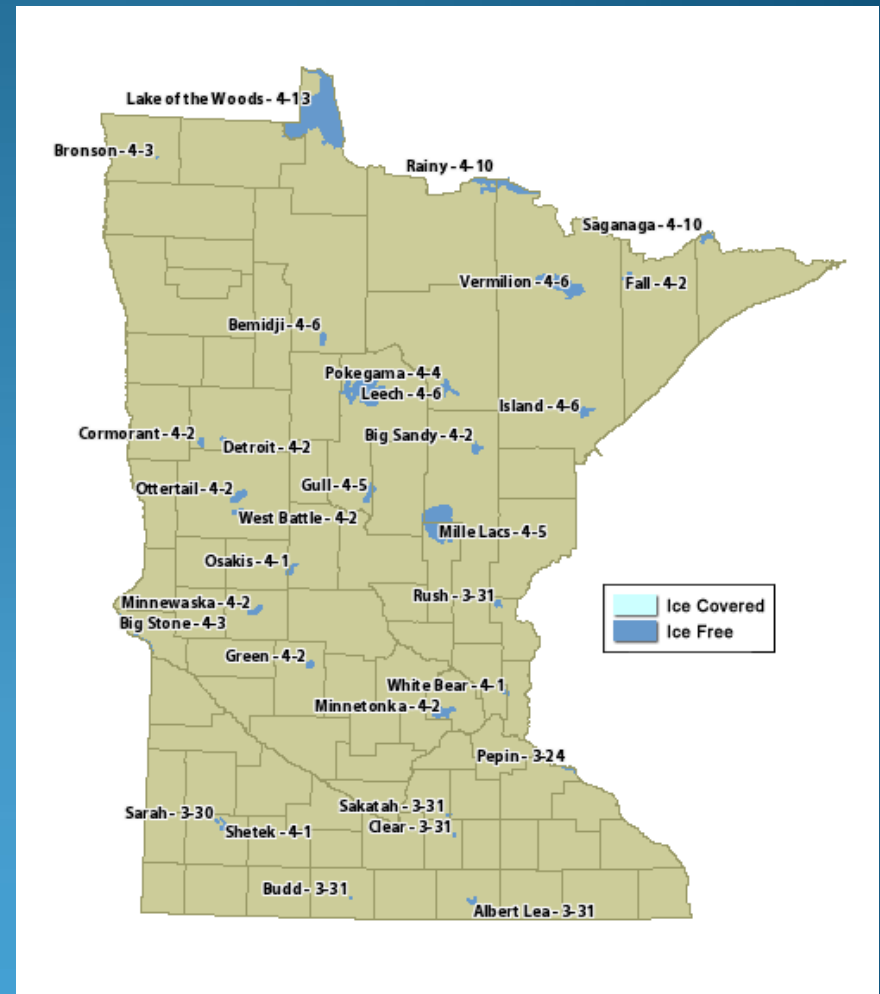
- Projections of changes in temperatures in 2041-2070, compared to 1971-2000.
- Temperature changes depend on:
 - ◆ Time of day
 - ◆ Night warming faster than day
 - ◆ Time of year
 - ◆ Winter warming faster than summer
- Changes in extremes:
 - ◆ More frequent extreme heat
 - ◆ Longer frost-free season

Little or No Change to Emissions: "Business as Usual"



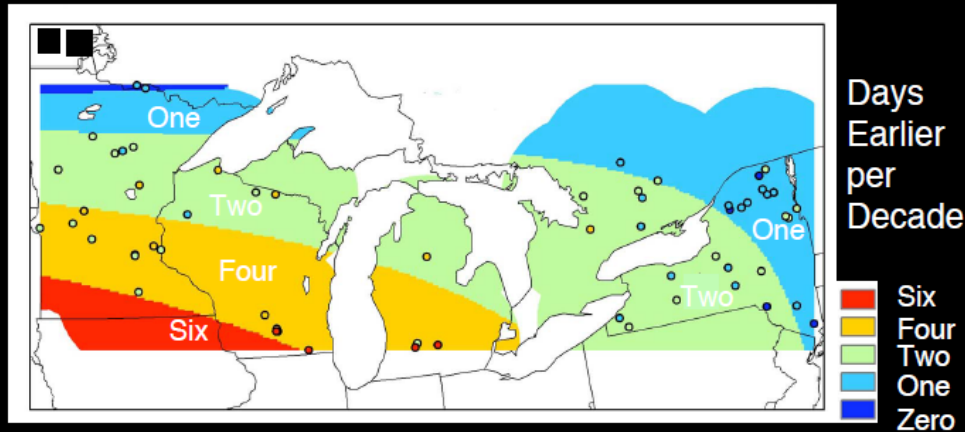
Weather versus climate

- Record ice-out across Minnesota spring 2010 (extreme weather)
- Late ice-out in spring 2013 (extreme weather)
- A pattern in ice cover duration, growing season days and planting zones (changing climate)



Our place in space ...

Rate of Change in Breakup Date of Lake Ice
across the Great Lakes Region
from 1975 to 2005



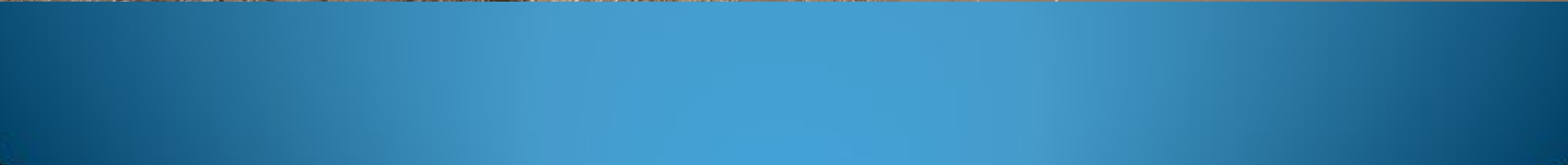
Benson et al. draft

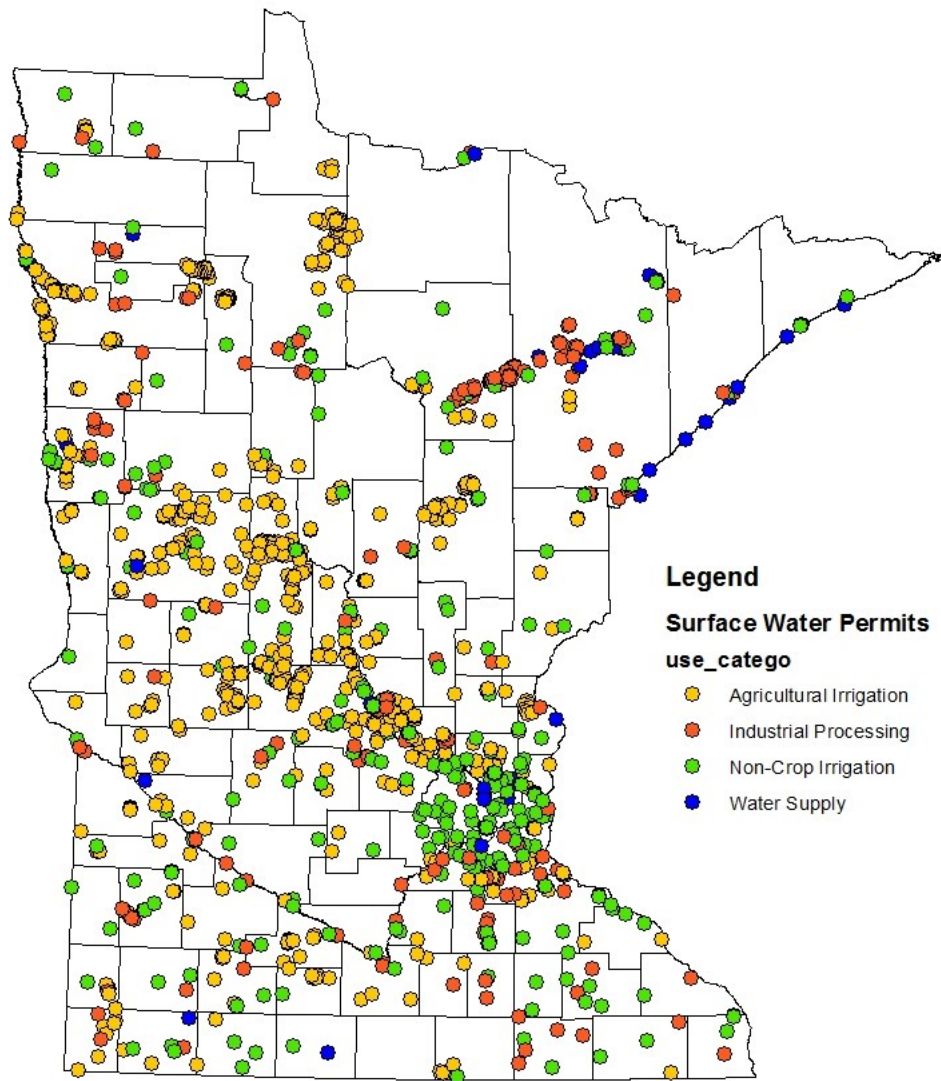
- Regional and worldwide trend toward reduced ice cover duration in northern latitudes



Iconic Minnesota Winter Recreation







Opportunities



- Implement water conservation measures
 - Maximize the benefit of every drop used
- Prioritize water uses and allocations
 - What uses are the most important to maintain in a drought
- Plan water-consumptive development
 - How much and where

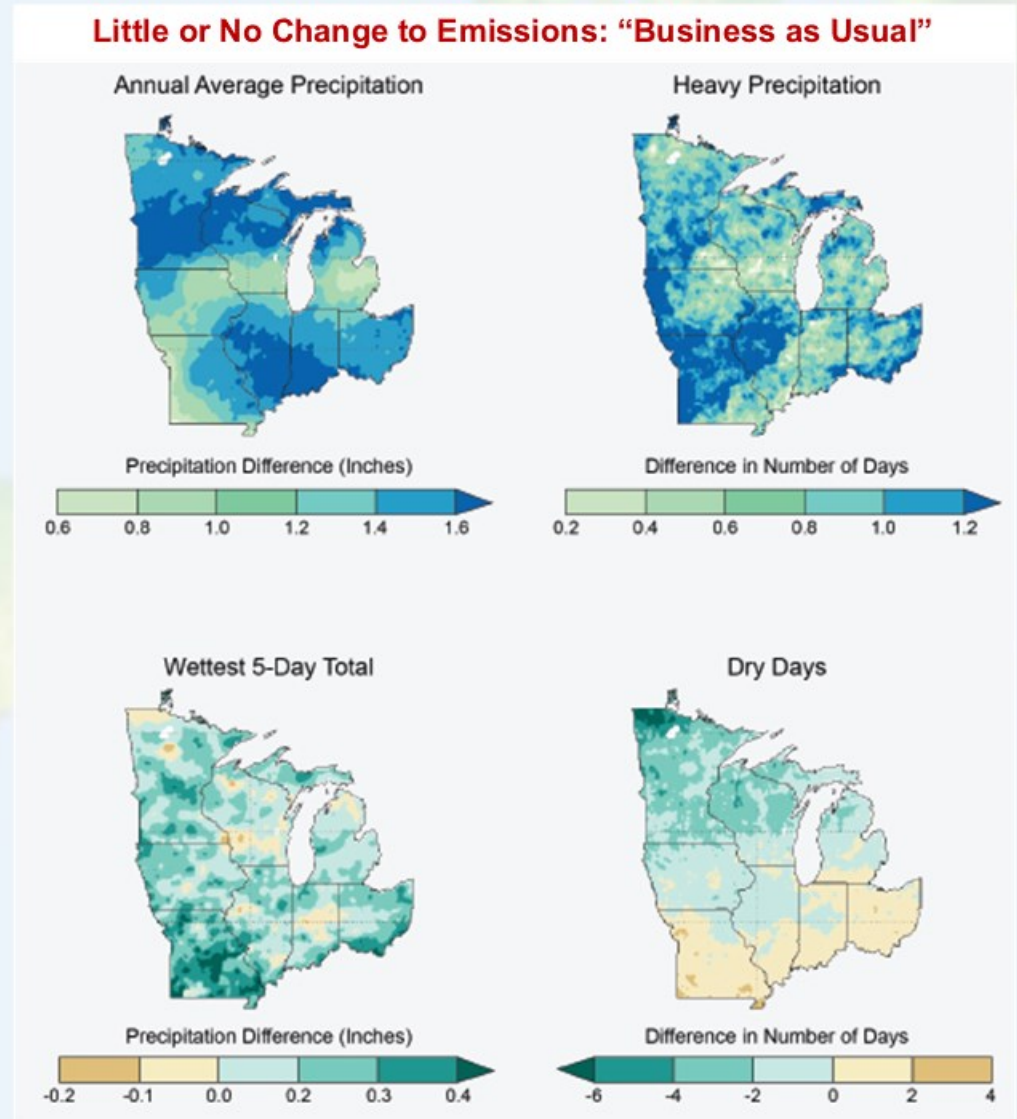
Challenge #2

More water



Climate Change: Precipitation

- Projections of changes in precipitation in 2041-2070, compared to 1971-2000.
- Precipitation changes:
 - ◆ Depends on time of year
 - ◆ Spring increasing more
 - ◆ May include both longer droughts (especially Southwest) and more heavy rain events
- Changes in extremes:
 - ◆ More frequent heavy rainfall
 - ◆ Higher heavy rainfall totals
 - ◆ More frequent dry days in some areas, less frequent in others



A changing future climate ... today

Frequency of Storms by Size in the Midwest
Changes by Decade, 1960s Through 2000s, Compared to 1961-1990

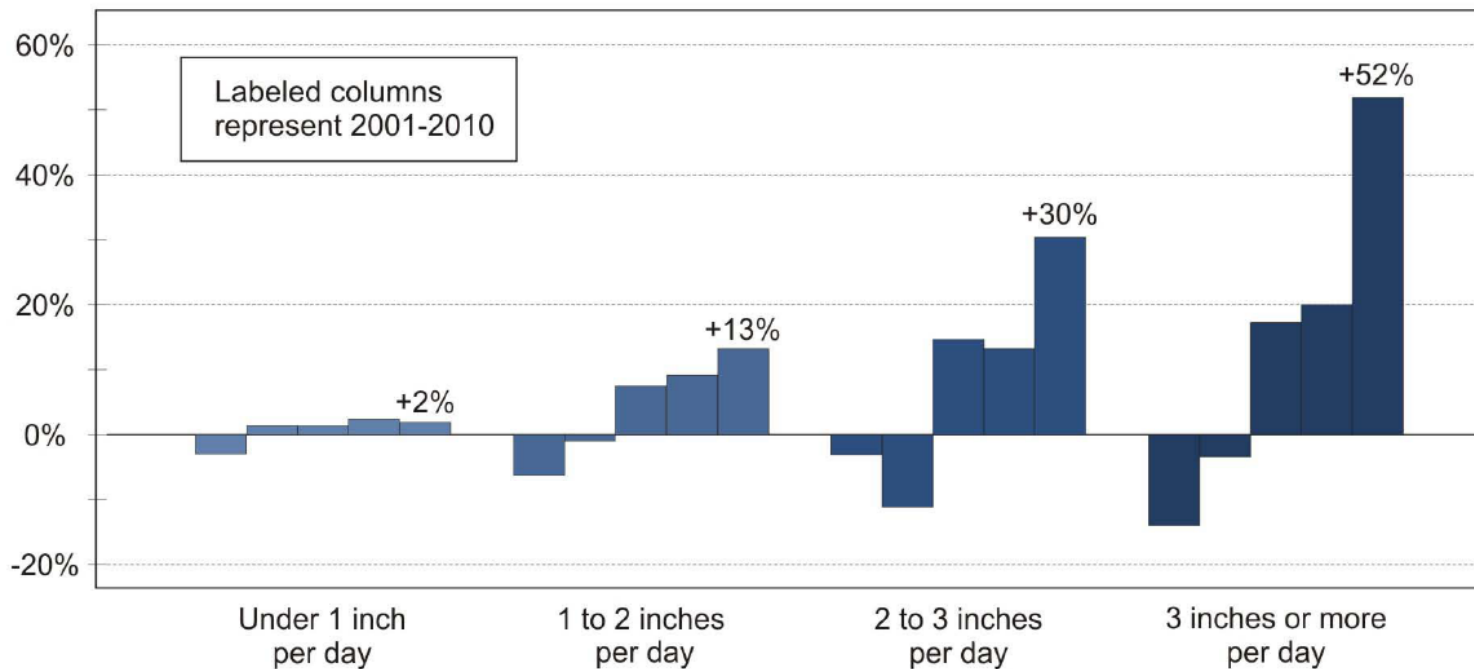
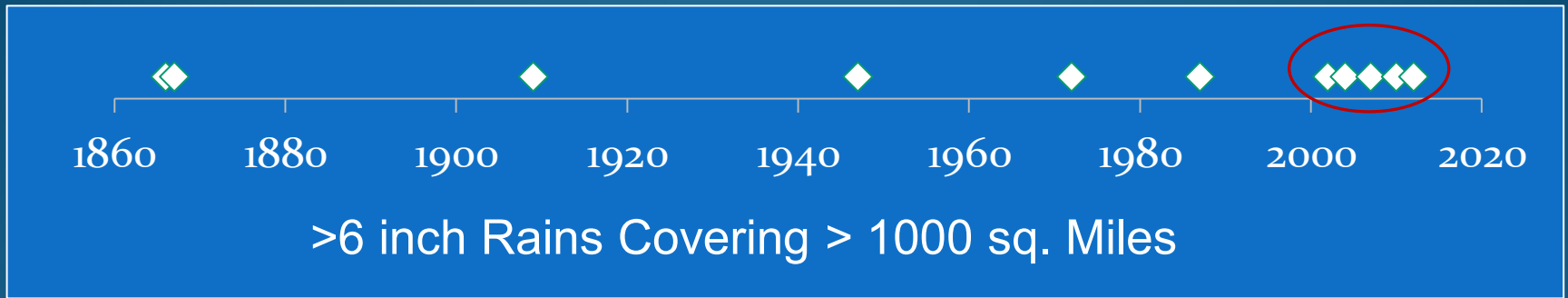


Figure ES-1. Changes by decade in the annual frequencies per station of storms of different sizes, compared to 1961-1990. Storms are grouped by days with less than 1 inch of precipitation, at least 1 inch but less than 2 inches, at least 2 but less than 3 inches, and 3 inches or more. In each group, the columns from left to right represent 1961-1970, 1971-1980, 1981-1990, 1991-2000, and 2001-2010.

Source: Double Trouble: More Midwestern Extreme Storms

http://www.rockymountainclimate.org/reports_3.htm

Extreme Rainfall Events




SE Minnesota 2007



NE Minnesota 2012





Duluth Harbor, Lake Superior
St. Louis Co, MN
June 19-20, 2012
7.24" in 48 hours

Source: MODIS Today (<http://ge.ssec.wisc.edu/modis-today/>)

Opportunities

- Reduce imperviousness
 - Allow water to infiltrate
- Manage storm water
 - Adapt infrastructure to higher volume
- Maintain riparian buffers and forest cover
 - Use natural features that slow or retain water
- Avoid developing in floodplains

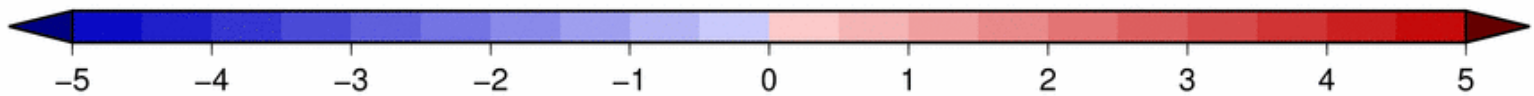
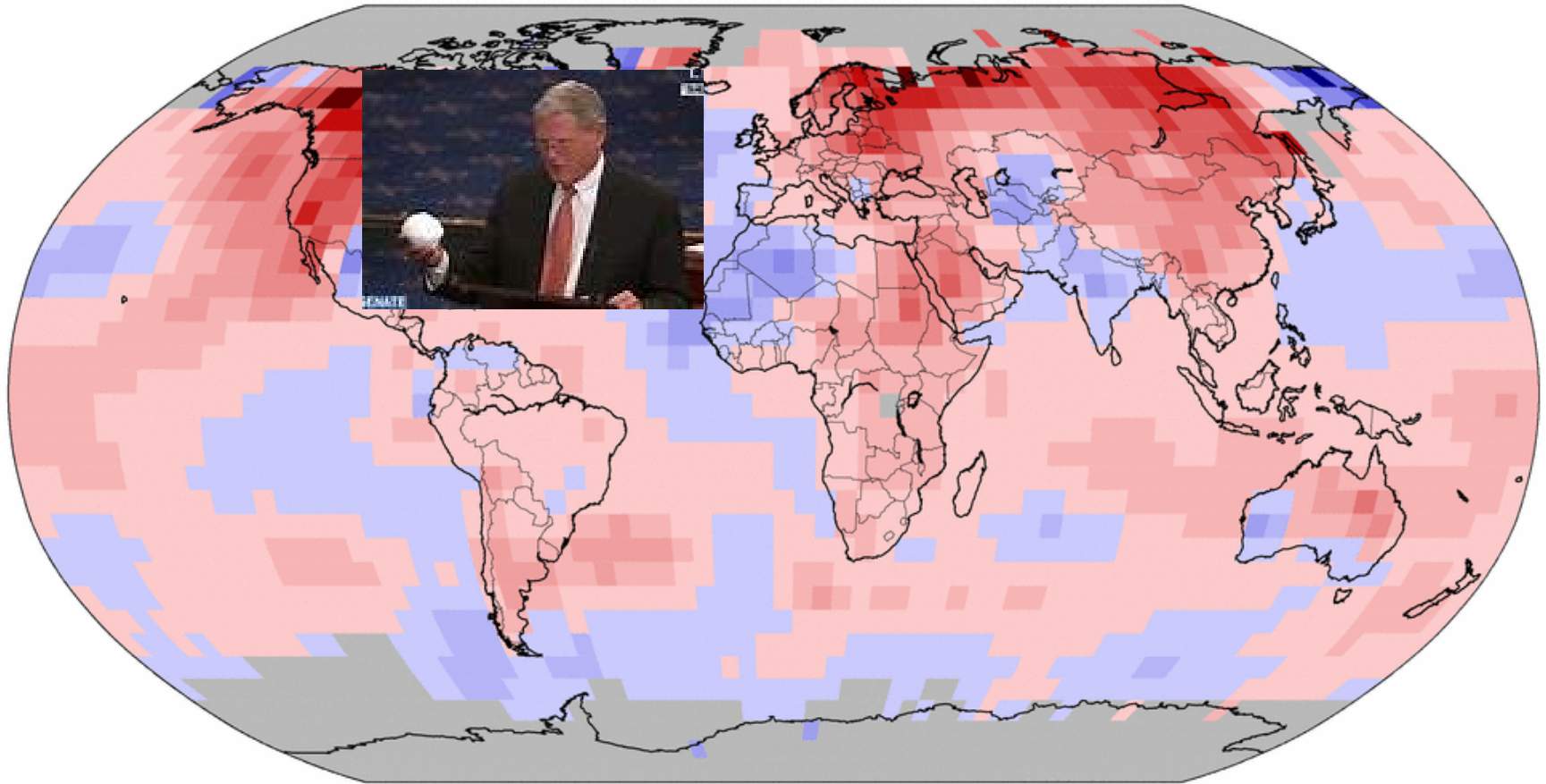


Be aware of our place!

Land & Ocean Temperature Departure from Average Mar 2015

(with respect to a 1981–2010 base period)

Data Source: GHCN-M version 3.2.2 & ERSST version 3b



Degrees Celsius



NOAA's National Climatic Data Center
Tue Apr 14 12:31:32 EDT 2015

Please Note: Gray areas represent missing data
Map Projection: Robinson

Personal actions add up!

- Don't wait for public policy consensus
- Acts by millions of individuals got us to where we are
- Acts by millions of individuals can move us to a less grim future for our children & grandchildren

What is Possible Now?

Home: insulation, efficient bulbs, appliances, passive and active solar

Transportation: bike, 50MPG cars, more rail, bus not car, fly less - use teleconference

Energy Production: increase efficiency, alternate sources such as wind and solar

Agriculture: energy efficiency and renewable energy, no till, reduce fertilizer use, reduce methane and nitrous oxide emissions using manure digesters

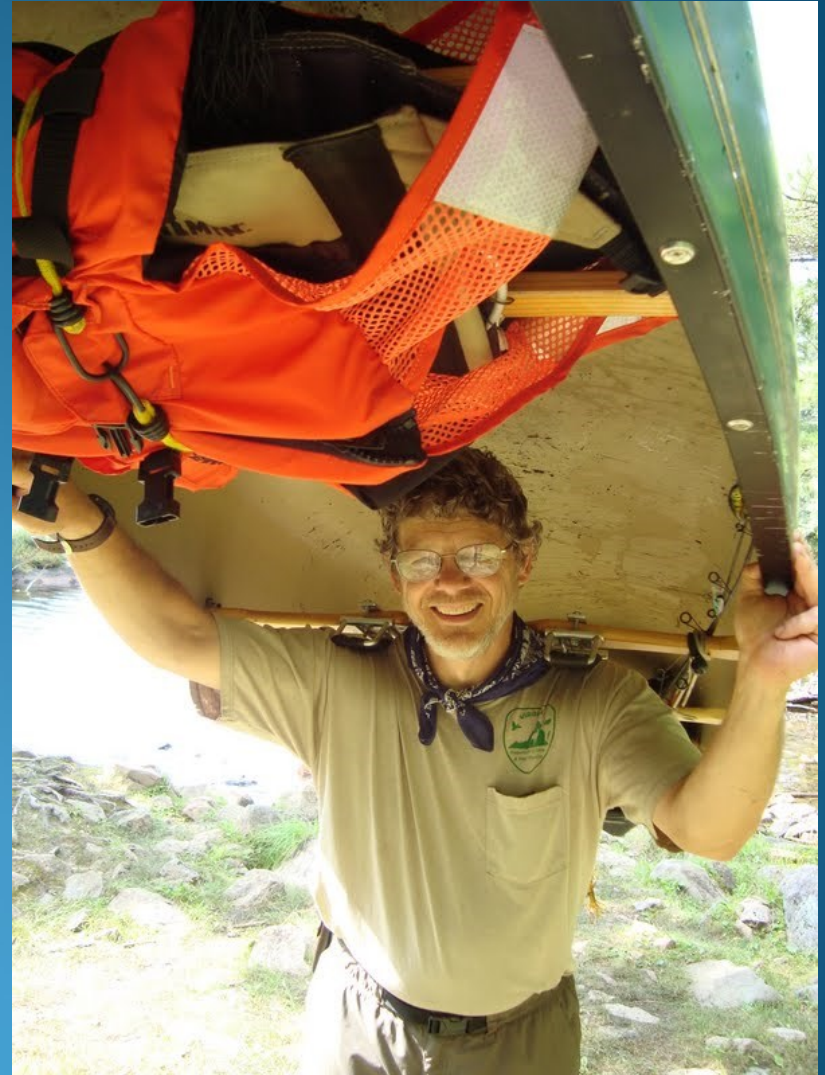
Thank you!

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Challenge #3

Changing land cover

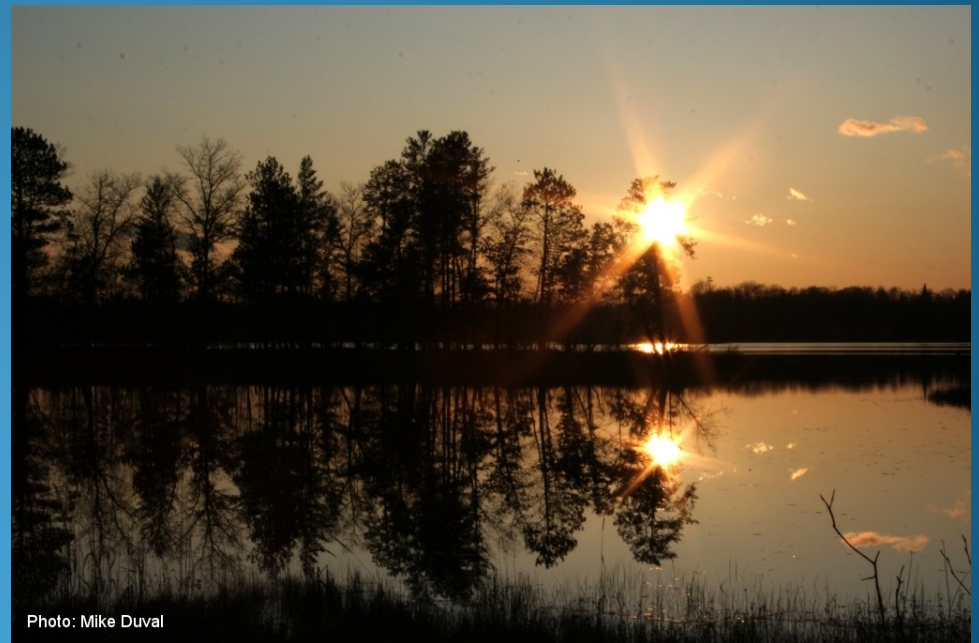
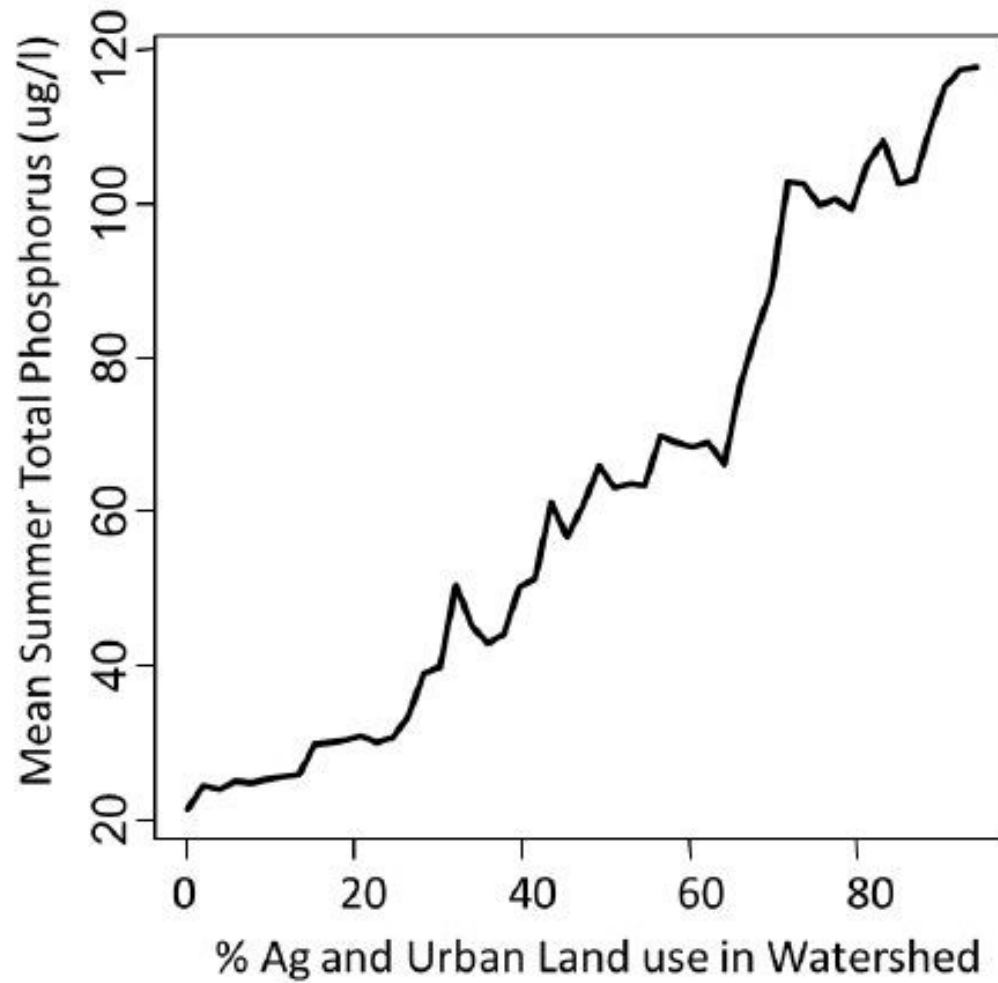


Photo: Mike Duval

Partial Dependence on % Disturbance

Random Forest Model



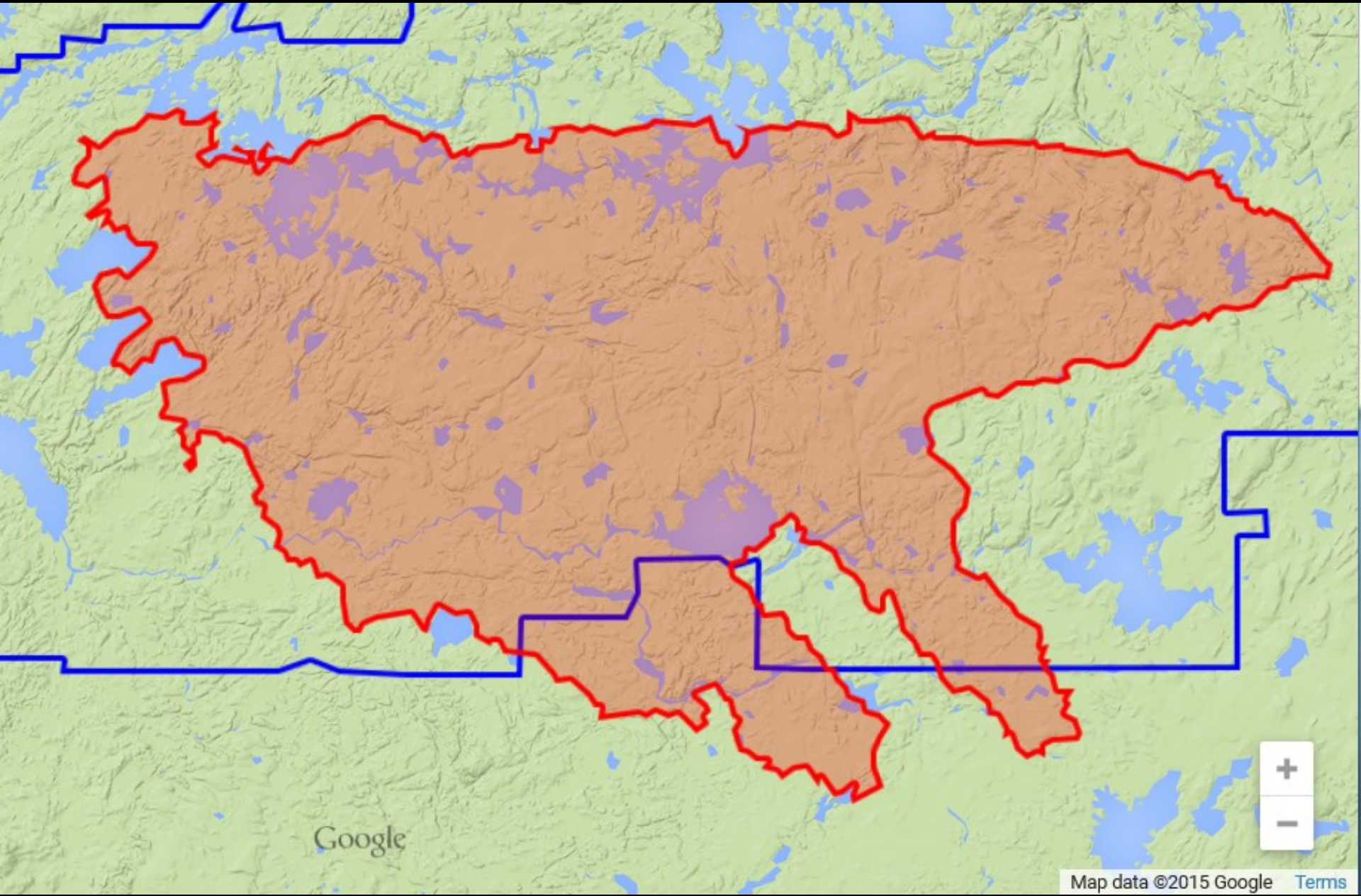
Windthrow and Fire



1999 BWCA Blowdown
damaged > 477,000 acres



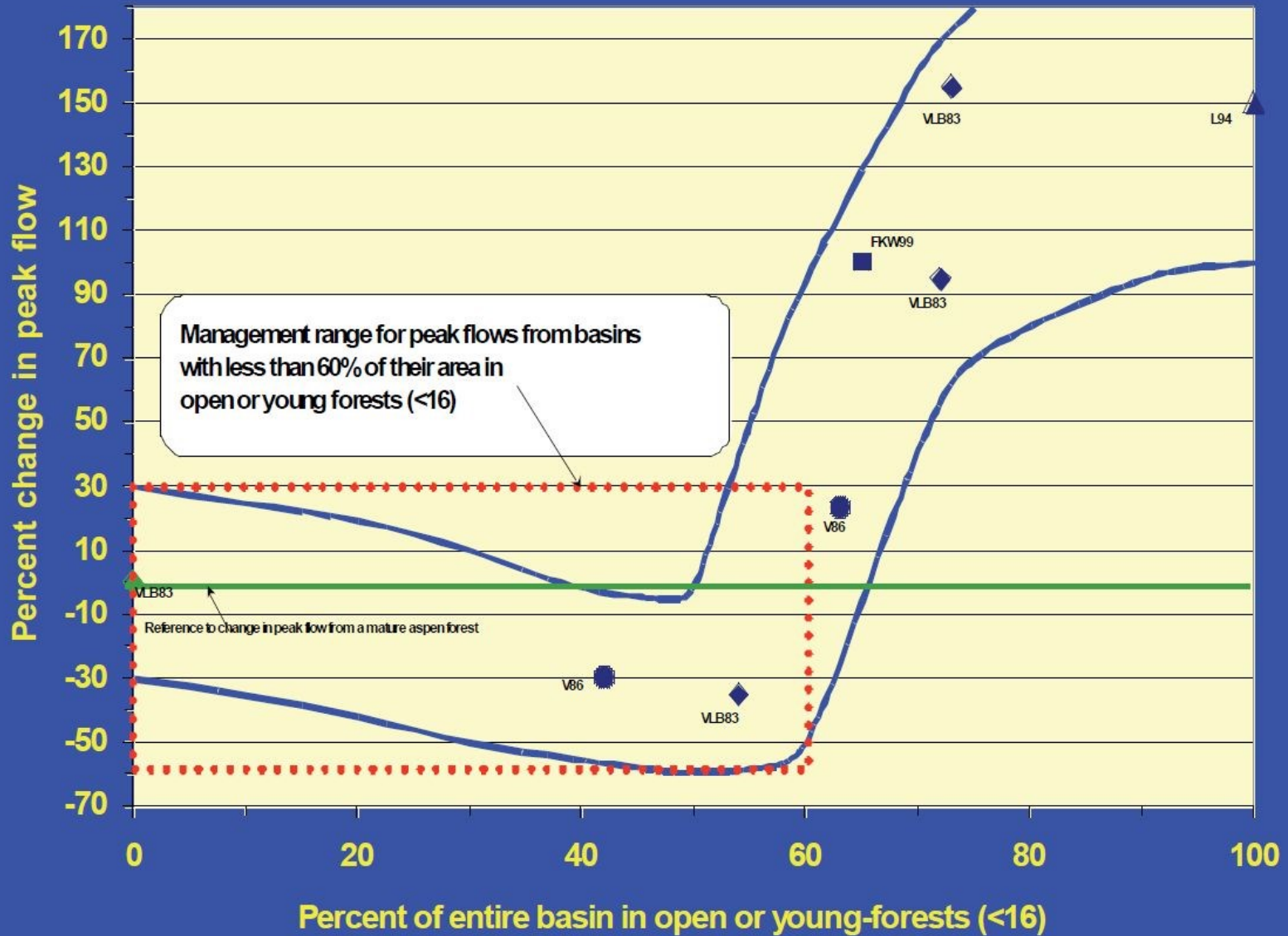
2006-2011 Fires
burned >200,000 acres



Google



Open Land Threshold

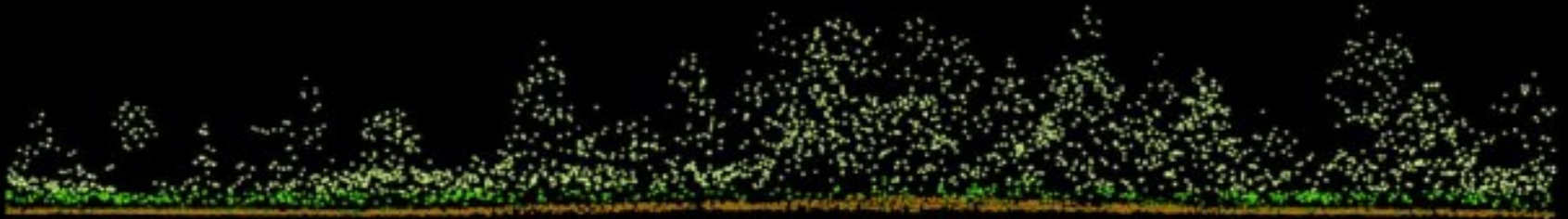


LiDAR estimate of Canopy Cover/Open Lands

LIDAR hits

John Jereczek

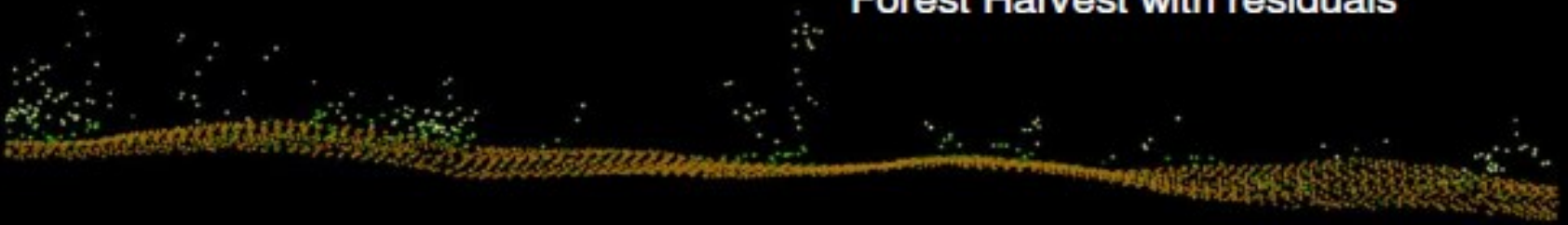
Conifer Forest



Deciduous Forest



Forest Harvest with residuals



ADAPTING TO AN UNCERTAIN FUTURE

"The only thing we know about the future is that it will be different."

- Peter Drucker

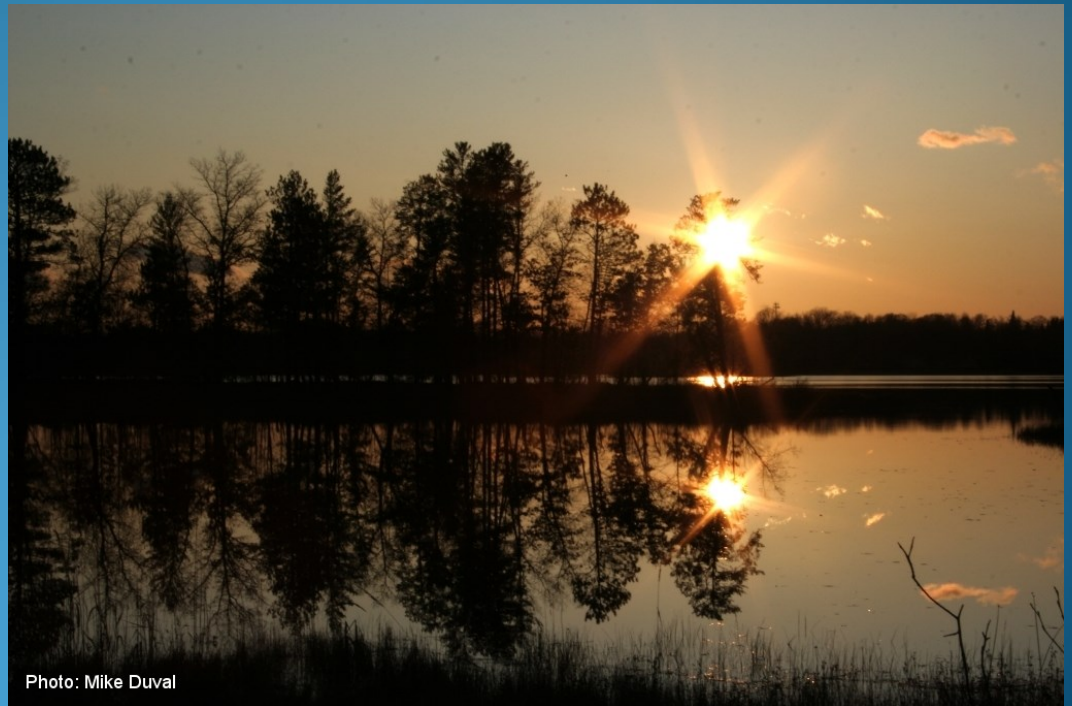


Photo: Mike Duval

Ways to Think about Uncertainty

1. Uncertainties will continue to change
2. Uncertainties have decreased in last 15 years
3. Do and apply science
4. Risk averse versus risk prone behavior
5. Do right thing regardless
6. Preserve future options
7. All decisions are long term
8. Reflect on other Issues for wisdom

**New and proposed pivots since 03-04 photo
Hubbard Prairie Area**

