Nonlinear Response of Prairie Pothole Landscapes to Climate Change and Land Management

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Website: http://wetlandscape.sdstate.org/

SDSU

USGS science for a changing world

USDA ars

University of Wyoming New Thinking

The University of Montana

OSU Oregon State University

A Great University on a Great Lake — University of Minnesota UMD Duluth — Reaching higher

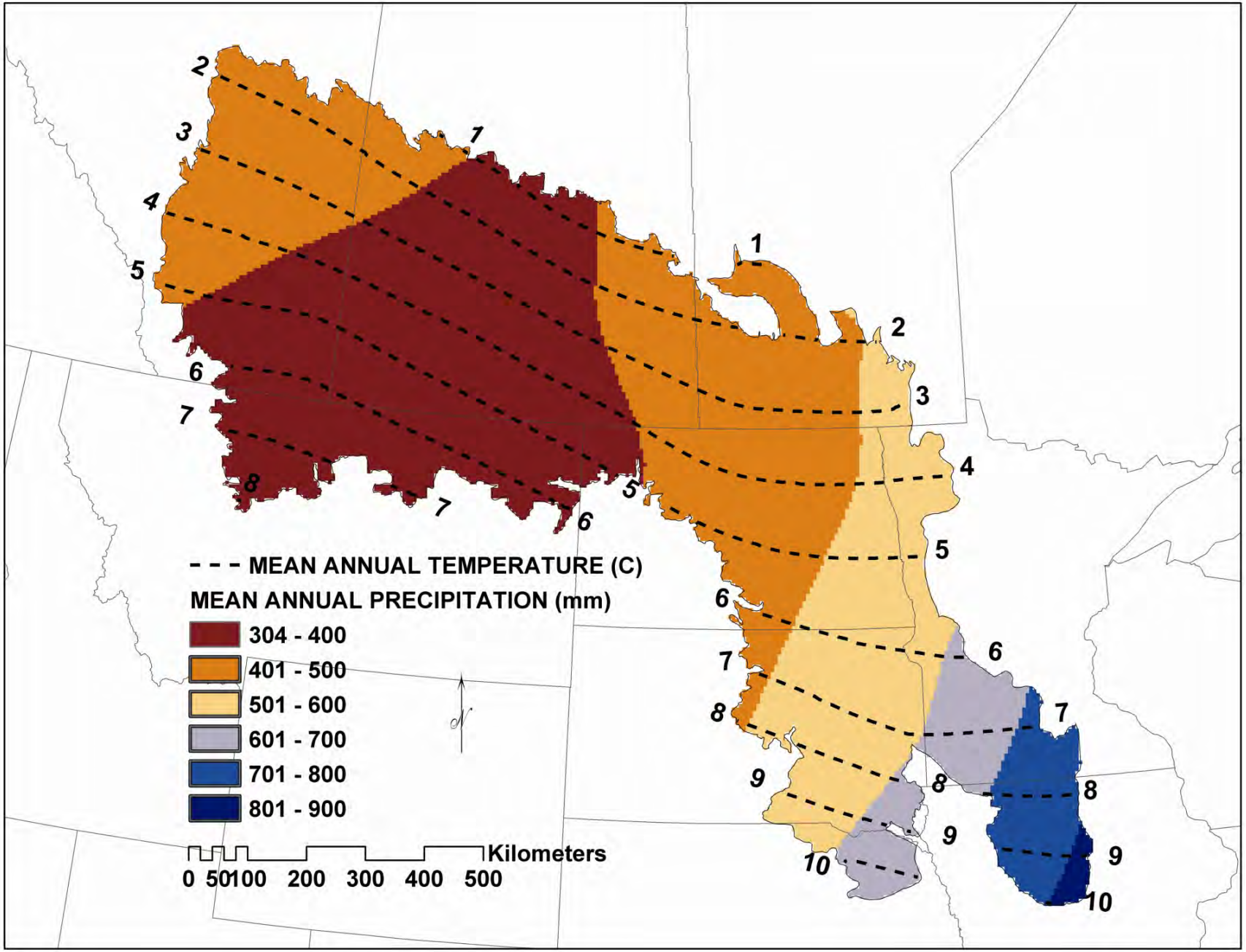
Overarching Goal

- Complete and test new simulation model (WETLANDSCAPE) to examine non-linear or threshold effects caused by climate change and land management on complexes of glaciated prairie wetlands.

Prairie Pothole Region

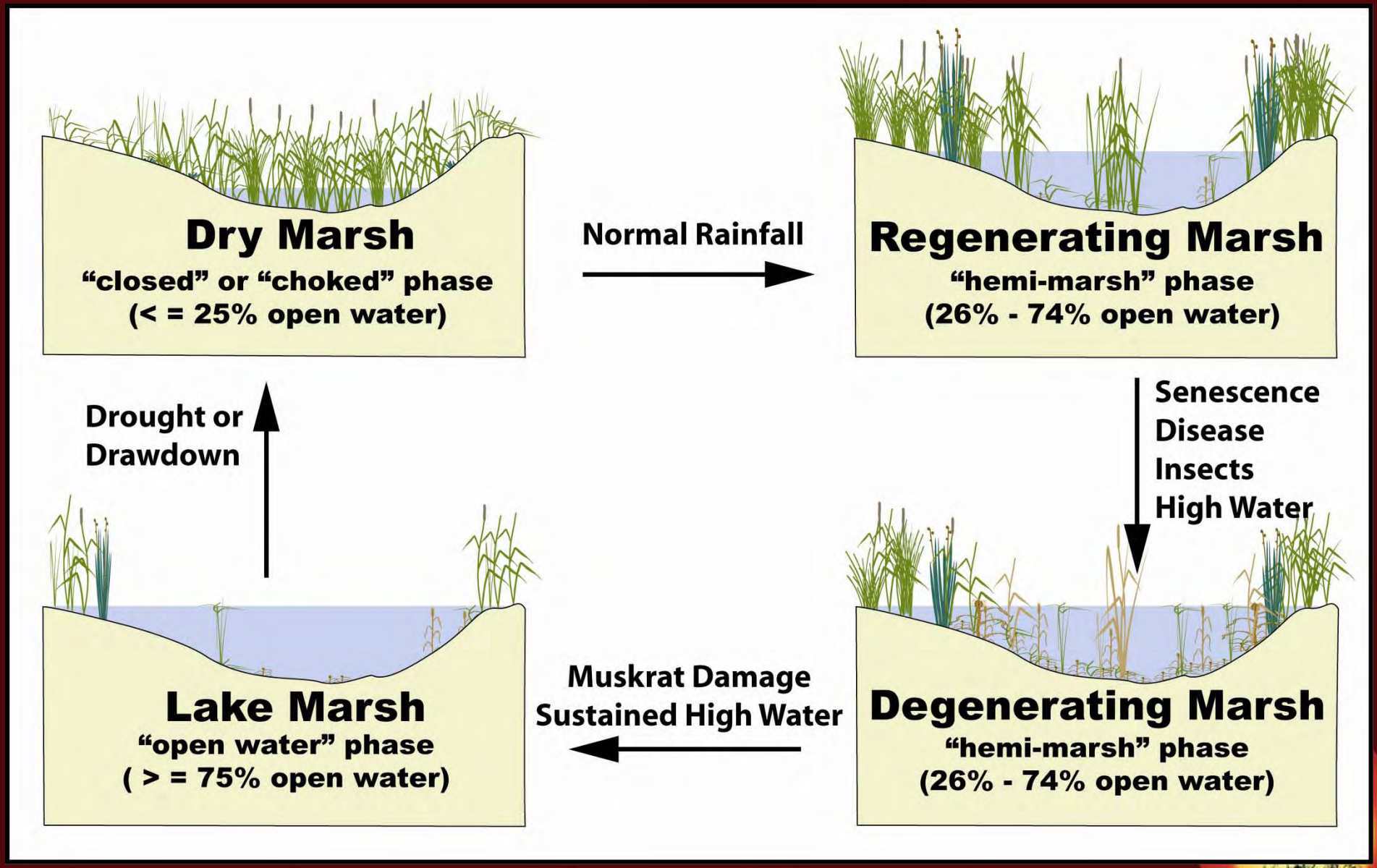
Weather Stations

0 100 200 400 600 800 Kilometers

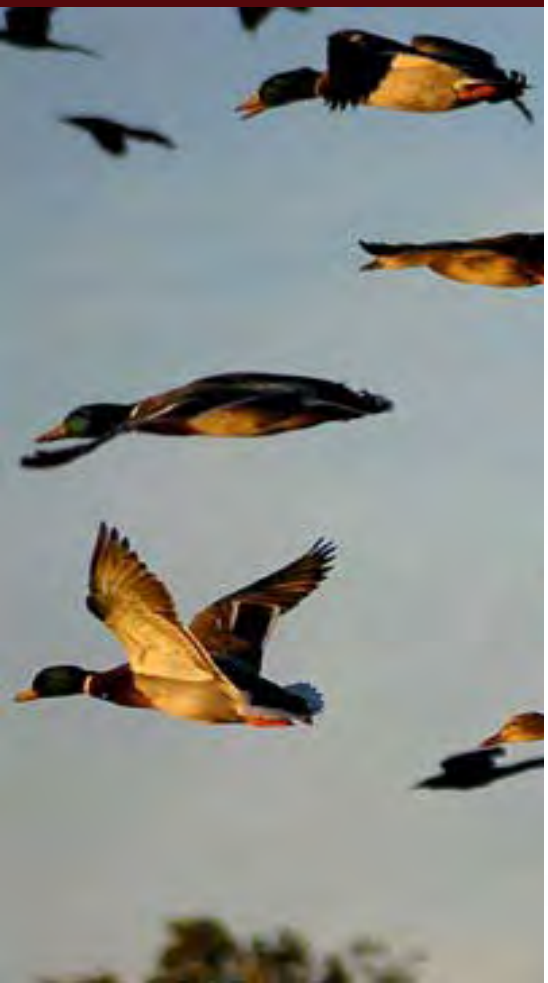

MEAN ANNUAL TEMPERATURE (C)
MEAN ANNUAL PRECIPITATION (mm)
304 - 400
401 - 500
501 - 600
601 - 700
701 - 800
801 - 900
Kilometers
0 50 100 200 300 400 500

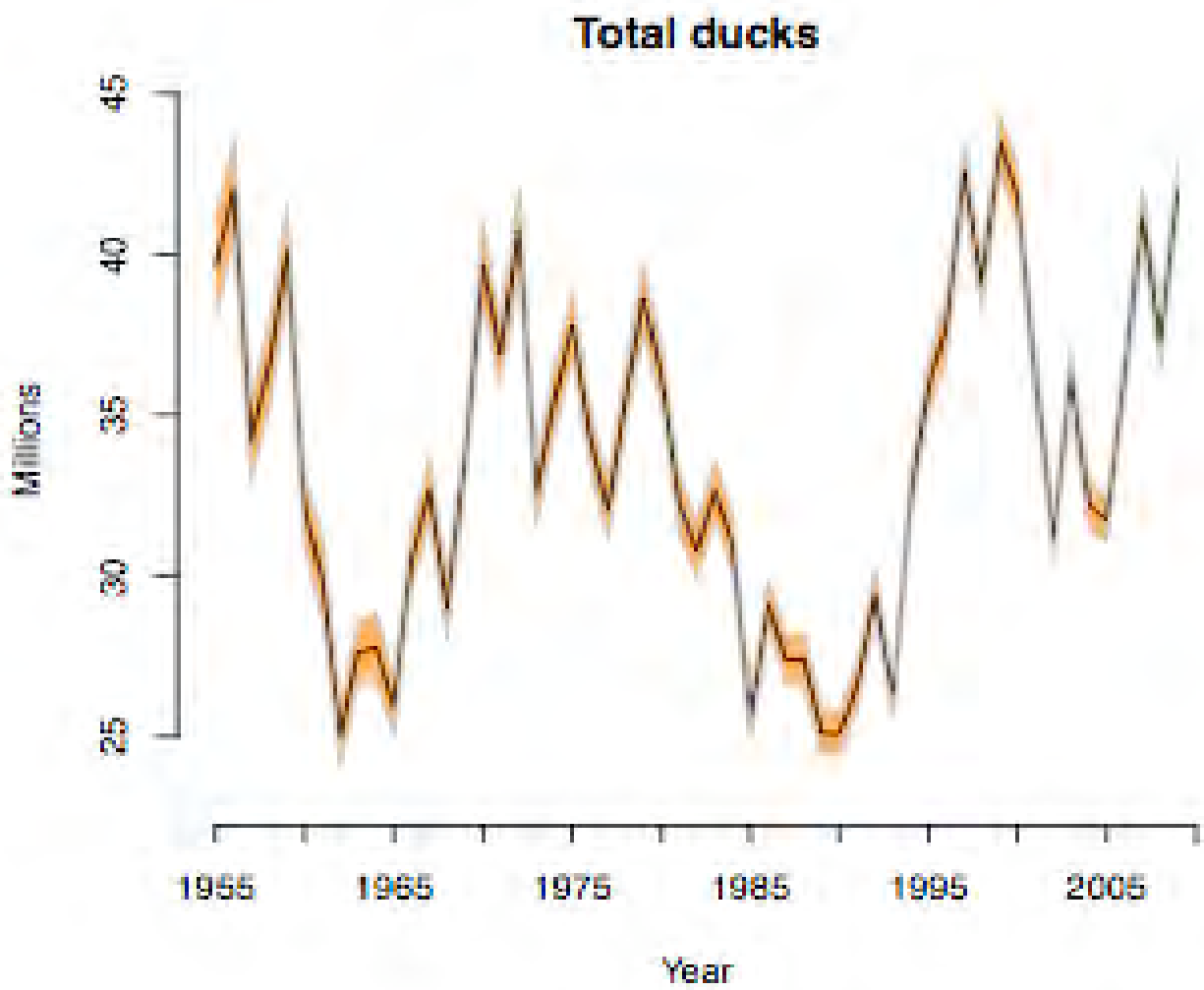
Orchid Meadows Flyover

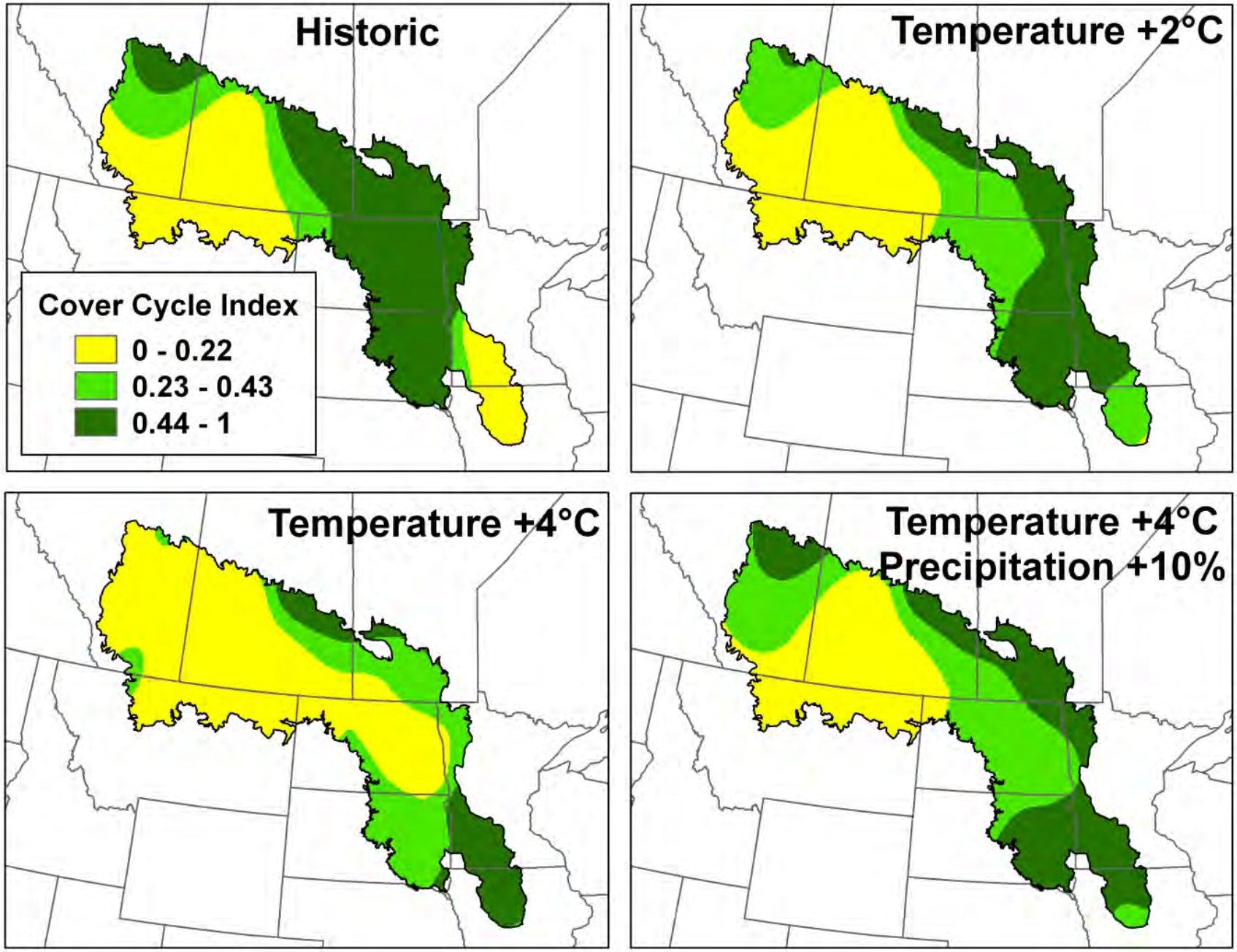
Wetland Vegetation Cover Cycle



Total Ducks (1955-2009)






Historic
Cover Cycle Index
0 - 0.22
0.23 - 0.43
0.44 - 1
Temperature +2°C
Temperature +4°C
Temperature +4°C
Precipitation +10%

•Snowmelt Management •Watching Extinction
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February 2010
American Institute of Biological Sciences
Vol. 60 No. 2
Prairie Wetland Landscape in a Changing Climate
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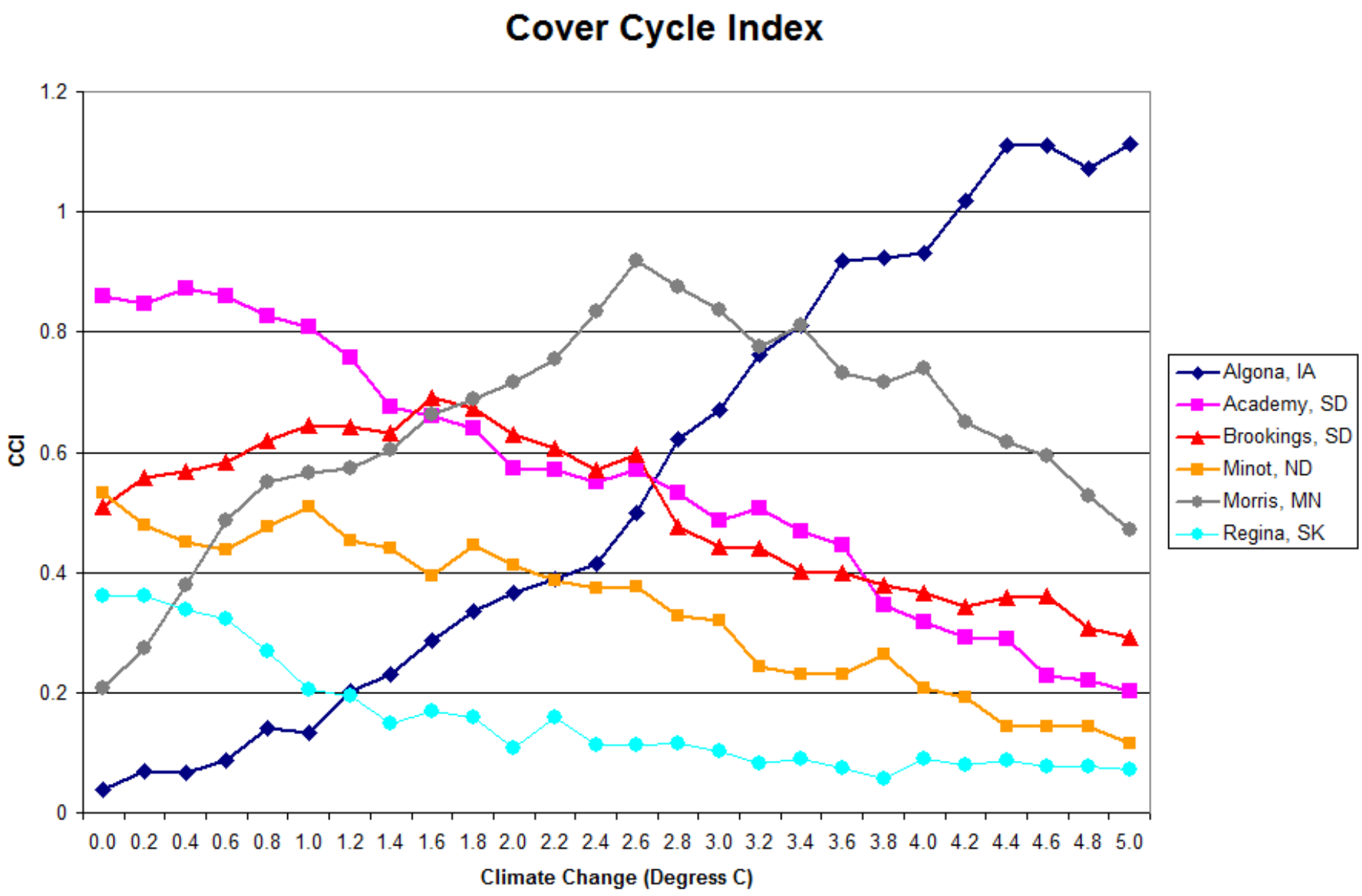
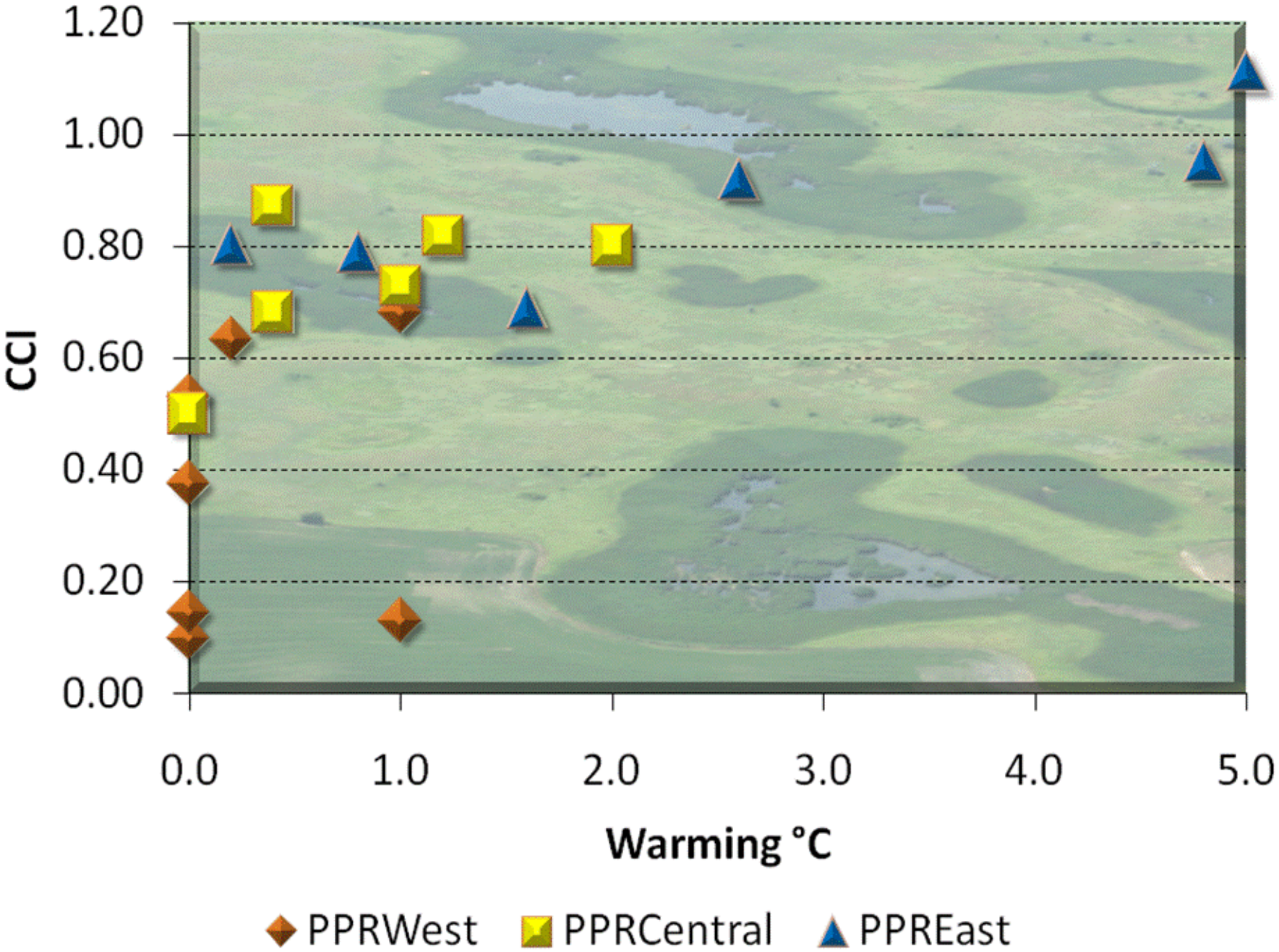
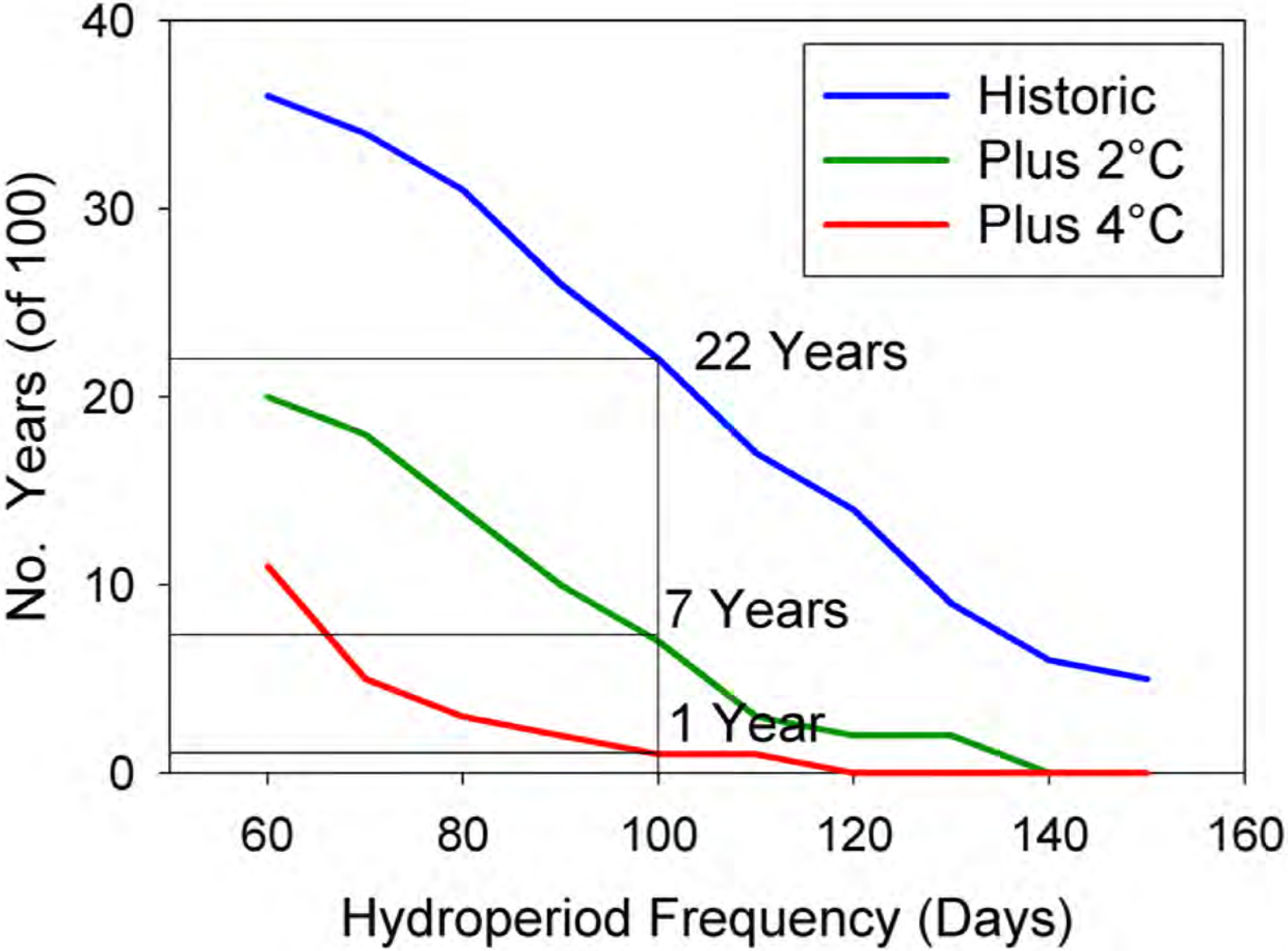
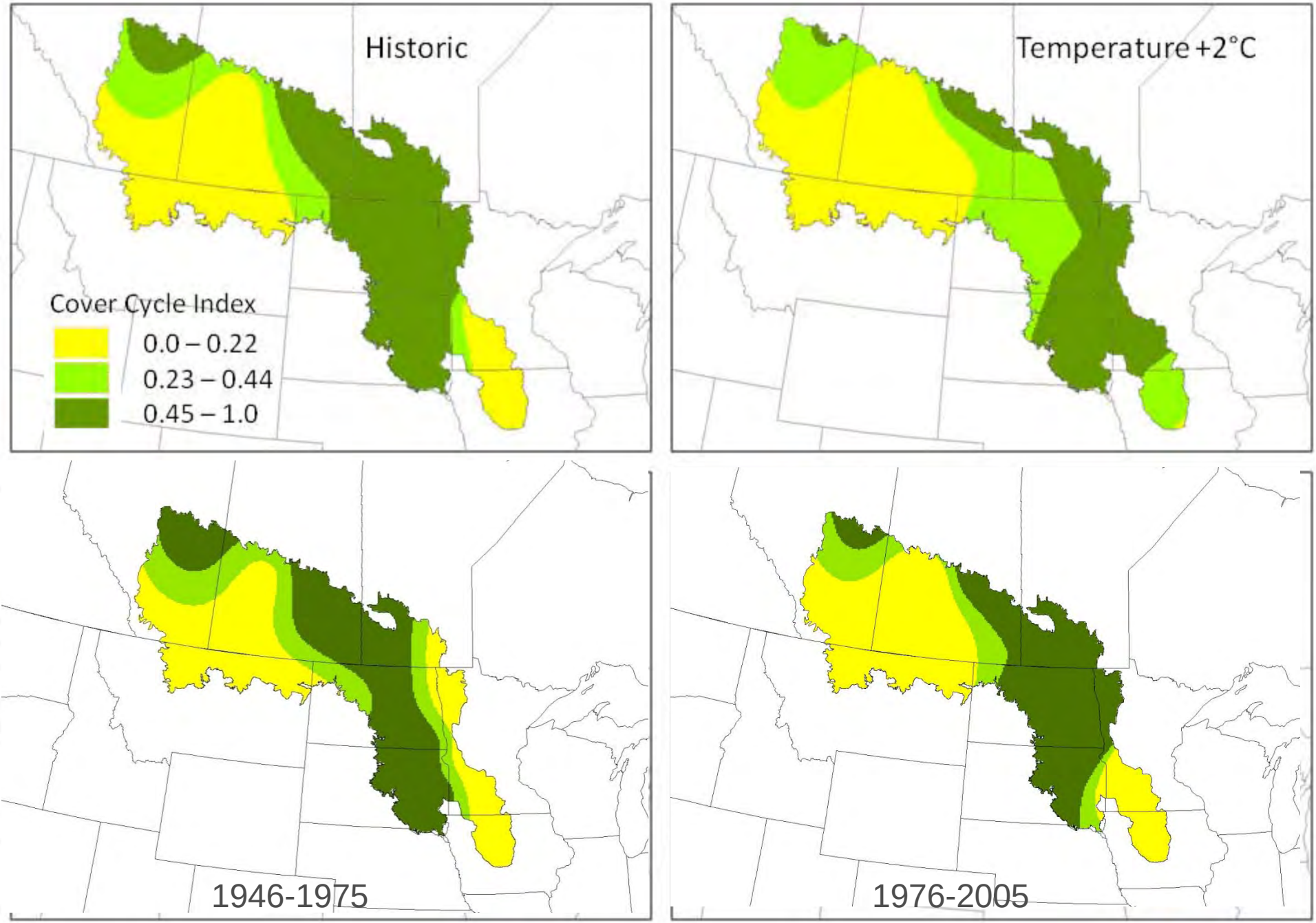

Cover Cycle Index
CCI
1.2
1
0.8
0.6
0.4
0.2
0
0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.4 3.6 3.8 4.0 4.2 4.4 4.6 4.8 5.0
Climate Change (Degress C)
Algona, IA
Academy, SD
Brookings, SD
Minot, ND
Morris, MN
Regina, SK


1.20
1.00
0.80
0.60
0.40
0.20
0.00
CCI
0.0
1.0
2.0
3.0
4.0
5.0
Warming °C
PPRWest
PPRCentral
PPREast


Historic
Plus 2°C
Plus 4°C
22 Years
7 Years
1 Year
No. Years (of 100)
Hydroperiod Frequency (Days)
0
10
20
30
40
60
80
100
120
140
160


Historic
Temperature +2°C
Cover Cycle Index
0.0 – 0.22
0.23 – 0.44
0.45 – 1.0
1946-1975
1976-2005

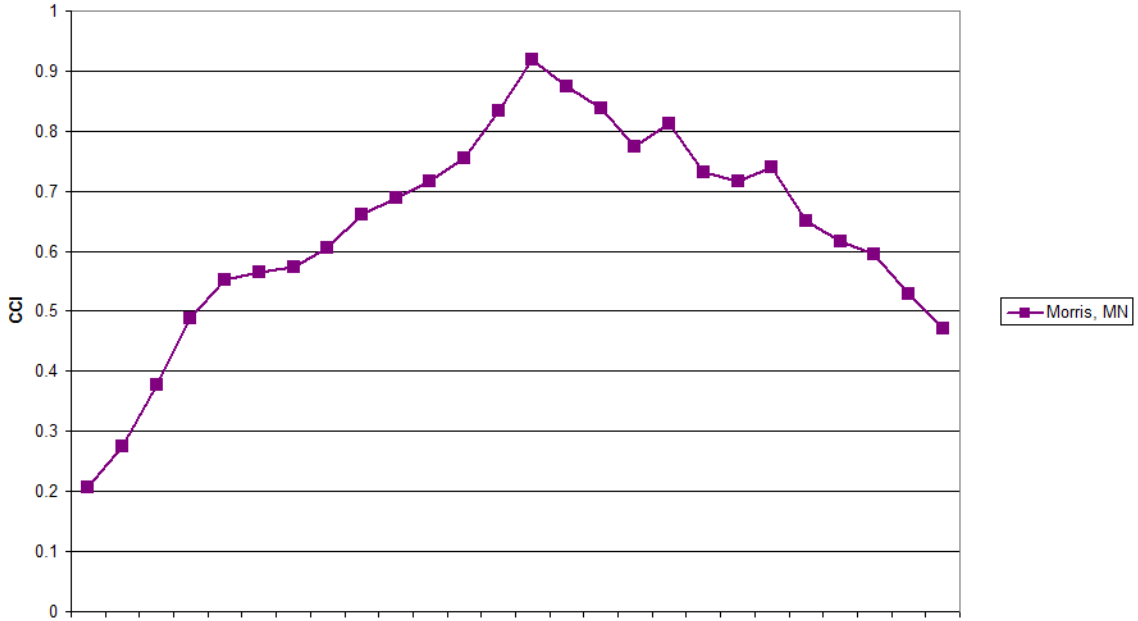
Conclusions

- WLS confirms that prairie wetlands are **highly vulnerable** to climate warming
- Climate warming will cause an **eastward shift** in the most favorable wetland climate, towards heavily farmed areas where most wetlands have been drained and grassland tilled.
- Productive area of the PPR **will shrink** as the climate warms

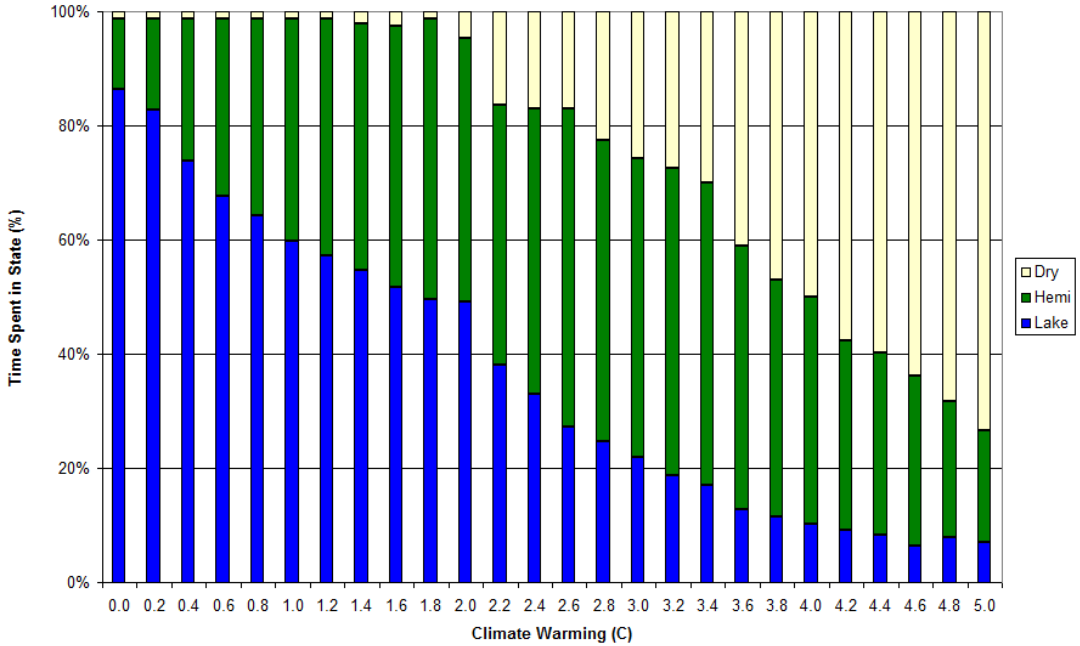
Conclusions

- Climate change poses a **conservation challenge** because the highest wetland densities occur in the western PPR where the effects of climate change are expected to be more severe.
- Wetlands in nearly all PPR ecoregions will lose significant productivity if warming exceeds a **2 degrees C threshold.**
- 30-year hindcast simulations provide evidence that **wetlands have already been affected by climate change** in the most vulnerable ecoregions.

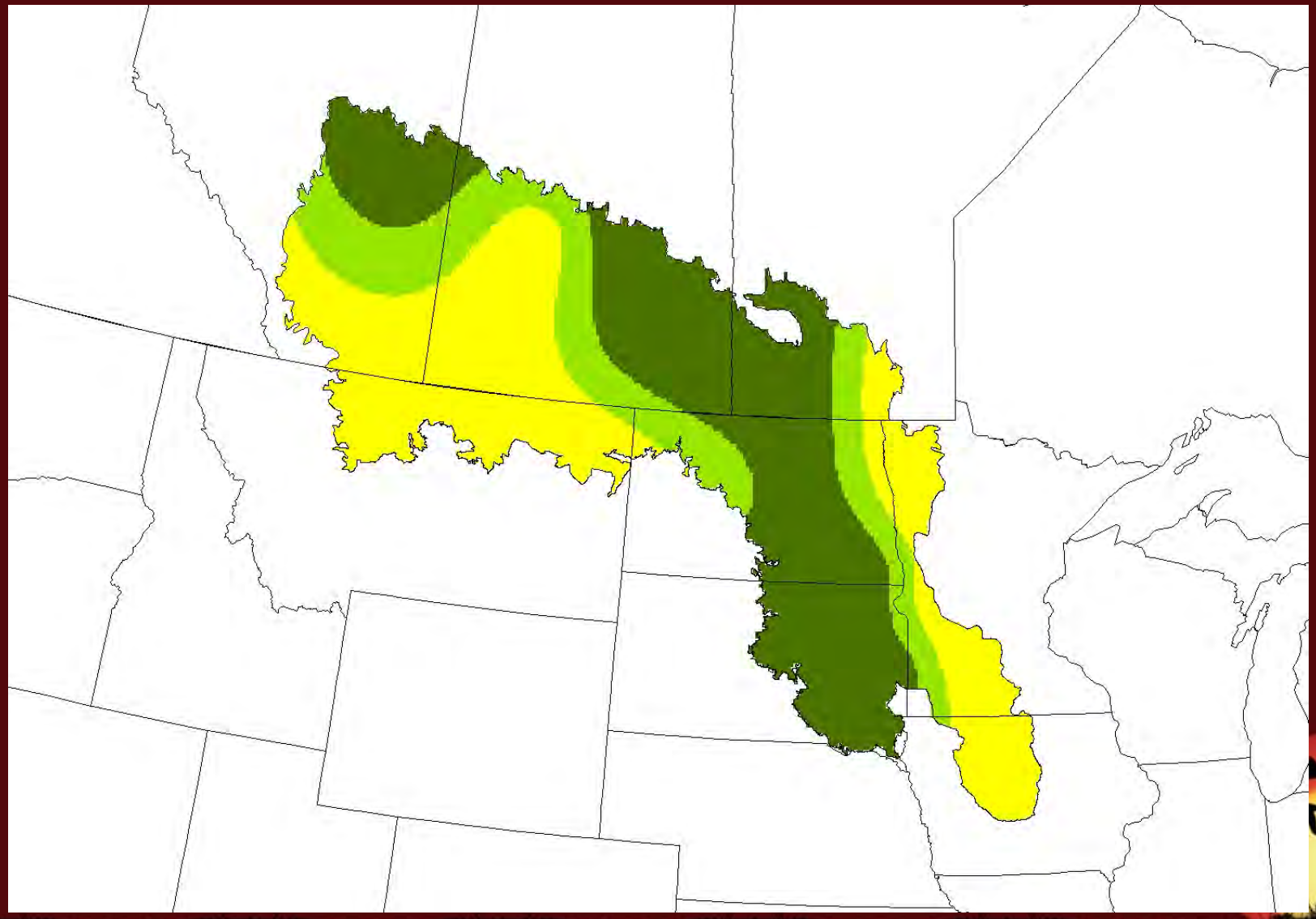
Thank you


CCI
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Morris, MN

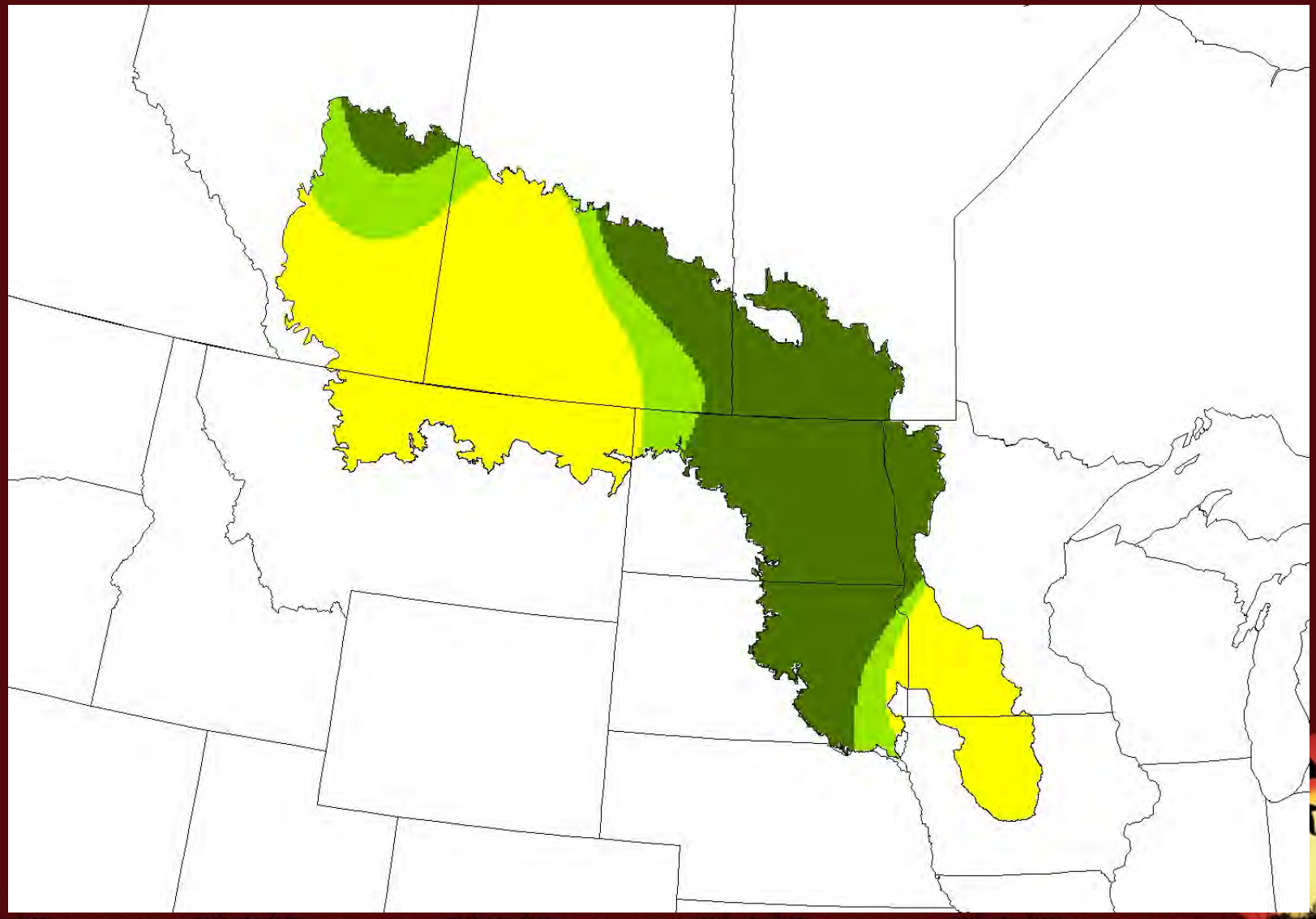
Morris, MN

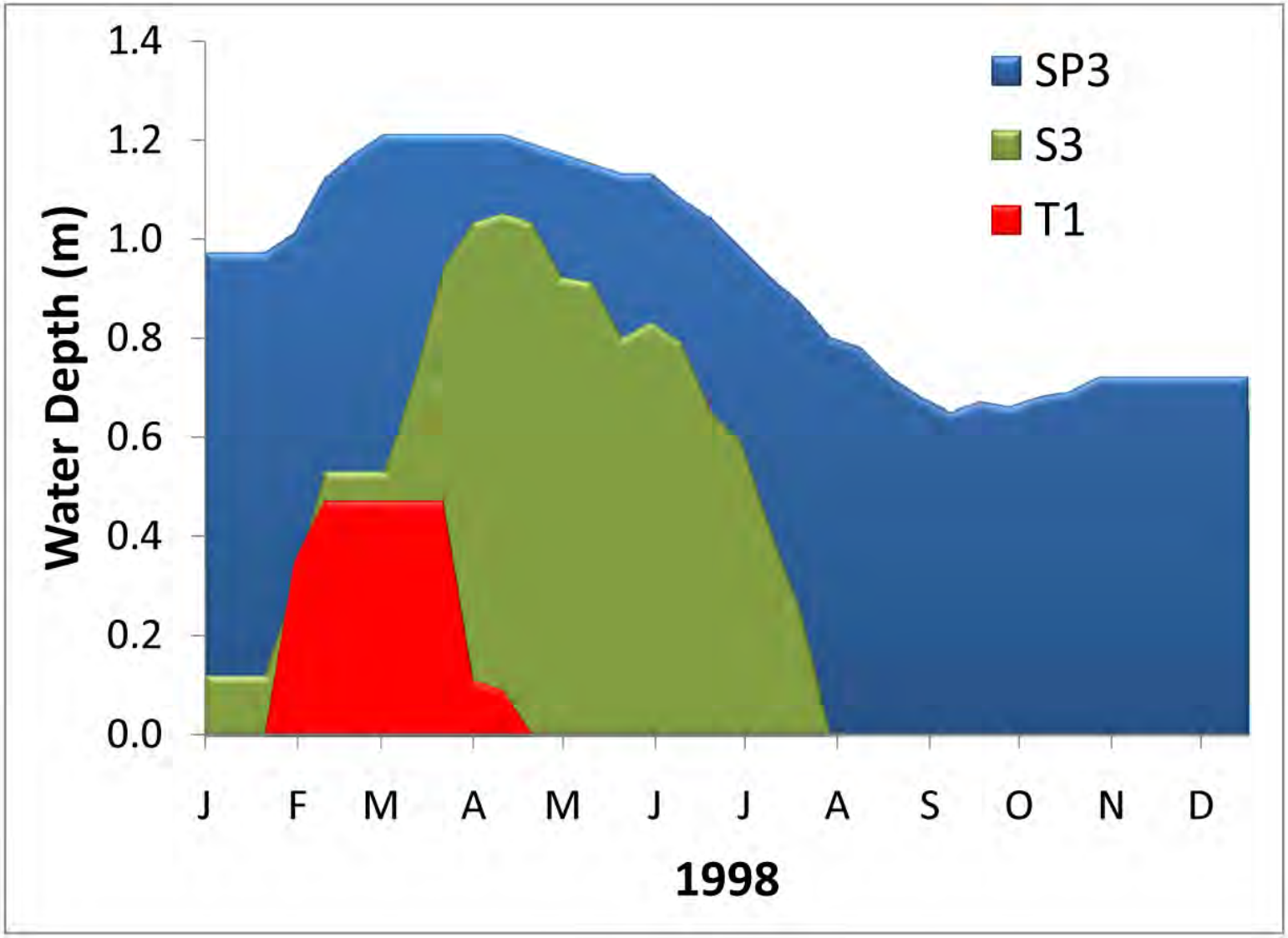

Time Spent in State (%)
100%
80%
60%
40%
20%
0%
0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.4 3.6 3.8 4.0 4.2 4.4 4.6 4.8 5.0
Climate Warming (C)
Dry
Hemi
Lake

1946-1975



1976-2005




1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Water Depth (m)
SP3
S3
T1
J
F
M
A
M
J
J
A
S
O
N
D
1998