2019 Environmental Summit

- CANCELLED

High temperature -10 F

Low temperature -23 F

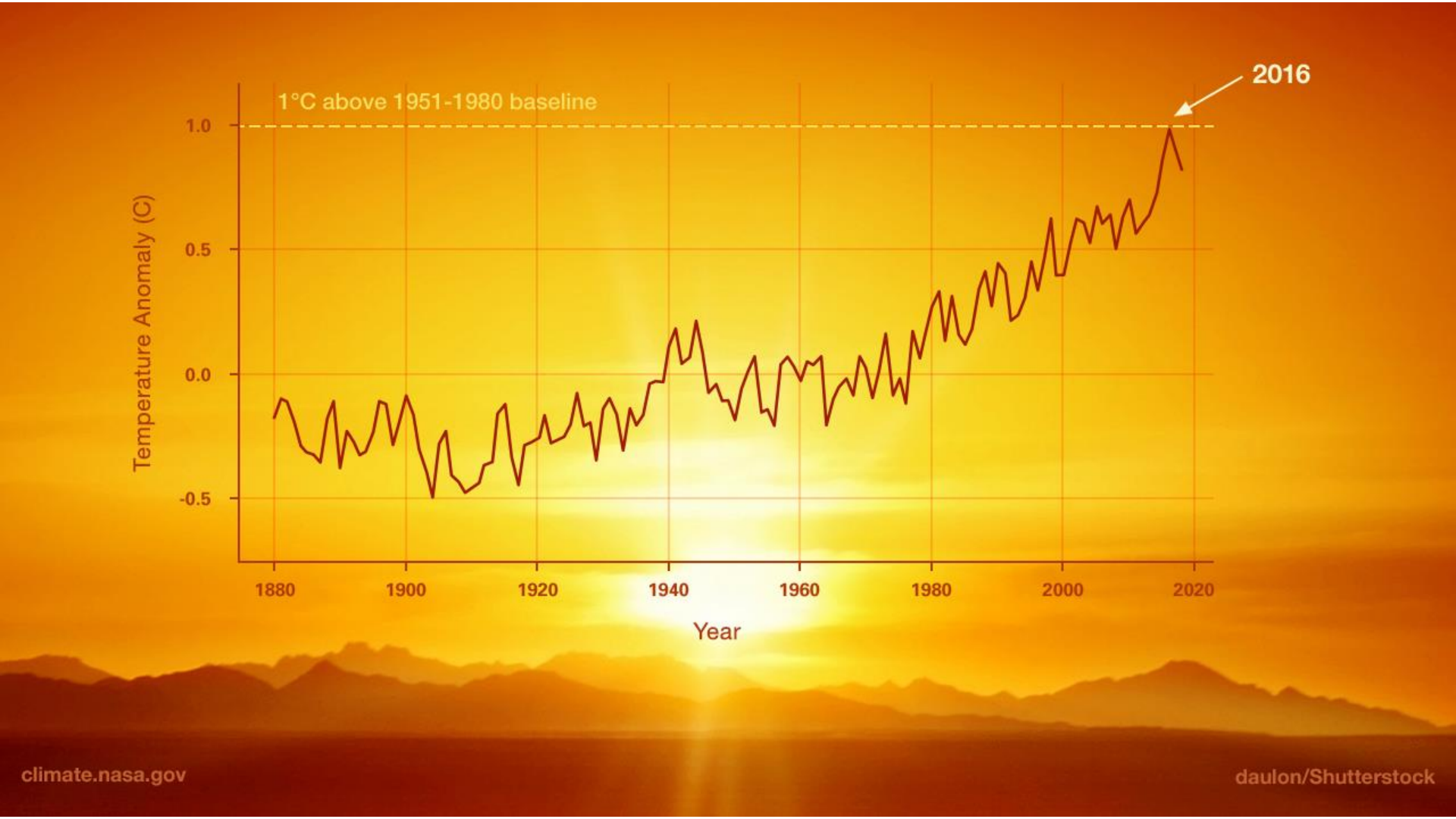
(record for date)

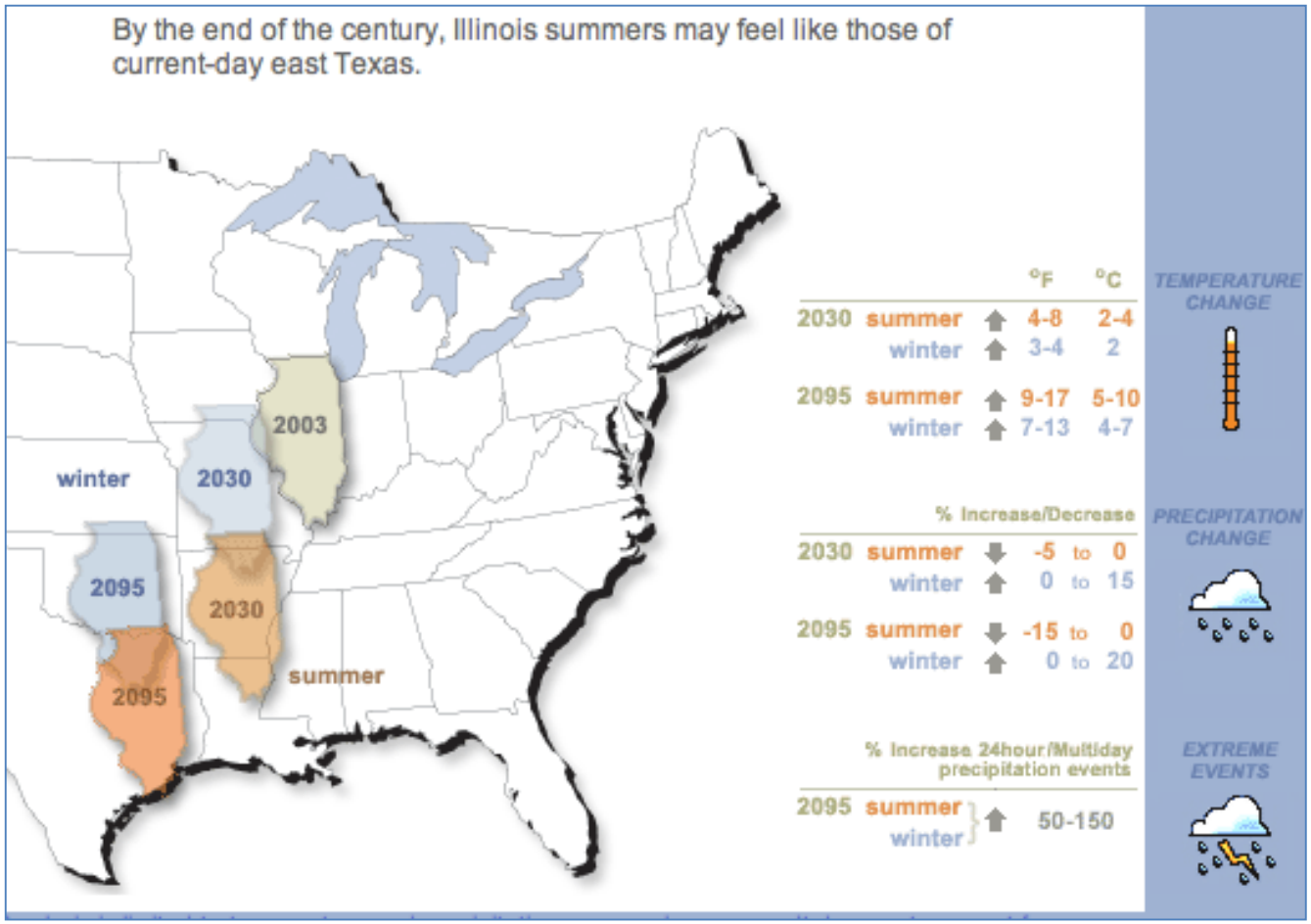
Evidence of climate change?

Climate change in the Chicago region: Adapting to its impact on natural communities

- What changes in climate are we seeing and what do we anticipate in the future
- What are the impacts on natural areas and biodiversity in Chicago
- What can we do to help natural areas in Chicago adapt to changing climate

Global Warming Trend



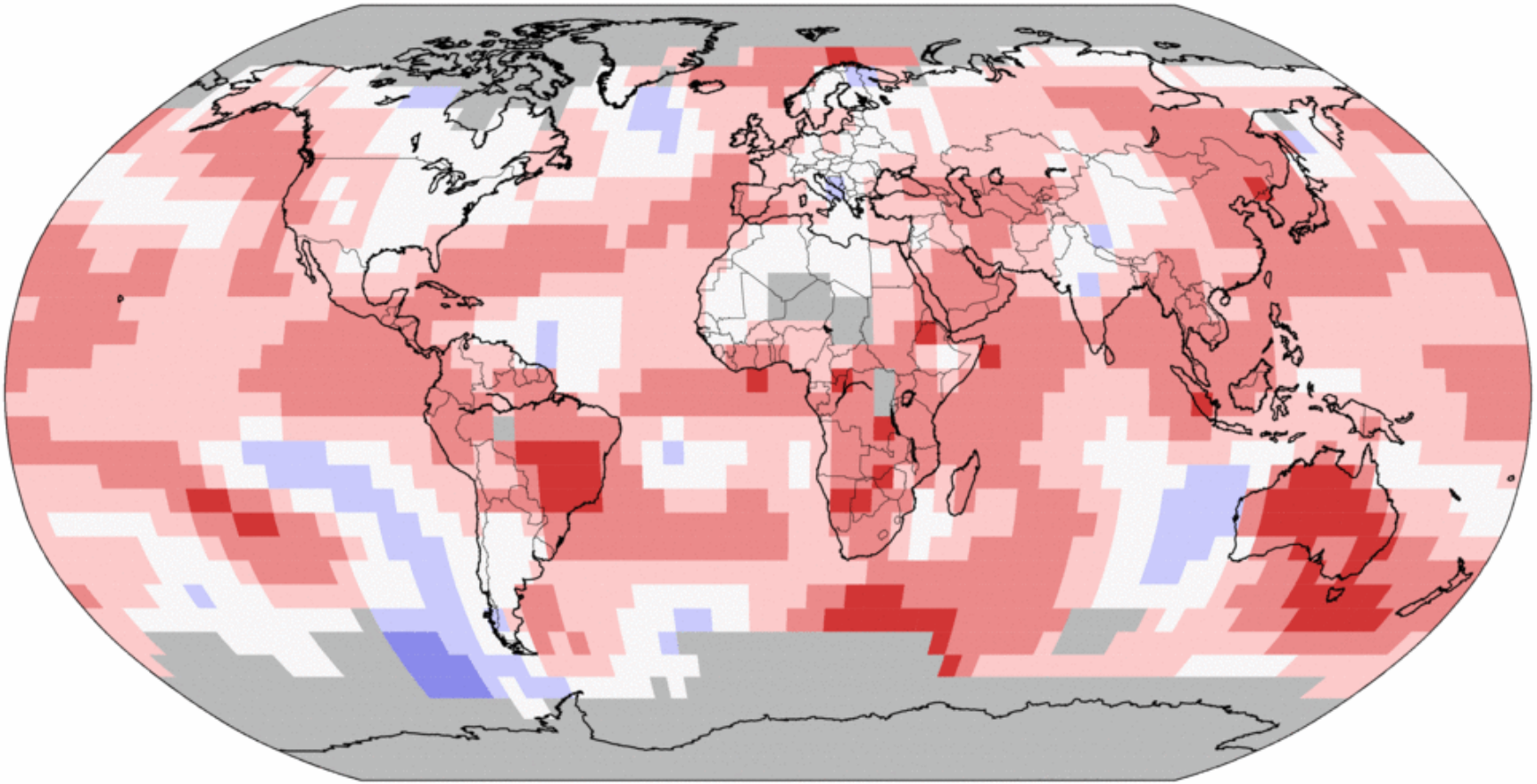


**Climate protection policies, if implemented quickly, could reduce emissions significantly below the emissions scenario considered here

Land & Ocean Temperature Percentiles Jan 2019

NOAA's National Centers for Environmental Information

Data Source: GHCN–M version 3.3.0 & ERSST version 4.0.0



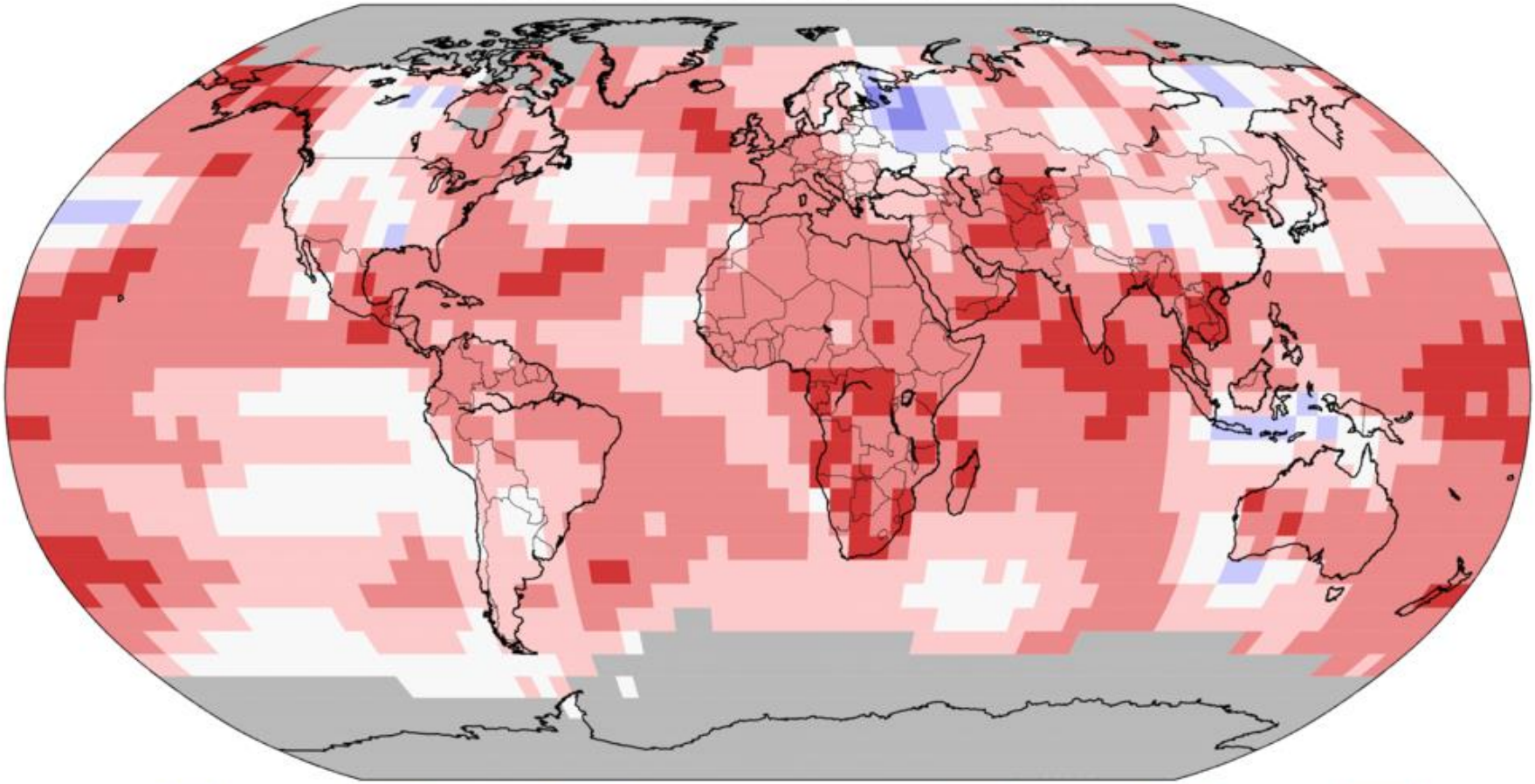
Record Coldest | Much Cooler than Average | Cooler than Average | Near Average | Warmer than Average | Much Warmer than Average | Record Warmest

Wed Feb 13 03:48:50 EST 2019

Land & Ocean Temperature Percentiles Jul 2019

NOAA's National Centers for Environmental Information

Data Source: NOAAGlobalTemp v5.0.0–20190808



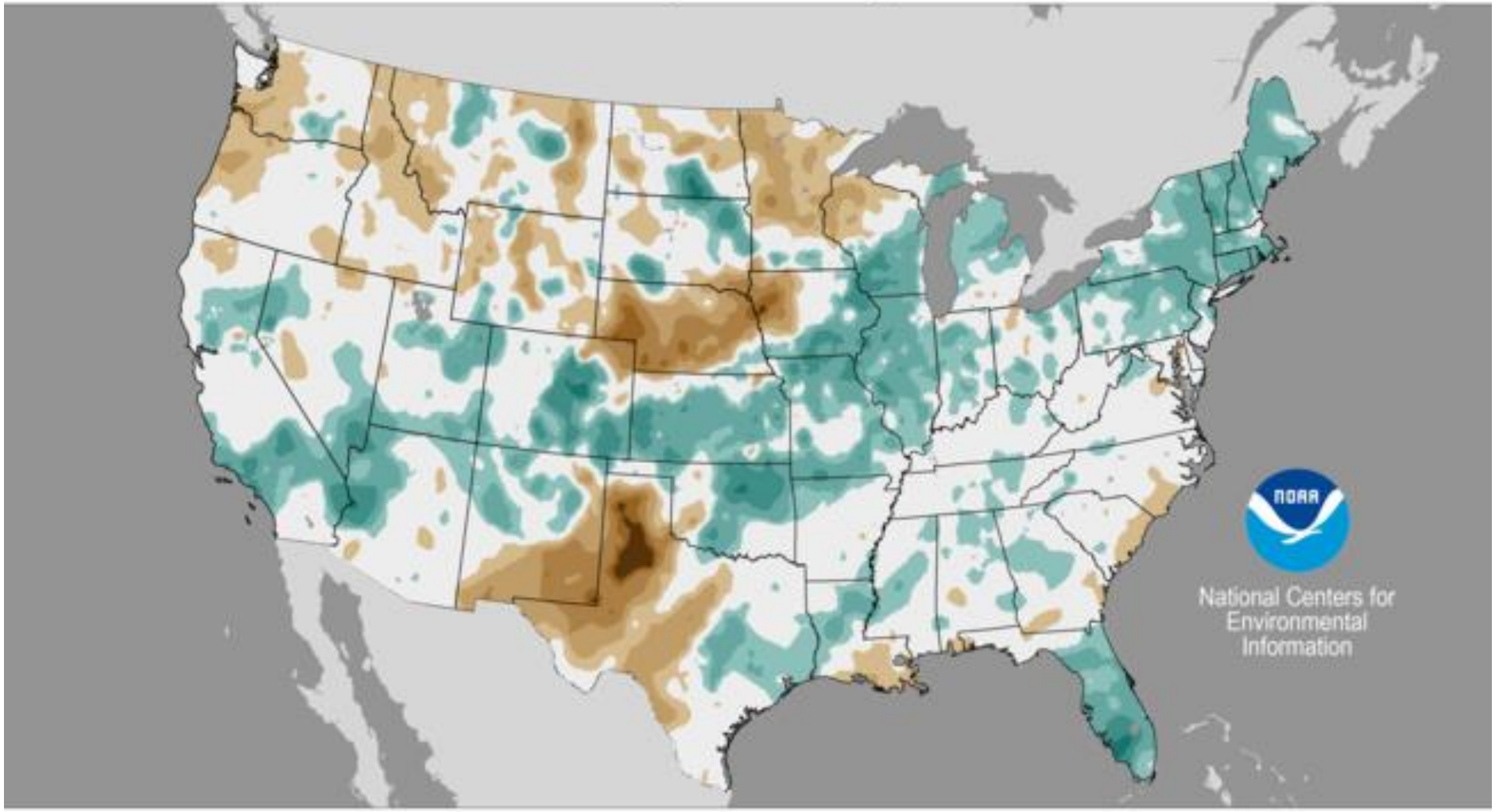
Record Coldest | Much Cooler than Average | Cooler than Average | Near Average | Warmer than Average | Much Warmer than Average | Record Warmest

GHCNM v4.0.1.20190806.qfe

Precipitation Percent of Average

January 2019

Average Period: 20th Century



5 10 25 50 75 100 125 150 200 300 500

Percent

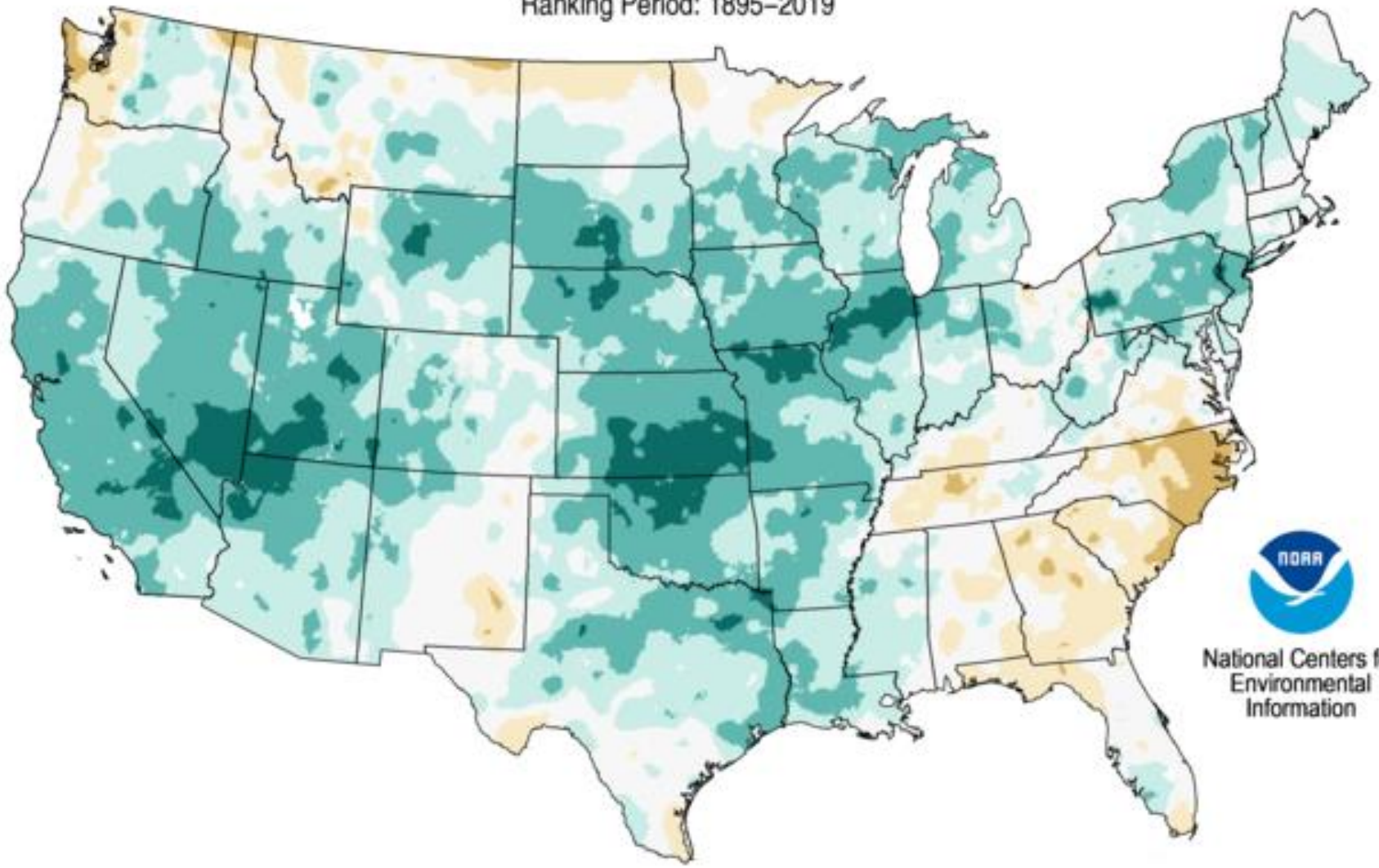
Created: Mon Feb 04 2019

Data Source: 5km Gridded (nClimGrid)

Total Precipitation Percentiles

May 2019

Ranking Period: 1895–2019



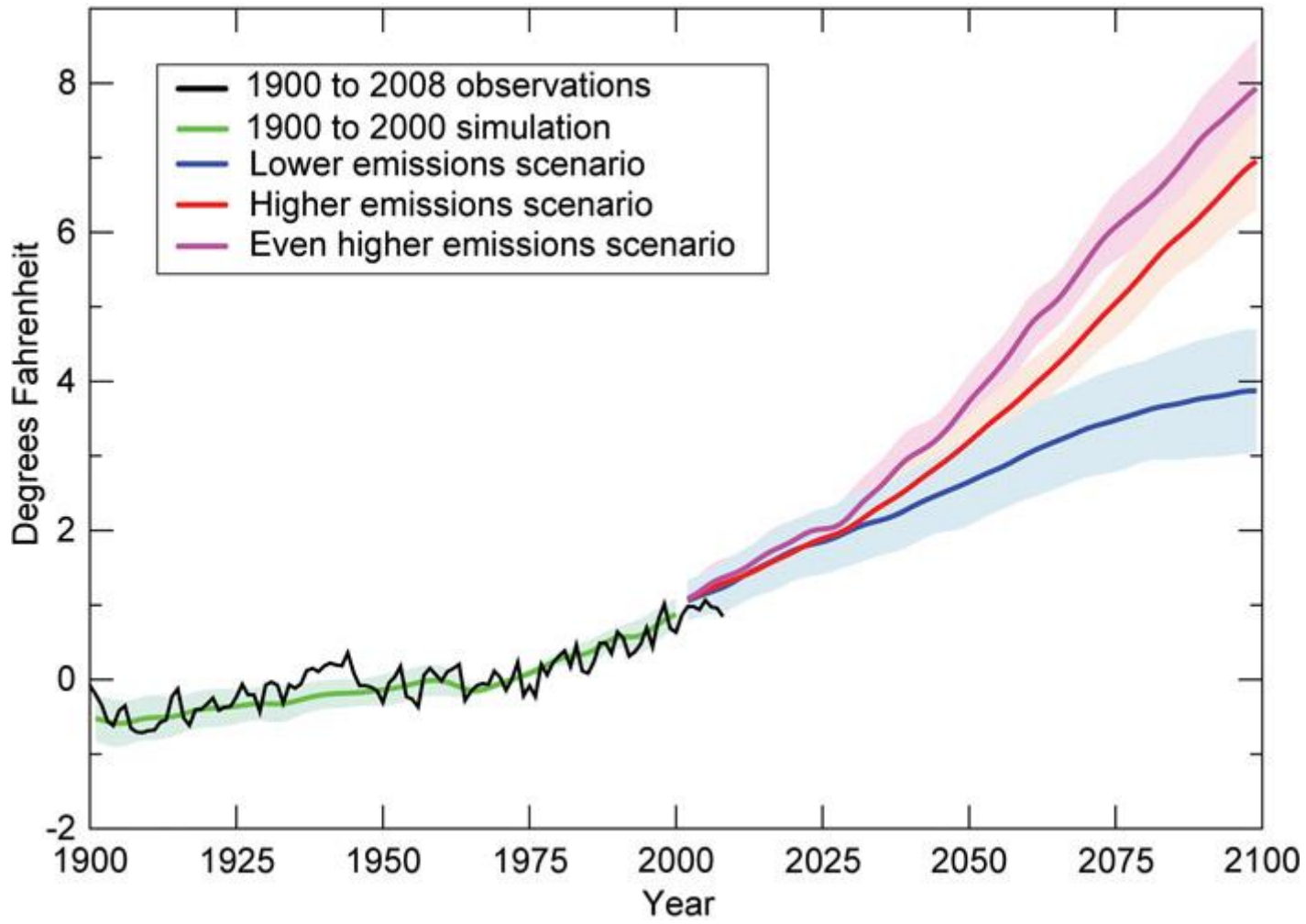
National Centers for Environmental Information

Record Driest | Much Below Average | Below Average | Near Average | Above Average | Much Above Average | Record Wettest

Created: Tue Jun 04 2019

Data Source: 5km Gridded Dataset (nClimGrid)

Where the global climate is headed



Most warming of the climate still to come, even if we come to terms with Climate change now.

Midwest temperature projections

High emissions scenario: 9.5 degree F increase over 1900-1999 average by end of century

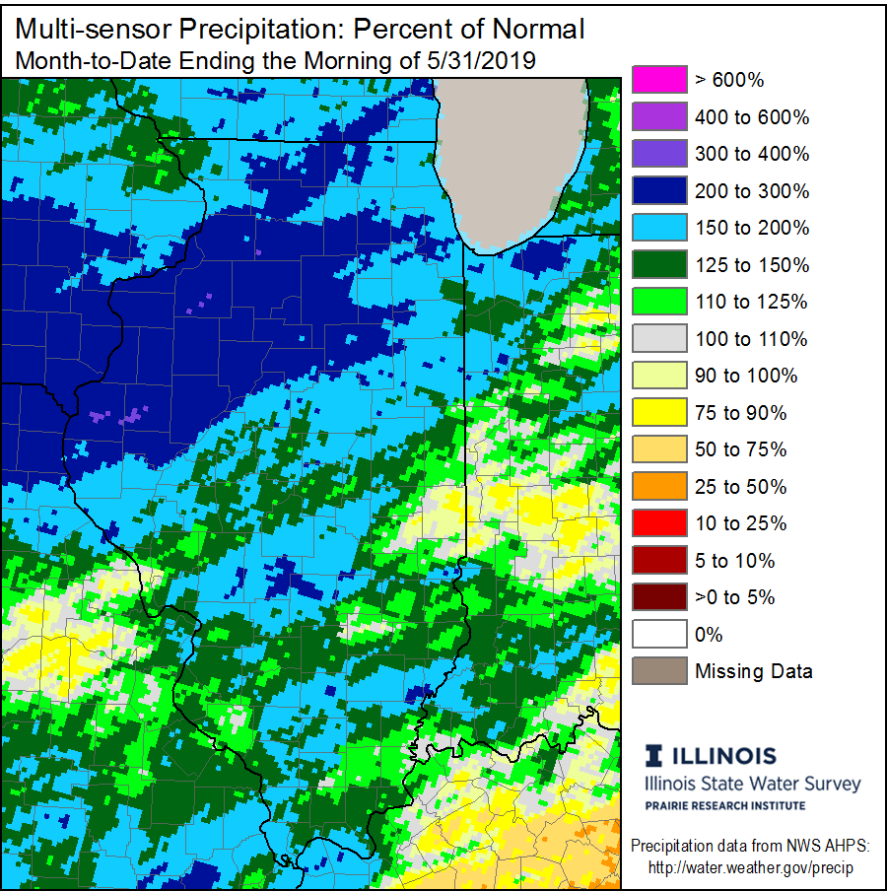
Low emissions scenario: 5.7 degree F increase

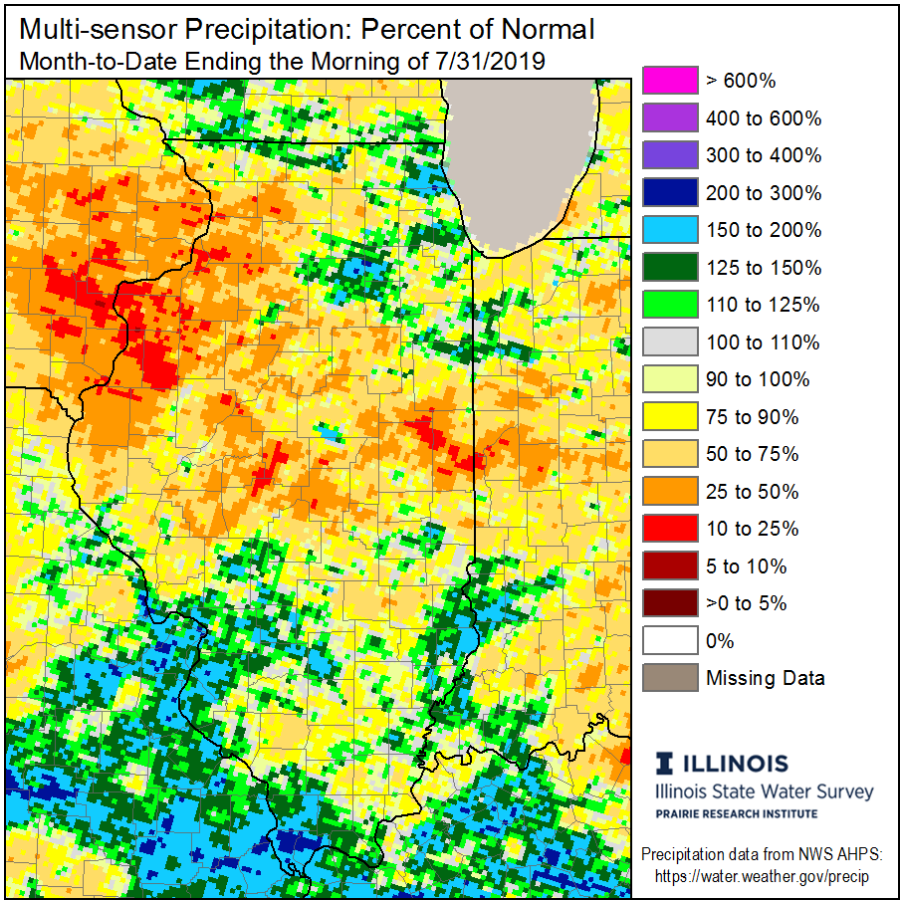
1.4 degree increase since 1985 already in place

Midwest precipitation projections

- Increasing precipitation (up 4.3 inches/year since 1900; projected to continue to increase)
- More extreme rain events (2+ inches in storm)
- Shift of precipitation to more winter, less summer
- Despite more precipitation, we'll see more extreme drought (20% worse by 2050)
- More winter precipitation falling as rain than snow

2019 Precipitation pattern





May 2019 2-3 times normal

July 2019 25-75% of normal

Climate change issues for wildlife

- Direct effects
  - Temperature
  - Precipitation
  - Increased intensity of storms
  - Increased drought
  - Increased flooding

- Indirect effects
  - Prey base
  - Predators/disease
  - Habitat changes
  - Timing of important annual cycle events
    - Leaf out
    - Flowering
    - Fruit availability
    - Insect flushes
    - Freezes

Seasonal Changes

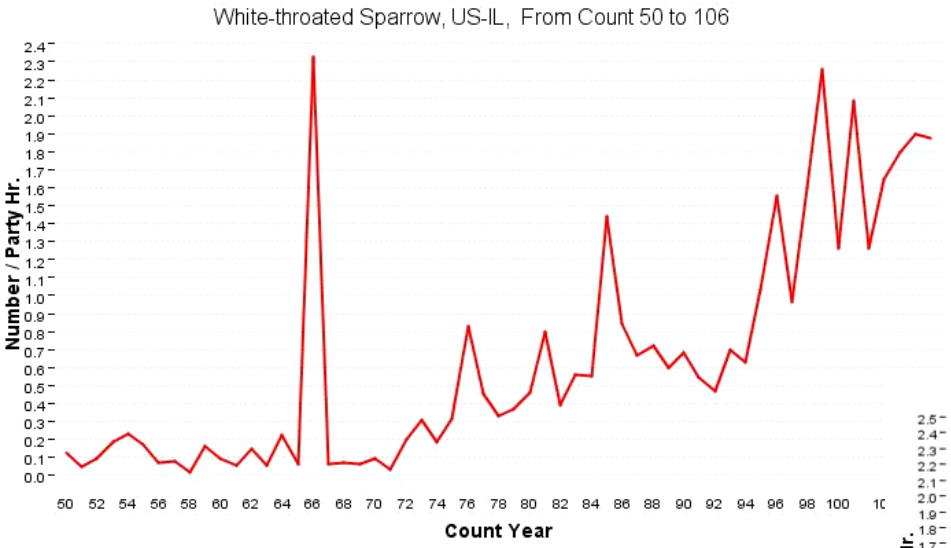
- Winter
  - Distributional and activity changes
- Spring and Fall
  - Changes in phenology

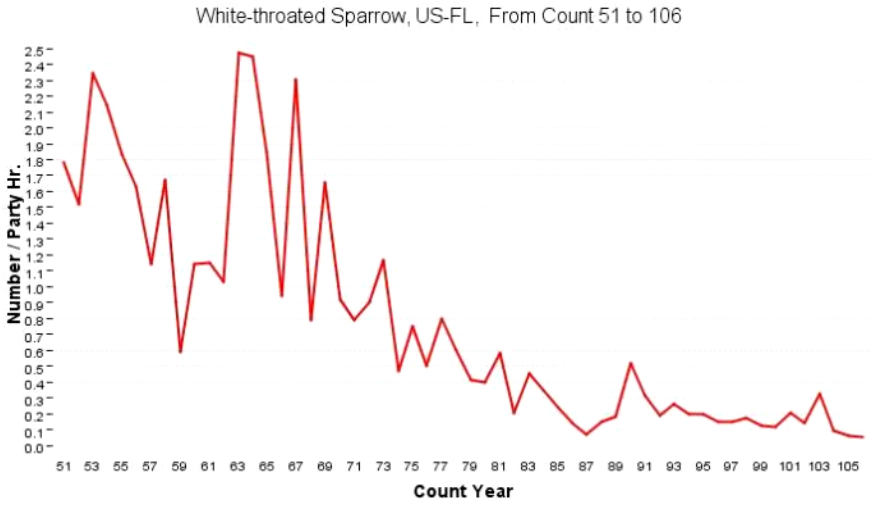
    Timing of leafout, migration, insect emergence
- Summer
  - Distributional changes
  - Changes in timing of breeding
  - Success

Winter distributional changes

- Southern birds north
  - Waterbirds
  - Ground foragers
  - Fruit-eaters
- Northern birds lost
  - Evidence for this in Midwest weak

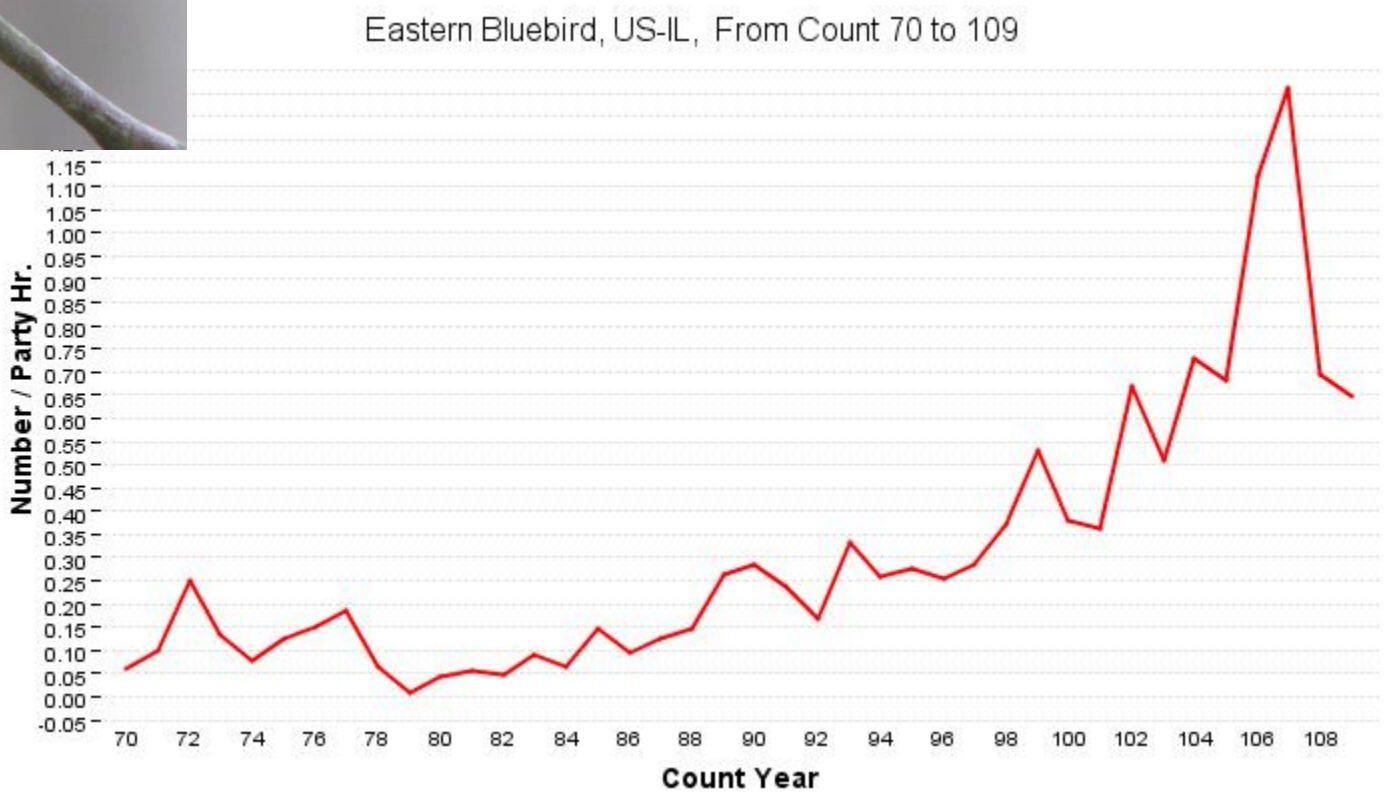
White-throated Sparrow changes in winter abundance Florida and Illinois 1960 to 2010





Other frugivores increasing: American Robin, Cedar Waxwing, Yellow-rumped Warbler. Yellow-shafted Flicker

Why? Warmer winters, more fruiting shrubs.



Invasive, exotic shrubs

Buckthorn

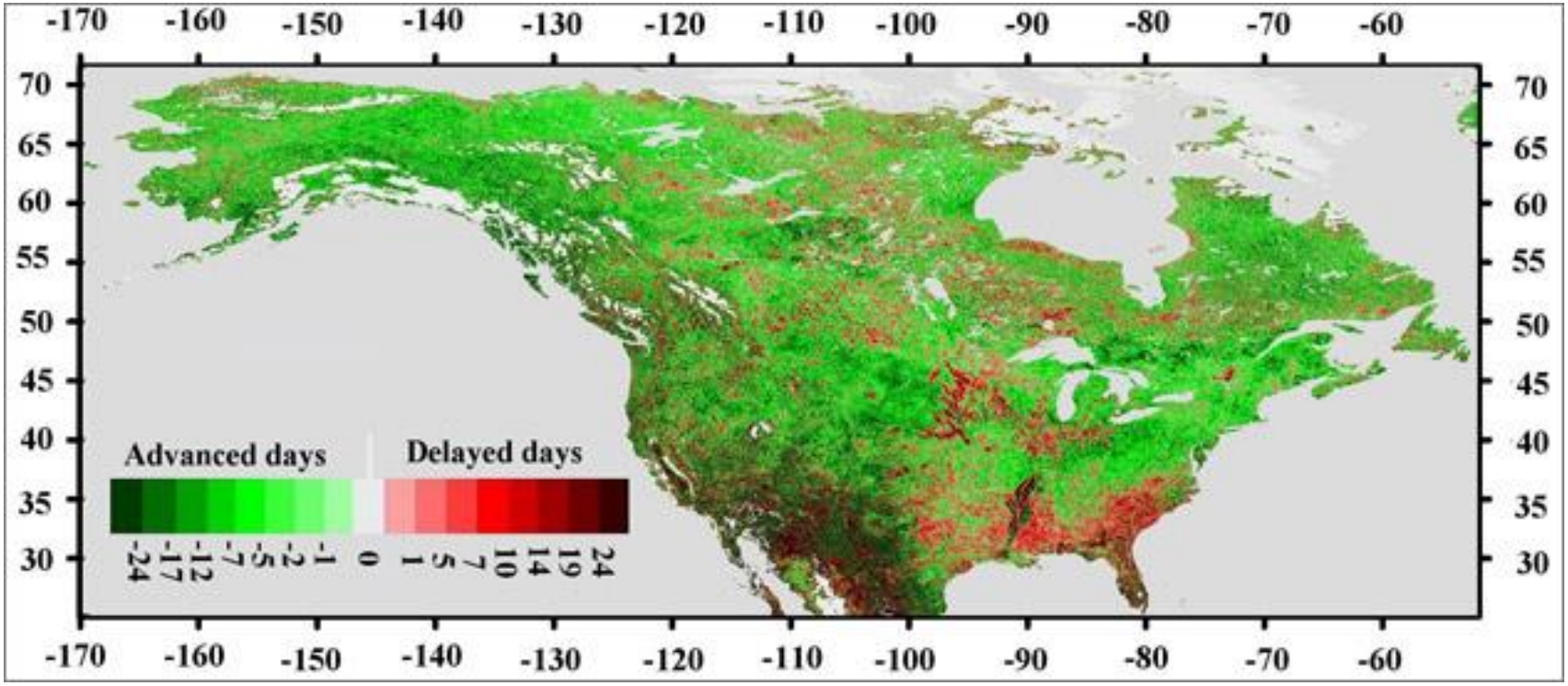
Honeysuckle

Updated in 2012. Northern Illinois shifted one zone warmer

Springtime Phenological Change

- Suite of related events occur in spring as growing season begins
  - Trees leaf out and flower
  - Insects emerge
  - Birds migrate north
  - Mammals, Herps end hibernation

Change in leaf out in North America (1983-2005)



Timing of leafout

- Birds migrating in spring take advantage of insects associated with leafout
- Leafout advancing with global warming; average 4-5 days earlier per degree increase in temperature
- Lake effect more extreme with warming temperatures?
- Continental effects could overwhelm local changes

Timing of migration

- The timing of bird migration is set by climate in evolutionary time
- Timing influenced by departure date and latitude of wintering grounds
- Most birds use cues from photoperiod to time migration.
- Why not weather?
  - Weather too variable
  - Birds in other areas can’t judge current weather here

Weather variability

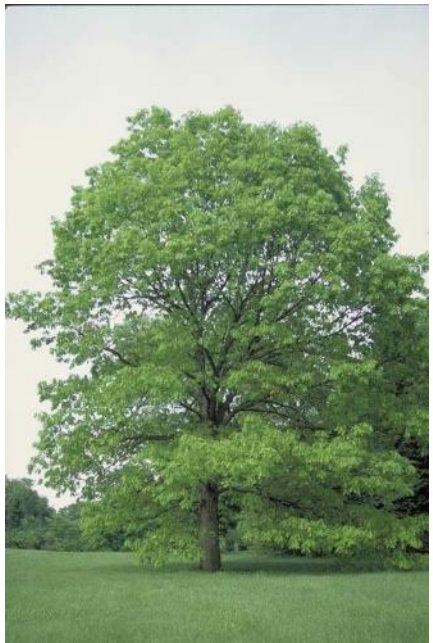
- Chicago 21 March-3 April 2007
  - 64.9 high, 45.8 low (= average 2 May)
- Chicago 4-15 April 2007
  - 42.8 high, 29.8 low (= average 17 March)

Note warm March followed by cold April caused one of the ten largest weather-related economic losses of all time in North America

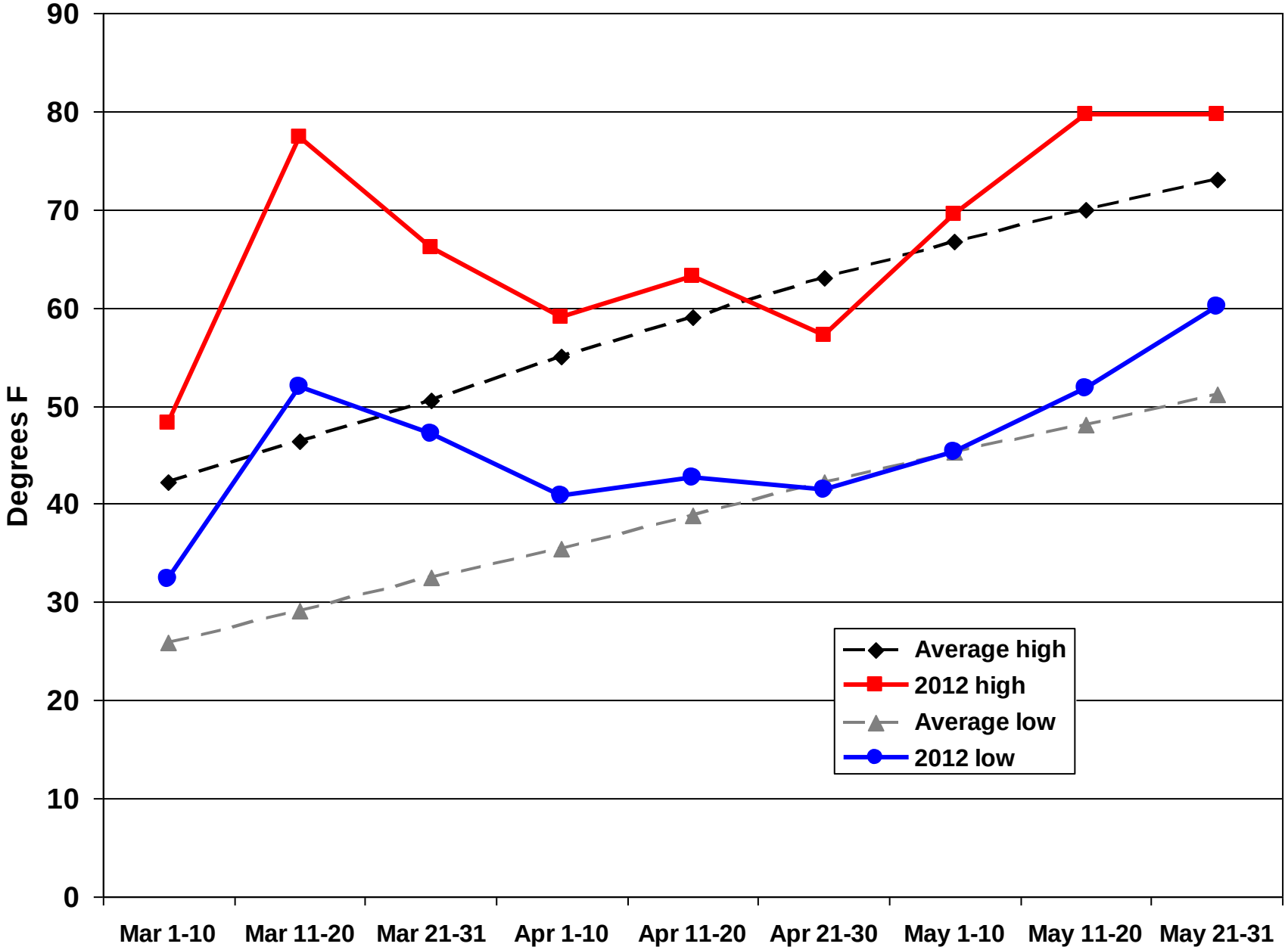
Migration changes due to global warming

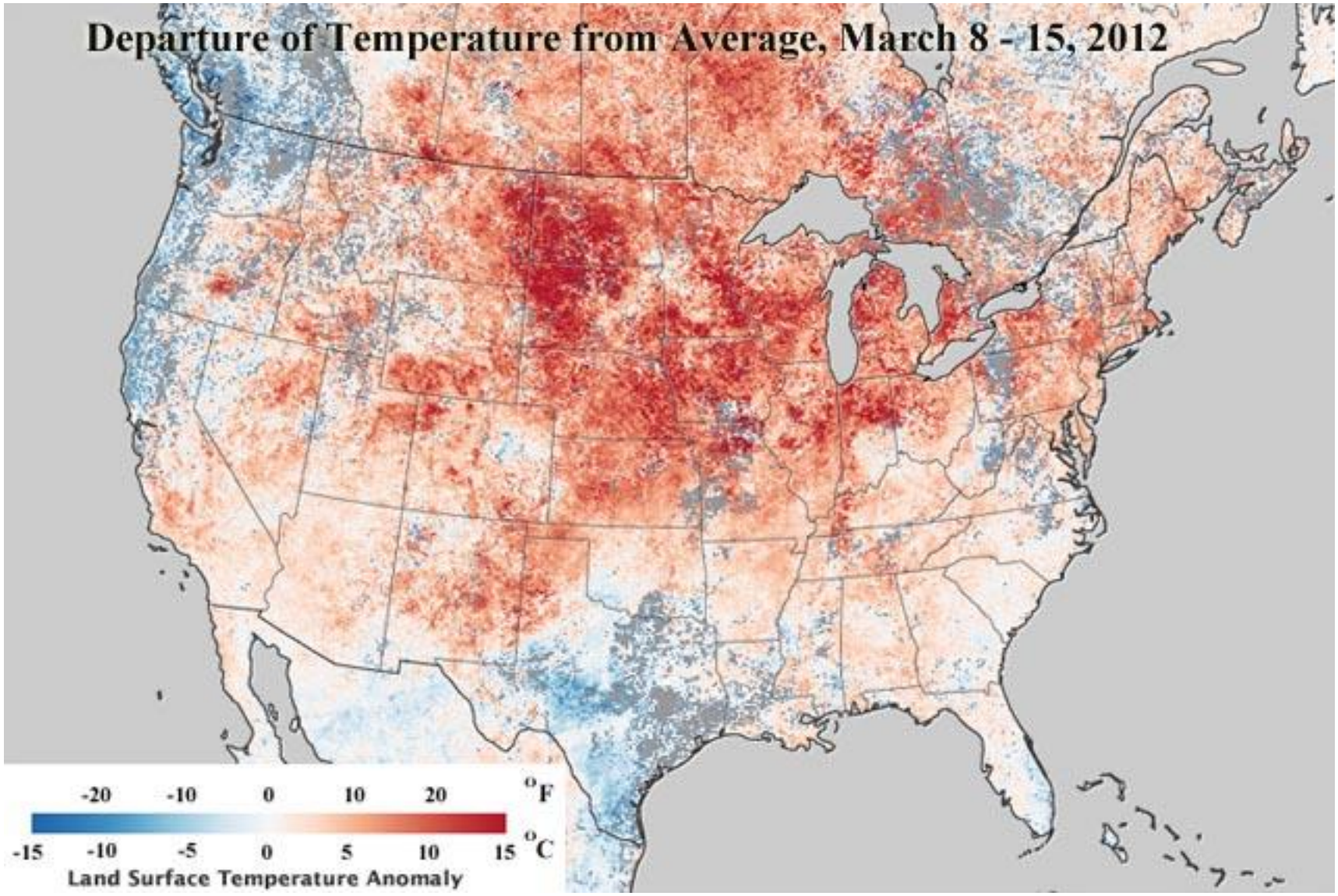
- Timing of bird migration (primarily set by photoperiod)
  - Much evidence of changing timing of migration
- Timing of leafout (set by weather)
  - Leafout generally earlier, but extremely variable
- Effects strongest in spring
  - Clear phenological event (leafout/greenup)
  - Selection for early arrival on breeding grounds

Spring 2012: effects of anomolous weather on migration in Chicago



What was the weather like in Spring 2012


90
80
70
60
50
40
30
20
10
0
Degrees F
Mar 1-10
Mar 11-20
Mar 21-31
Apr 1-10
Apr 11-20
Apr 21-30
May 1-10
May 11-20
May 21-31
Average high
2012 high
Average low
2012 low


Departure of Temperature from Average, March 8 - 15, 2012
-20 -10 0 10 20 °F
-15 -10 -5 0 5 10 15 °C
Land Surface Temperature Anomaly

March 2012: Unusual weather or climate change?

YES

Proximate causes: a La Nina pattern in the ocean temperatures and a blocking high pressure ridge affecting jet stream winds

But global warming over last 30 years has increased probability of extreme heat waves about 50%.

Warming Arctic has weakened zonal flow of jet stream

(Polar vortex outbreaks like last year part of same pattern)

What happened ecologically in 2012?

- Vegetation came out 1 month plus early
- Oaks in forest preserves leafing out at end of March instead of normal early May
- More overlap among species of plants
- Less delay of vegetation along lakefront
- Early emergence of many insects
- Gyllenhaal data on elm leaf beetle

Elm Leaf beetle larvae from Oak Park

In 2011 dropping to ground to pupate in 1st week of May

In 2012 happened in last week of March

- In 2011 provided food to warblers
- In 2012 provided food to residents and some early migrants

Examined spring migration using E-bird

- 113 landbird species
- Compared timing of migration start, peak of migration, and end of migration
- 2012 verses previous 10 years; Cook County data only

Spring Migration 2012

- 75 of 113 species (66%) showed some evidence of earlier migration
  - 23 arrived early (10% of checklists)
  - 46 peak of migration was early (median checklist)
  - 33 ended migration early (90% of checklists)
  - 9 were early in all 3 measures

  Generally about 1 week early.

Golden-crowned Kinglet

Why does this matter?

- Both birds and plants benefit from birds arriving at time of leafout.
  - Birds get food
  - Plants get pest control
- Wood and Pidgeon 2015 studied this in southern Wisconsin in black oaks (2009 vs. 2010)
- Results look similar to those I found in 2012; they documented that migrant warblers foraged at lower rate in warmer year & more insect damage occurred on trees
- Similar study by Strode (2009,2015) at Trelease Woods (Champaign) comparing early warm-up year 2003 to normal years and had similar results.

Oaks and migrating birds

- In spring, peak of migration by insectivorous birds corresponds to oak flowering and early leaf-out.
- A number of bird species preferentially use oaks for foraging
- What happens if timing of oak leaf-out and peak migration no longer correspond?

Extirpation of Karner Blue Butterfly at IDNL due to ridiculous spring of 2012

Karner Blue Butterfly

Host plant -- Lupine

Butterflies emerged in 2012 before food plant

How is temperature integrated into phenology

- Many potential mechanisms
  - First/last freezes
  - Timing of thaw
  - Maximum/minimum temps
  - Sum of temperature
  - Warm/cold spell of sufficient length and strength
  - Temperature above/below certain threshholds
  - Soil, Water or Air Temperatures may be main cue
- Different taxa may respond preferentially to different temperature cues

Summer changes

Timing of breeding

Tree Swallows nesting on average 9 days earlier than in 1960s

Timing mismatches
Decreased nesting success

- Pied Flycatcher in Europe
  - Caterpillars peaking earlier
  - Nesting season earlier (but complicated)
  - Less food when Pied Flycatchers nesting

Idiosyncratic breeding success problems

Nesting success declining because of warmer winters

Adult Gray Jay

Juvenile Gray Jay

Recent Audubon Study

- Based on modeling of bird ranges using a set of about 12 climate variables
- Predicts that 314 of 588 North American bird species will lose half or more of breeding range
- 126 of these will not show range expansion into new areas.
- 40 species will lose all of their current range

Bobolink

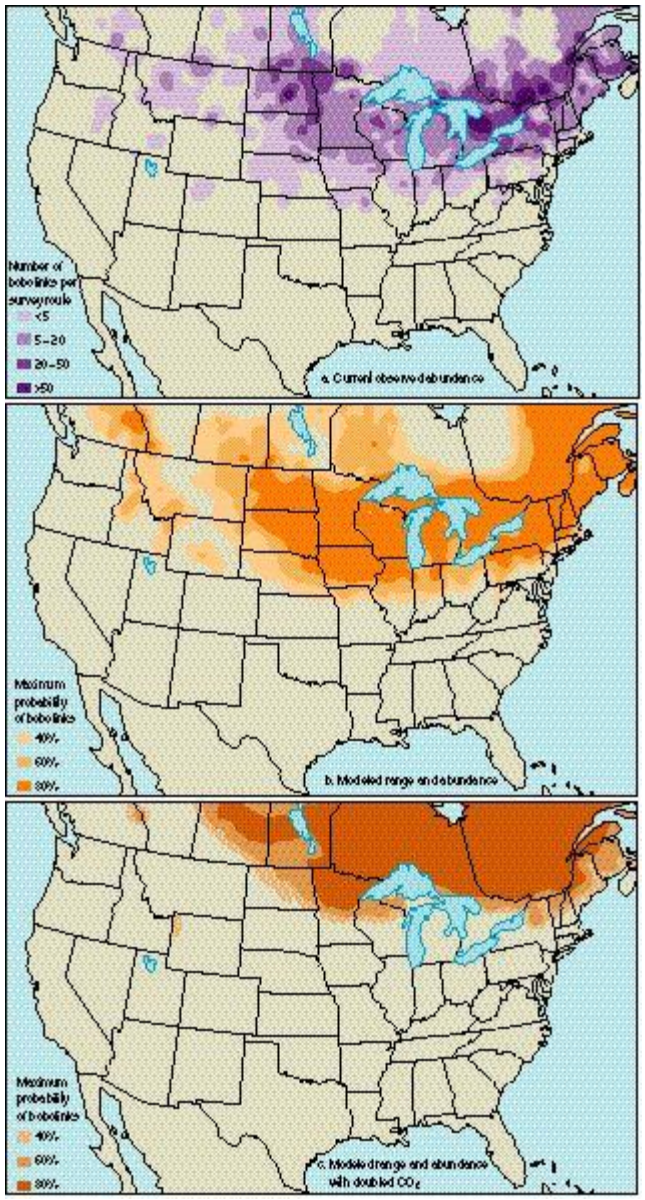
State population estimate

1909	1,175,000
1957	1,860,000
2004	34,000

BBS 9.3% annual decline in Illinois

Preferred nesting habitat: hayfields, but an ecological trap

Winter in SE South America, considered pest in rice fields


Number of bobolinks per survey route
<5
5–20
20–50
>50
a. Current observed abundance
Maximum probability of bobolinks
40%
60%
80%
b. Modeled range and abundance
Maximum probability of bobolinks
40%
60%
80%
c. Modeled range and abundance with doubled CO_2

What to do about Bobolink?

Is it ***DOOMED?***

What to do about Bobolink?

- Is it doomed?

NO

But maintaining it will be tricky.

large grasslands important

protected lands crucial

like it moist and thick

main strategy is probably to maintain and extend

populations where they currently exist

The future for birds with climate change

- Climate change a threat intensifier
- Birds are a best-case scenario. Every other group of organisms will do worse, because birds:
  - Very mobile
  - Respond primarily to habitat structure rather than species of plants
- Birds will do worse than models suggest
  - Models are based on climatic regimes, assume everything will respond in same way
  - Susceptible to timing mismatches because they use mostly photoperiod; plants and insects mainly use temperature

Changes to other wildlife

- Expect changes in ranges
- Expect changes in overwintering status
- Phenological shifts will be important
  - Watch out for disruption of species interactions
    - Predator-prey
    - Pollination
    - Dispersal

Little Sulphur

Partridge pea (host plant)

Currently invades annually from south, but does not overwinter; that may change with climate.

Species most at risk

- Species with limited dispersal
- Patchily distributed species; especially of associated with specialized habitats
- Species involved in obligate or near-obligate species interactions
- Species near range edges (i.e., Chicago is at the southern most range)
- Species with narrow ecological tolerances
- Species requiring cold-mediated ecological conditions (e.g. dormancy)

What to do about Climate Change and its effects on natural environment

- Reduce human carbon output
- Reduce stresses on natural environments
- Provide ways for organisms to move
- Increase phenological diversity of spring leaf out (more late season species)
- Create large connected landscapes of quality habitat

Reducing Human Carbon Output

- Personal
  - Reduce carbon use for transportation
  - Eat less meat (especially beef)
  - Vote for candidates who take climate change seriously
- Governmental/Corporate
  - Green New Deal
  - Carbon Tax or other mechanism to require payment for all of harms due to carbon use

Chicago Wilderness Climate Action Plan for Nature

Climate Action Plans

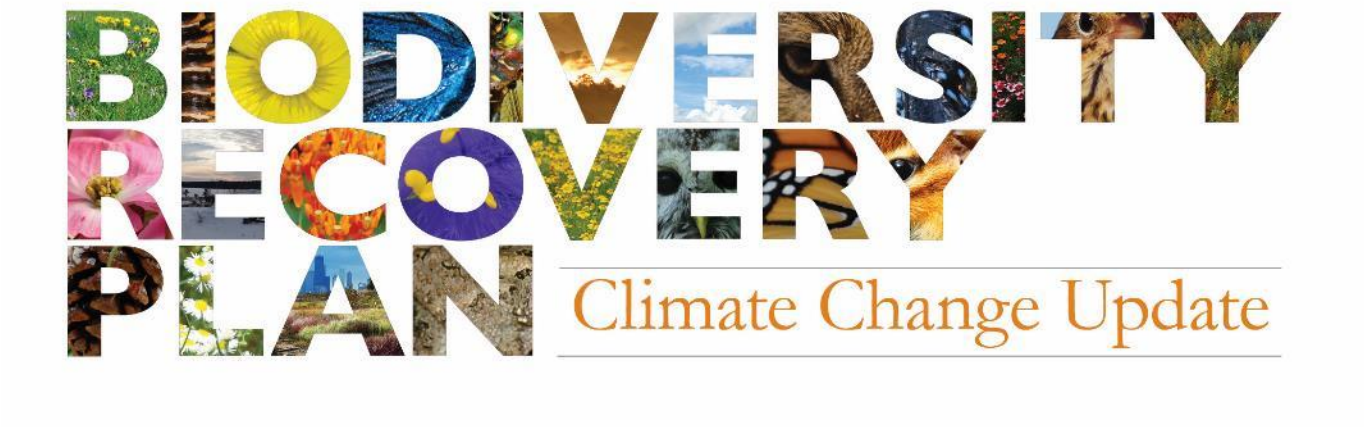
City of Chicago Climate Action Plan

- Human population
- Buildings
- Transportation infrastructure
- Landscaping

- Urban forests
- Water infrastructure
- Vacant land

Chicago Wilderness Climate Action Plan for Nature

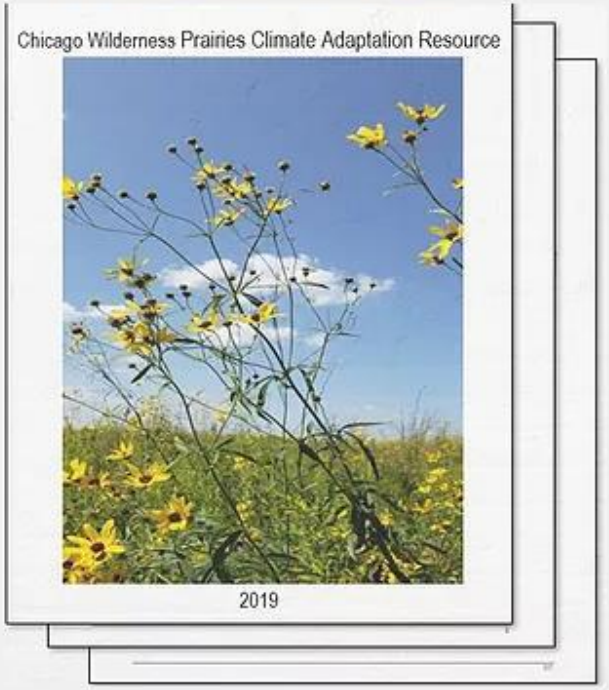
- Rivers and lakes
- Restored natural areas
- Remnant natural areas
- Native species



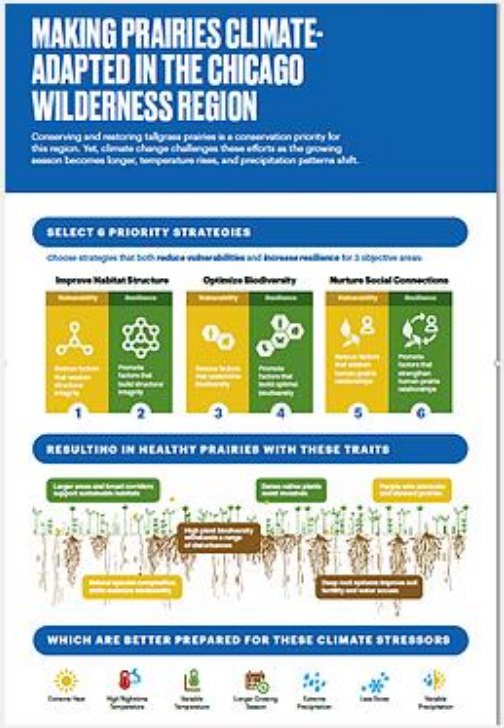
- **What is the purpose?**
  - **Identify and understand the specific ways natural communities, and existing threats, will be affected by climate change**
  - **Examine if strategies needed to promote biodiversity adaptation differ from current restoration/conservation strategies**
  - **Outline actions to help natural communities adapt to both current and future landscapes**

The Prairies Climate Adaptation Resource

Download the Full Report

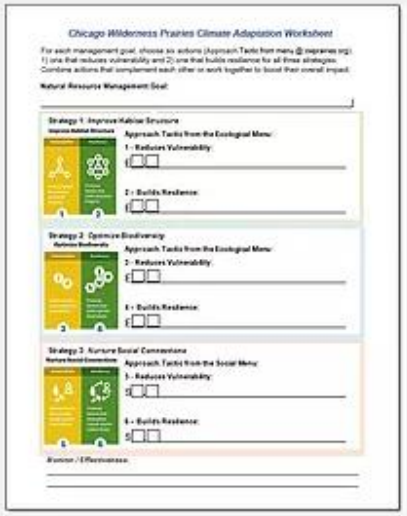


Download the Poster



Go to the Decision Support Tool

Download the Worksheet



CWprairies.org

MAKING PRAIRIES CLIMATE-ADAPTED IN THE CHICAGO WILDERNESS REGION

FIELD MUSEUM

Conserving and restoring tallgrass prairies is a conservation priority for this region. Yet, climate change challenges these efforts as the growing season becomes longer, temperature rise, and precipitation patterns shift.

SELECT 6 PRIORITY STRATEGIES

Choose strategies that both ***reduce vulnerabilities*** and ***increase resilience*** for 3 objective areas:

Improve Habitat Structure

Vulnerability	*Resilience*
Reduce factors that weaken structural integrity	Promote factors that build structural integrity
1	2

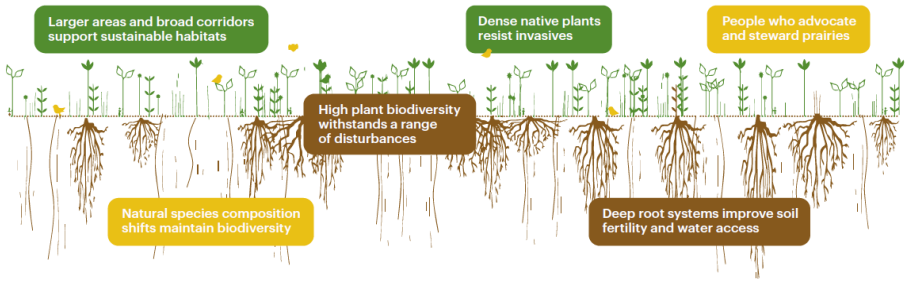
Optimize Biodiversity

Vulnerability	*Resilience*
Reduce factors that undermine biodiversity	Promote factors that build optimal biodiversity
3	4

Nurture Social Connections

Vulnerability	*Resilience*
Reduce factors that weaken human-prairie relationships	Promote factors that strengthen human-prairie relationships
5	6

RESULTING IN HEALTHY PRAIRIES WITH THESE TRAITS



WHICH ARE BETTER PREPARED FOR THESE CLIMATE STRESSORS

Extreme Heat

High Nighttime Temperature

Variable Temperature

Longer Growing Season

Extreme Precipitation

Less Snow

Variable Precipitation