Climate Change and Wildlife Refuges:
Managing for resilience in the face of uncertainty

Brad Griffith and J. Michael Scott
USGS, Alaska and Idaho Cooperative Fish & Wildlife Research Units
University of Alaska Fairbanks and University of Idaho

Desert Manager's Group
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US Climate Change Science Program Synthesis and Assessment Product 4.4:

Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources

National Wildlife Refuges
National Parks
National Parks
Wild and Scenic Rivers
National Estuaries
Marine Protected Areas

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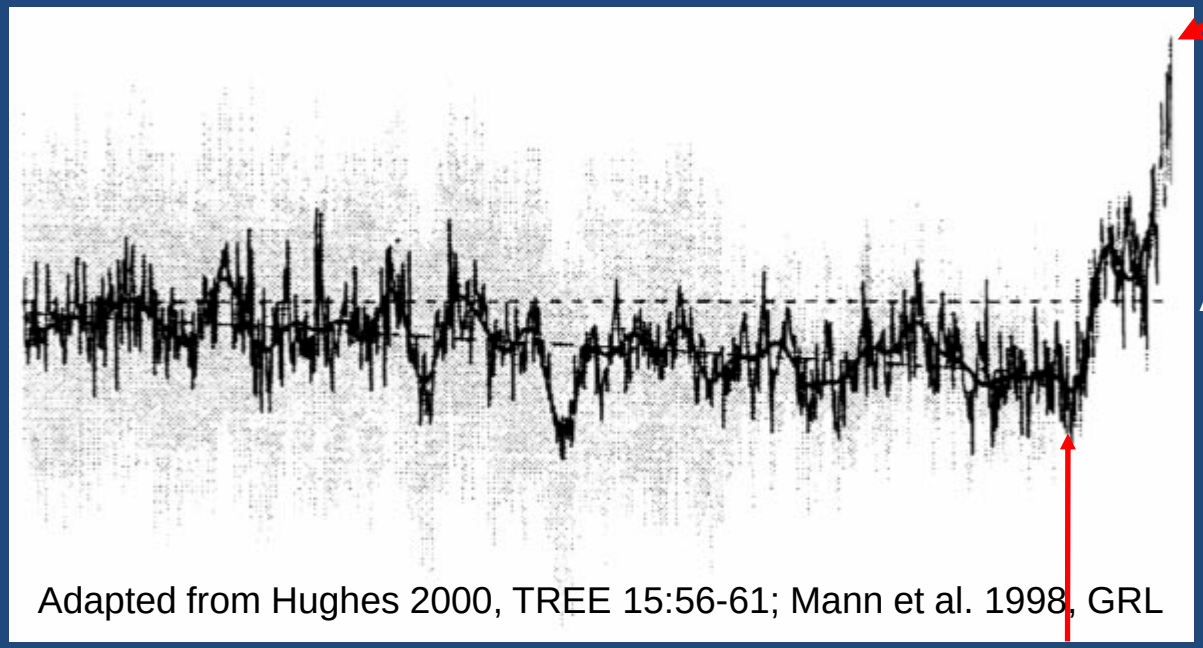
NATIONAL WILDLIFE REFUGE SYSTEM

EPA United States Environmental Protection Agency

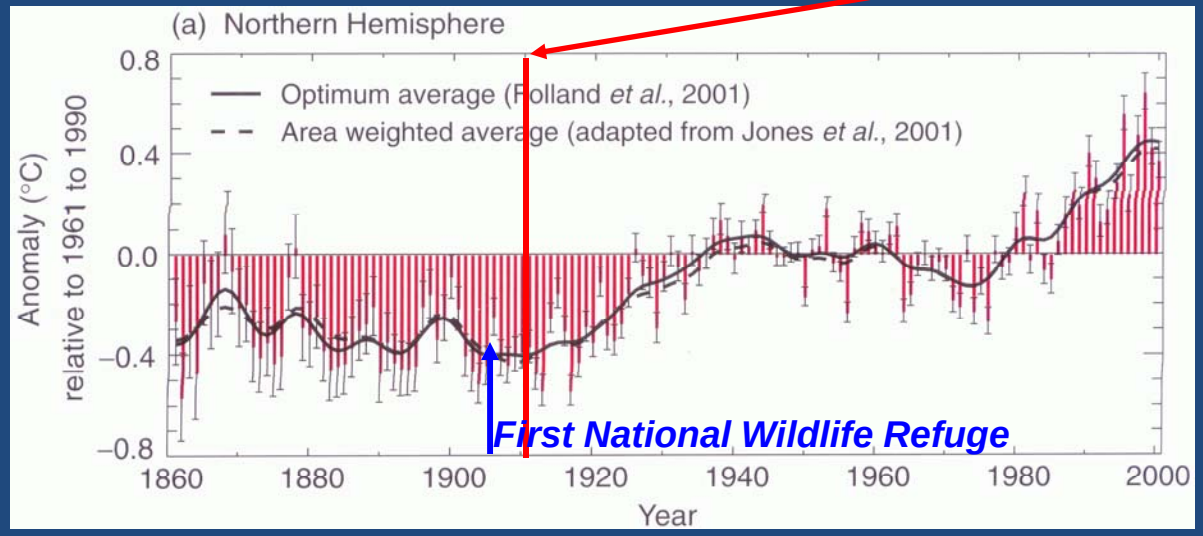
US Climate Change Science Program www.climatescience.gov

Northern Hemisphere Temperature Anomaly



1000

1910



Warming

- Globally, +0.4 ± 0.2 ^{o}C since late 19th century
  - Expected to increase an additional 3-7 ^{o}F in 100 years
- Two periods of recent warming:
  - 1910 - 1945
  - 1976 – present
- Reduction in diurnal temperature range
  - Minimum increased at 2x rate of maximum
- Greatest warming in winter and spring
  - but significant in summer
- Greatest confidence in temperature projections
  - Less for precipitation, wind, radiation, clouds, humidity……

Climate Change Susceptibility

- Most Likely Affected:
  - Habitat specialists
  - Non-volant species
  - Poor colonizers/dispersers
  - Fragmented / restricted populations
  - Bulk-headed habitats
  - Southern peripheries of ranges
  - Poikilotherms
  - Disease vectors
  - Threatened or endangered species

Expected Effects of Increased Temperature

- Increased rates of growth and development
  - vectors of diseases/parasites may be favored
- Changes in phenology
  - both spring and fall for ice, plants and animals
- Changes in distribution of “acceptable” temperatures
  - species ranges may shift
- Sea level rise and habitat inundation
- Synergistic interactions expected
  - mismatch of predator and prey, community/regime shifts
- Climate change may surpass habitat loss as the leading threat to biodiversity (Thomas et al. 2004)

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Global Observations

Parmesan and Yohe 2003 Nature 421:37-42

Distribution:

- 893 species
  - 48% shifted
  - 80% of shifts in expected direction
- 99 species
  - ~6.2 km/decade northward or m/decade upward

Phenology

- 677 species
  - 62% advanced
  - 87% of shifts in expected direction
- 172 species
  - ~2.3 days/decade earlier

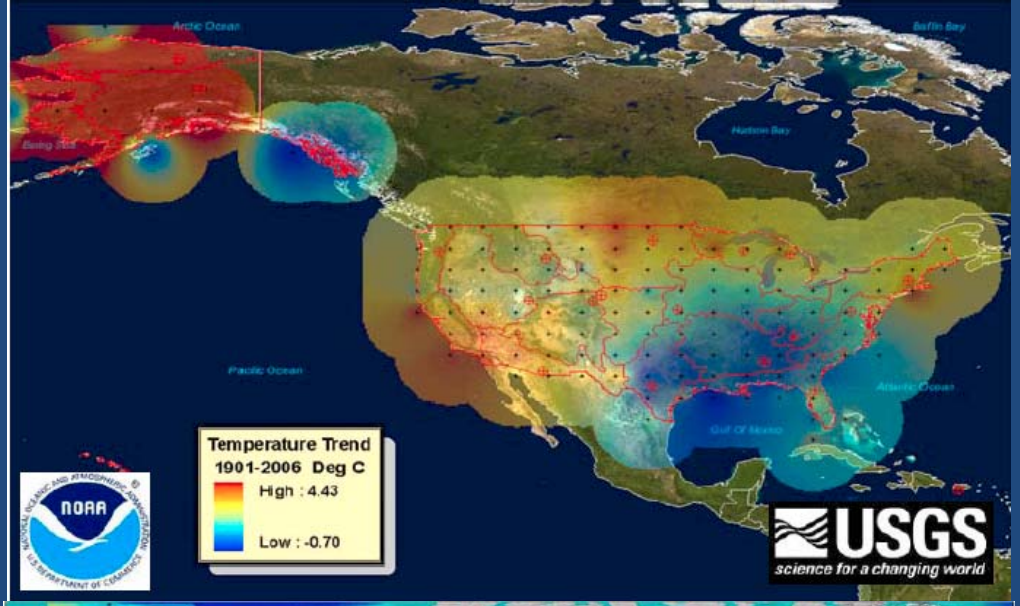
Diagnostic sign-switching

- 84% of 334 species

Spatial Heterogeneity

a.

Temperature



b.

Precipitation

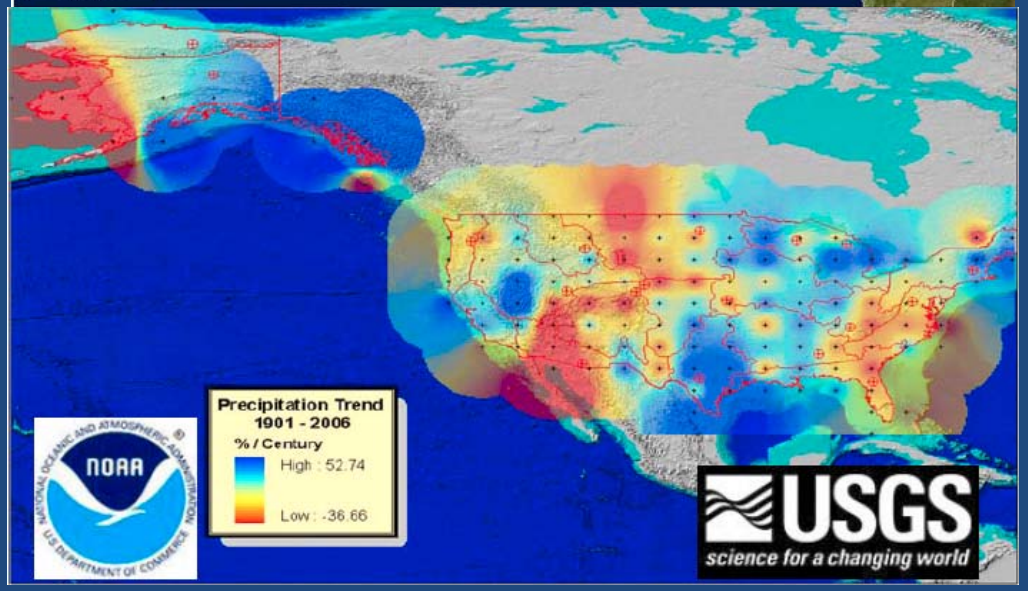
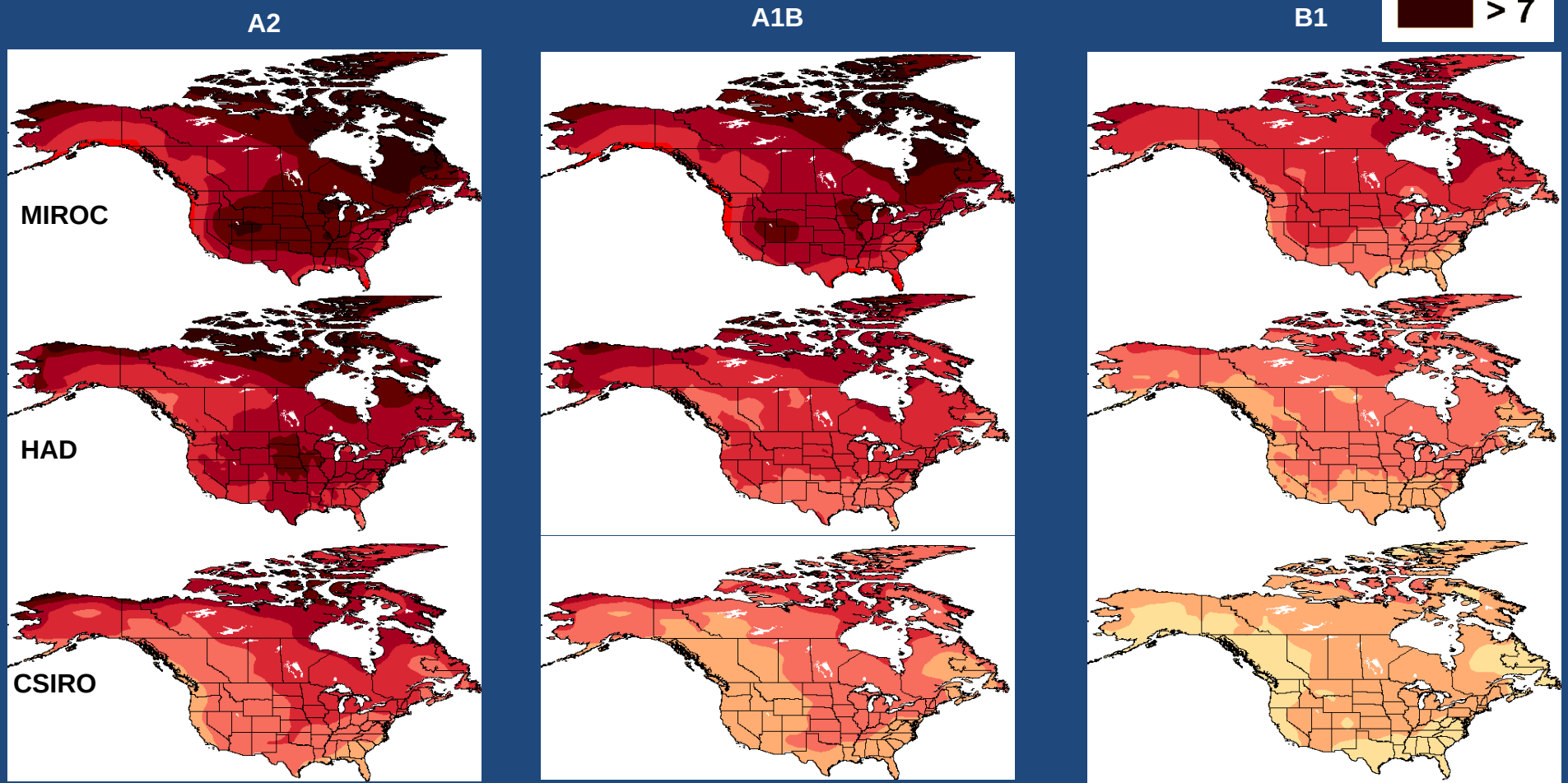


Figure 5.9. Observed annual trends in a) temperature and b) precipitation, 1901-2006, for the coterminous United States and Alaska. Data and mapping courtesy of NOAA's National Climate Data Center (2006a) and the U.S. Geological Survey.

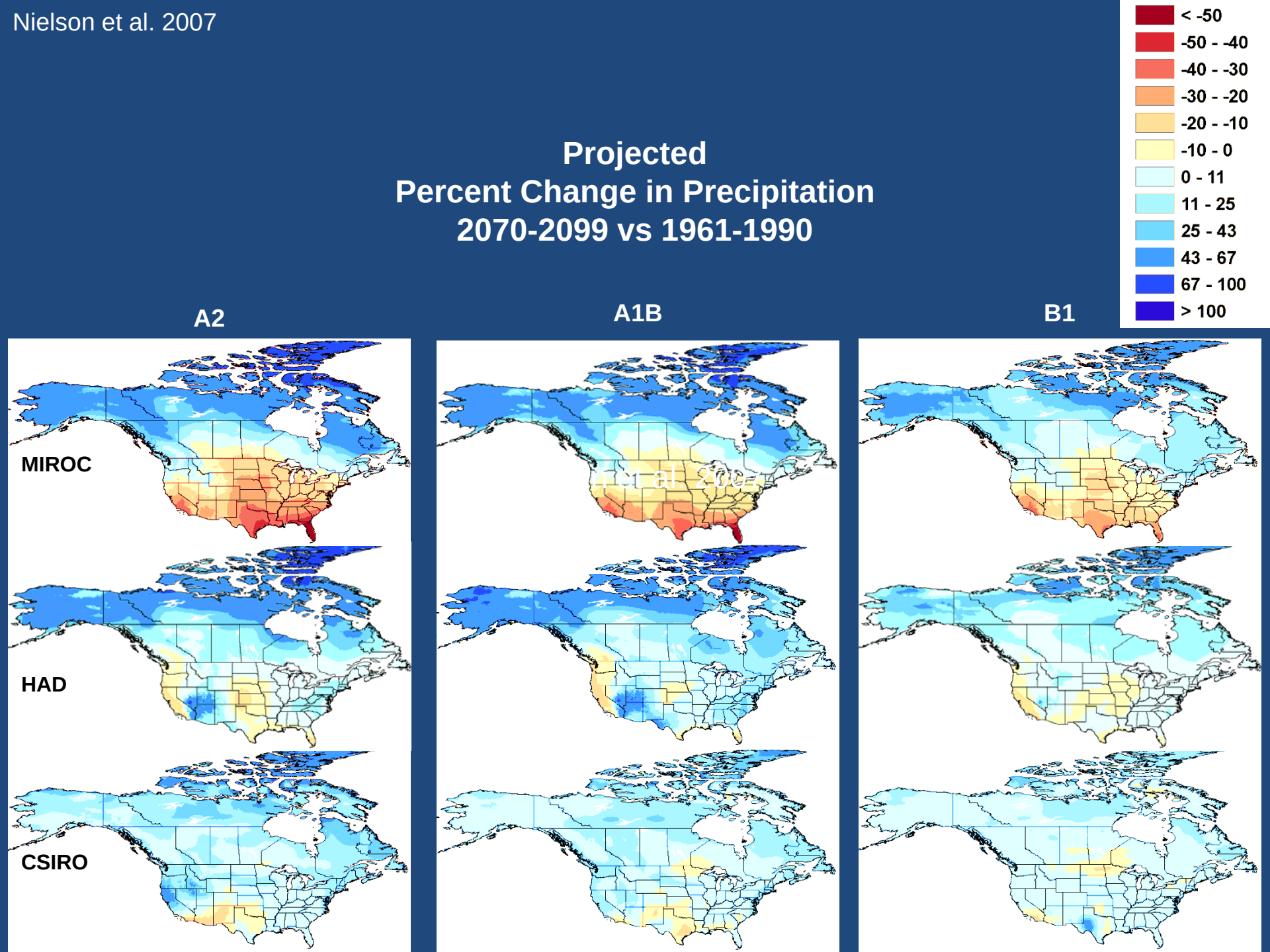
Nielson et al. 2007

Projected
Change in Mean Monthly Temperature
(Degrees C)
2070-2099 vs 1961-1990

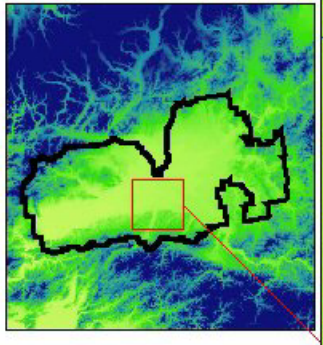


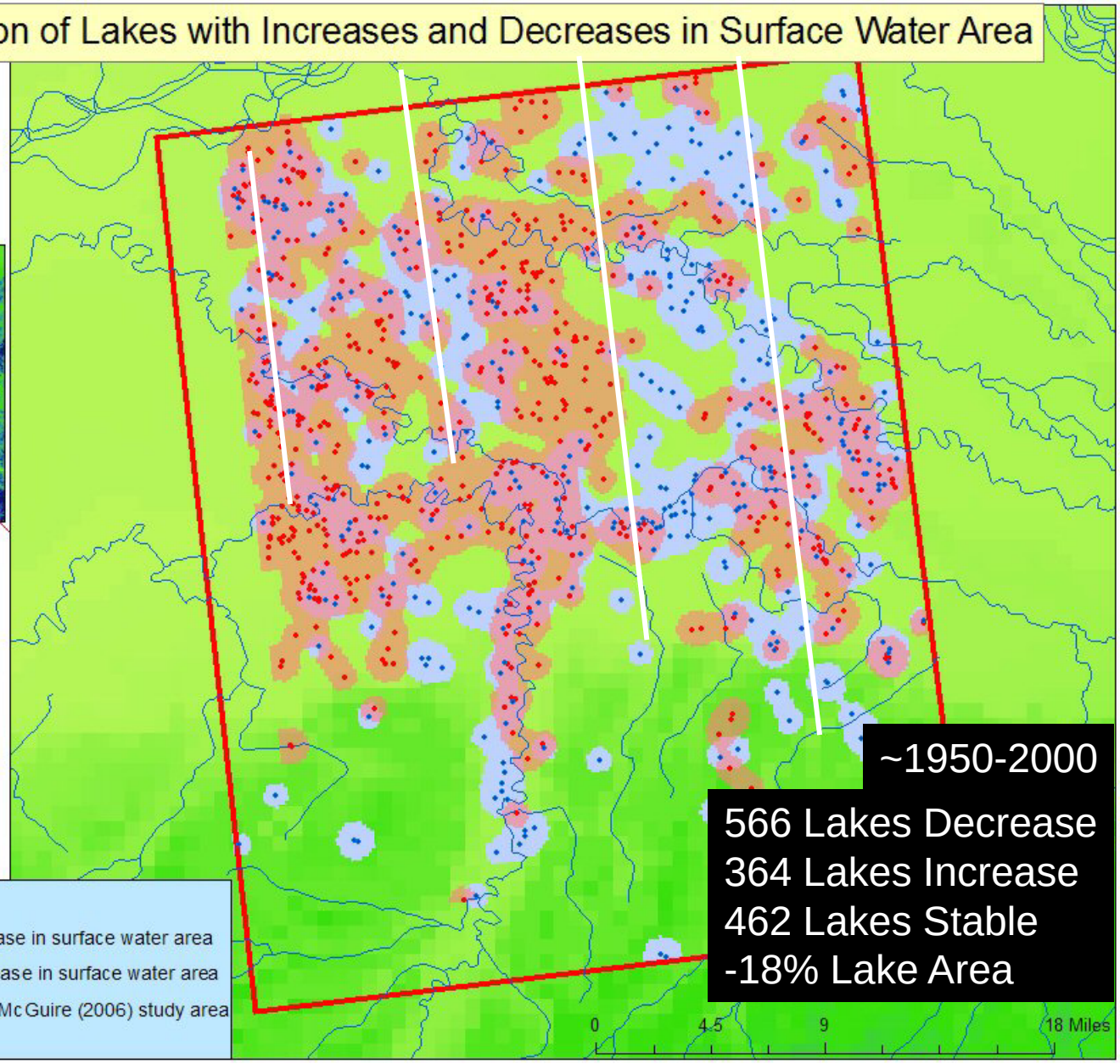
Nielson et al. 2007

Projected
Percent Change in Precipitation
2070-2099 vs 1961-1990

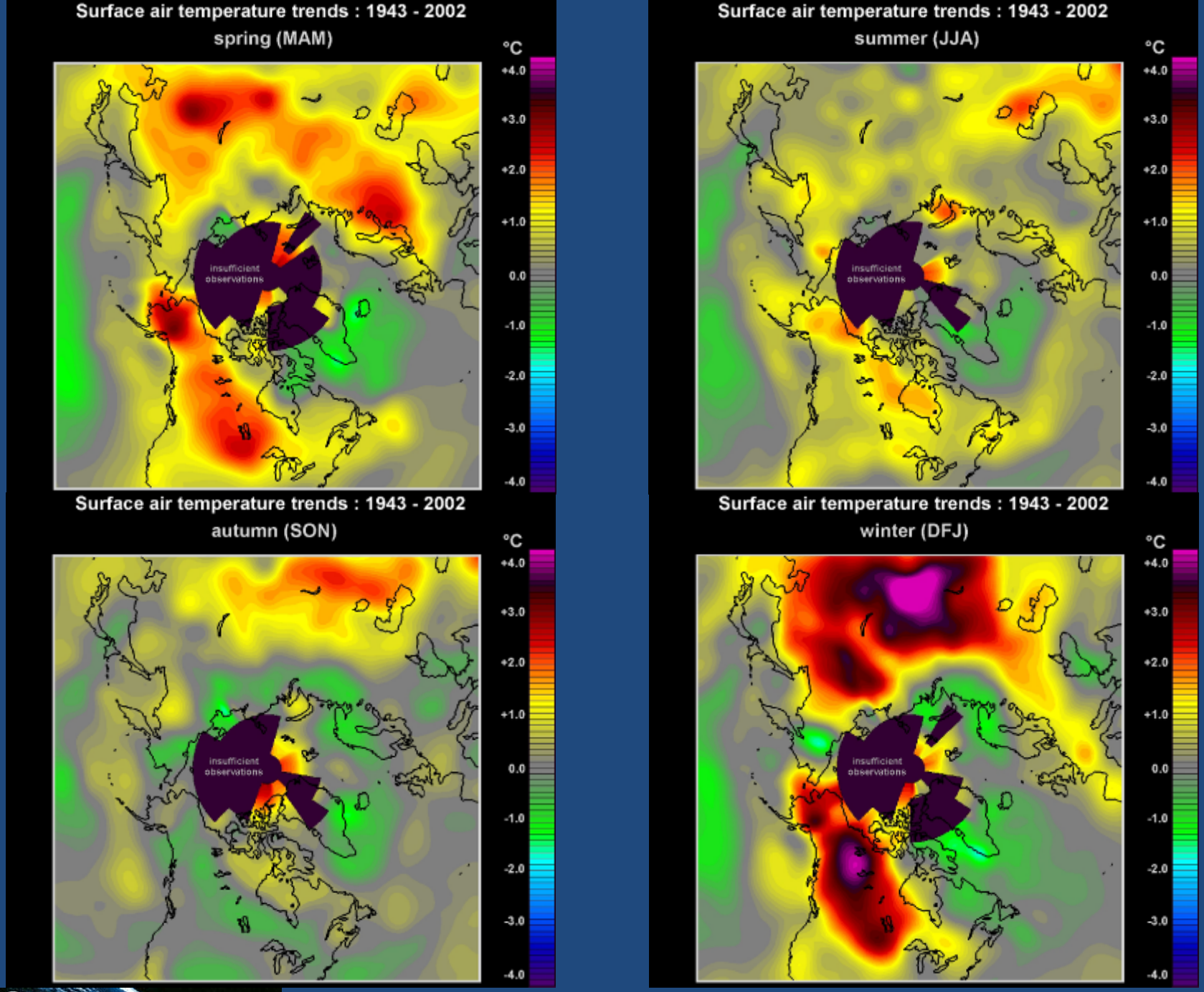


Distribution of Lakes with Increases and Decreases in Surface Water Area

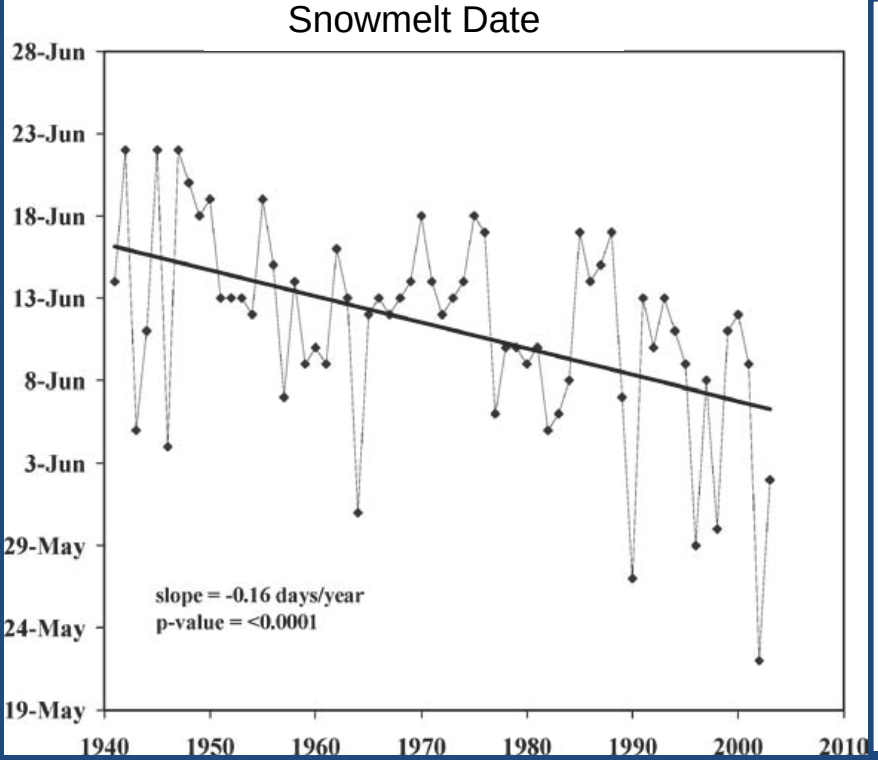


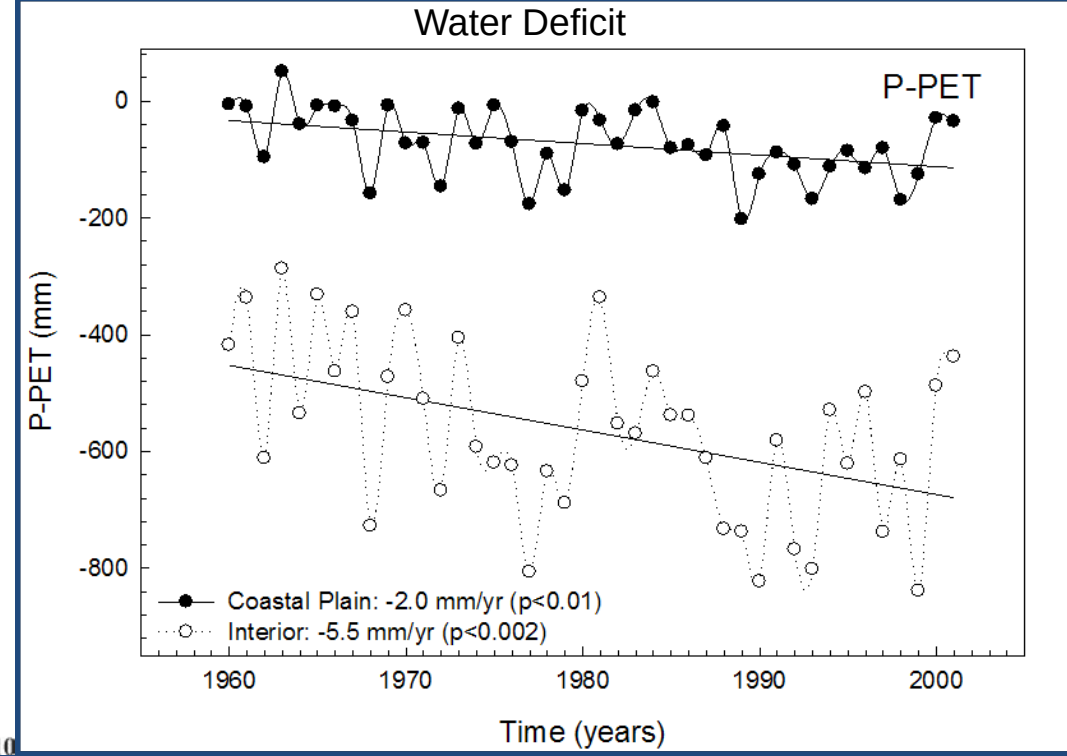


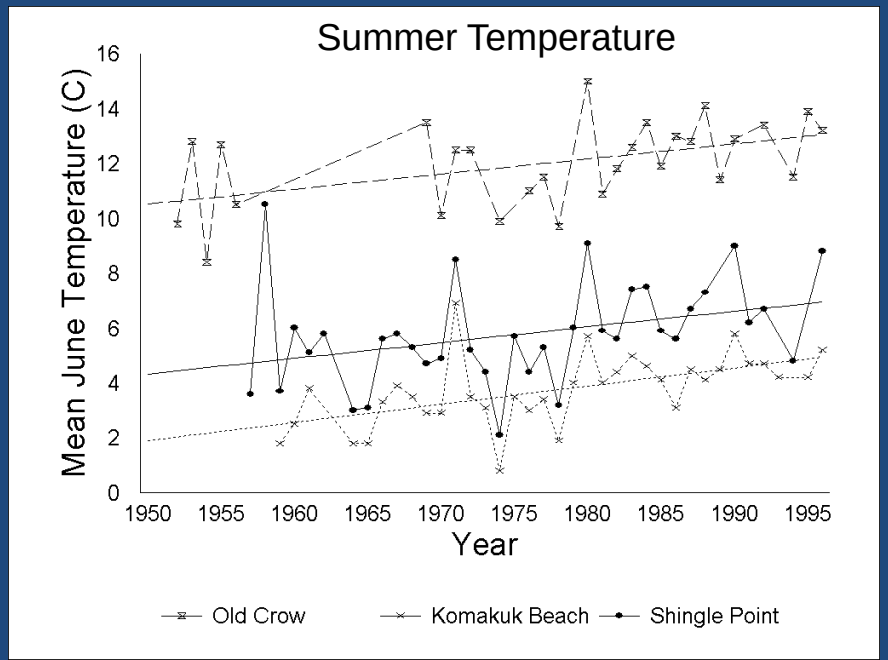
Temporal Heterogeneity



Walsh and Chapman, Univ. Illinois, http://arctic.atmos.uiuc.edu/







Implications for Adaptive Management

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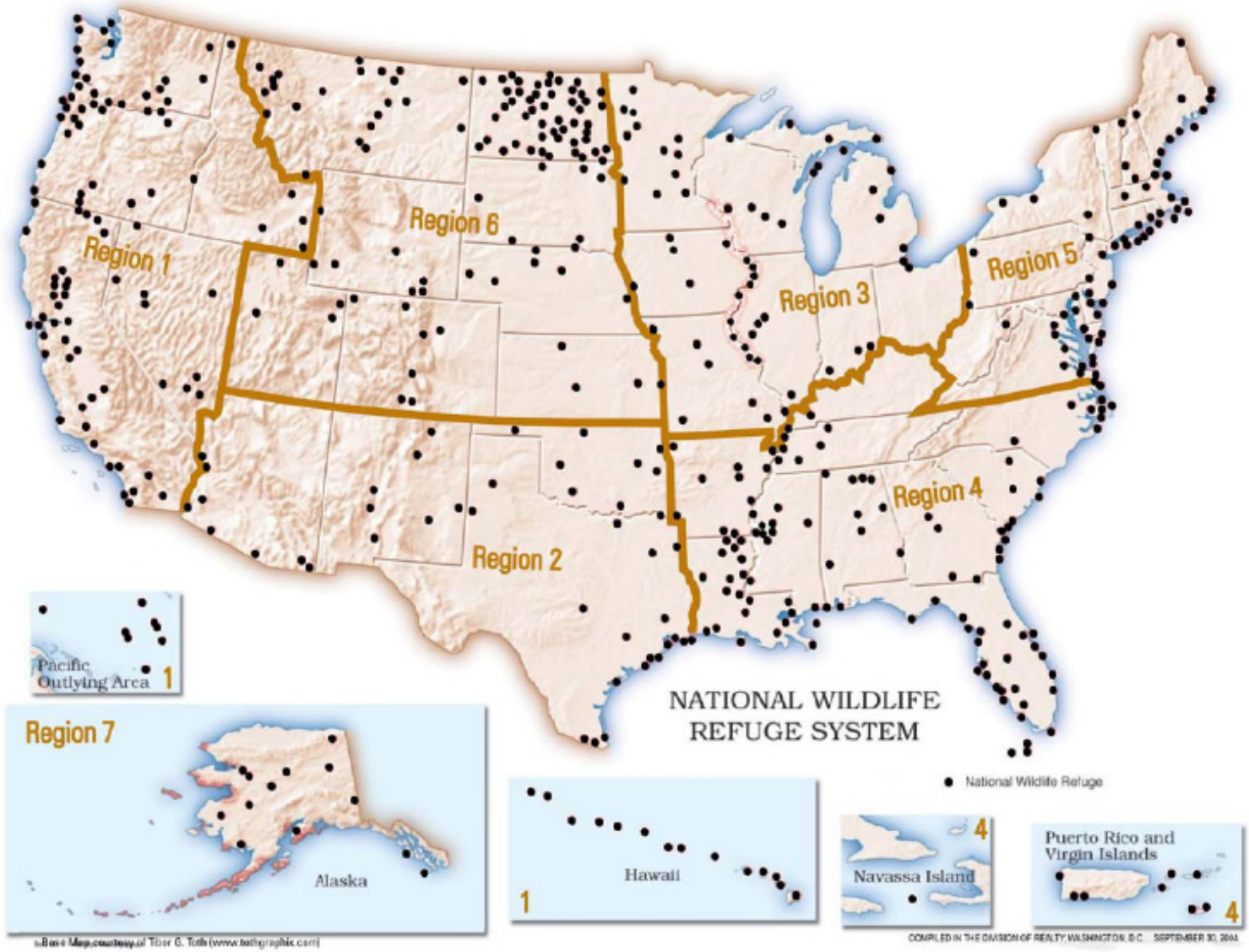
Refuges

U.S. FISH AND WILDLIFE SERVICE

NATIONAL WILDLIFE REFUGE SYSTEM



The Problems with Refuges

- Too Small to consistently provide
  - Genetically
  - Demographically or
  - Evolutionarily viable populations
- Not well connected
- Embedded in an imperfect matrix

Climate Change Increases Complexity

- Lots of “usual” problems
  - Fragmentation, pollution competition for water….
- Climate change adds forcing trends
  - These are not uniform across refuges
  - They may create complex non-linear responses
  - The concept of a stable equilibrium is untenable
- Difficult to project
  - What, when and where
- Biome shifts or Non-analog communities

How to respond to climate change and associated complexities?

- Ignore
- Resist
- Reduce non-climate stressors
- Triage
- Mitigate
- Anticipate and adapt
  - Manage to accommodate and exploit change

Managing to Accommodate Change: Enhancing Resilience of Refuge Systems

- Increase ability to project and monitor
- Focus on dynamic “system state” that
  - Increases Representation
  - Increases Redundancy
- Enhance Partnerships
- Anticipate direction of habitat shifts
- Focus on Connectivity
  - May need to pass species to other entities
- Evaluate projects in context of changing climate

Managing to Accommodate Change: Caveats

- Can't wait for "accurate"predictions
  - opportunities will be lost
- Must use Expert Opinion
- Mistakes will be made
- Adaptive Management will take multiple careers to "execute"

New tools, new ideas and new relationships are needed

- Nontraditional partnerships.
- Thinking across boundaries and scales.
- Thinking across disciplines.
- Reintegration of conservation areas into the American consciousness and landscape (Rosenzweig, 2003).

Summary

- Climate change is pervasive but will have variable effects.
- Exploit opportunities and prepare for negative effects.
- Management for static conservation targets is impractical.
- Species with limited dispersal abilities are at greatest risk.
- Acknowledge interaction among climate & other stressors.
- Act now to avoid irreversible losses (and save $$).
- Model possible futures at all relevant management scales.
- Initiate comprehensive & multi-scale collaborations.
- Increase the effective conservation footprint of refuges.

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