Potential Impacts of Climate Change on Terrestrial Wildlife Habitat

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Wildlife Habitat Policy Research Program

Outline

- Brief project overview.
- What are the threats to wildlife that are attributable to climate change?
- How is wildlife expected to respond?
- Where may climate stress be greatest?
- What are states doing to prepare?
- Questions

Project Overview

Phase 1

- Literature synthesis
  - Review impact of climate change to habitat change
  - Management recommendations
  - How do the SWAPs address climate change

Phase 2

- Climate stress index (national)
  - Temperature, precipitation, production, habitat type

Phase 3

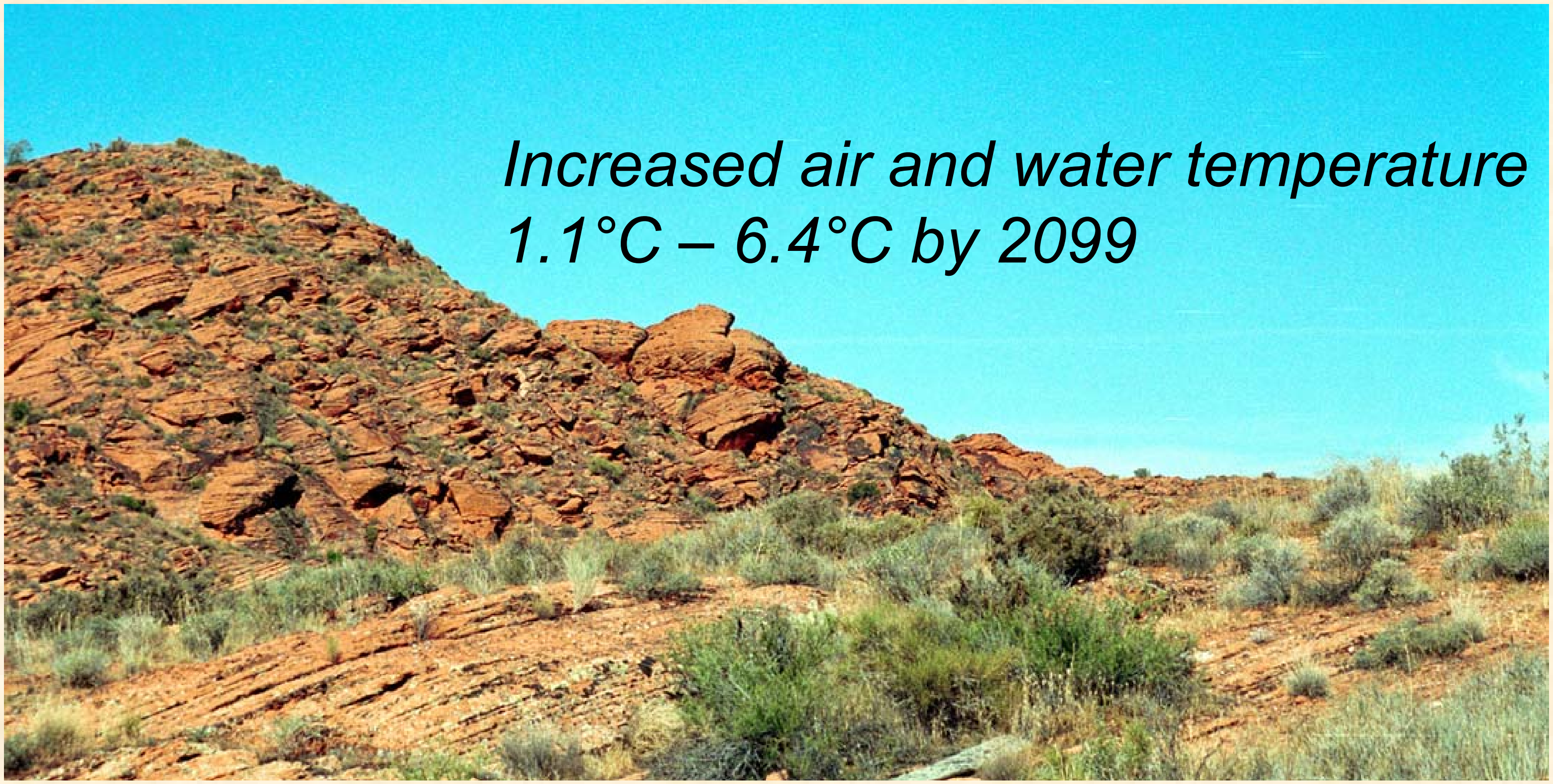
- Case study of 3 hotspots
- Habitat specific stress analyses

Recommendation to States:

How to better address climate change impacts on terrestrial wildlife habitat

Threats associated with climate change

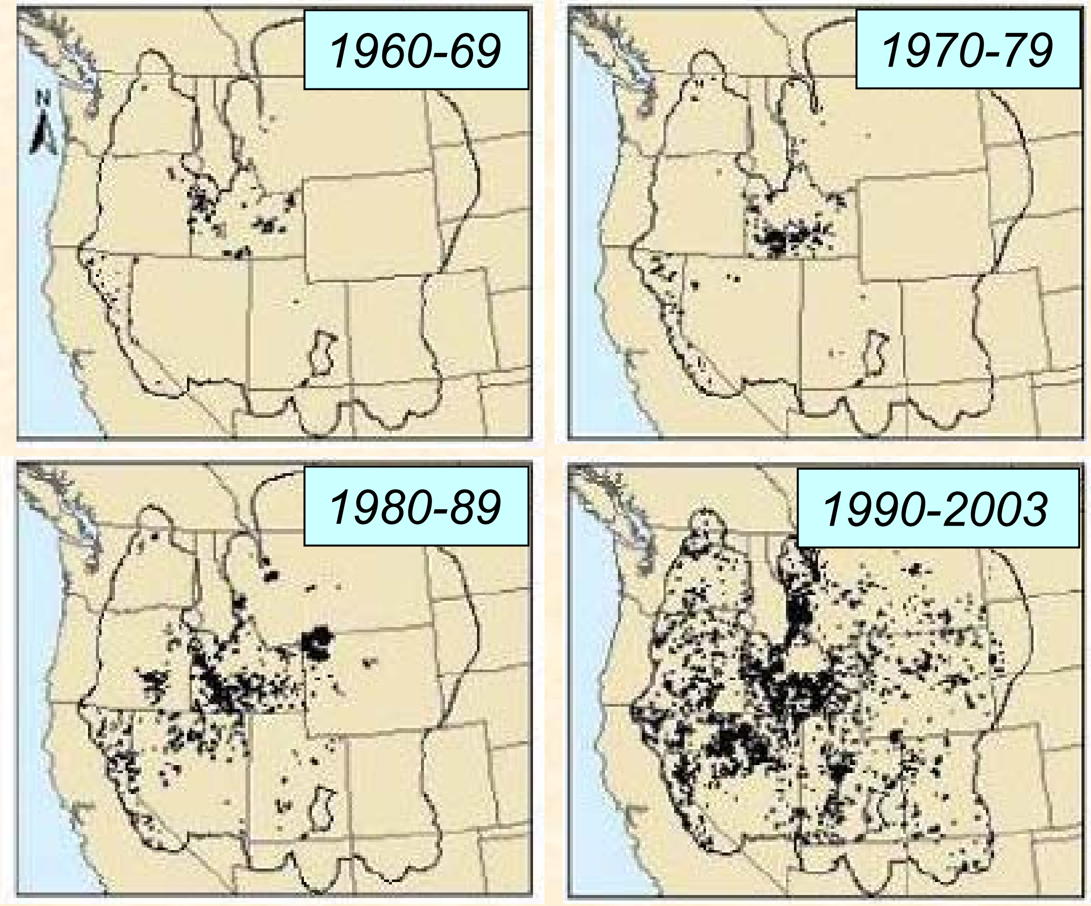
Changes to climate regime



-Changes in precipitation
-Decline in snowpack
-Earlier runoff
-Higher drought stress in summer
-Increase in severe storms

Threats associated with climate change

Changes to disturbance regimes: Fire



Threats associated with climate change

Changes to disturbance regimes: Insects and Disease

Cumulative effect: trigger rapid shifts in vegetation at broad scales

Threats associated with climate change

Climate change intensifies effects of other stressors

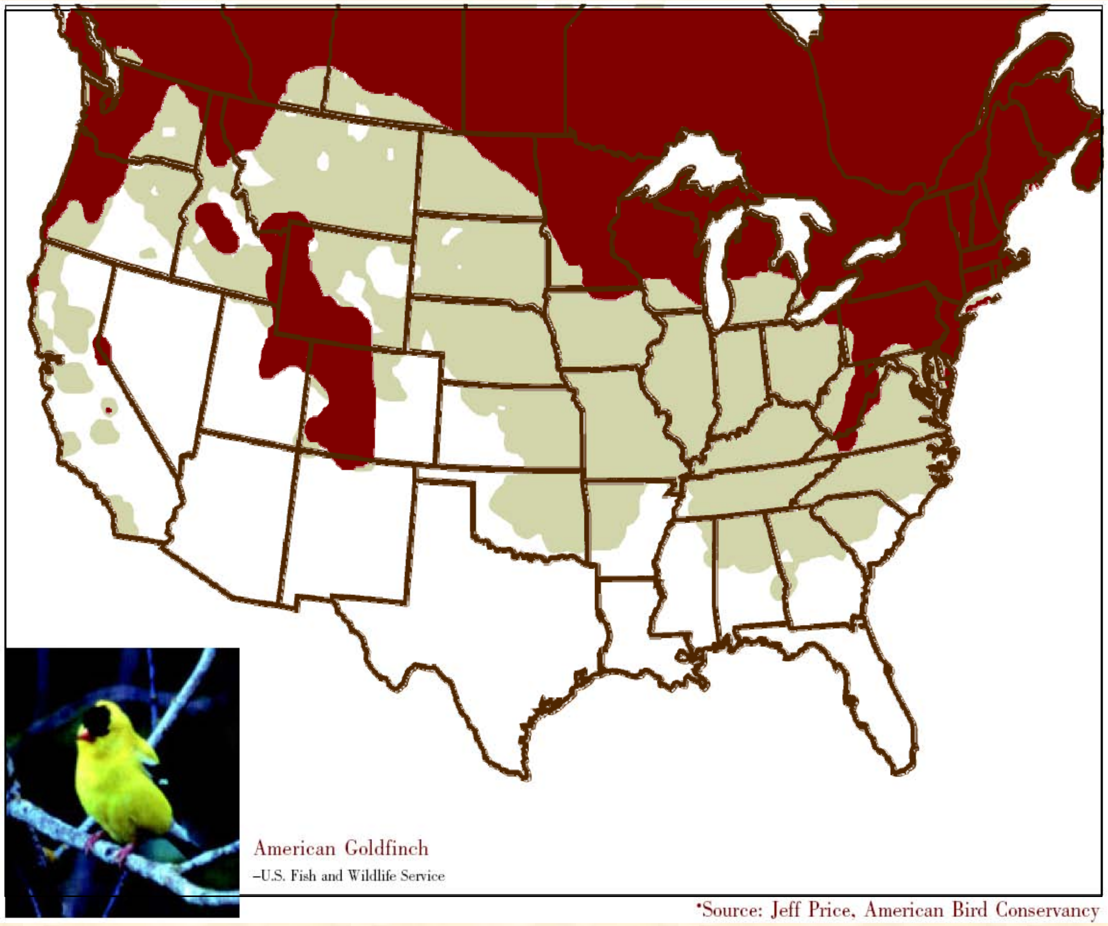
Synergisms between the effects of climate change and other stressors pose the greatest threat to the world's biodiversity

-International Panel on Climate Change 2001

- Habitat loss/fragmentation
- Water diversion
- Air and water pollution
- Disease
- Exotic species
- Low genetic diversity

Wildlife responses to climate change

Shifts in geographic range



Wildlife responses to climate change

Shifts in geographic range

Changes to population abundance

26-58% decline in ducks due to projected drought in the Prairie Pothole Region (Sorenson et al. 1998)

Wildlife responses to climate change

Shifts in geographic range

Changes to population abundance

Breeding/migration phenology change

Potential for mistimed food resources, leading to lower reproduction and survivorship

Wildlife responses to climate change

Shifts in geographic range

Changes to population abundance

Breeding/migration phenology change

Changes in trophic relationships

↑ temp

↑ tick population

↓moose foraging

↑ moose infestation

↑ wolf predation

↑ wolf pop (short term)
↓ wolf pop (long term)

Wildlife responses to climate change

Shifts in geographic range

Changes to population abundance

Breeding/migration phenology change

Changes in trophic relationships

Changes in morphology

13% decline in body size among woodrats in New Mexico (Smith et al. 1998)

Wildlife responses to climate change

Shifts in geographic range

Changes to population abundance

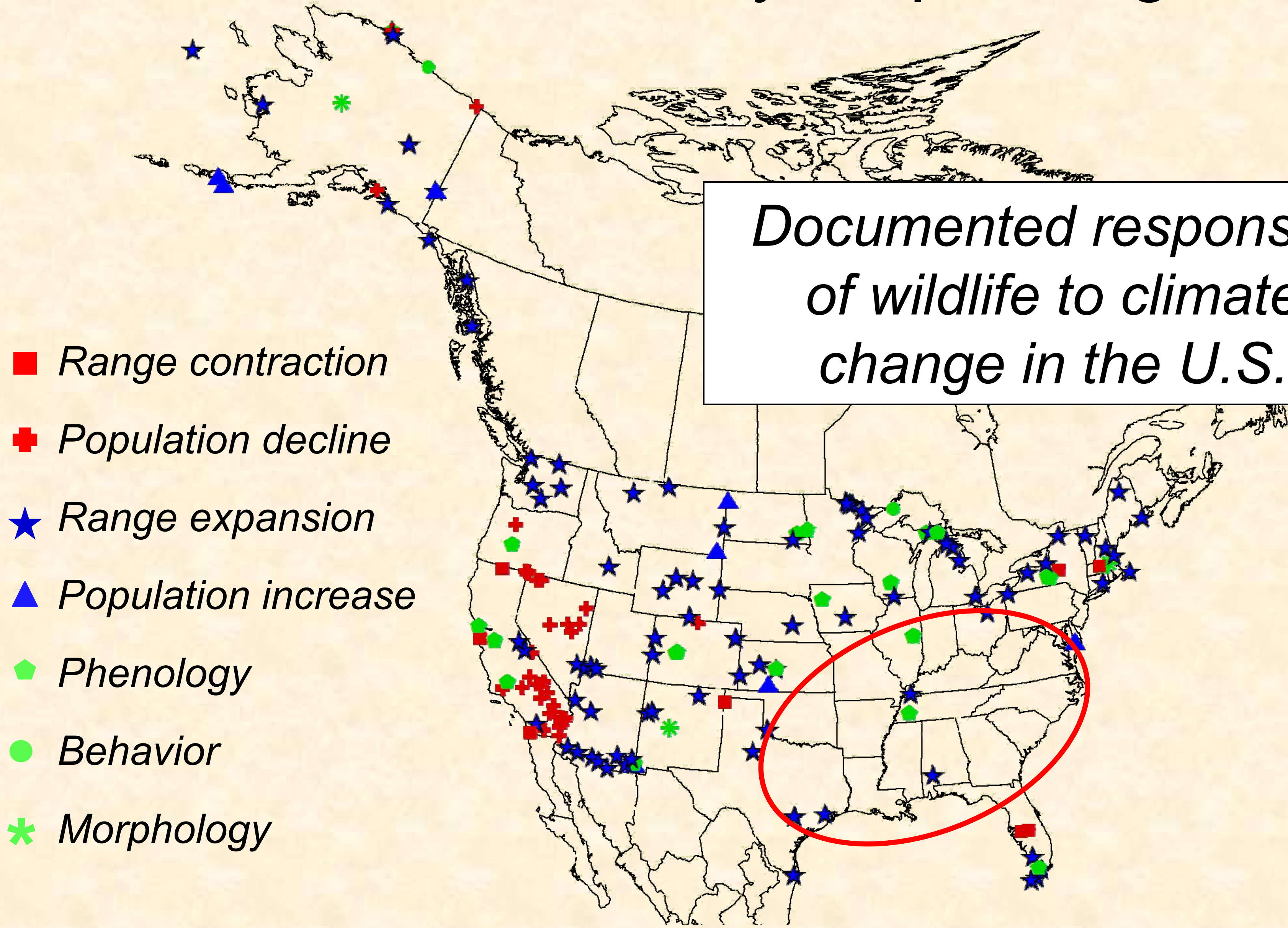
Breeding/migration phenology change

Changes in trophic relationships

Changes in morphology

Extinction

Are wildlife already responding?



Documented responses of wildlife to climate change in the U.S.

Outline

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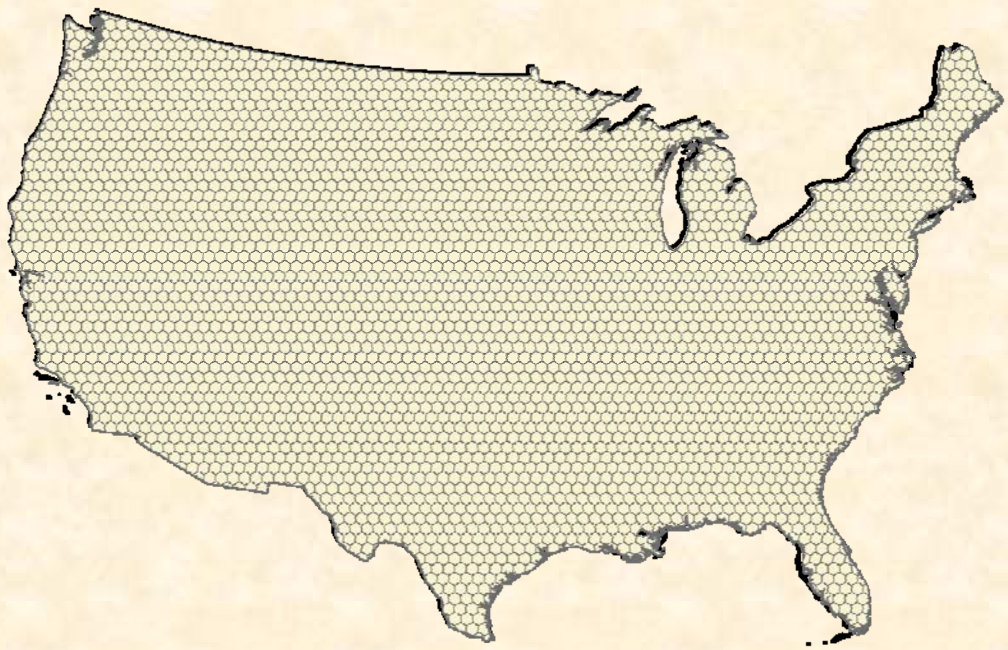
- How is wildlife expected to respond?
- Where may climate stress be greatest?
- What are states doing to prepare?

Identifying Areas of Climate Stress

Issues of Scale – extent and grain

Spatial

- Extent = coterminous US
- Grain = hexagonal grid
  - Equal area
    area ≈ ½º x ½º



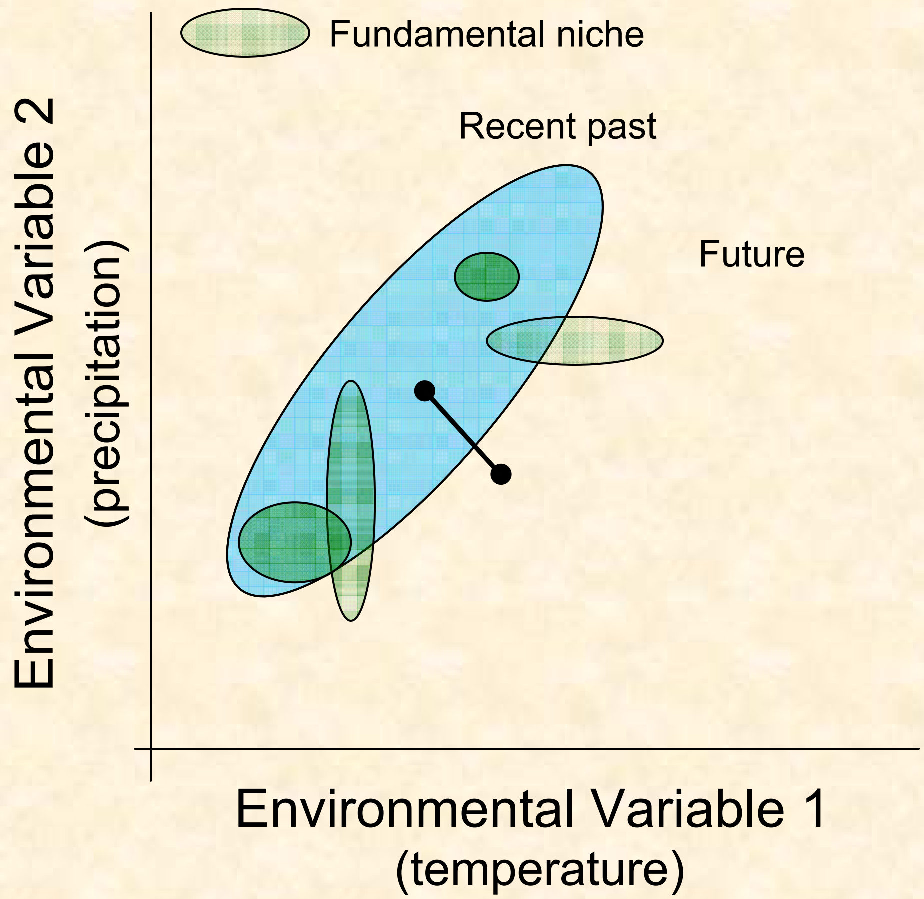
Temporal

- Two 50-yr time periods
  time 1: 1950-1999
  time 2: 2050-2099

Identifying Areas of Climate Stress

Components of climate stress

- Shift in climate regime
  (temperature, precipitation)
- Habitat quality effects
  (production)
- Habitat area effects
  (vegetation dissimilarity)



Identifying Areas of Climate Stress

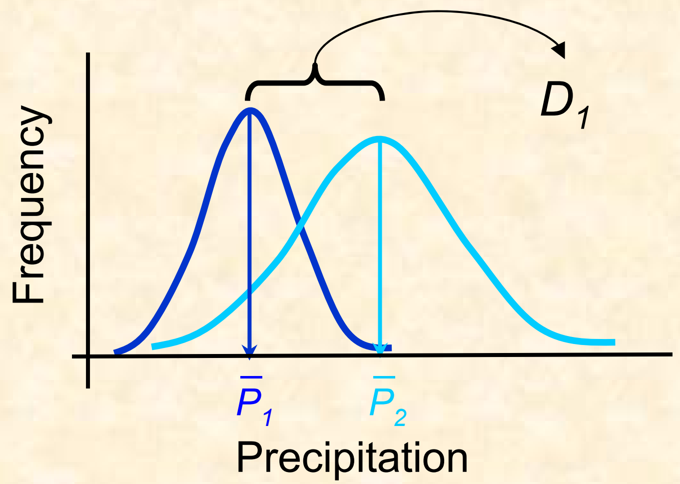
The Climate Stress Index

$$CSI_i = \sum (\underbrace{CSt_i, CSp_i}_{\text{Climate Shift Effects}},$$

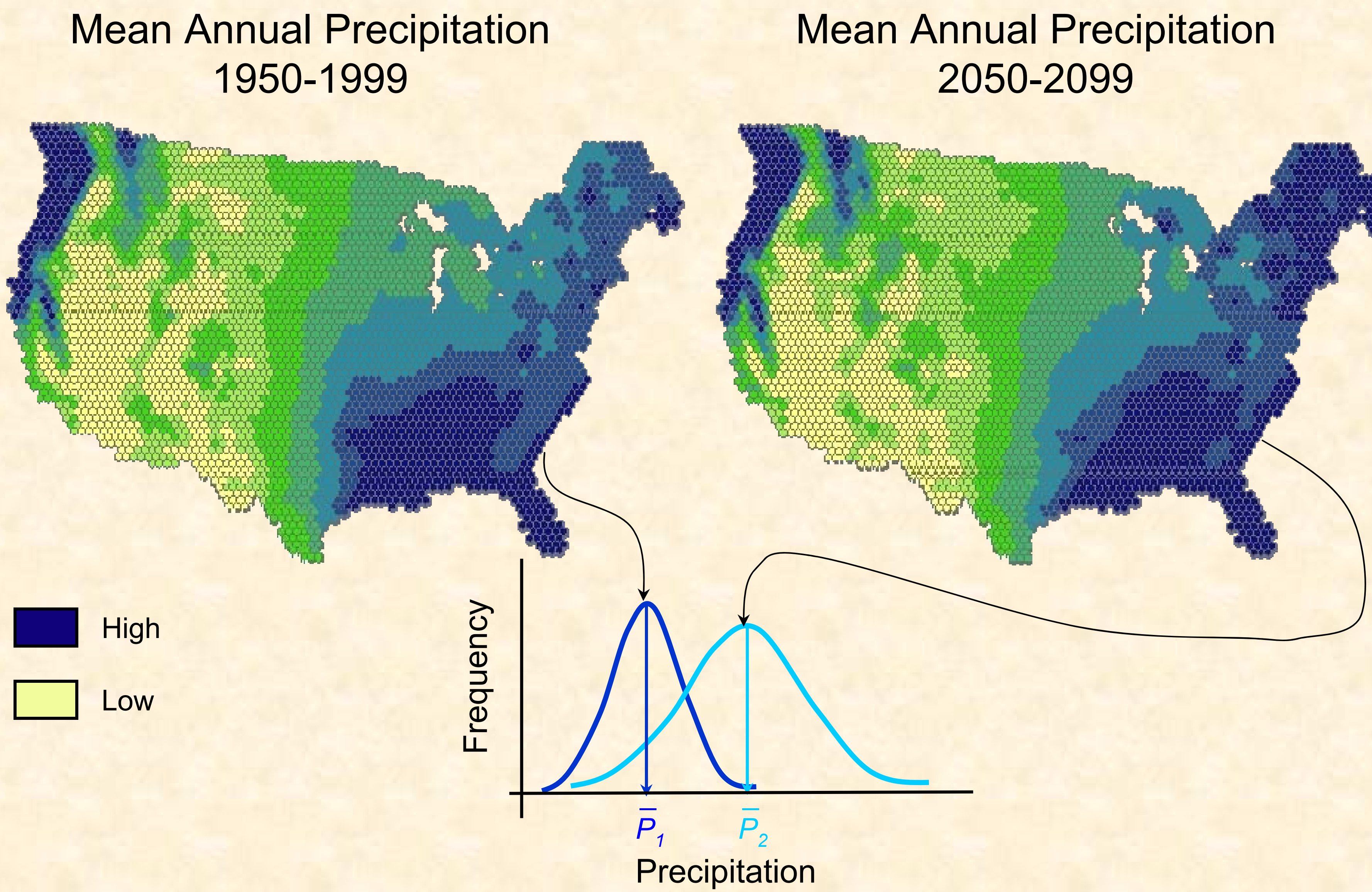
where, *i* indexes equal-area hexagon

Climate Shift Effects

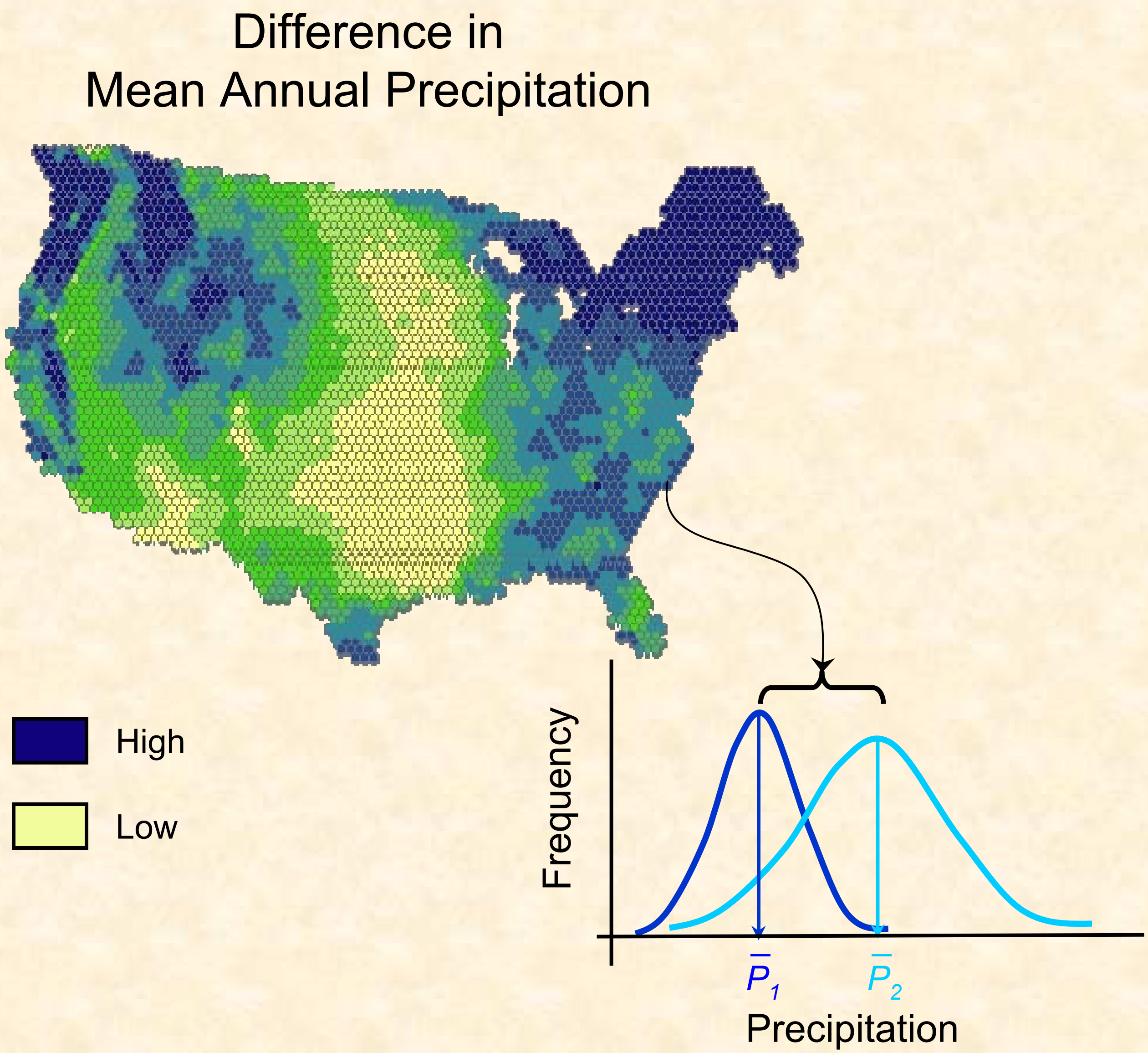
statistical distance
t – temperature
p - precipitation



Identifying Areas of Climate Stress



Identifying Areas of Climate Stress



Identifying Areas of Climate Stress

$$CSI_i = \sum \left(\underbrace{CSt_i, CSp_i}, \underbrace{P_i}, \underbrace{A_i}\right)$$

where, *i* indexes equal-area hexagon

Climate Shift Effects

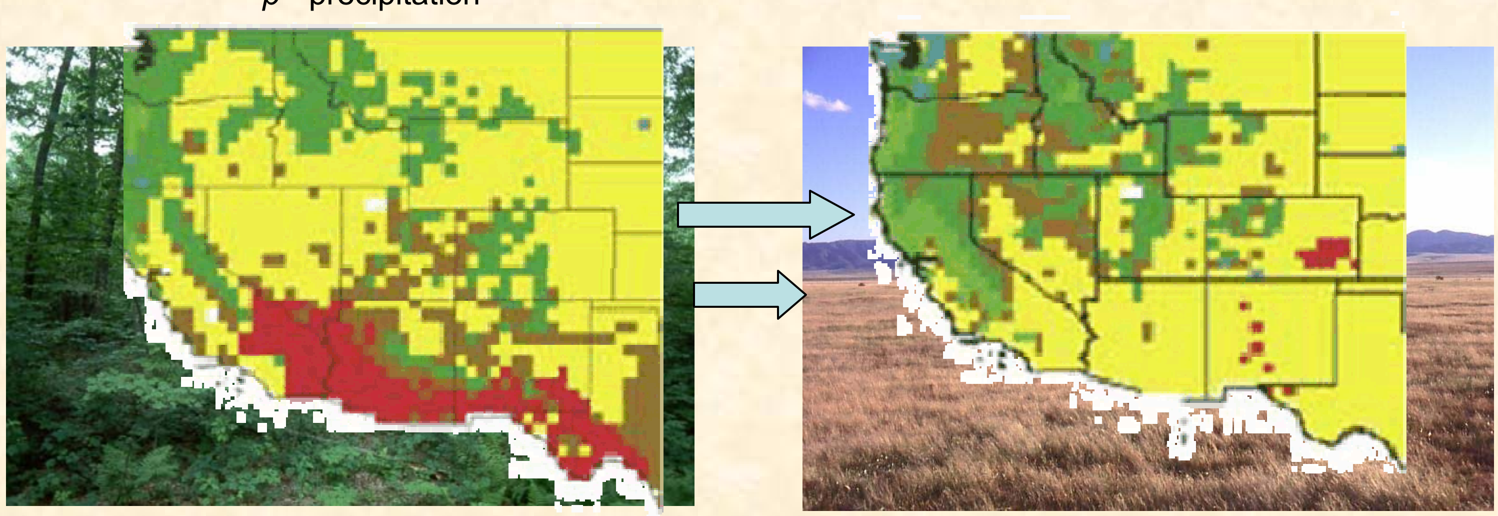
statistical difference
t – temperature
p - precipitation

Habitat Quality Effects

statistical distance in production

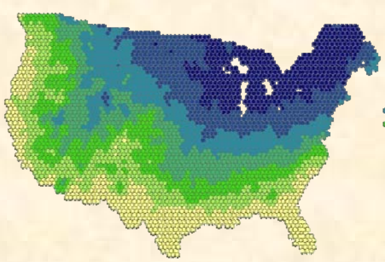
Habitat Area Effects

dissimilarity in habitat types

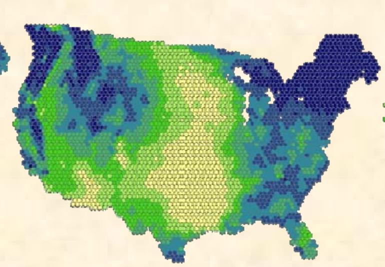


Identifying Areas of Climate Stress

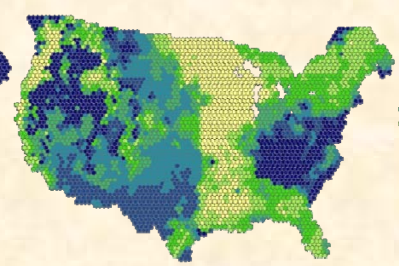
$$CSI_i = \sum (CSt_i, CSp_i, P_i, A_i)$$



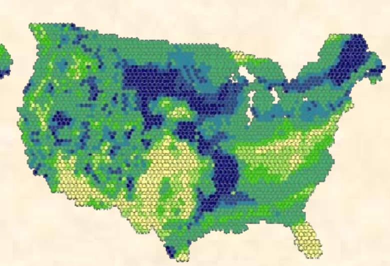
Δ Temperature



Δ Precipitation



Δ Production

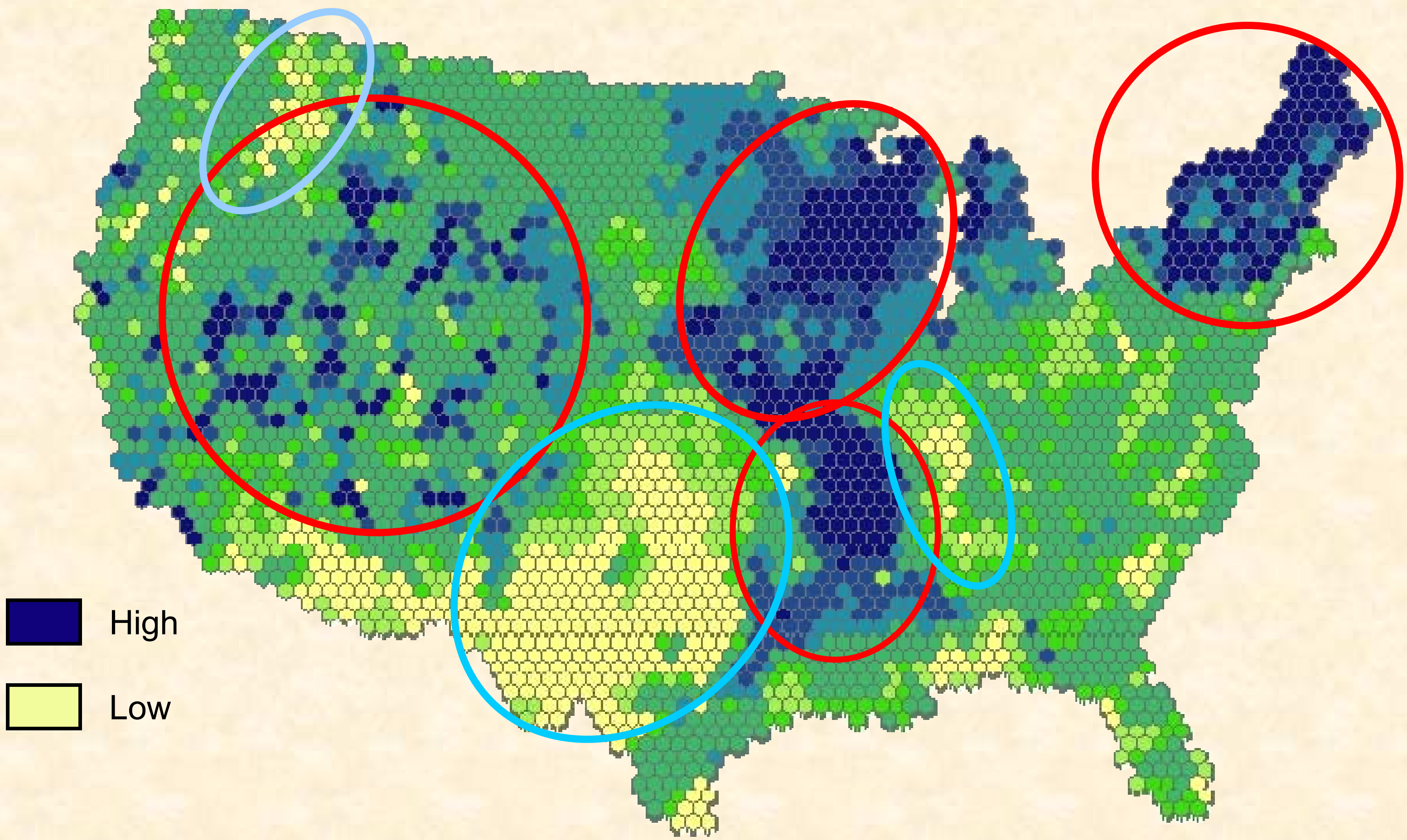


Area Effects

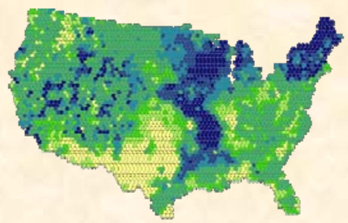
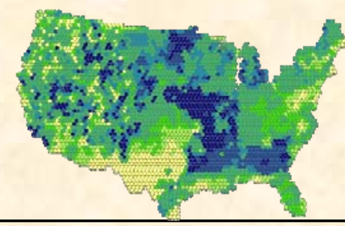
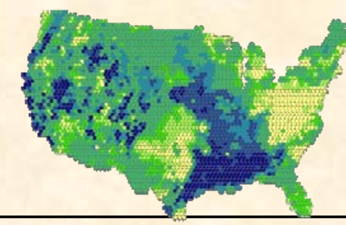
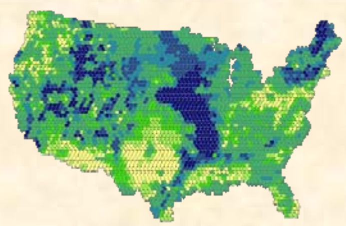
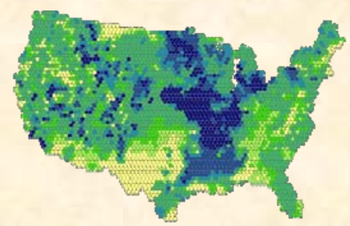
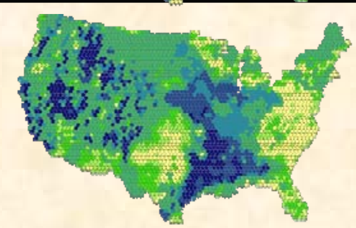
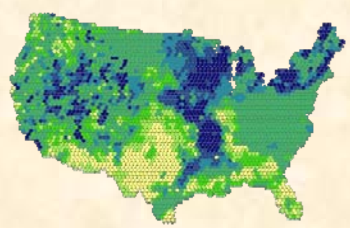
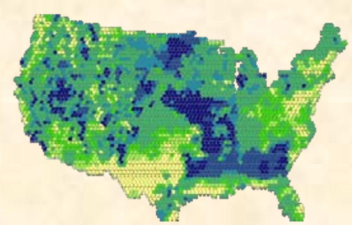
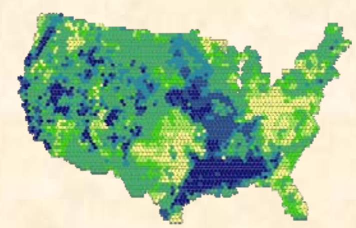
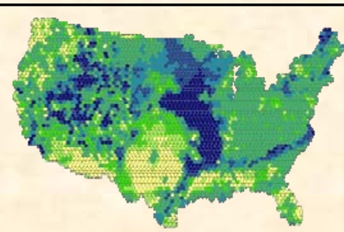
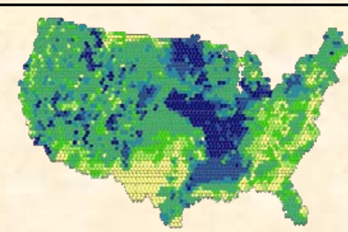
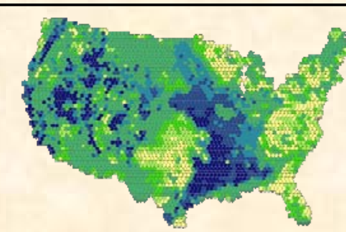
Scale all terms to vary 0 ⟶ 1

Identifying Areas of Climate Stress

$$CSI_i = \sum (CSt_i, CSp_i, P_i, A_i)$$

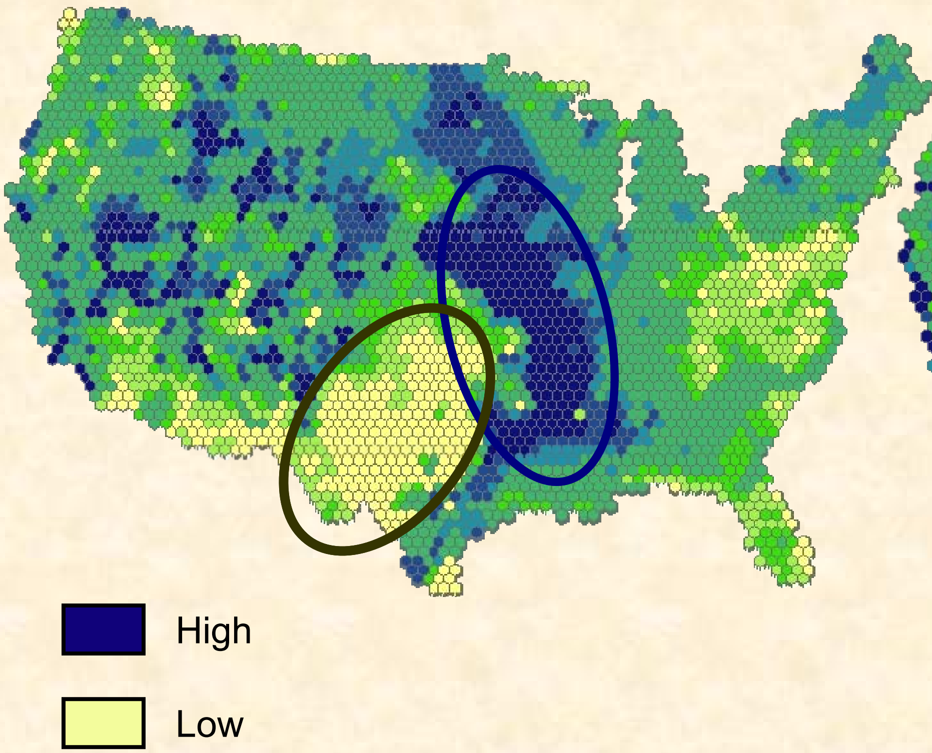


Identifying Areas of Climate Stress

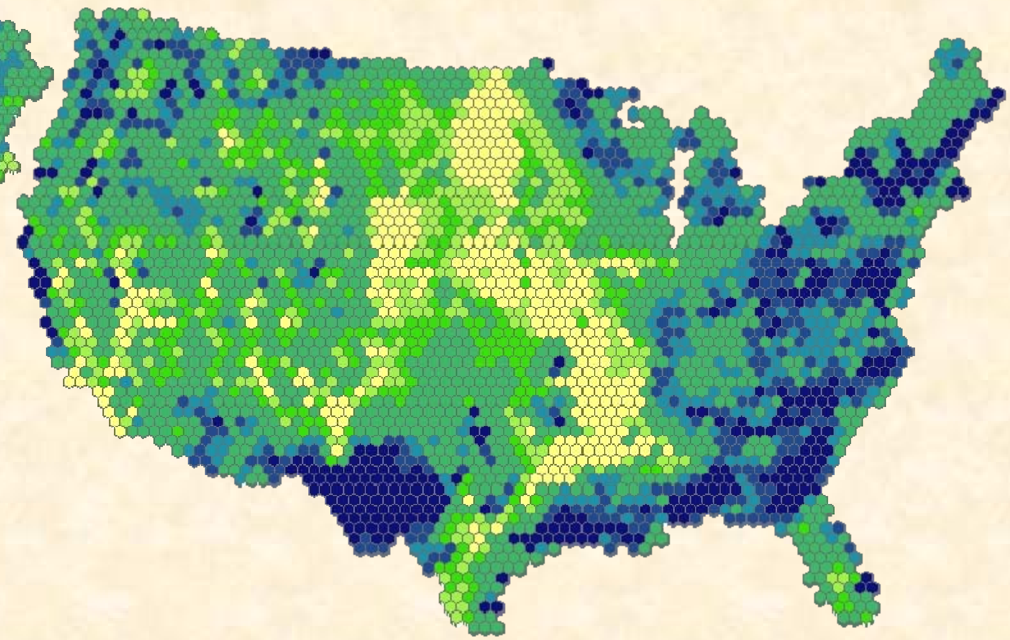
IPCC Scenario and Response to CO_2	Climate Model		
	CSIRO	CGCM	HADLEY
A2 Low			
B2 Low			
A2 High			
B2 High			

Identifying Areas of Climate Stress

Composite

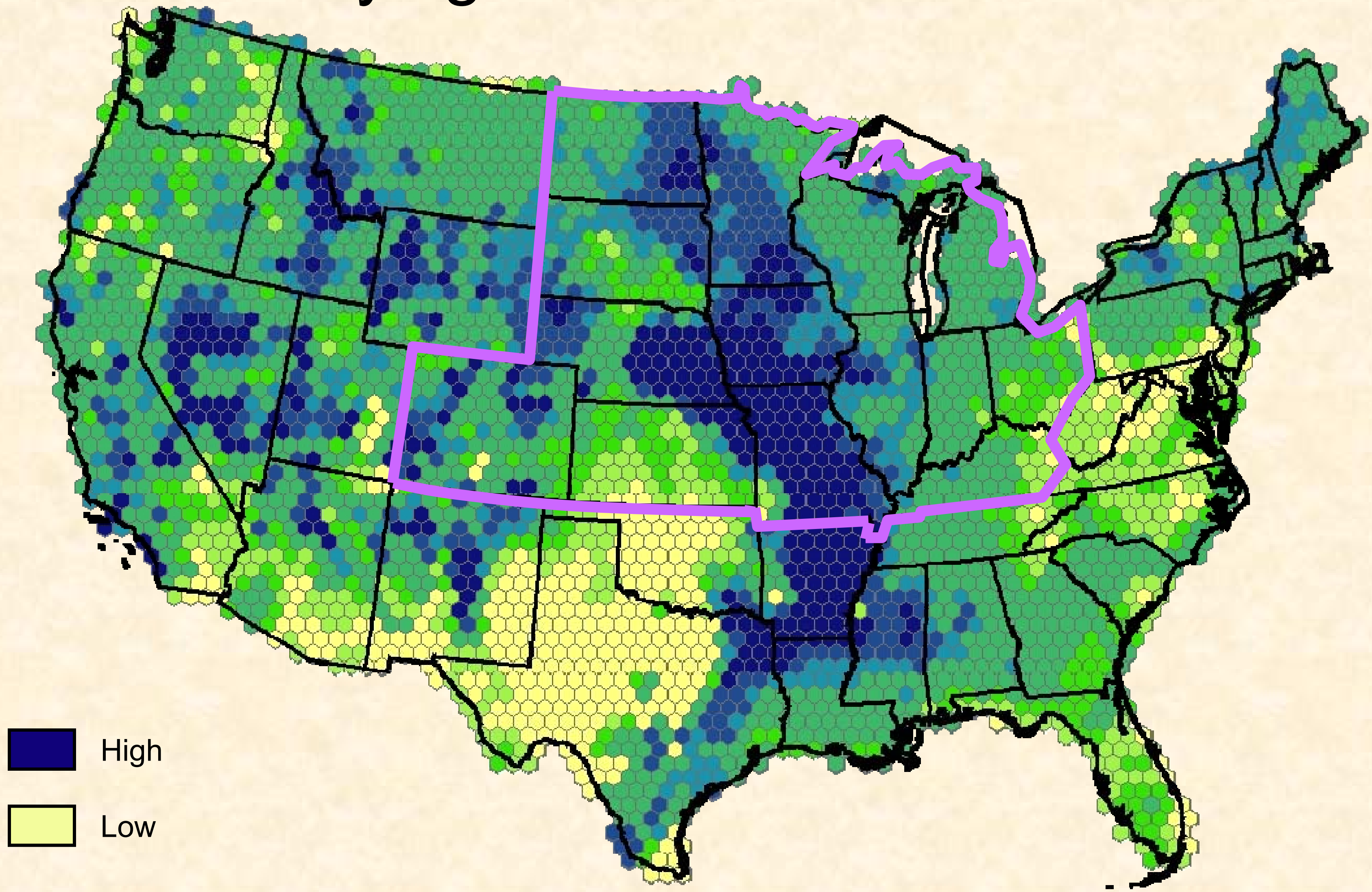


Coefficient of Variation



Variation of CSI is generally low in high stress areas, high in low stress areas.

Identifying Areas of Climate Stress



Composite Climate Stress Index -- 12 scenarios

What are the States doing to prepare?

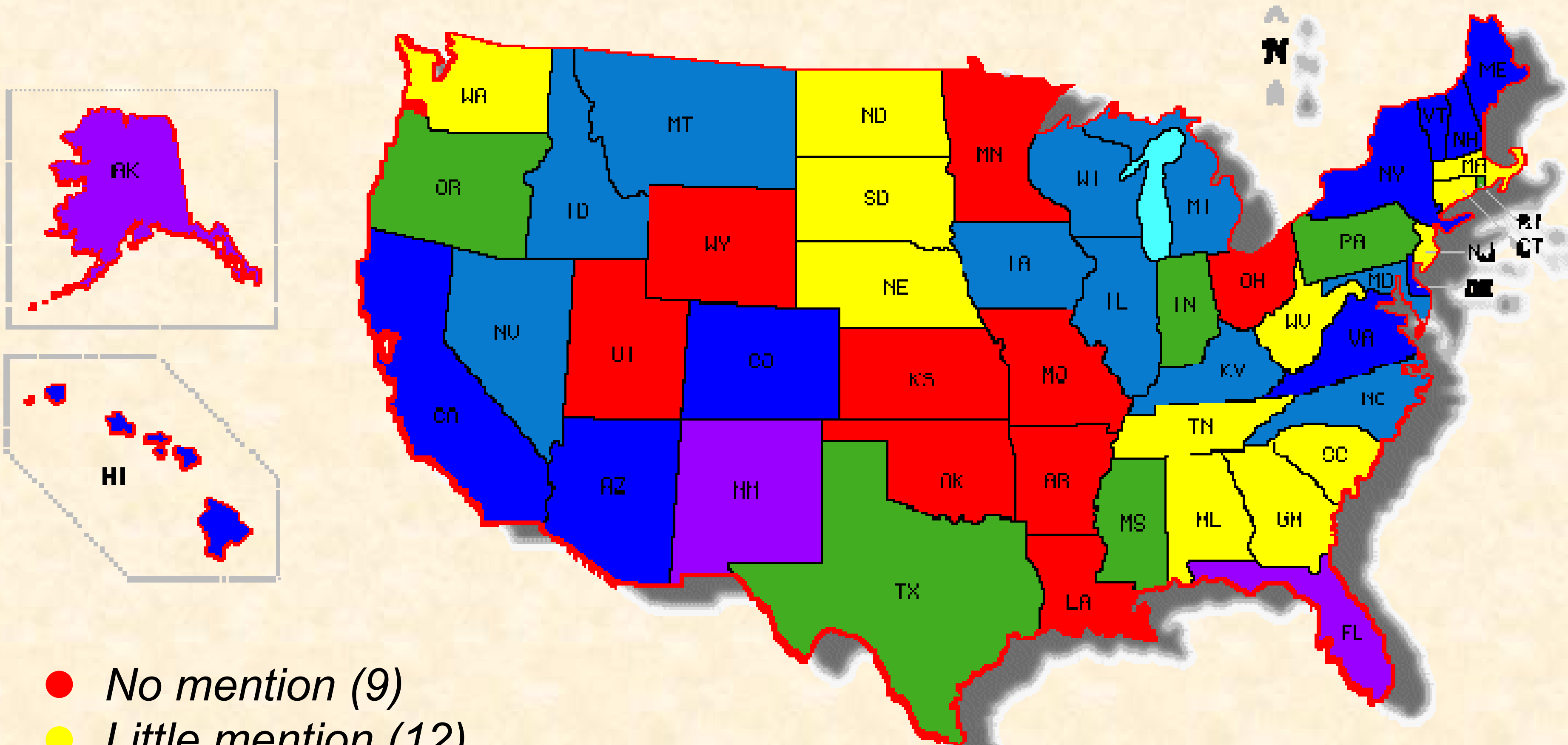
State Wildlife Action Plans (SWAPs)

Completed by all states in 2005 as mandated by Congress.

Purpose is to help conserve wildlife and vital natural areas before they become more rare and more costly to protect.

Goal is for plans to be proactive and address the needs of all wildlife in every state.

What are the States doing to prepare?



- *No mention (9)*
- *Little mention (12)*
- *Addressed, but not specific to wildlife or habitat (5)*
- *Addressed as threat to some species or habitats (10)*
- *Included management recommendations (11)*
- *Thorough assessment with recommendations (3)*

How helpful is the literature?

<u>What management recommendations have appeared?</u>

No Recommendations Offered	32%	57%
More Research	25%	
Management or Policy	43%	

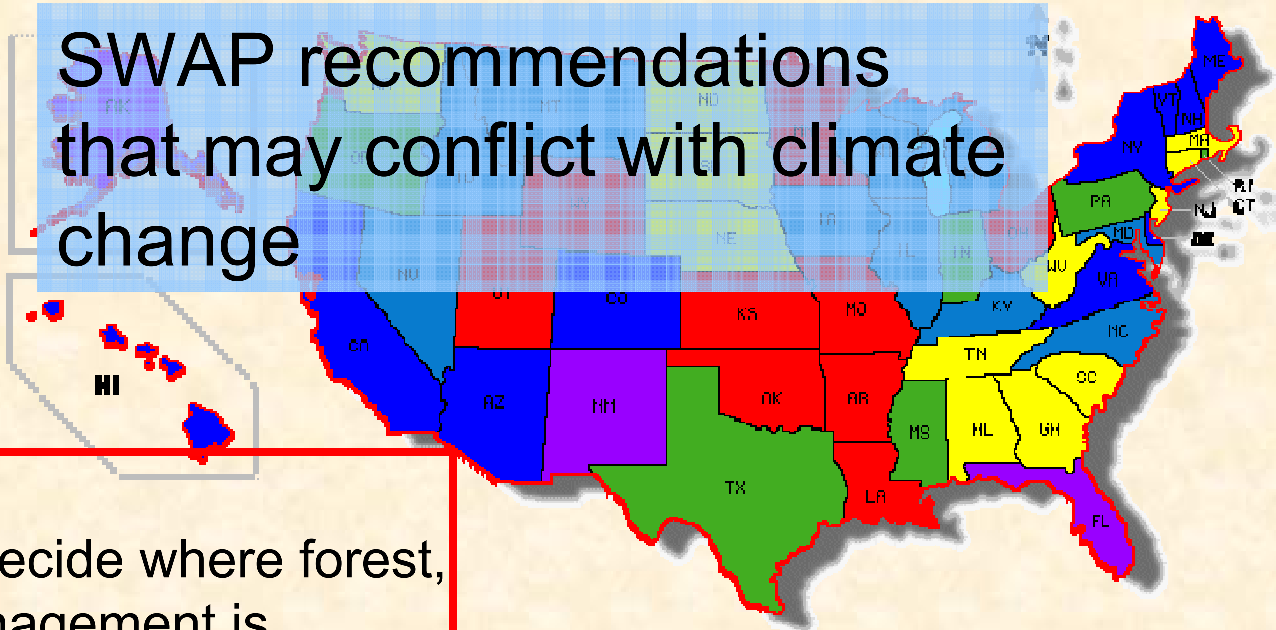
Comparing the SWAPs to the literature?

	SWAPs	Lit.
NO RECOMMENDATIONS	50%	32%
More research and/or modeling ONLY	8%	25%
	58%	*57%*
POLICY		
Policy changes (water policy, etc.)	26%	6%
Reduce greenhouse gas emissions	16%	14%
EDUCATION & COMMUNICATION		
Collaboration	16%	8%
Inform managers	2%	1%
Education	16%	0%

Comparing the SWAPs to the literature?

	SWAPs	Lit.
ON-THE-GROUND MANAGEMENT		
Restoration/Resiliency	20%	11%
Land conservation	16%	13%
Habitat manipulation	6%	13%
Adaptive/flexible management	2%	8%
Translocation	2%	13%
Connectivity	14%	6%

SWAP recommendations that may conflict with climate change



Alaska – Maintain Kittzletz's Murrelets within historical distribution and natural population levels

Illinois – Analyze historic vegetation to decide where forest, prairie or savanna management is appropriate

Maine – Maintain large contiguous tracks of mature spruce-fir forest

Montana – Maintain small populations of hoary marmot found on the periphery of their distribution

Nevada – Sustain wildlife in intact alpine and tundra habitats

Missouri – Translocate Greater Prairie Chickens to previously occupied habitat

Alabama – Avoid conversion of dry hardwood forest to other forest types

How might managers need to adapt?

CHANGE

- Return to species-based management
- Manage outside the historical range of variation
- Translocate species
- Use new criteria to prioritize areas
- Increase hands-on management
- Work across boundaries

CONTINUE

- Restore ecological processes to increase resilience
- Control invasive species
- Monitor populations
- Increase connectivity and amount of protected habitat
- Maintain biodiversity within and among species

Questions ?

Applications of Climate Stress Index

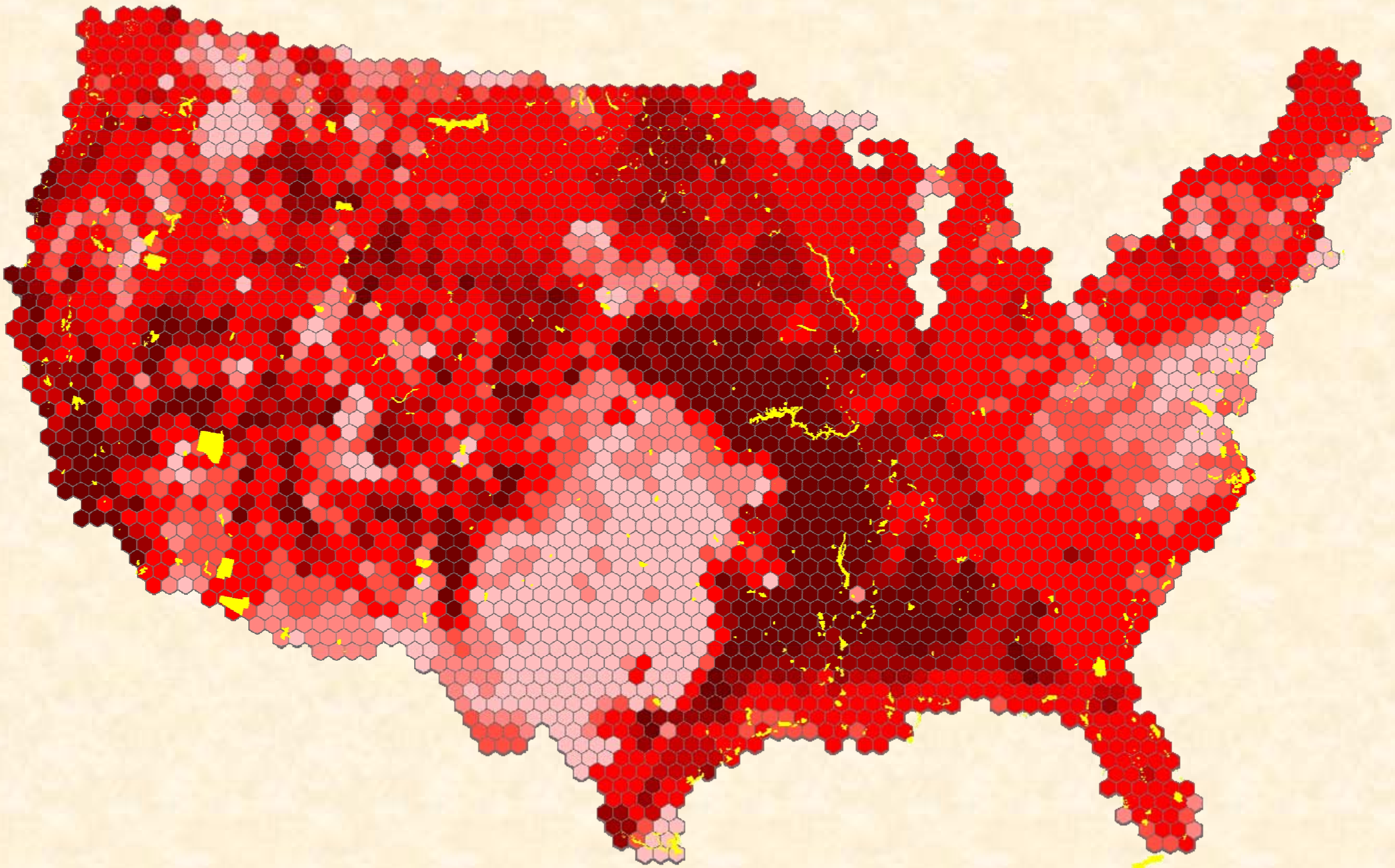
- *Wildlife corridor initiative with the Western Governors' Association*

  - *using climate stress to prioritize landscapes in need of corridors*

- *Fish and Wildlife Service's Land Acquisition Program*

  - *using climate stress to rank Refuges by degree of stress*

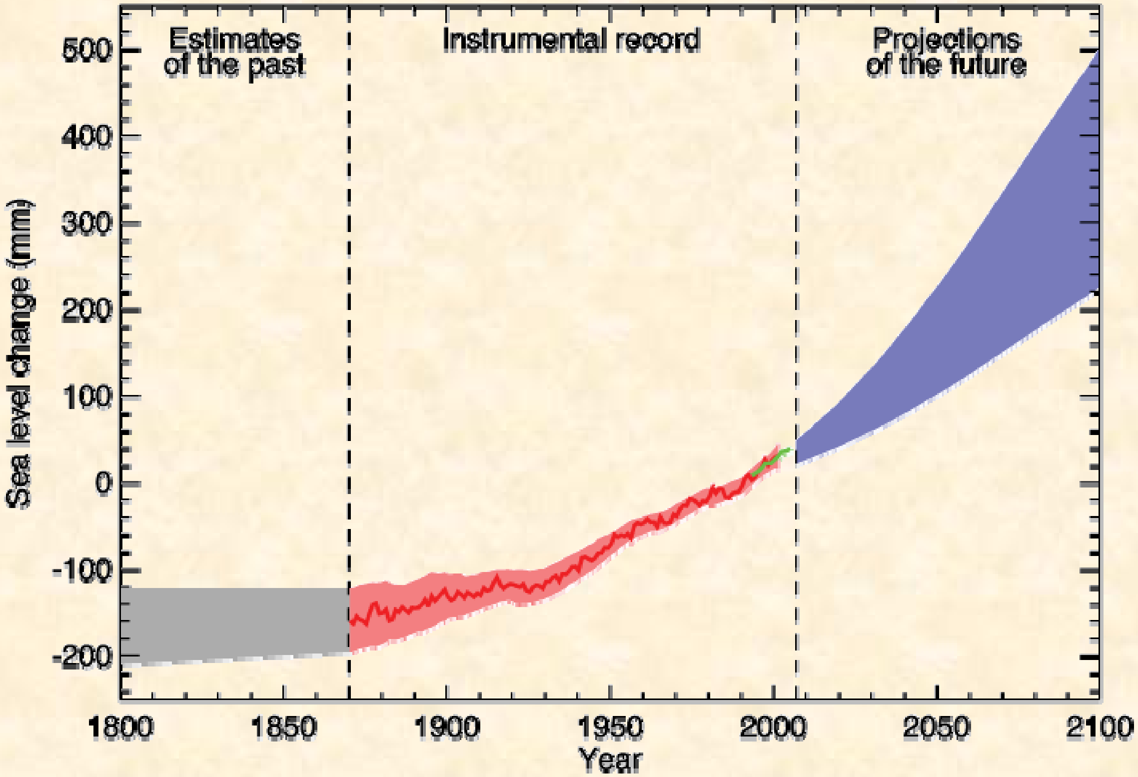
Applications of Climate Stress Index



Threats associated with climate change

Increase in global average sea level

At current rates, sea level will rise ~0.5 - 2m by 2099



- A 1-meter rise could drown approx. 25 – 80% of the U.S. coastal wetlands and 5,000 – 10,000 miles^2 of dryland (IPCC 2007).

Wildlife responses to climate change

Shifts in geographic range

Changes to population abundance

30 bird species projected to INCREASE in abundance or range (>25%)

Scissor-tailed Flycatcher
Mississippi Kite
Loggerhead Shrike
Northern Cardinal
Fish Crow
Northern Cardinal

Wildlife responses to climate change

Shifts in geographic range

Changes to population abundance

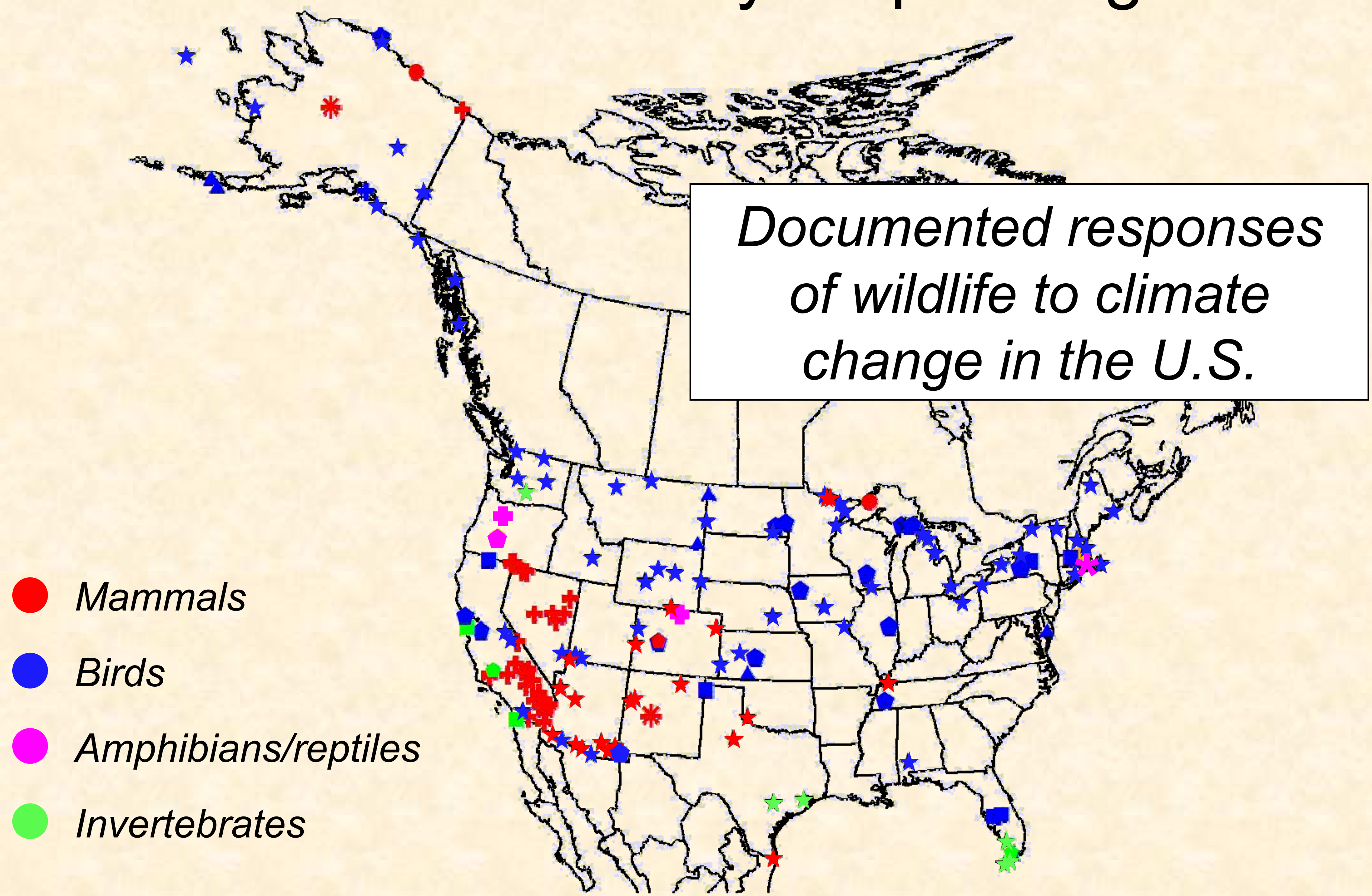
Breeding/migration phenology change

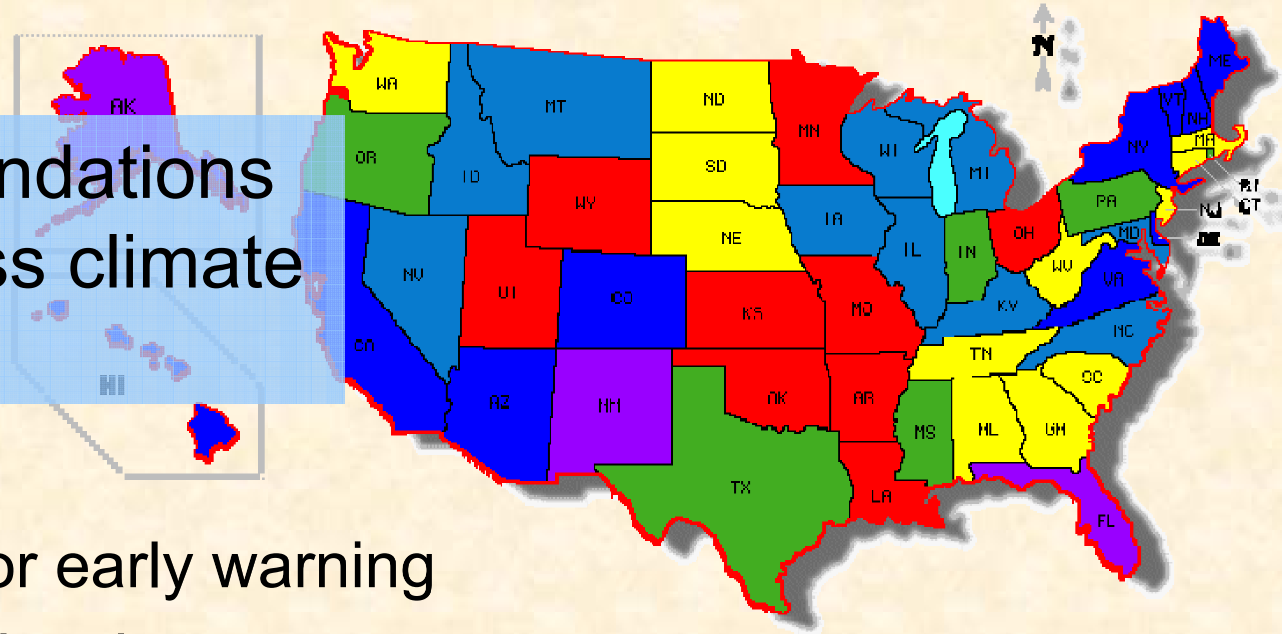
Changes in trophic relationships

↓ snowpack → ↓ wolf predation → ↑ moose populations → ↓ Balsam fir

(Schmitz et al. 2003)

Are wildlife already responding?





SWAP recommendations to directly address climate change

Alaska – Monitor for early warning

Illinois – Minimize local stressors

Vermont – Maintain forest connectivity

Nevada – Control pinyon-juniper encroachment

Colorado – Reduce CO^2 emissions

Florida – Relocate species

New Mexico – Obtain water rights for wildlife

Massachusetts – Regional, national, and international cooperation