

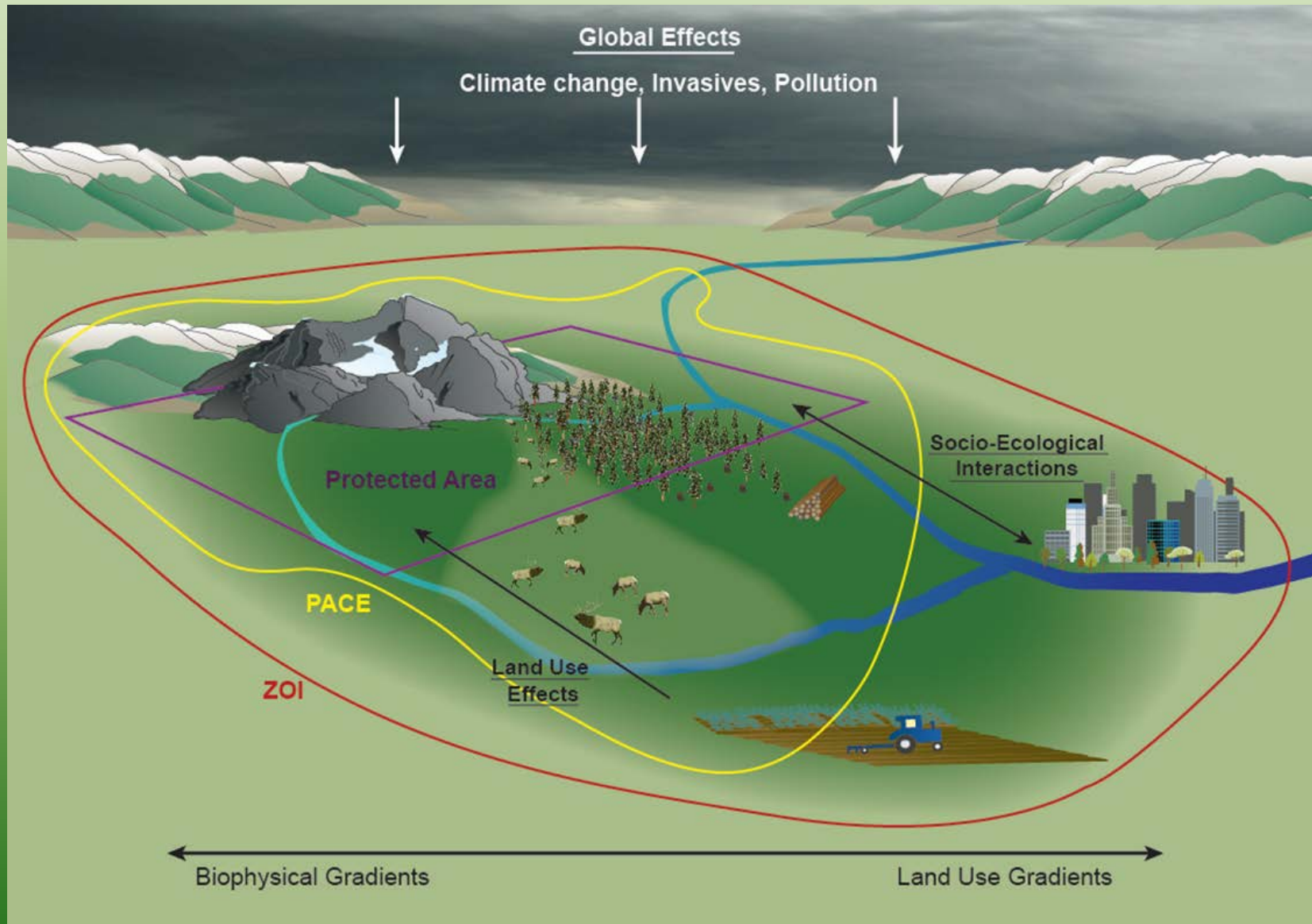
# Exposure of US National Parks to Land Use and Climate Change 1900-2100

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Haas, David Theobald, John Gross, William Monahan,  
Tom Olliff, Steve Running

**Ecological Applications (In Press)**



# Vulnerability of Protected Areas

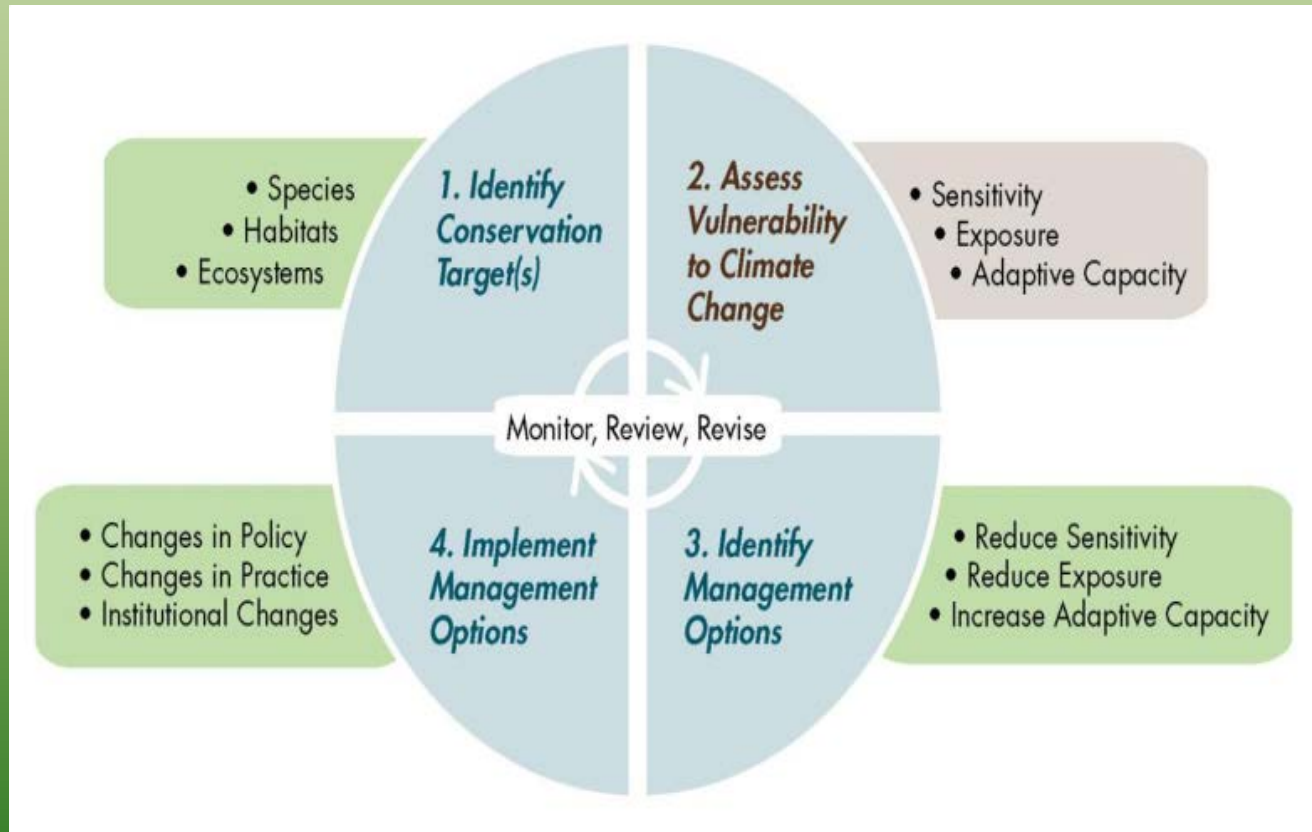


# Challenges to Managing under Global Change

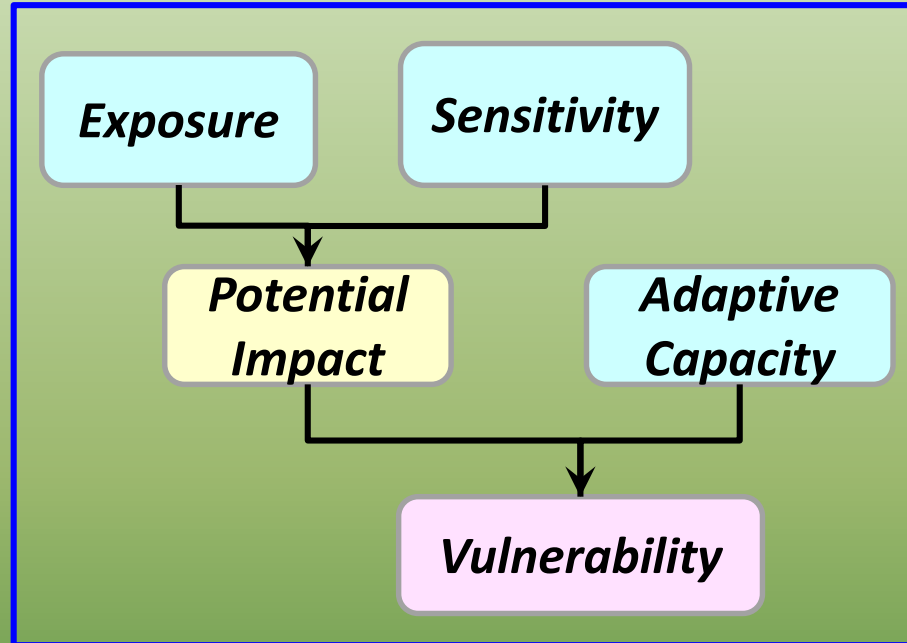
- PA managers consumed by within-PA issues, so looking outside is limited.
- Knowledge is lacking on where outside to monitor and collaborative manage.
- Protected areas lack the data and tools for regional to subcontinental analysis.
- Protected areas are seldom considered elements in a broader network.
- Management philosophies aimed at maintaining “naturalness” may lead to confusion in areas of rapid global change.

# Vulnerability Assessment

Glick et al. 2011. Scanning the Conservation Horizon: A guide to climate change vulnerability assessment. National Wildlife Federation, Washington, D.C.



# Vulnerability Assessment



Exposure = magnitude & extent of change experienced

Sensitivity = degree to which fitness/process is affected

Adaptive capacity = coping responses of species/process

# Goals and Objectives

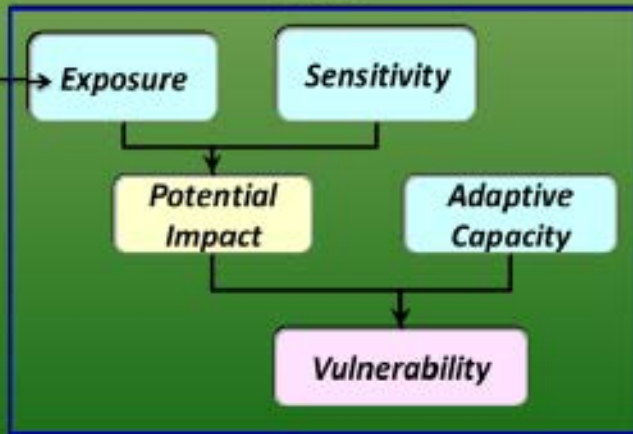
Goal: Illustrate the initial steps in an assessment of vulnerability to land use and climate change for the network of US National Parks

Objectives:

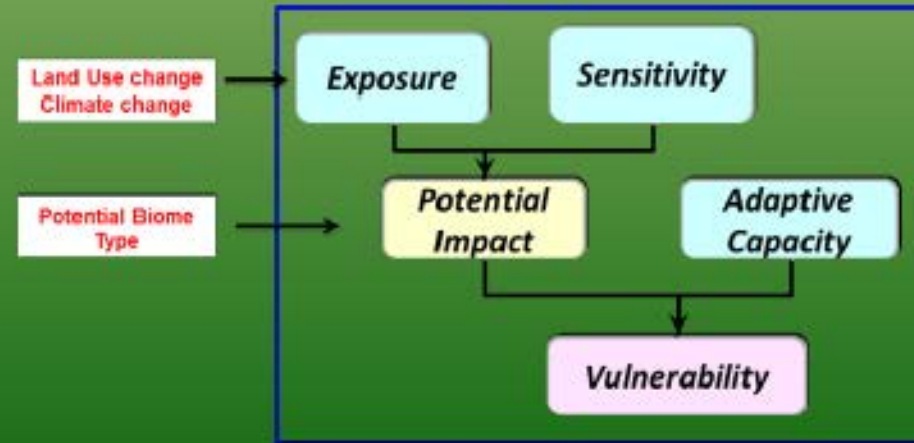
1. Define the surrounding Protected Area Centered Ecosystem (PACE).
2. Quantify past exposure.
3. Quantify potential future exposure and potential impact.
4. Consider implications for management.



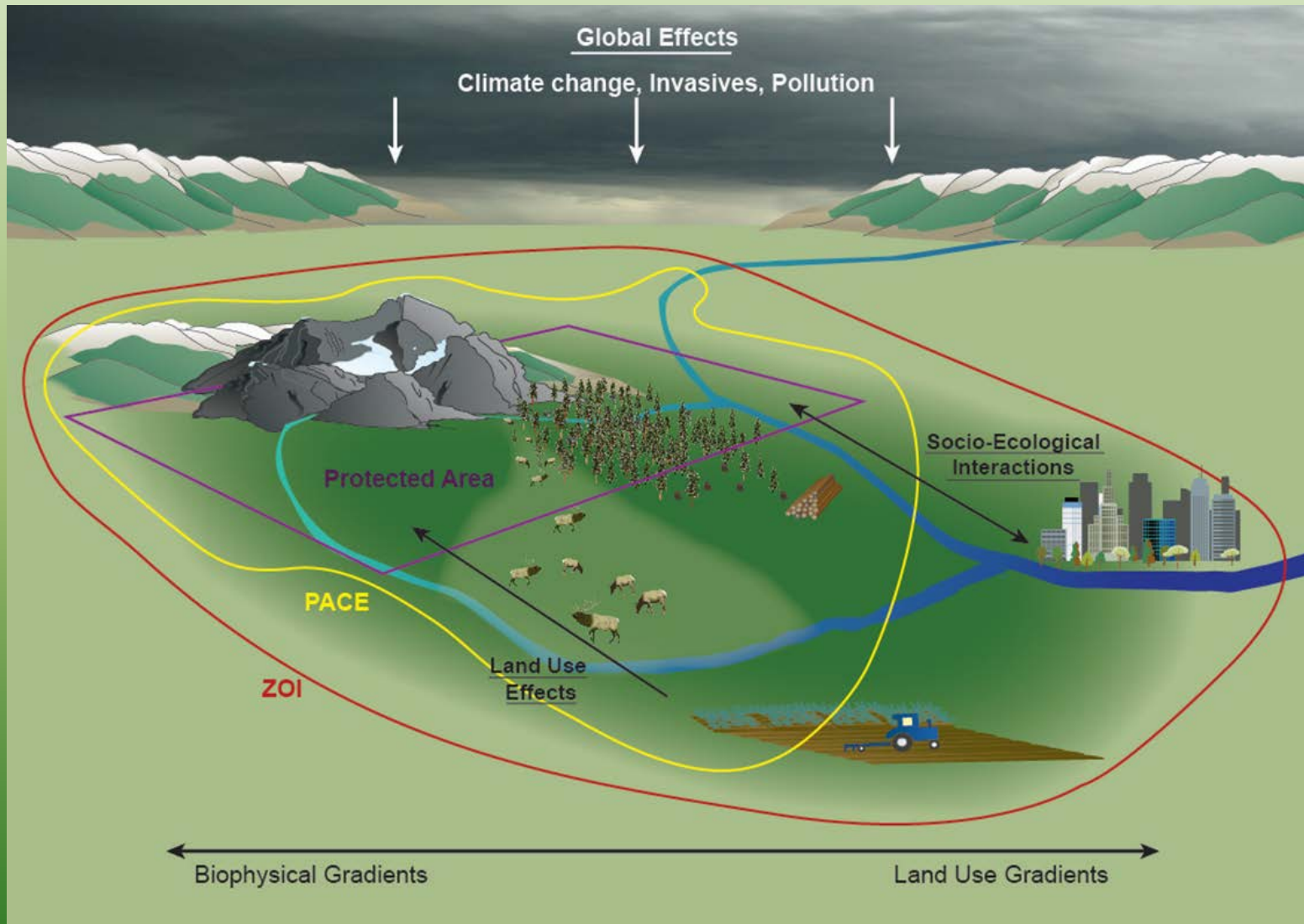
1900-2010



2010-2100



# Protected-Area Centered Ecosystem (PACE)

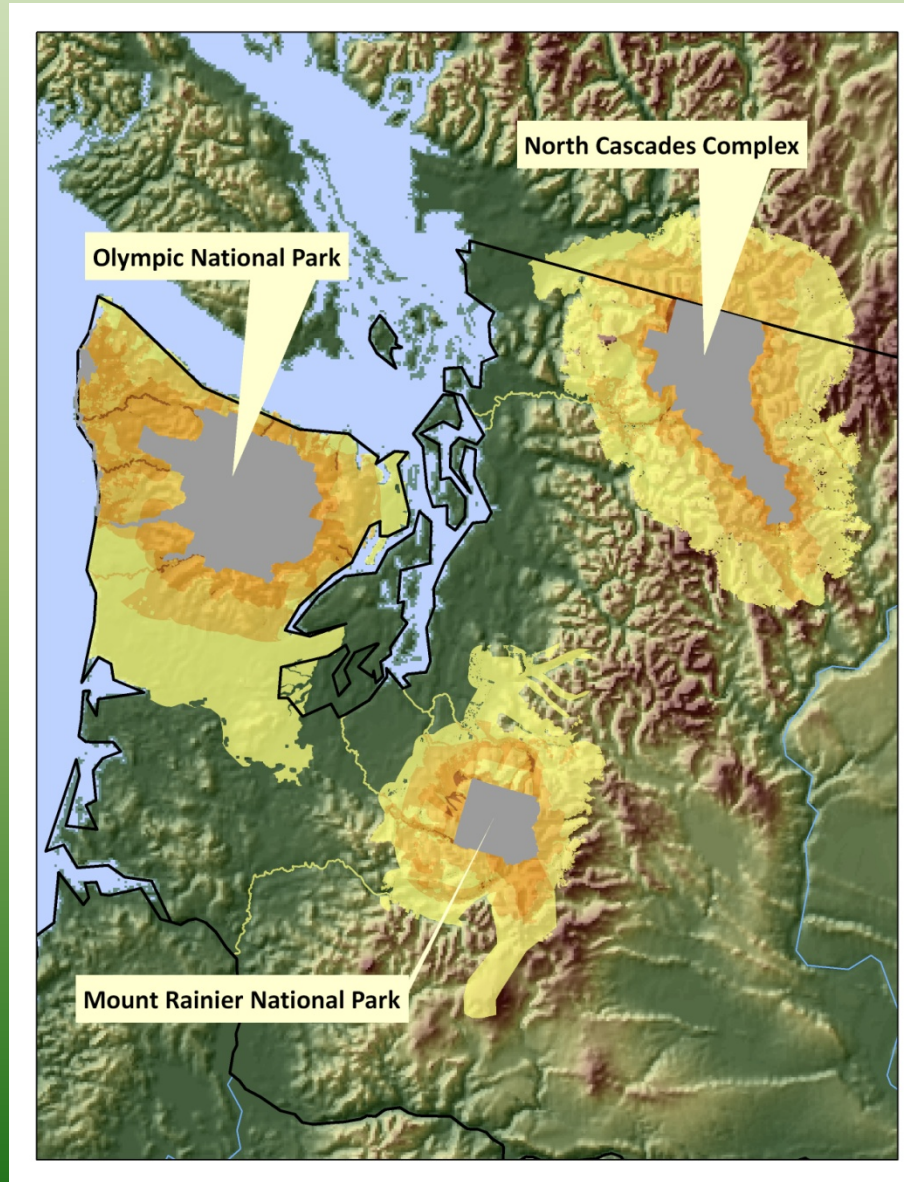


The surrounding area essential to maintaining natural processes and native populations within the Protected Area.

# Delineating Protected-Area Centered Ecosystems

PACES were delineate based on five criteria:

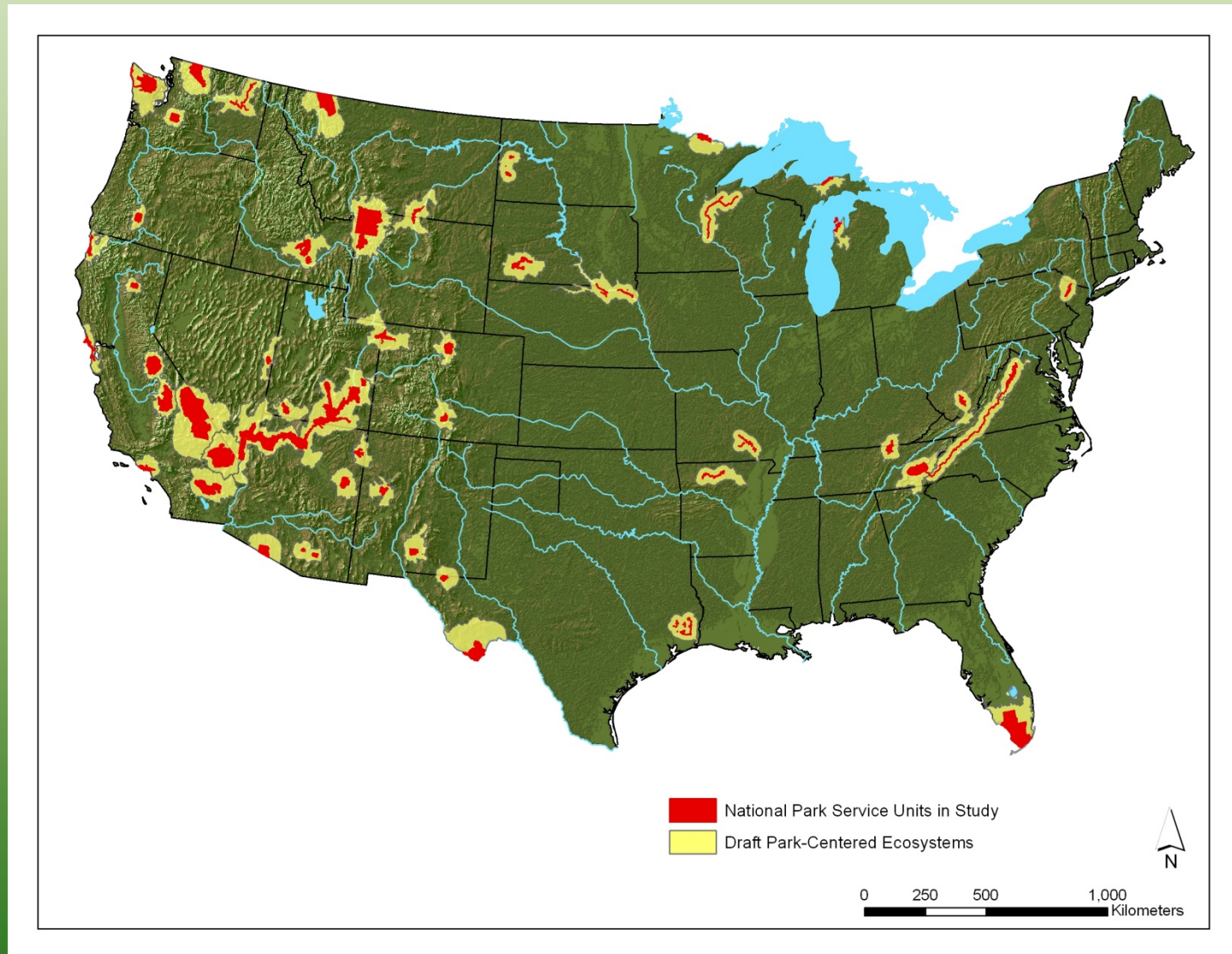
1. Contiguity of surrounding natural habitat
2. Watershed boundaries
3. Extent of human edge effects
4. Disturbance initiation and run-out zones
5. Crucial habitats outside the park



Hansen et al. 2011. BioScience.



# PACES for 57 Larger NPS Units in the Contiguous U.S.



Davis and Hansen 2011.  
Ecological Applications.

# Data Sources

Time Period	Element of vulnerability	Examples of metrics	Data Source
1900-2010	Land Use	Housing density	US Census
	Invasives	Non-native vascular plants	NPSpecies
	Climate	Mean annual temperature	PRISM
2010-2100	Land Use	Housing density (4 IPCC SRES scenarios)	Bierwagen et al. 2010
	Climate	Mean annual temperature (6 IPCC SRES scenarios)	Rehfeldt et al. 2012
	Biome climate suitability	% of PACE projected to shift in biome climate suitability (6 IPCC SRES scenarios)	Rehfeldt et al. 2012

# Home Density, Temperature, Non-Natives: 1900-2010

## Average Change Across PACES

Housing density:

+ 741% during 1940 - 2000

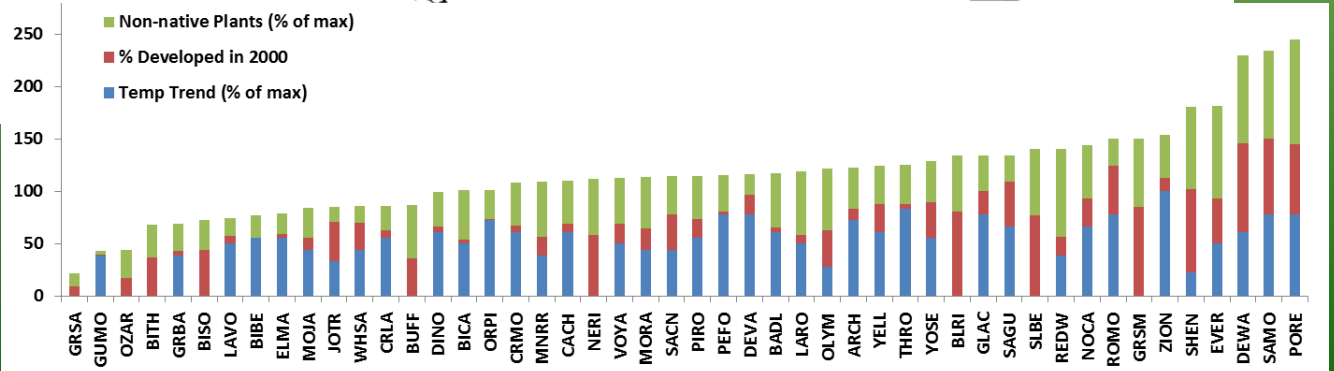
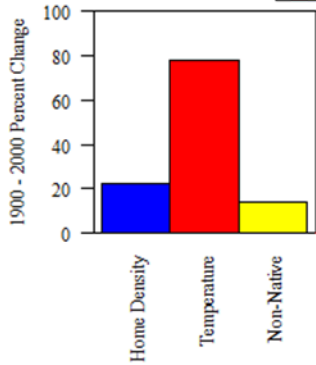
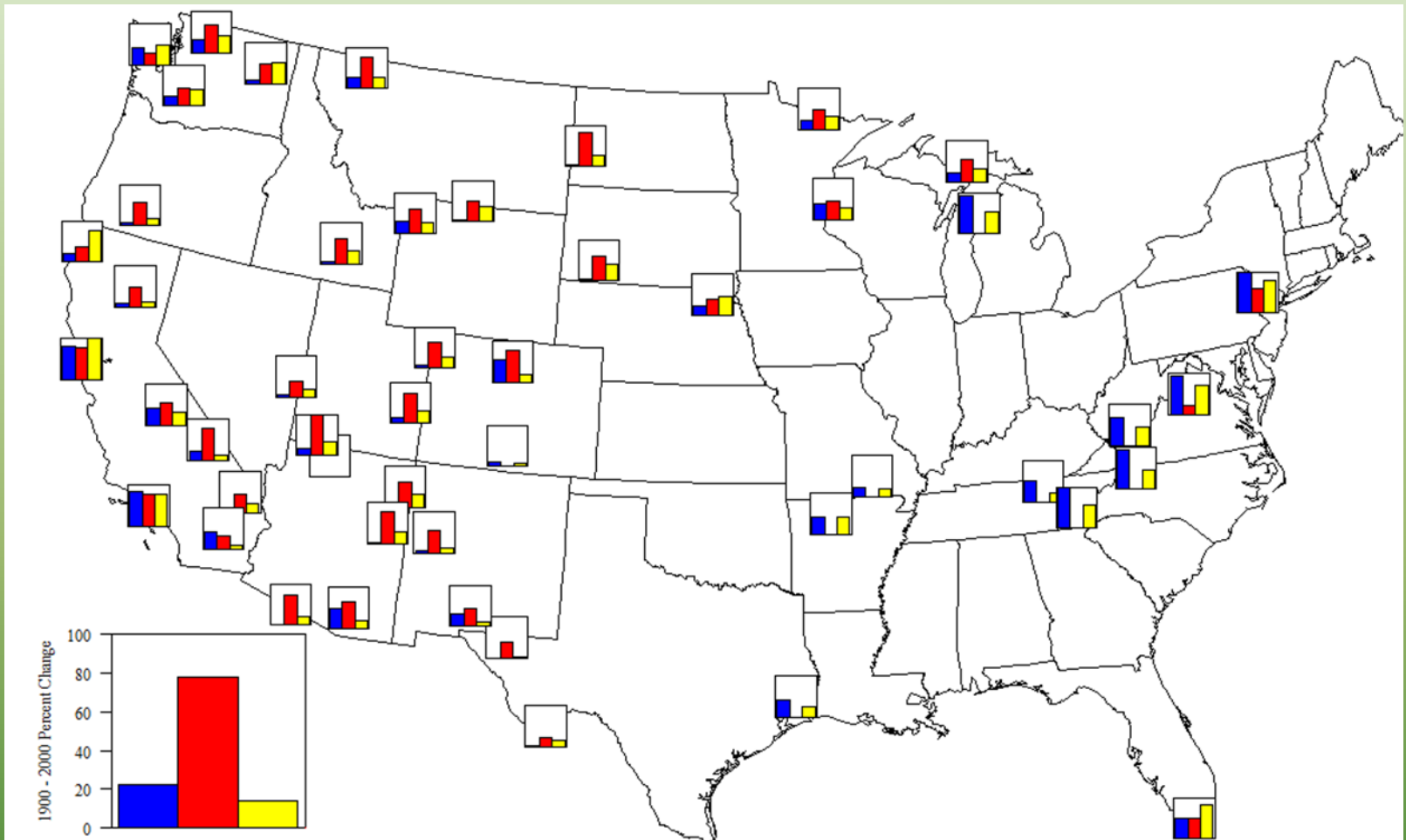
Proportion of Vascular Plants That Are Non-native in  
2010:

+ 13%

Temperature Change:

+ 1 °C / 100 years since 1895 (in 80% of PACES)

# Home Density, Temperature, Non-Natives: 1900-2010



# Home Density, Temperature, Biome Shifts: 2010-2100

## Average Projected Change Across PACES

**Housing density:**

**+ 255%**

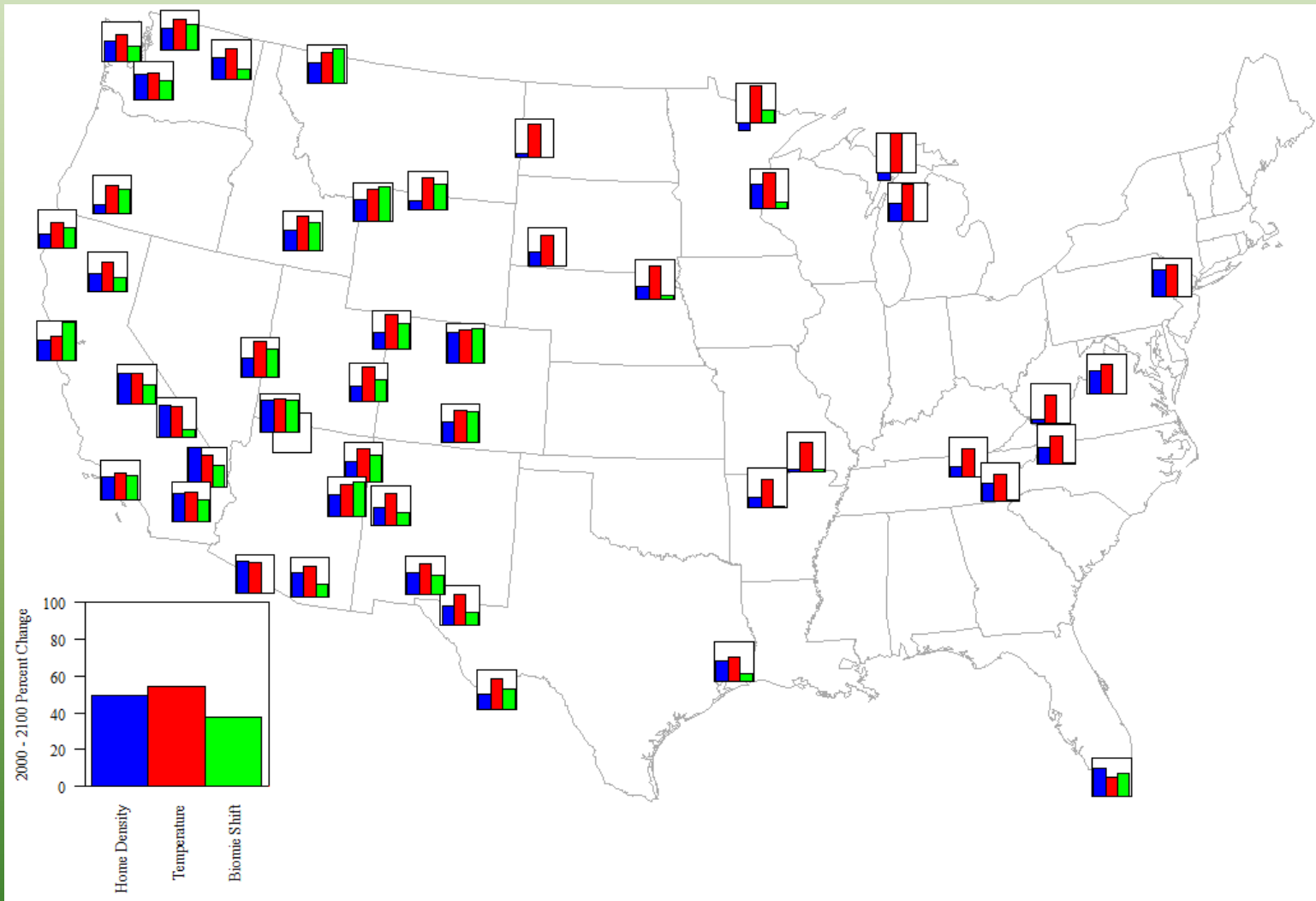
**Temperature Change:**

**+ 2.5 - 4.5 °C/ 100 years**

**Biome Climate Suitability**

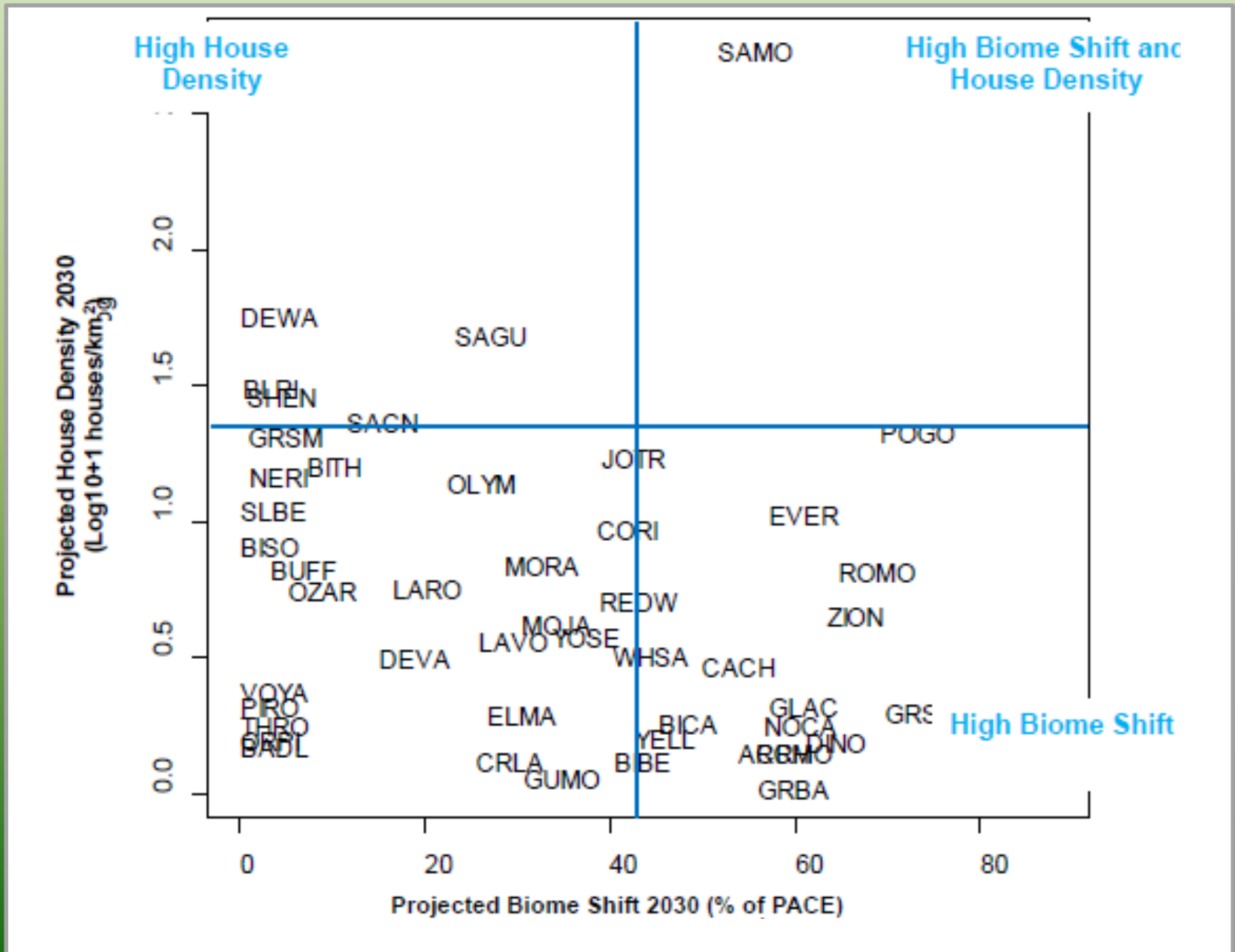
**39% of PACE areas will not have climates suitable  
for current biomes**

# Home Density, Temperature, Biome Shift: 2010 - 2100

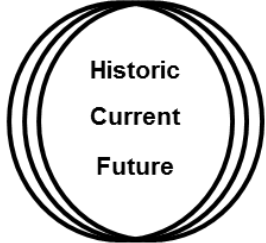
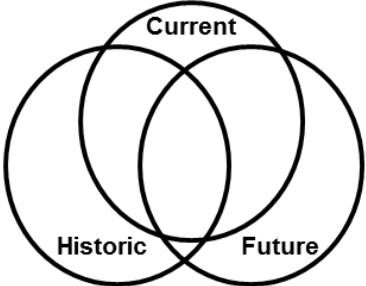
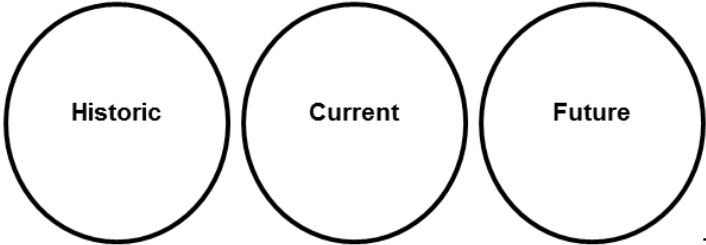


E.g., 14 PACEs in the mountain and southwest US are projected to experience unsuitable climates for their biomes across 50-86% of their areas within the PACEs by 2030 and up to 96% by 2090.

# Home Density, Temperature, Biome Shift: 2010 - 2100



# Management Implications

<u>Past, Present, Future Ecological Conditions</u>	<u>Management</u>		
	<u>Relevant Philosophy</u>	<u>Feasibility</u>	<u>Cost/Risk</u>
 <p>Substantial Overlap</p>	HRV	High	Low
 <p>Moderate Overlap</p>	Restore Resilience	Moderate	Moderate
 <p>No Overlap</p>	DFC	Low	High

Knowledge of differences in vulnerability among PACES can be used to guide adaptation strategies.



# Case Study: Olympic National Park

## Exposure:

- Land Use Typology: Wildland Developable
- PACE Developed: 45%
- Temp change (1900-2010): 0.5 C°
- Non-native plants: 19%
- Temp change (2100-2030): 1.37 C°

## Sensitivity

- Low

## Potential Impact

- Area shifting biome 2030: 22%

## Vulnerability

- Low - Moderate

## Management Philosophy

- Historic Range of Variation



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# Case Study: Santa Monica Mountains

## Exposure:

- Land Use Typology: Urban
- PACE Developed: 72.4%
- Temp change (1900-2010): 1.45 C°
- Non-native plants: 27%
- Housing density (2100-2030): 27%
- Temp change (2100-2030): 1.4 C°

## Potential Impact

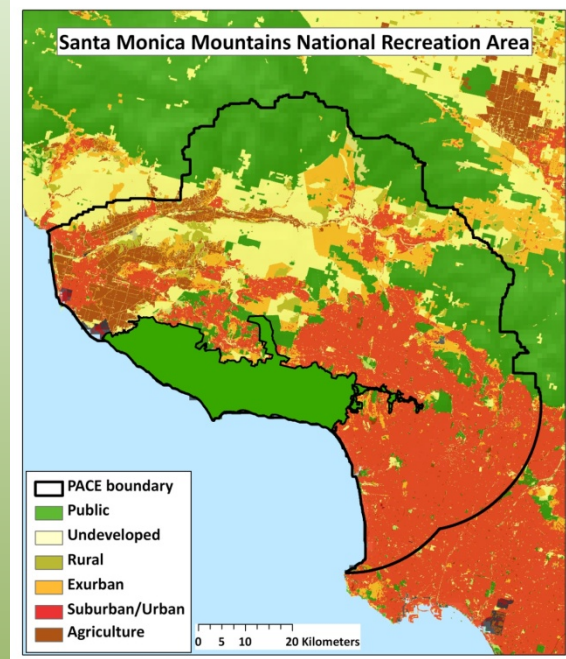
- Area shifting biome 2030: 52%

## Vulnerability

- High

## Management Philosophy

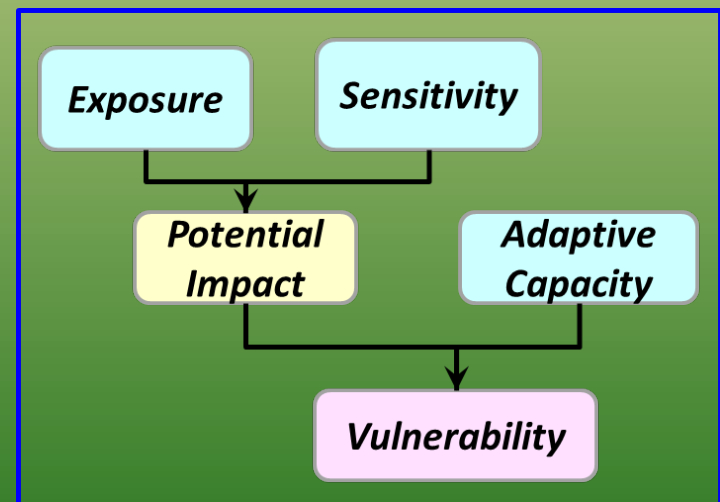
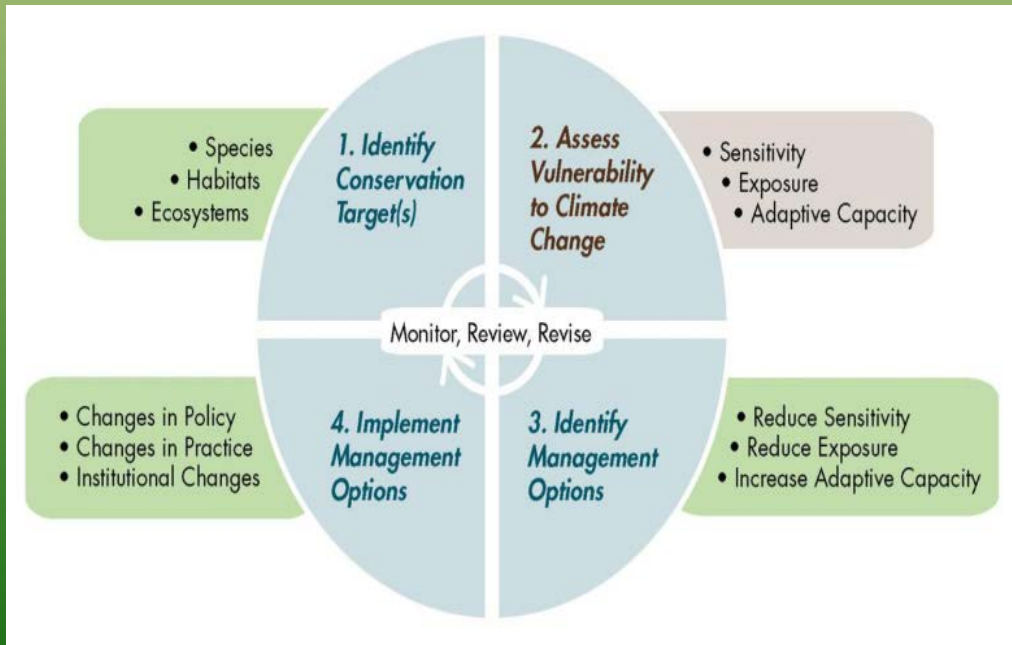
- Desired Future Conditions



# Recommendations for US NPS Policy

1. Set goals for ecological integrity as a benchmark for guiding vulnerability assessments
2. Institutionalize periodic vulnerability assessment of the network of US national parks in the context of the Glick et al. approach.

Glick et al. 2011. Scanning the Conservation Horizon: A guide to climate change vulnerability assessment. National Wildlife Federation, Washington, D.C.



# **Benefits of Vulnerability Assessments across Networks of PAs**

- **The national network can monitor and assess how well nation-wide conservation goals are being met.**
- **Managers of individual units can be updated on rates of change in their PA relative to the national network.**
- **Managers of PAs with similar threats and opportunities can band together to find management solutions.**
- **Results can be used for interpretive education programs to help park visitors understand the rates and consequences of regional and global change.**

# Acknowledgements

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- Rob Bennetts, NPS I&M

## Review Comments

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