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

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Abstract

We conducted an assessment of exposure of U.S. National Parks to climate and land use change and consequences for vegetation communities. We first defined park protected-area centered ecosystems (PACEs) based on ecological principles. We then drew on existing land use, invasive species, climate, and biome data sets and models to quantify exposure of PACEs from 1900 through 2100. Most PACEs experienced substantial change over the 20th century (.740% average increase in housing density since 1940, 13% of vascular plants are presently nonnative, temperature increase of 18C/100 yr since 1895 in 80% of PACEs), and projections suggest that many of these trends will continue at similar or increasingly greater rates (255% increase in housing density by 2100, temperature increase of 2.58–4.58C/100 yr, 30% of PACE areas may lose their current biomes by 2030). In the coming century, housing densities are projected to increase in PACEs at about 82% of the rate of since 1940. The rate of climate warming in the coming century is projected to be 2.5–5.8 times higher than that measured in the past century. Underlying these averages, exposure of individual park PACEs to change agents differ in important ways. For example, parks such as Great Smoky Mountains exhibit high land use and low climate exposure, others such as Great Sand Dunes exhibit low land use and high climate exposure, and a few such as Point Reyes exhibit high exposure on both axes. These results are foundational to developing effective adaptation strategies and suggest policies to better safeguard parks under broad-scale environmental change.

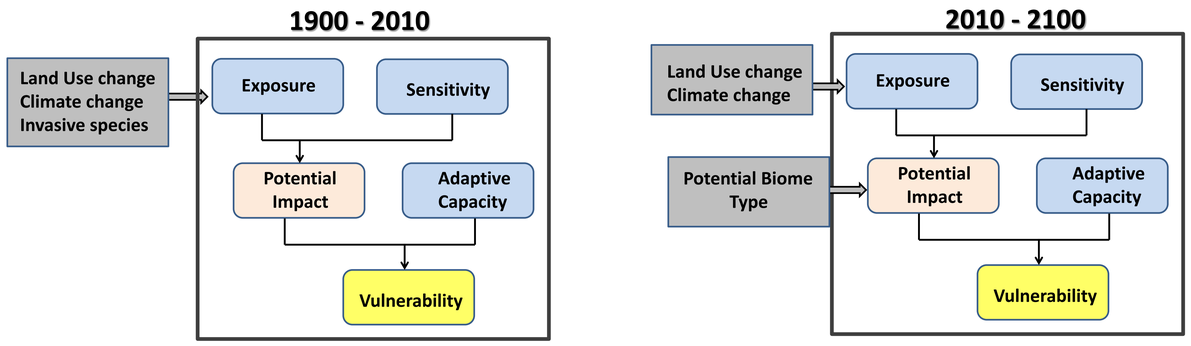
Goals and Objectives

Goal

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

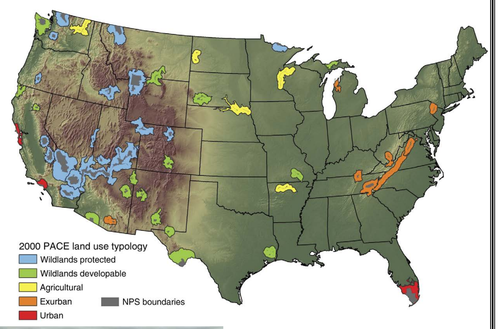
Objectives

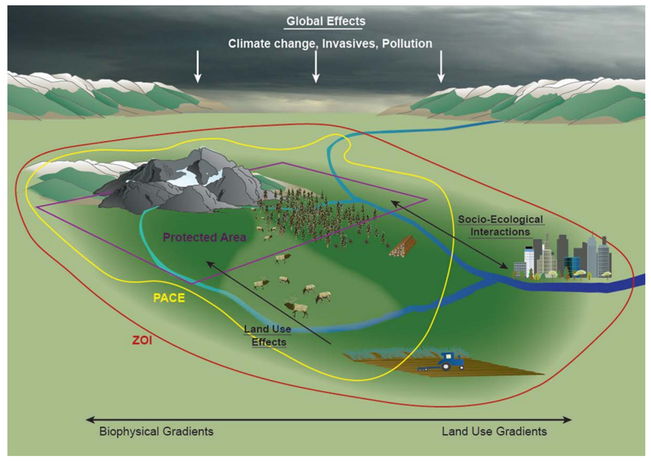
1. **Define the surrounding Protected Area Centered Ecosystem (PACE).**
2. **Quantify past exposure.**
3. **Quantify potential future exposure and potential impact.**
4. **Consider implications for management.**



Study Area and Conceptual model

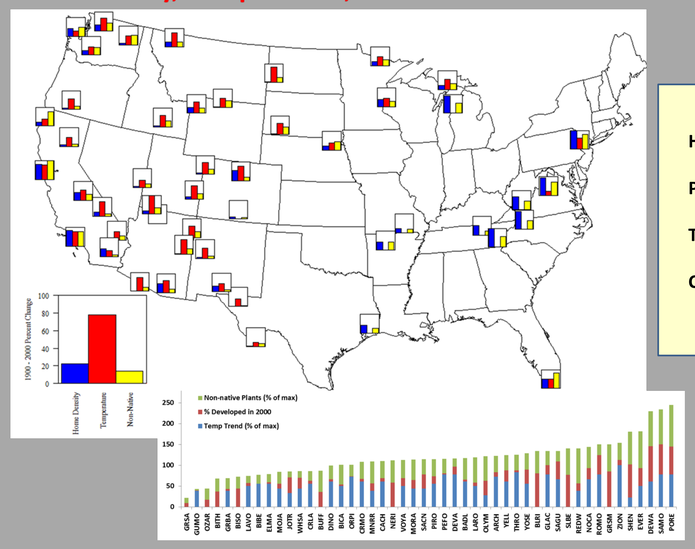
Conceptual model of a protected area (PA) depicted in the context of regional and global human influences.





Results

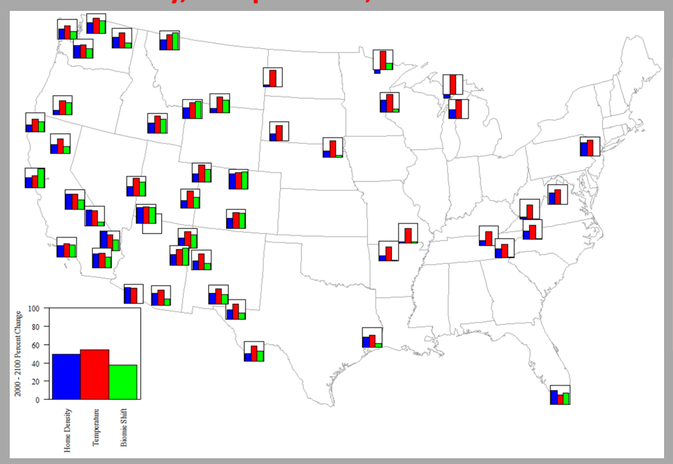
Home Density, Temperature, Non-Natives: 1900-2010



1900-2010

Housing density:
+ 741% during 1940 - 2000
Proportion of Vascular Plants That Are Non-native in 2010:
+ 13%
Temperature Change:
+ 1 ^{0}C / 100 years since 1895 (in 80% of PACEs)
Cumulative Effects:
Some PACES have had 5 fold greater exposure to change agents than other PACEs

Home Density, Temperature, Biome Shift: 2010 - 2100



2010-2100

Housing density:
+ 255%
Temperature Change:
+ 2.5 - 4.5 ^{0}C/ 100 years
Biome Climate Suitability
39% of PACE areas will not have climates suitable for current biomes
14 PACEs in the SW US are projected to experience unsuitable climates for their biomes across 96% of their areas by 2090

Management Implications

Past, Present, Future Ecological Conditions	Management: Relevant Philosophy	Feasibility	Cost/Risk
Historic, Current, Future — Substantial Overlap	*HRV	High	Low
Current; Historic, Future — Moderate Overlap	Restore Resilience	Moderate	Moderate
Historic, Current, Future — No Overlap	*DFC	Low	HIgh

*HRV is historic range of variability and DFC is desired future conditions

Case Study: Olympic National Park

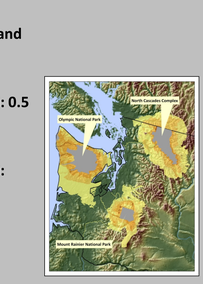
Exposure:
- **Land Use Typology: Wildland Developable**
- **PACE Developed: 45%**
- **Temp change (1900-2010): 0.5 C^o**
- **Non-native plants: 19%**
- **Temp change (2100-2030): 1.37 C^o**

Sensitivity
- **Low**

Potential Impact
- **Area shifting biome 2030: 22%**

Vulnerability
- **Low - Moderate**

Management Philosophy
- **Historic Range of Variation**



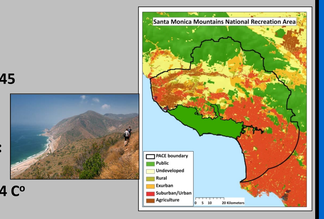
Case Study: Santa Monica Mountains

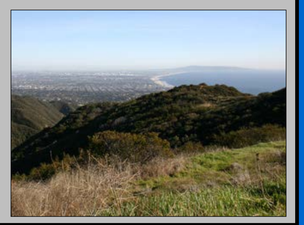
Exposure:
- **Land Use Typology: Urban**
- **PACE Developed: 72.4%**
- **Temp change (1900-2010): 1.45 C^o**
- **Non-native plants: 27%**
- **Housing density (2100-2030): 27%**
- **Temp change (2100-2030): 1.4 C^o**

Potential Impact
- **Area shifting biome 2030: 52%**

Vulnerability
- **High**

Management Philosophy
- **Desired Future Conditions**





Acknowledgements

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