

Tennessee Wildlife Resources Agency  
Ed Carter, Executive Director

Bill Reeves

Chris Simpson

# AppLCC/TWRA Partners Workshop

Jean Brennan PhD  
Coordinator & Chief Scientist  
Appalachian Landscape Conservation Cooperative

February 9, 2017. Crossville, TN

OVERVIEW: Using AppLCC Science Investments  [GET STARTED](#)

<http://www.applcc.org>

The **Big** Questions

- I. Why landscape planning & design approach?**
- II. What are Landscape Conservation Designs (LCDs)?**
- III. How can the LCD inform decision-making?**

*...toward achieving our conservation objective*

**The Big Questions**

# I. Why landscape-level conservation approach?

**Preservation Era**  
John Muir ~1820  
– “set aside”

...reliance on PAs proven insufficient ... underlying assumption of – stability

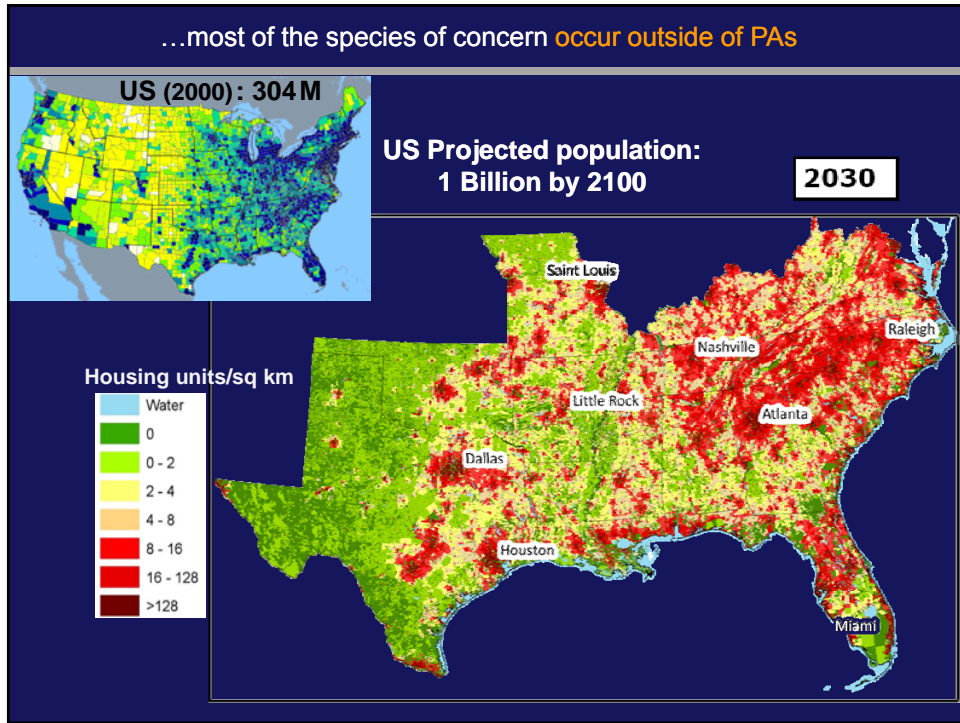
islands/safe haven – in dynamic equilibrium, species able to move freely among these

Environmental (Awareness) – Evolutionary-Ecological) Era – 1980  
**Conservation Biology, Landscape Ecology, Restoration Ecology**

2014

**US protected lands mismatch biodiversity priorities**  
 Clinton N. Jenkins<sup>1</sup>, Kyle S. Van Houtan<sup>2\*</sup>, Stuart L. Rimm<sup>3</sup>, and Joseph O. Sexton<sup>4</sup>  
1. Institute of Pacific Islands Ecology, National Park Service, Pacific Islands Fisheries Science Center, National Oceanic and Atmospheric Administration, Honolulu, HI 96814; 2. Pacific Islands Fisheries Science Center, National Oceanic and Atmospheric Administration, Honolulu, HI 96814; 3. Department of Biology, University of California, San Diego, La Jolla, CA 92037; 4. National Park Service, Washington, DC 20540

**Significance**  
 The United States has one of the oldest and most sophisticated systems of protected areas in the world. Given the large amount of information on the country's biodiversity, and the potential resources available, one might expect it to do well in protecting biodiversity. We find that it does not. The United States protected areas do not adequately cover the country's unique species. To improve the coverage, we map priorities for



## I. Why landscape-level conservation approach?

### Reflecting on our historic conservation paradigm

...reliance on PAs proven insufficient ... underlying assumption of – stability

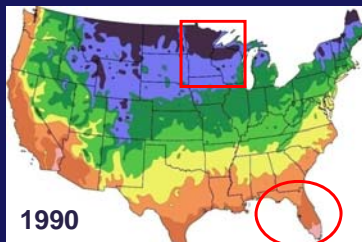
...most of the species of concern occur outside of PAs

...efforts insufficient given scale and scope of the challenge

### Reflecting on management imperative



...observed changes, increase in the rate of change



Source: Arbor Day Foundation

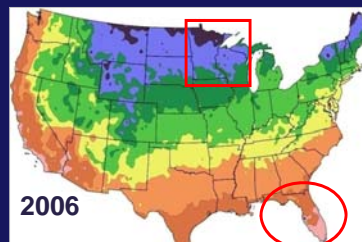
### Plant hardiness map

### Recorded Shift in Climatic Zones

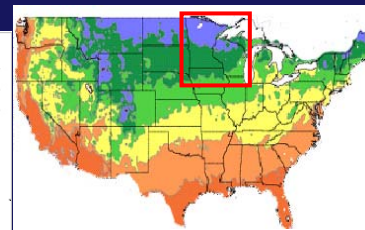
Changes “will affect

- structure and function of ecosystems,
- species' ecological interactions, and
- geographic ranges, with consequences for biodiversity and ecosystem services”

Malcom et al.2006



Zone	Avg. Annual Low
3	-30°F through -40°F
4	-20°F through -30°F
5	-10°F through -20°F
6	0°F through -10°F
7	10°F through 0°F
8	20°F through 10°F
9	30°F through 20°F
10	40°F through 30°F



Projection: 2080-2099

## Charging the System ...and 'Change of State'

water vapor

GHG

evaporation

evapo-transpiration

evaporation

Water vapor => powerful natural GHGs - traps additional heat => increase surface T.

Drought stress and vegetation die-off  
=> decomp./burn  
=> increase GHG

Source: Adams et al. 2009

## ...manage non-linear response variables... maintain healthy ecosystems

“management...have been designed and operated under the assumption of stationarity.

Observed climatic changes => Change in Variance & Variability

CLIMATE CHANGE      SCIENCE VOL 319 1 FEBRUARY 2008

### Stationarity Is Dead: Whither Water Management?

P. C. D. Milly,<sup>1\*</sup> Julio Betancourt,<sup>2</sup> Malin Falkenmark,<sup>3</sup> Robert M. Hirsch,<sup>4</sup> Zbigniew W. Kundzewicz,<sup>5</sup> Dennis P. Lettenmaier,<sup>6</sup> Ronald J. Stouffer<sup>7</sup>

“implies that any variable has a time-invariant probability density function whose properties can be estimated from the instrument record.”

“stationarity. ....the idea that natural systems fluctuate within an unchanging envelope of variability

-- fundamental concept that permeates training and practice...”

## I. Why landscape-level conservation approach?

Reflecting on our historic conservation paradigm

Reflecting on management imperative

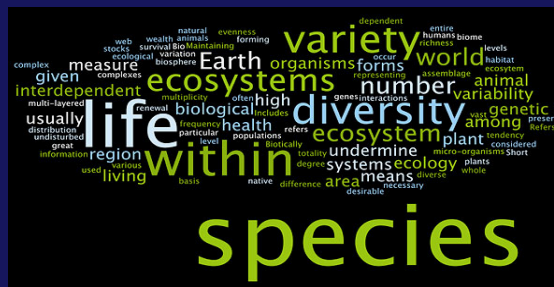
...observed changes, increasing rate of change, and 'Change of State'  
 ...manage non-linear response variables ... maintain healthy ecosystems

Reflecting on species' behavioral response to change

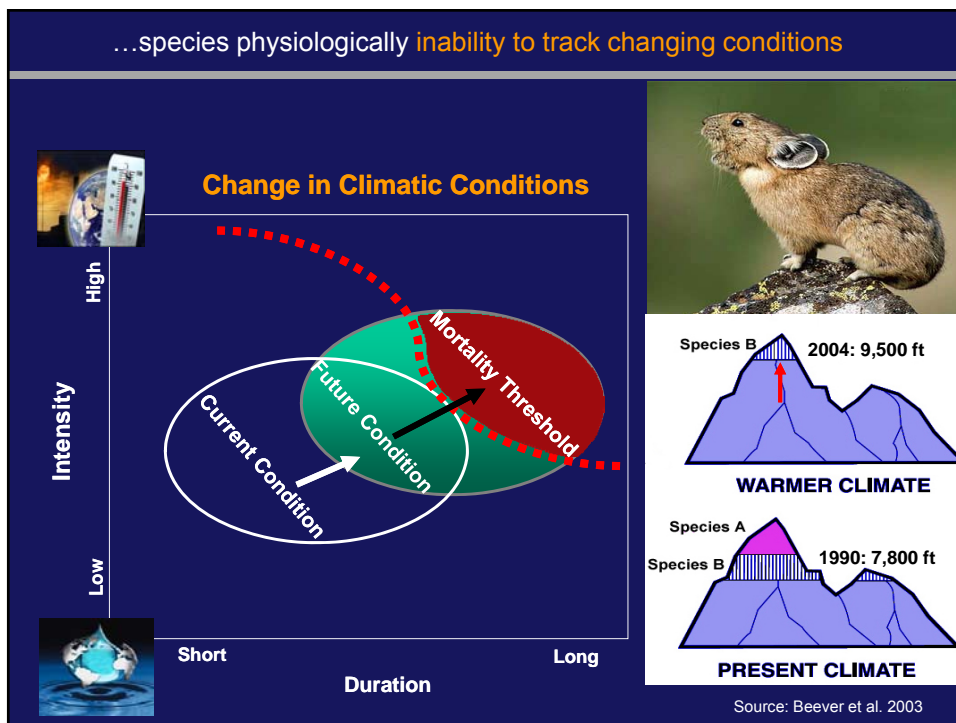
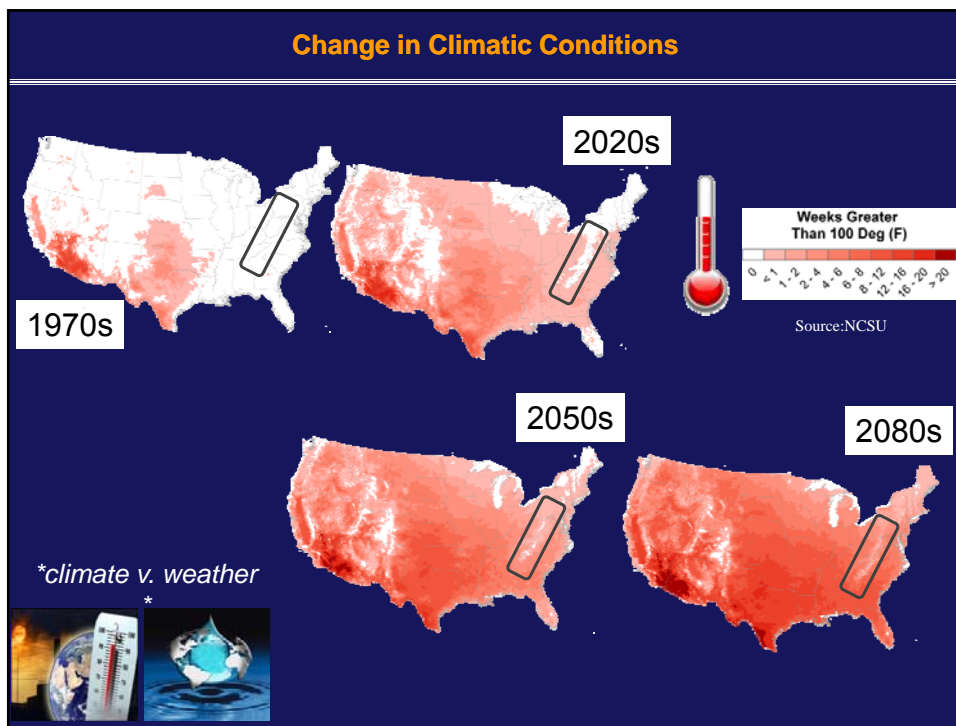


...toward achieving our conservation objective

*management*



Species will track change, adapt to new conditions, or go extinct



...increasing human-dominated landscape **physical barriers to movement**



Highly fragmented  
...Δ land-use



## ***I. Why landscape-level conservation approach?***

Reflecting on our historic conservation paradigm

Reflecting on management imperative

**Reflecting on species' behavioral response to change**

...species **physiologically inability** to track changing conditions

...increasing human-dominated landscape **physical barriers** to movement

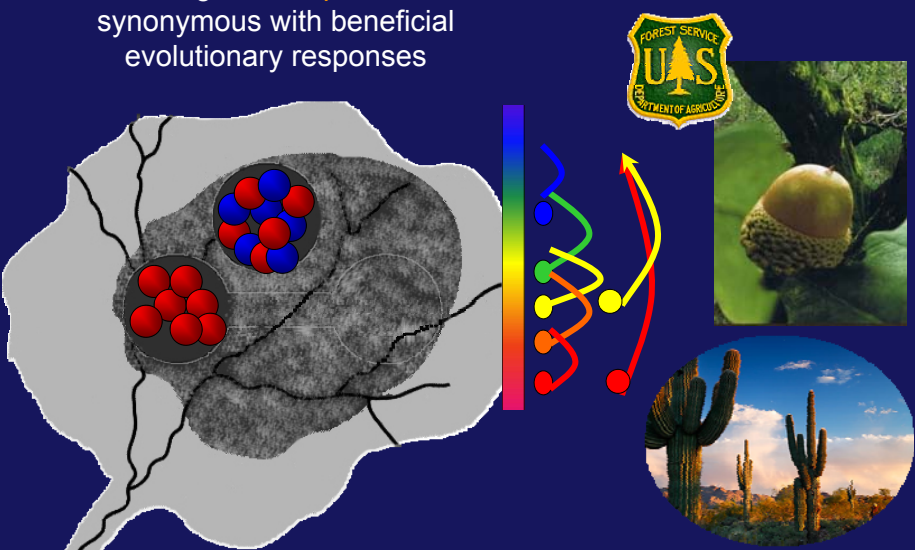






...safeguard **adaptive capacity** and **resilience**

to biologists “**adaptation**” is synonymous with beneficial evolutionary responses



**Genetic diversity...is the 'base currency' of Conservation**

***I. Why landscape-level conservation approach?***

Reflecting on our historic conservation paradigm

Reflecting on management imperative

Reflecting on species' behavioral response to change

Reflecting on genetic & ability to adapt

...**prevent** population isolation and associated loss genetic diversity

...safeguard **adaptive capacity** and **resilience**

## I. Why landscape-level conservation approach?

GIVEN:	Response: (1) react, (2) facilitate, (3) benign neglect	Design: target areas (modeling = 'reserve' selection)	Design: connected (given land-use change + forcings)
• Protected Areas (PAs)			
• outside of Protected Areas			
• Shift climatic zones /ecosystem (scale, rate)			
• Conservation (caution) under non-linear response			
• Human-dominated landscape – barriers to species movement / gene flow (adaptation)			
• Limited Conservation Resources			

**II. What are Landscape Conservation Designs (LCDs)?**