

# Introducing the Arizona Sky Islands and the Santa Catalina Mountains

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Dendroecology, 21 May 2014

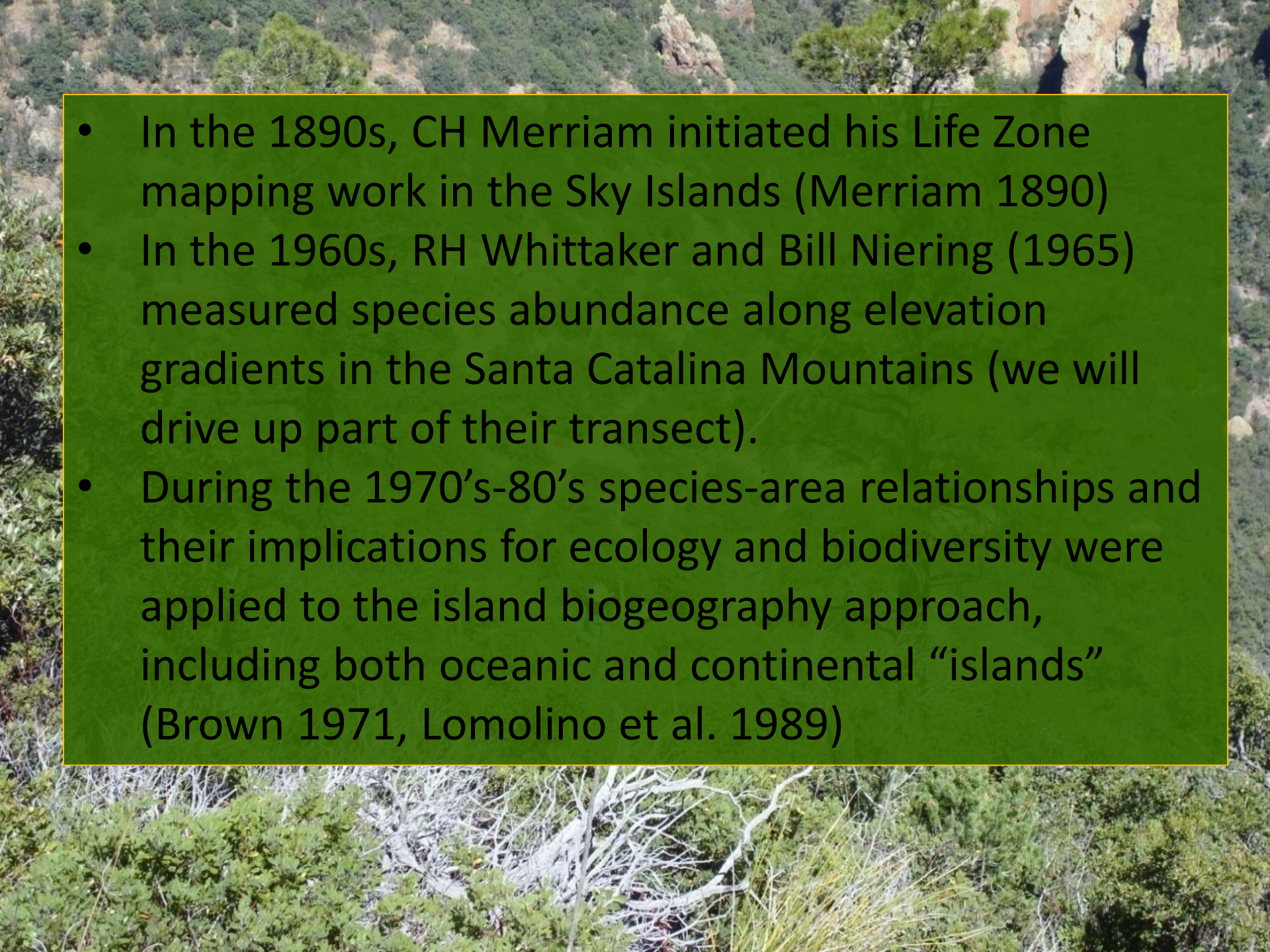


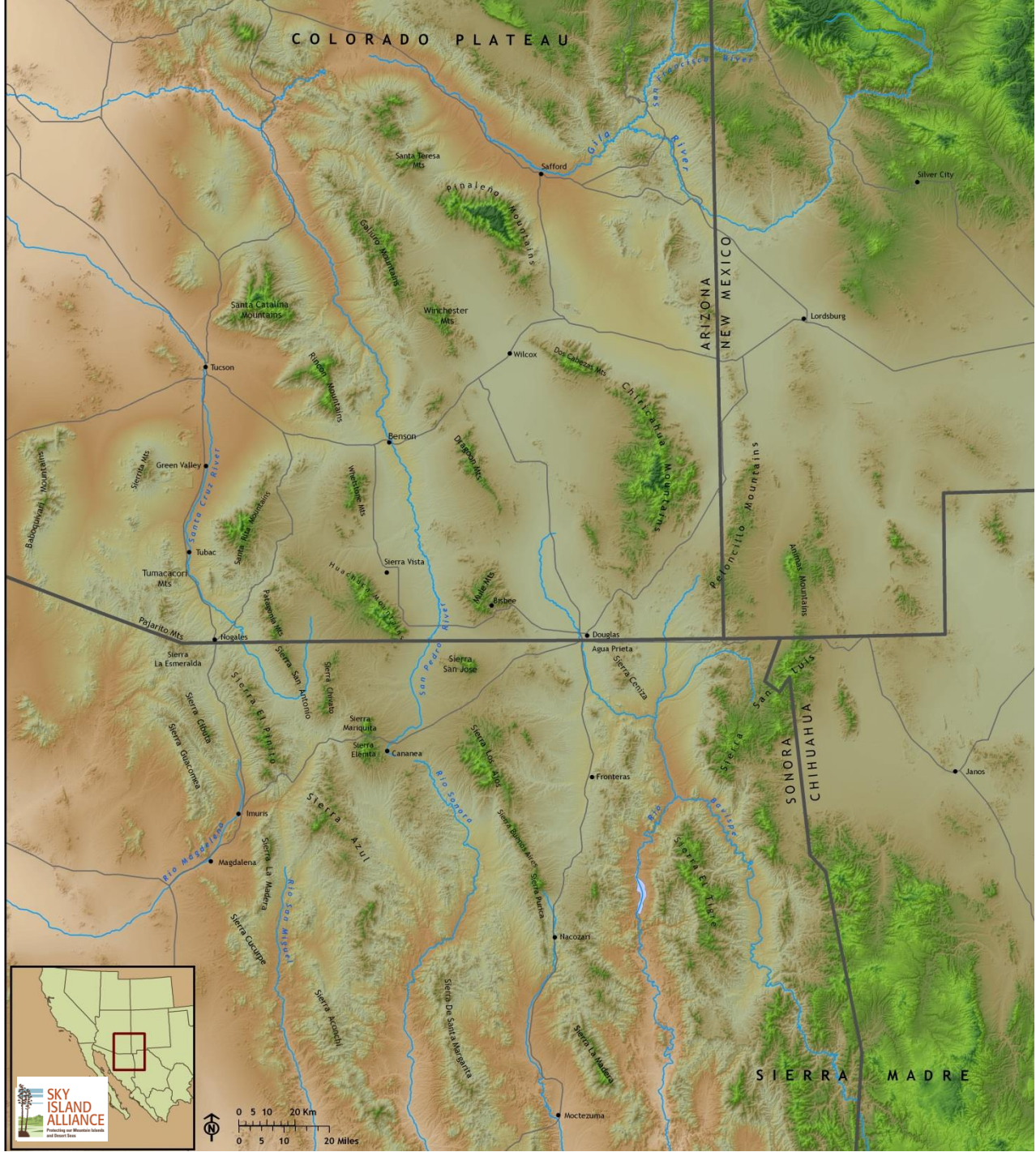
# What and where are Sky Islands?

- Term coined in 1967 by Arizona nature writer nature writer Weldon Heald
- Also called the “Madrean Archipelago”
- Generally, the term “sky islands” is used to describe continental mountain complexes comprised of isolated mountaintops surrounded by lower elevation valley “seas” (Warshall 1995)
- Other sky island systems include the Guadalupe Mountains USA, the Air Mountains in Niger, the Rwenzori Mountains in Uganda and the Democratic Republic of the Congo, and the Western Ghats in India.

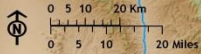
# Why research sky islands?

- Isolated mountaintops surrounded by contrasting habitat, with steep elevation gradients, which historically have changed in response to regional temperature shifts, provide excellent model systems in which to study the ecological impacts of climate change.
- SW Sky Islands span ~8,000 ft vertical rise (~2200 ft lower valleys to 10,300 ft peak)

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- In the 1890s, CH Merriam initiated his Life Zone mapping work in the Sky Islands (Merriam 1890)
  - In the 1960s, RH Whittaker and Bill Niering (1965) measured species abundance along elevation gradients in the Santa Catalina Mountains (we will drive up part of their transect).
  - During the 1970's-80's species-area relationships and their implications for ecology and biodiversity were applied to the island biogeography approach, including both oceanic and continental "islands" (Brown 1971, Lomolino et al. 1989)



**SKY ISLAND ALLIANCE**  
Protecting our Mountain Islands and Desert Dunes



# Biotic Influences in the Sky Island Region

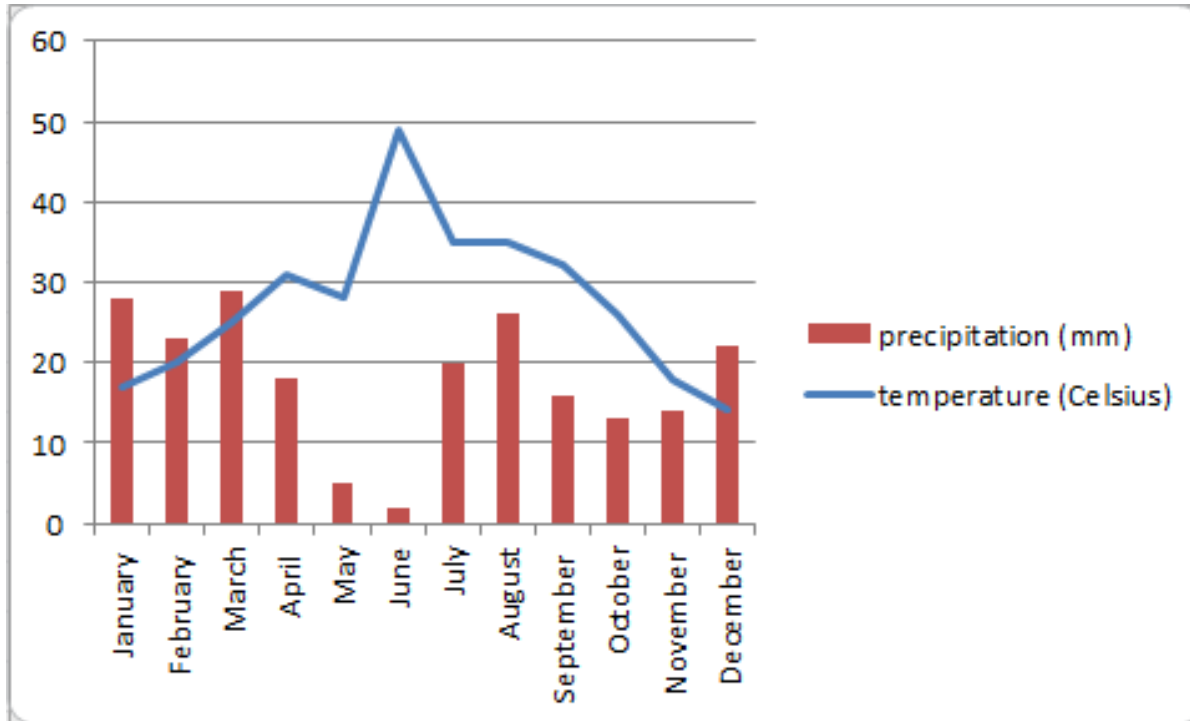


 Sky Island Region

 State Boundaries

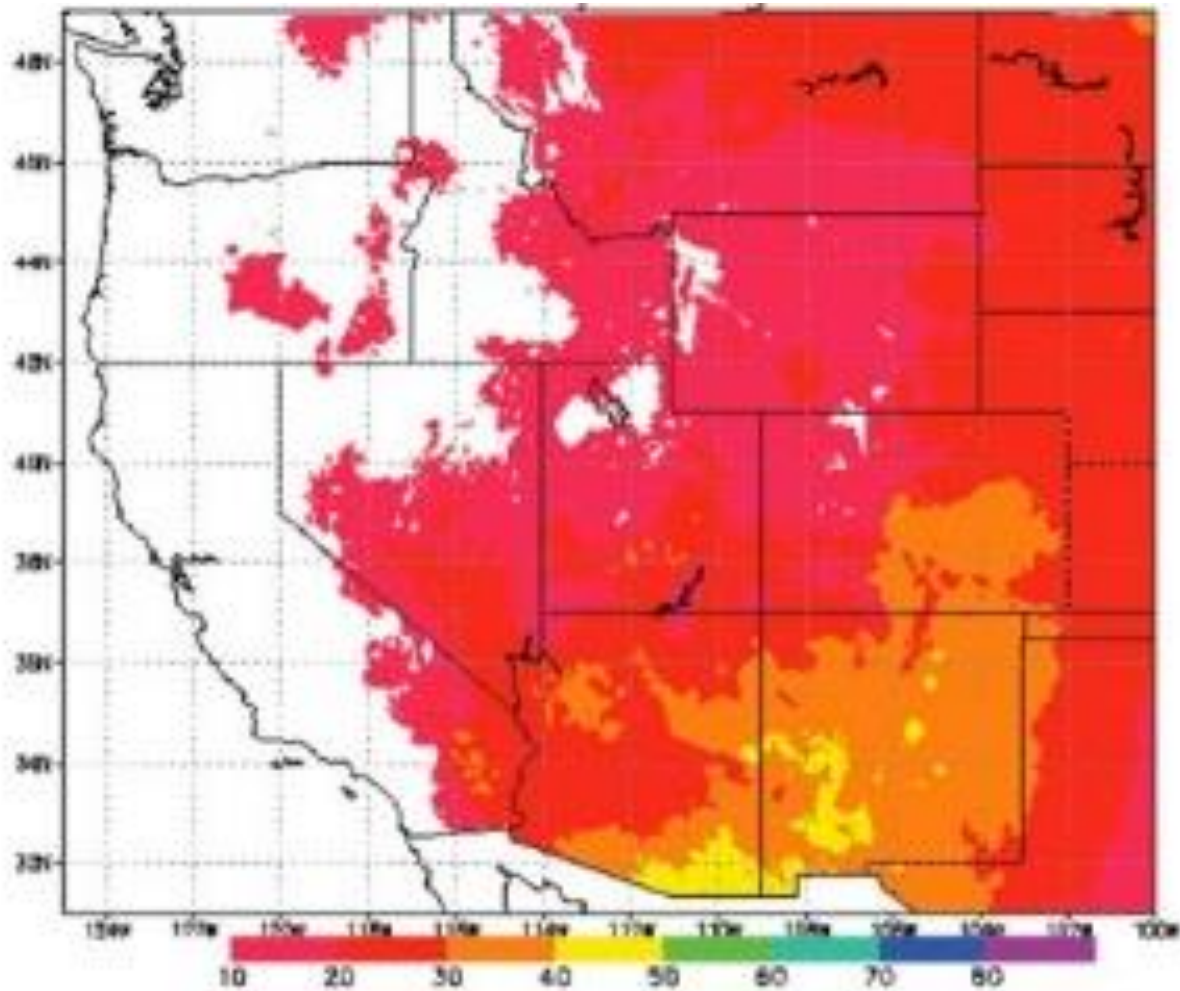
 0 250 500 km

# Sky Islands climate



- **Winter rains** from Pacific frontal storms, strongly controlled by **ENSO**
- **Summer rains monsoonal**, from central Mexico, Gulf of Mexico, Sea of Cortez

# Spatial pattern of the North American monsoon (Griffin et al. 2013)





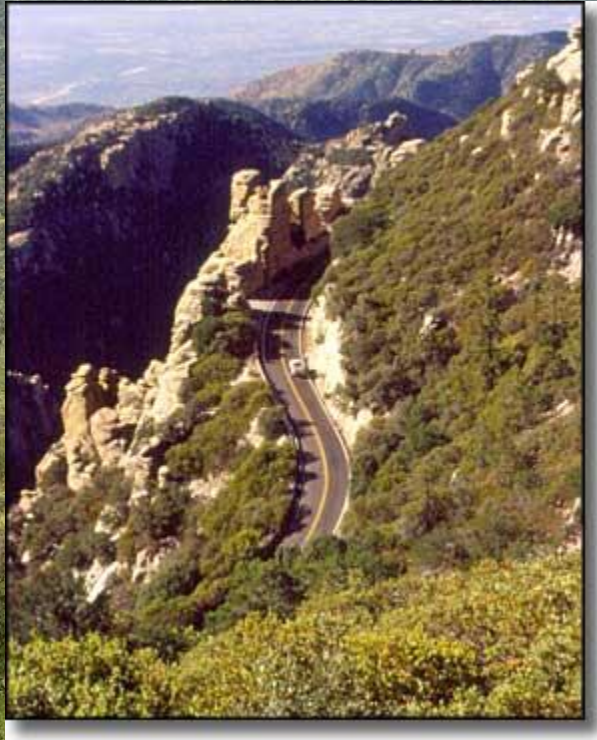
# Sonoran Desert upland (coolest and wettest section of the SD)



# Desert grassland and oak savannah



# Madrean Encinal woodland



# Ponderosa pine (various understories)



Photo: Jim Malusa, FireScape

# Mixed conifer forest (dry to mesic)



# Upper-elevation spruce-fir forest





**Over 4,700 plant species**

1/2 of the  
Bird  
Species



...of North  
America







176 reptiles

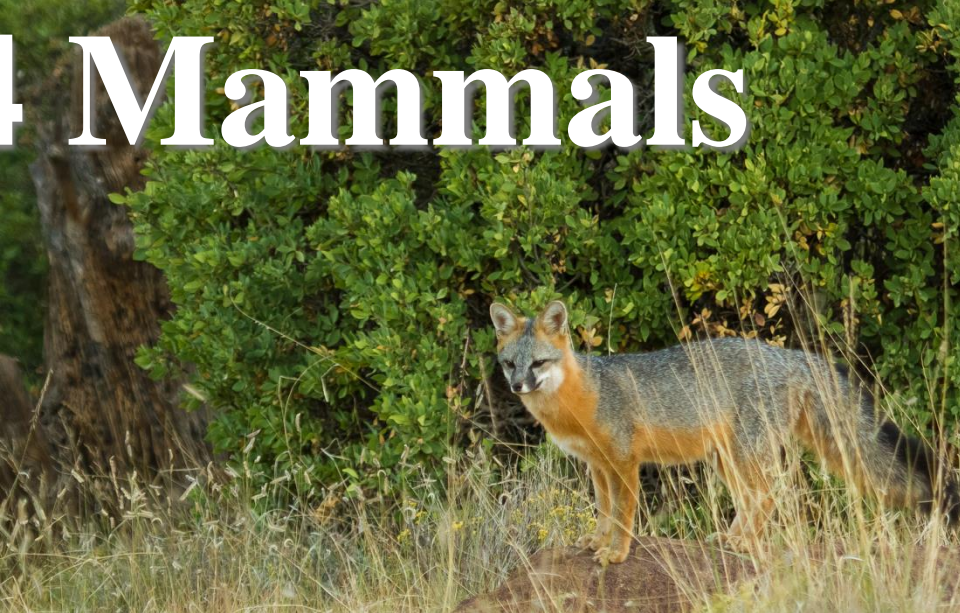




44 amphibians



# 114 Mammals





**2010 Sky Island Alliance / El Aribabi**



Tim Cook



© 2008 Sky Island Alliance / El Aribabi







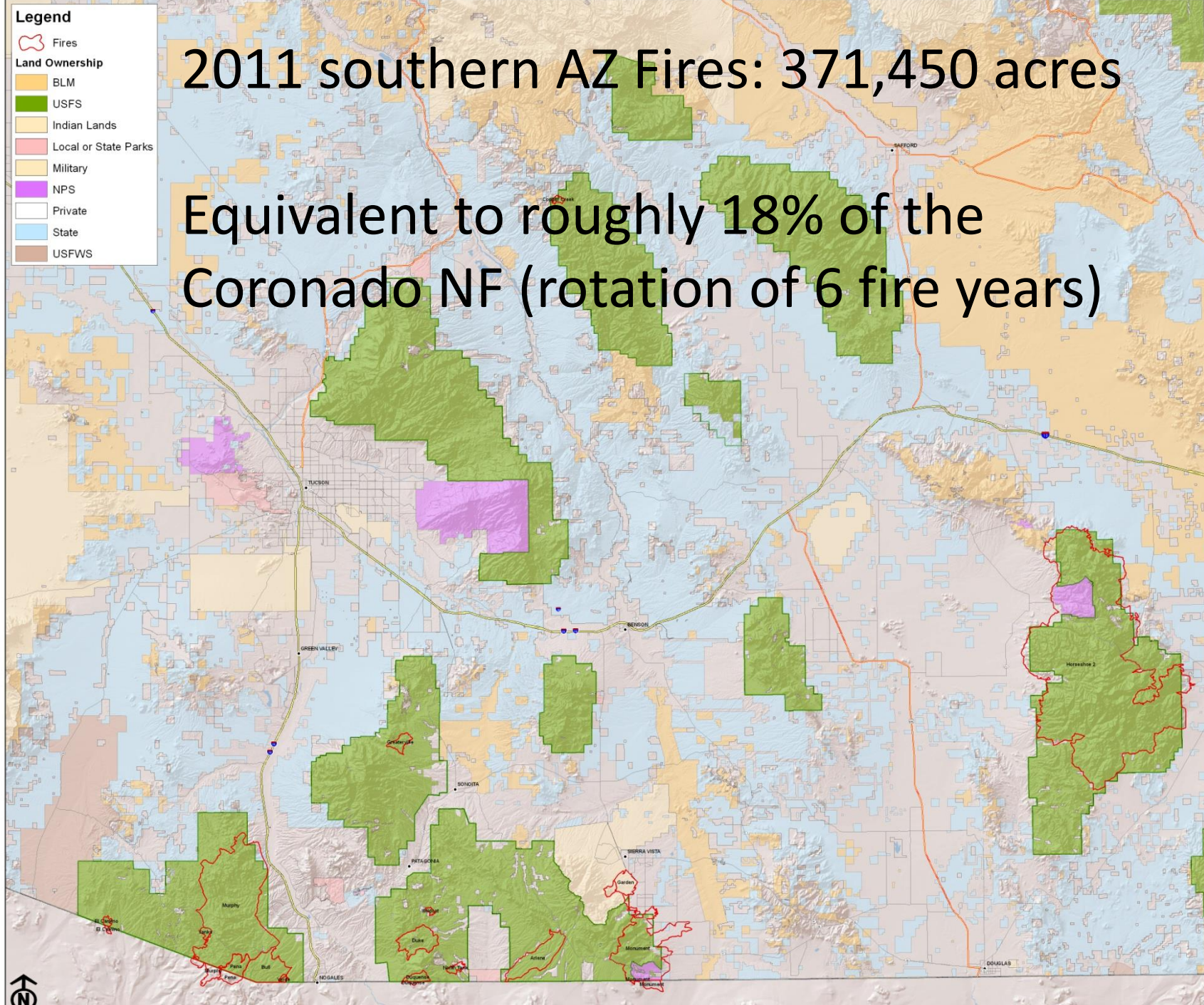


Name	Acres
Arlene	10,599
Bull	9,702
Copper Creek	618
Duke	7,649
Duquense	1,750
Duquense (MEX)	242
El Camino	609
El Camino (MEX)	269
Garden	3,766
Greaterville	2,279
Horseshoe 2	222,953
Monument (MEX)	1,659
Monument	30,393
Murphy	68,009
Murphy (MEX)	2,730
North Tank	1,143
Pena	3,523
Pena (MEX)	2,030
Verde	273
Wildcat	398
Yanks	856
<b>Total (w/MEX acres)</b>	<b>371,450</b>

Legend	
	Fires
	BLM
	USFS
	Indian Lands
	Local or State Parks
	Military
	NPS
	Private
	State
	USFWS

2011 southern AZ Fires: 371,450 acres

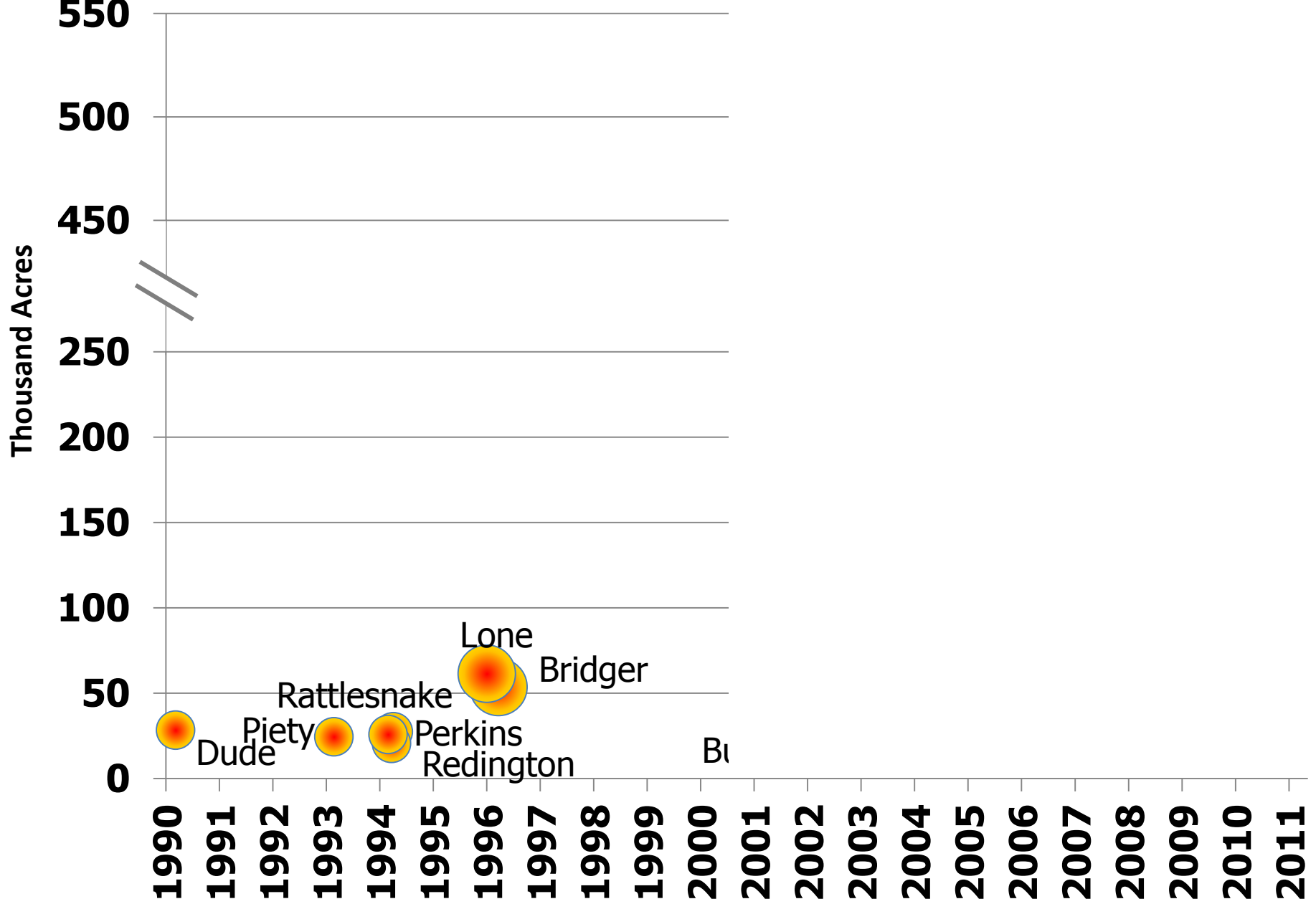
Equivalent to roughly 18% of the Coronado NF (rotation of 6 fire years)



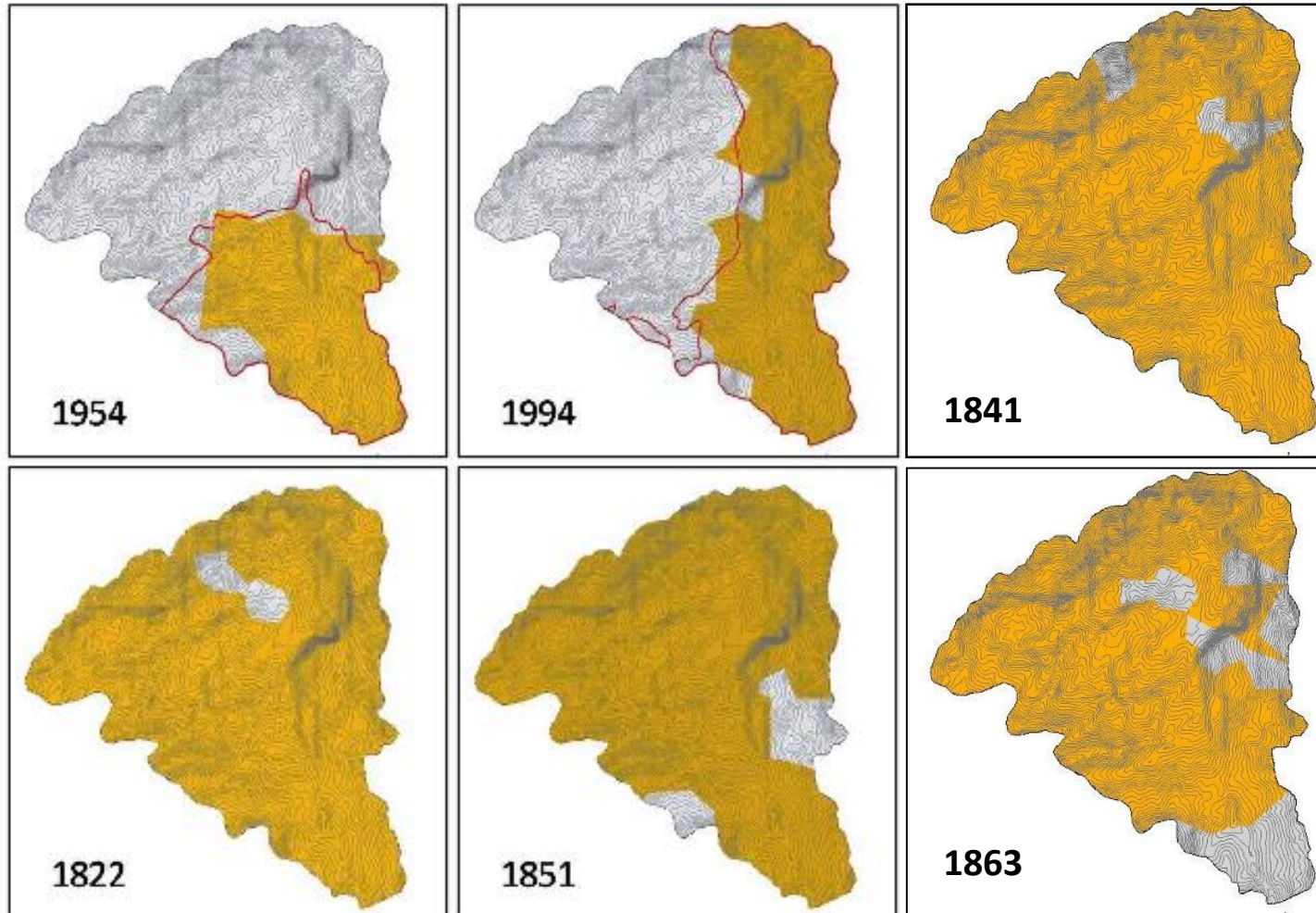
Coronado NF Large Wildfires 2011

# Largest Arizona Wildfires, 1990-2012 (SWCC Historic Data)

Graphic courtesy A Youberg, AZGS; data S



Reconstructing spatial pattern of landscape-scale  
low-severity fires at the mountain range scale  
indicates that historical fire sizes could be very large

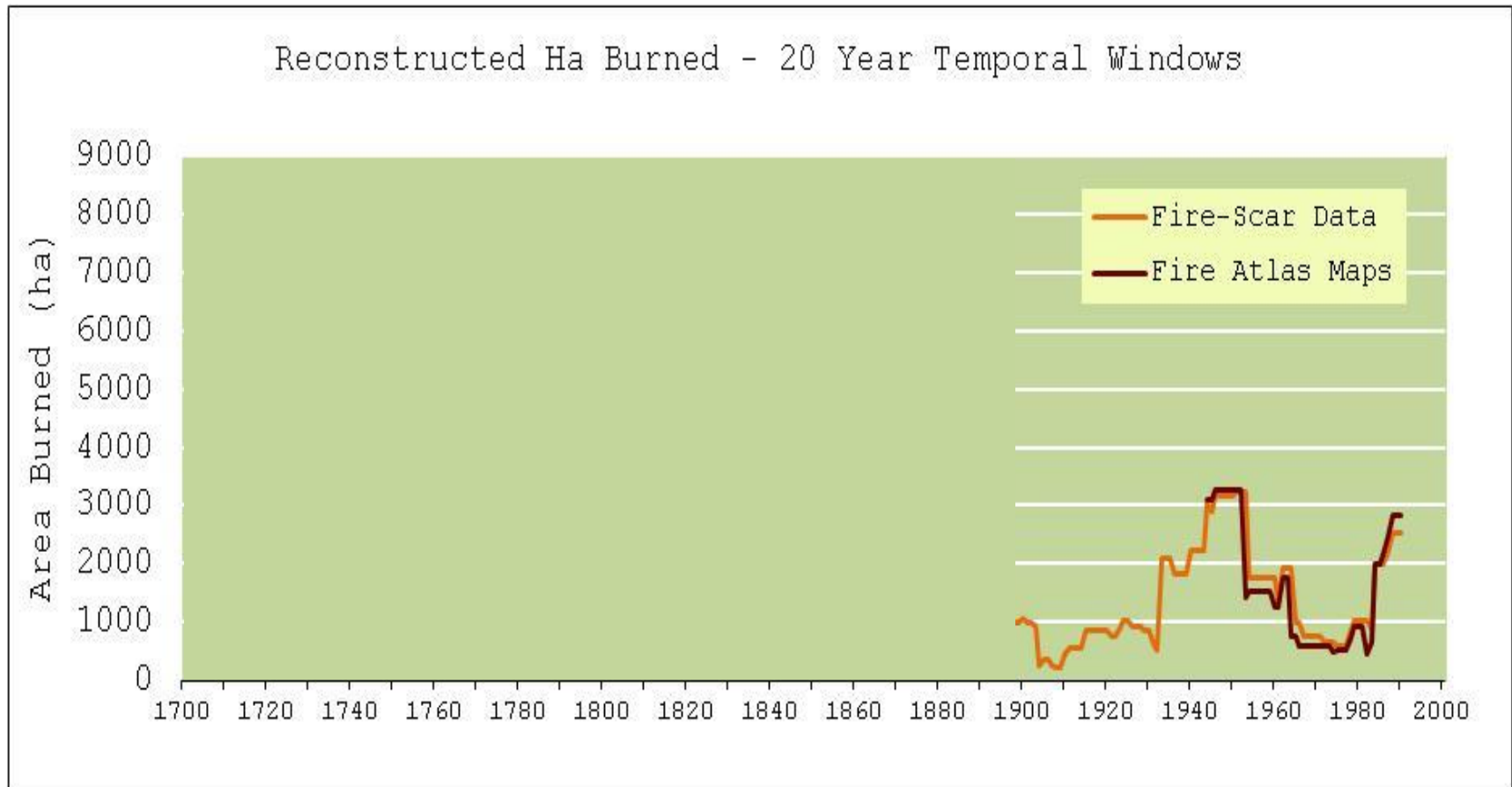


Reconstructed  
landscape fire  
patterns, Rincon  
Mountains  
(Farris 2010).

**Red outline: NPS  
Fire Atlas.**  
**Shaded  
polygons:  
Burned area  
reconstructed  
from fire scars.**

# Historical low-severity burned areas were large by comparison with today

Cal Farris (2010), comparison of pre-and post-settlement area burned, Rincon Mts



**Post-fire succession in the Chiricahuas after two events**  
Photo points, J. Minor



**ML**



**HL**



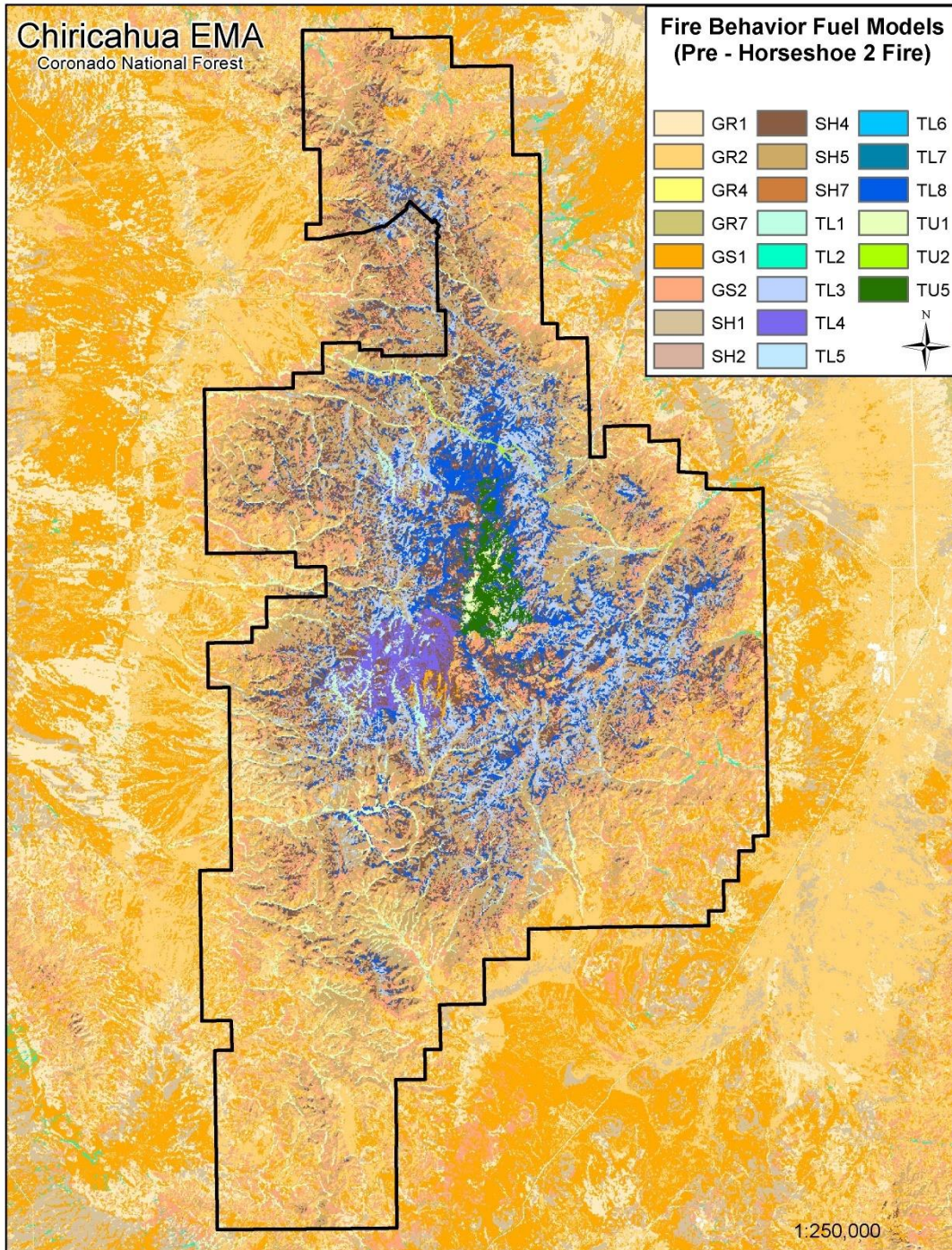
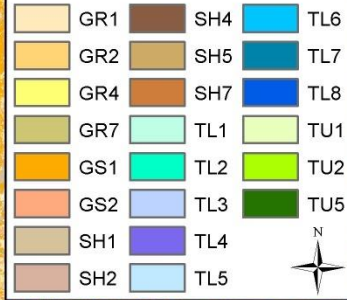
**LH**



**HM**

Chiricahua EMA  
Coronado National Forest

Fire Behavior Fuel Models  
(Pre - Horseshoe 2 Fire)



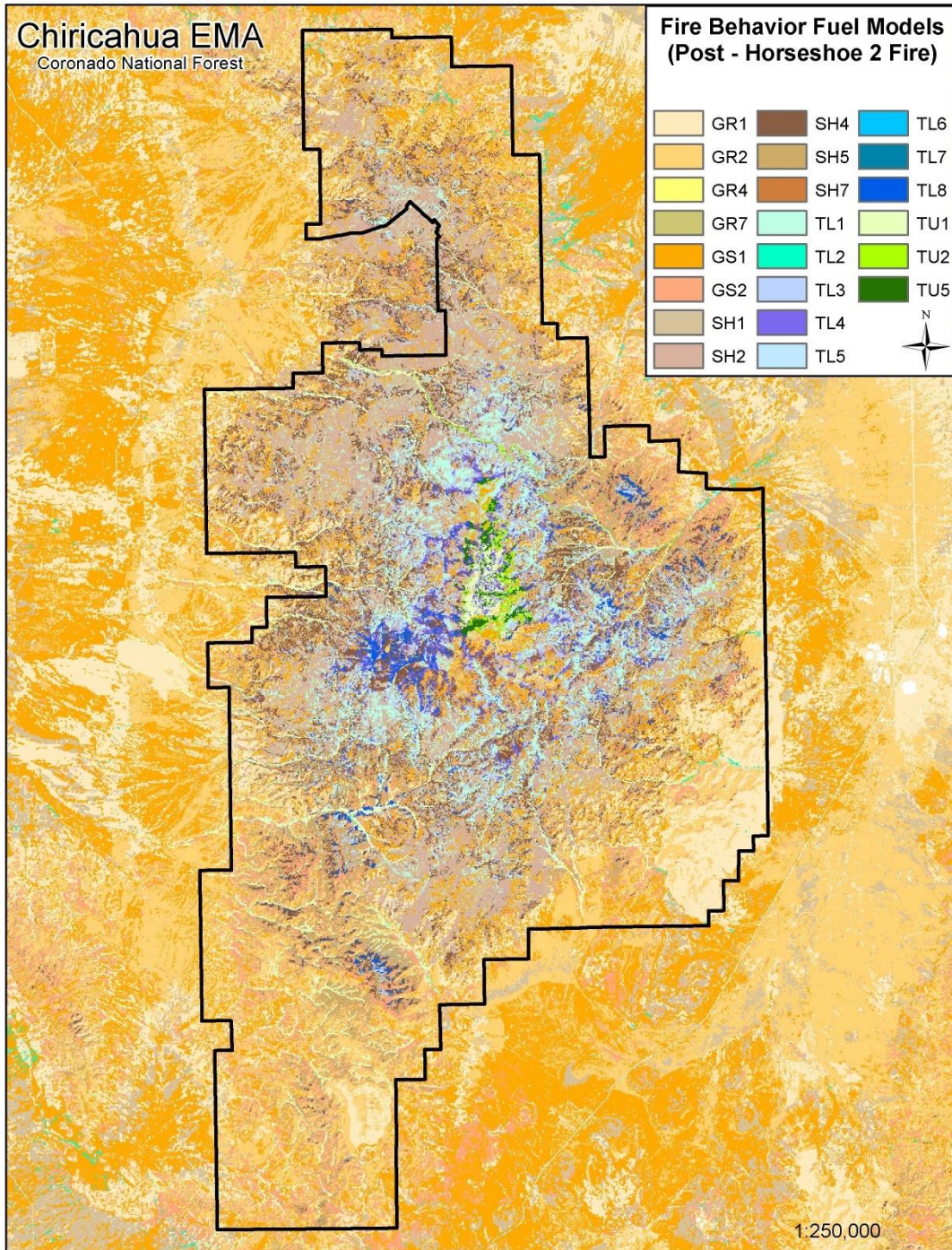
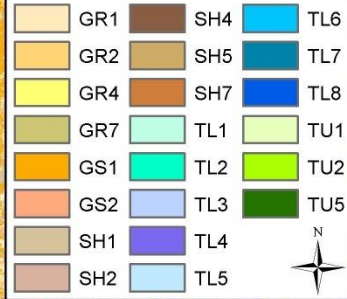
# Pre-fire Fuel models, Chiricahua Mountains

Figures courtesy  
C. Stetson,  
Coronado NF and  
D. Helmbrecht,  
USFS TEAMS



Chiricahua EMA  
Coronado National Forest

Fire Behavior Fuel Models  
(Post - Horseshoe 2 Fire)



1:250,000

# Post-fire Fuel models, Chiricahua Mountains

Figures courtesy  
C. Stetson,  
Coronado NF and  
D. Helmbrecht,  
USFS TEAMS

Jim Malusa, 2013



Forrest Shreve, 1912



# Sky Island Alliance



*Sky Island Alliance* is a grassroots organization dedicated to the protection and restoration of the rich natural heritage of native species and habitats in the Sky Island region of the southwestern United States and northwestern Mexico.





## Welcome to FireScape

**Background:** Fire plays a central role in the ecology of Arizona's Sky Islands, the regional mosaic of mountain ranges rising above the surrounding lowland deserts. Mid-elevation grasslands, woodlands, and forests of the Sky Islands developed over thousands of years under regimes of frequent fire. At the highest elevations, in wet mixed-conifer and spruce-fir forests, fire occurred less frequently (once every few centuries) but played an equally important role in regulating forest development. In lower elevation communities, such as the upland Sonoran desert, spreading fires were historically absent due to the lack of fine fuel to carry the flaming front. Each part of the Arizona landscape has a unique and long-established relationship to fire.

In the past century, this relationship of fire and ecosystems has been altered or disrupted, largely by human activities on the landscape. Extensive sheep and cattle grazing in the late 1800s reduced grass cover and disturbed soils, eliminating the fine fuels that carry spreading fires. Active fire suppression became increasingly effective in the 1940s with the use of aircraft and mechanized firefighting and the dedication of increased financial resources for firefighting on a regional and national scale. These human influences were superimposed on a background of climate variation, which tends to create periods of varying fire activity. One visible result of the lack of fire is the dramatic increase in tree density in many forest types where fire historically kept forests more open. These dense forests constitute unusually high fuel loads that set the stage for the dramatic high-severity fires that have occurred in several Sky Islands in recent years.

**The need for action at landscape scales:** Managers of public lands in Arizona recognize that these heavy fuel loads need to be reduced, and fire reintroduced as a natural process, to restore the ecological balance of the Sky Islands as well as to reduce the risk of catastrophic fires that threaten human safety and property. Fuel treatments and prescribed burning are among the main strategies used to achieve these objectives. However, the scale of treatments is often small -- often a few hundred acres per year -- compared to the scale of the ecological problem, which affects entire mountain ranges. Small-scale treatments simply cannot keep up with the ongoing increases in fuels and the hazard of severe fires. Recognizing this dilemma, the need for landscape-scale strategies has recently become a central vision for restoring the ecological health of the Sky Islands, and indeed across the West.

FireScape is our response to the need for landscape-scale fire and ecosystem management. FireScape is a framework for expanding safe, ecologically sound, large-scale fire management across multiple land ownerships in the mountains of southeastern Arizona. The FireScape leadership team includes representatives from the Forest Service, The Nature Conservancy, the University of Arizona (UA), Bureau of Land Management, National Park Service, and other southeastern Arizona land managers.

Each Sky Island landscape is a unique biophysical setting with its own management challenges. Thus, each range also requires an individual approach to fire management. The FireScape team works to develop strategies that are



<http://www.azfirescape.org/home>

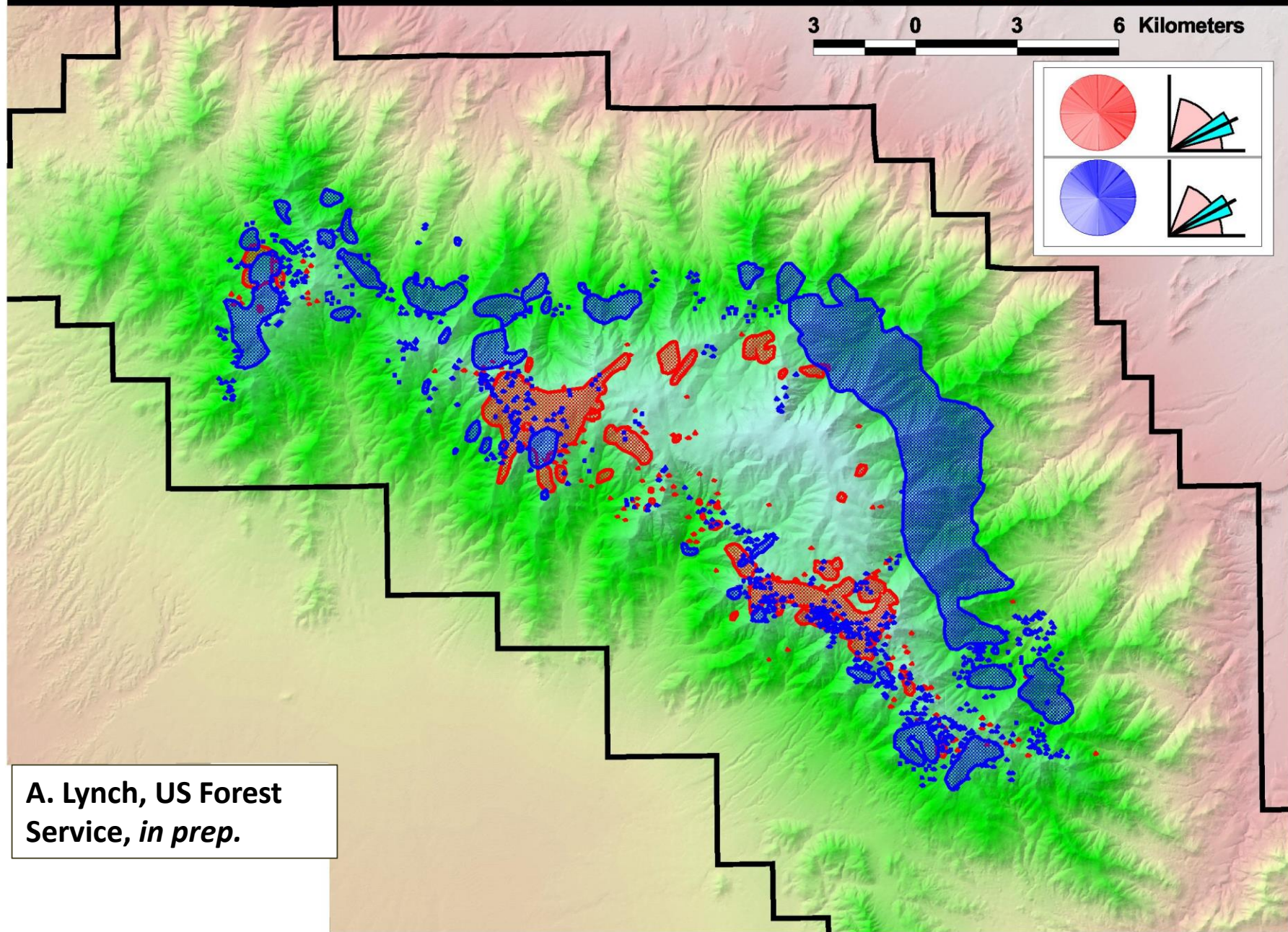
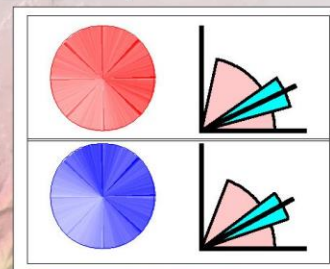


# Roundheaded, Western Pine Beetles (*D. adjunctus*, *D. brevicomis*)

1991 -1995

2000 - 2005

3 0 3 6 Kilometers



A. Lynch, US Forest Service, *in prep.*

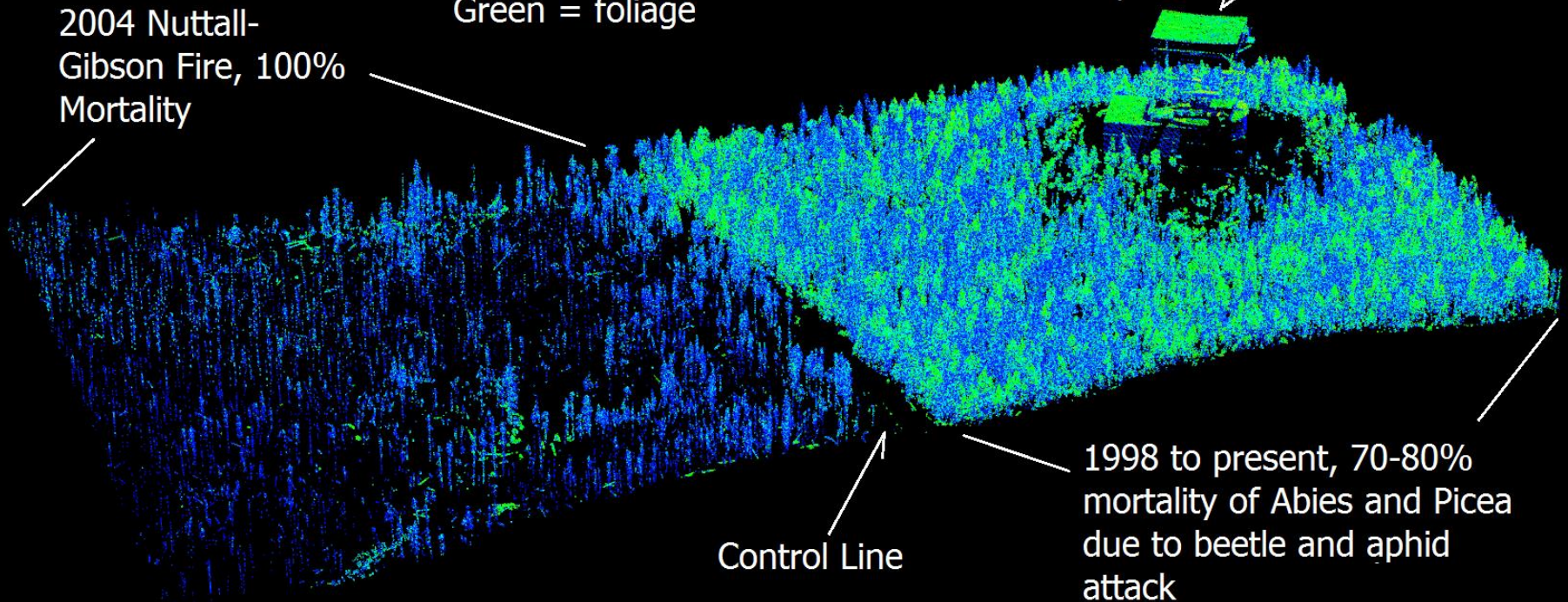
# LiDAR reveals individual tree fire and insect-caused mortality with unprecedented accuracy

ALSM Intensity (normalized 0-255)

Blue = defoliated  
Green = foliage

Large Binocular Telescope, Mt. Graham, AZ

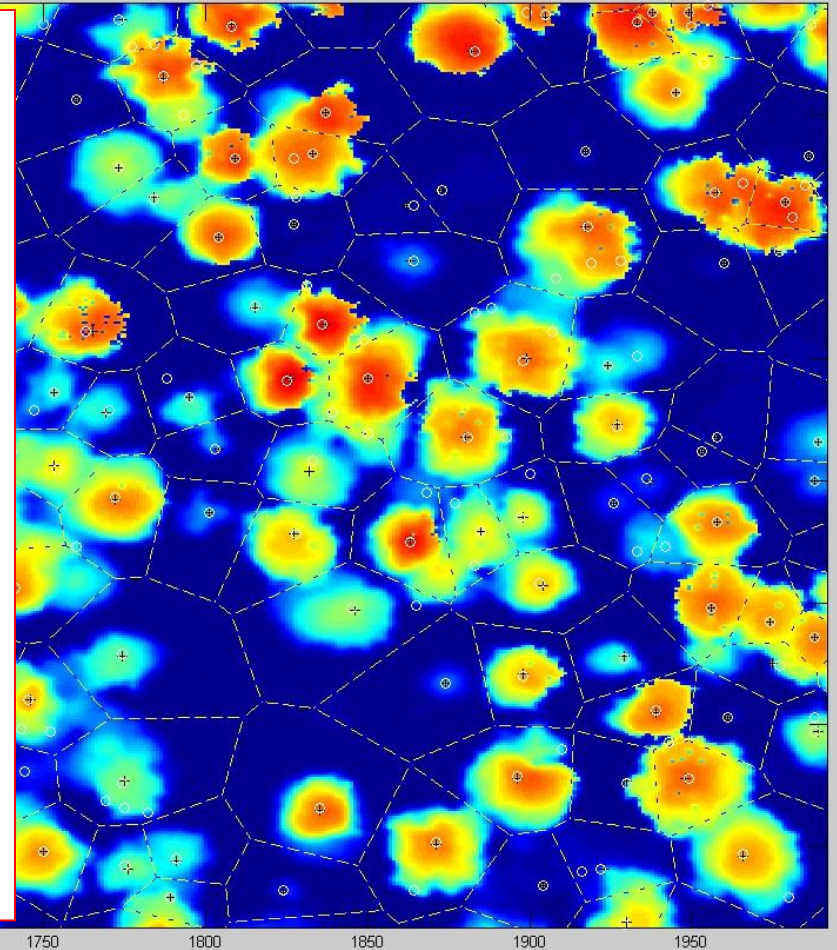
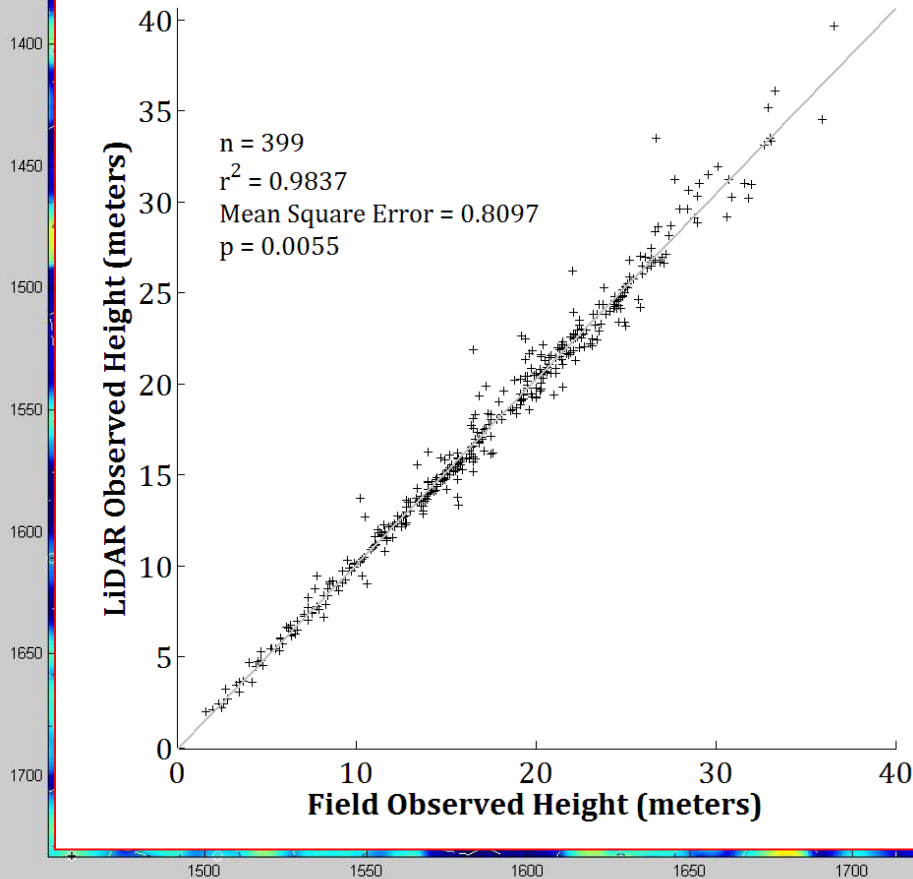
2004 Nuttall-Gibson Fire, 100% Mortality



# An ecosystem-scale inventory

- Biomass (i.e. carbon storage)
- Tree size and growth
- Fire Behavior
- Disturbance interactions

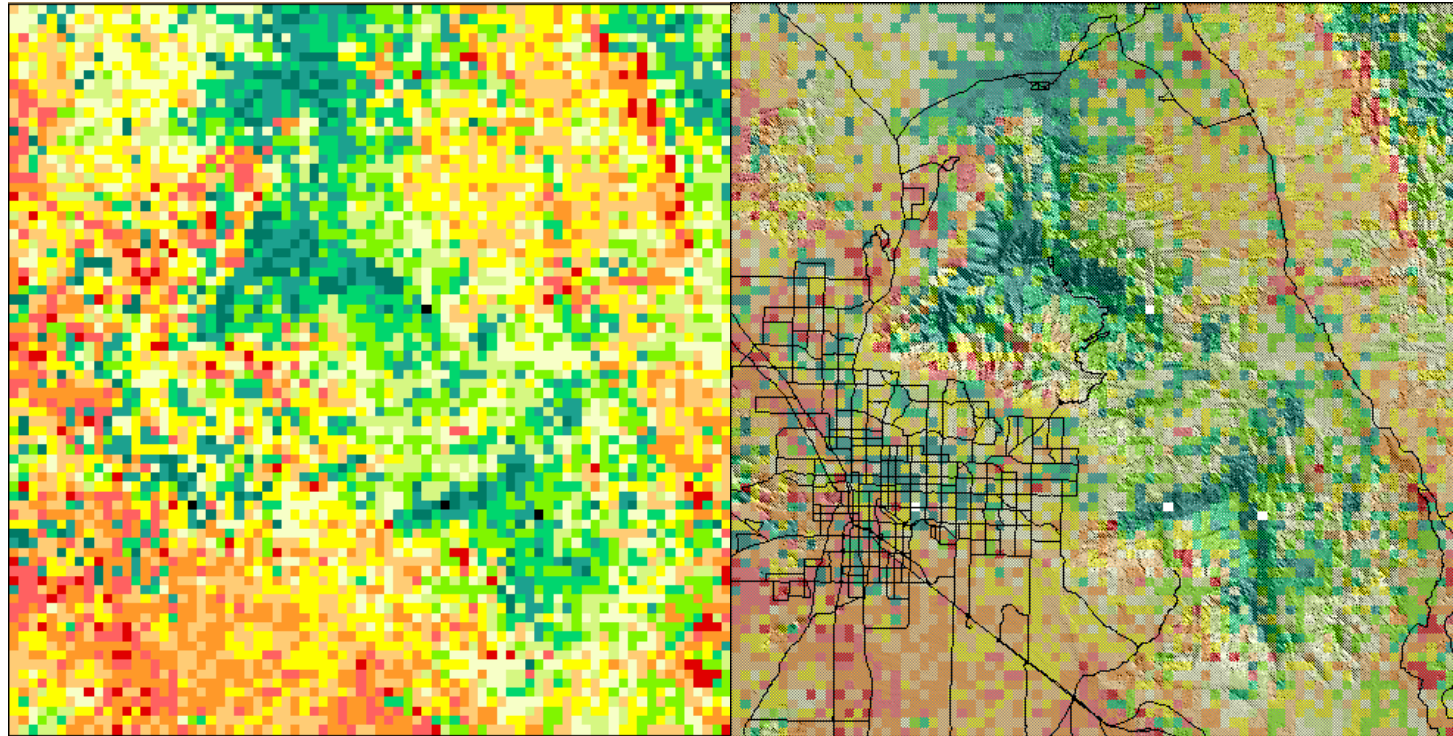
**Pinaleños observed vs LiDAR tree height**



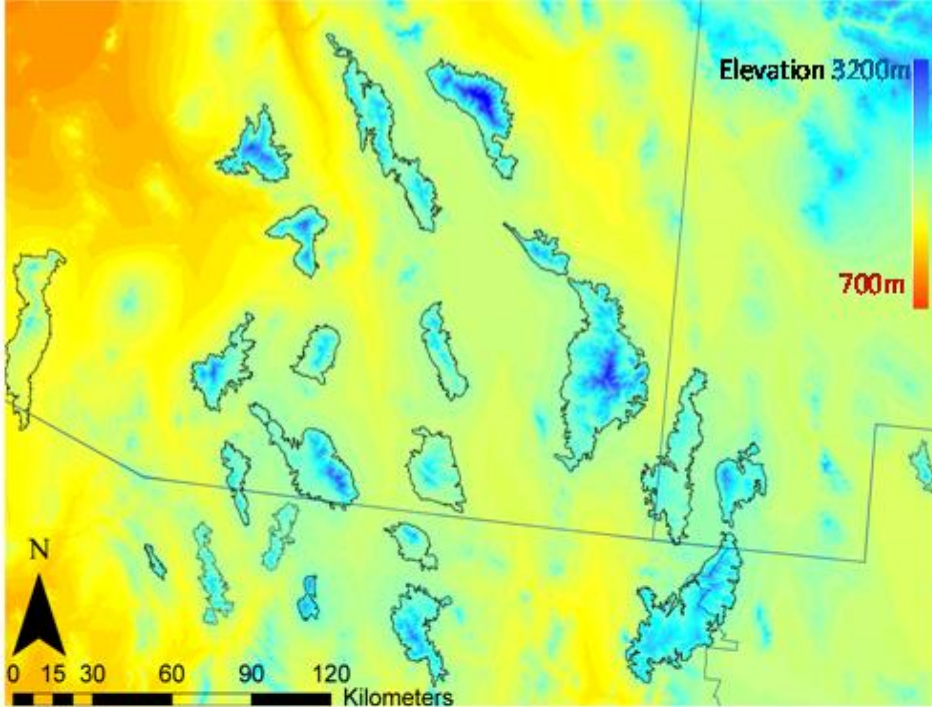


# Fuel Moisture Stress Index:

When and where are fuels most flammable?



Dr Steve Yool, University of Arizona



We can restore fire, and ecosystems, at large scales in the Sky Islands bioregion?

- NEPA-ready projects:
  - Pinaleños
  - Huachucas
  - Close: Catalina-Rincon
  - Coming: Chiricahuas



# Fire behavior modeling

Objective: Identify areas in the Sky Islands where current fuelscape would produce fires outside the historic range of variability

