Assessing Climate Change Vulnerability for the Southern Sierra Nevada

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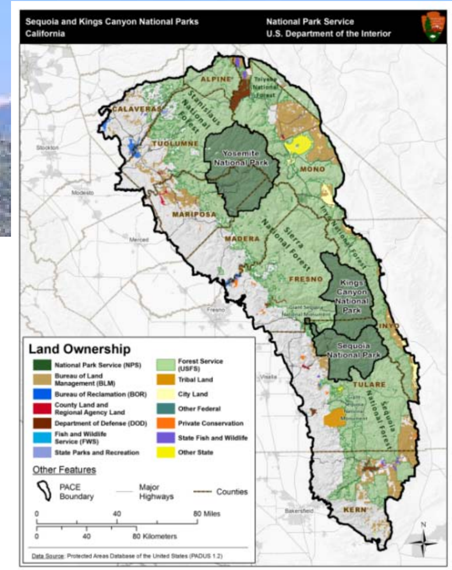
Koren Nydick (NPS)
Jim Thorne
Andy Holguin
Charisse Sydoriak
And about 25 others

oto

The Southern Sierra Nevada



- Temperatures are warming
- Glaciers are melting
- Earlier snowmelt
- changing rain /snow…
- Increased tree mortality
- Increasing fires: frequency, size intensity

- Unprecedented, unpredictable--Nate

MEANWHILE:

➢ The Leopold Report (1964) set Parks management to *restore and maintain historical representations*.

If current management goals and strategies don't make sense then, …what does?

Vegetation (biodiversity)

Climate

Fire

Three key features of this research:

1. Fire Management: Managing fire is influential, and costly; adjustments here matter.

Prescribed fire work in Sequoia and Kings Canyon National Parks. Photo–Ted Young, NPS.

2. Co-generation of research: NPS, USFS, USGS, University collaboration

3. **Geospatial**. We want to understand both the temporal and spatial variation in vulnerability

Geospatial Vulnerability Assessment

Vulnerability = F(Sensitivity, Exposure, Adaptive Capacity)

P(fire | climate change)

Exposure

P(high intensity | fire)

Exposure

Today

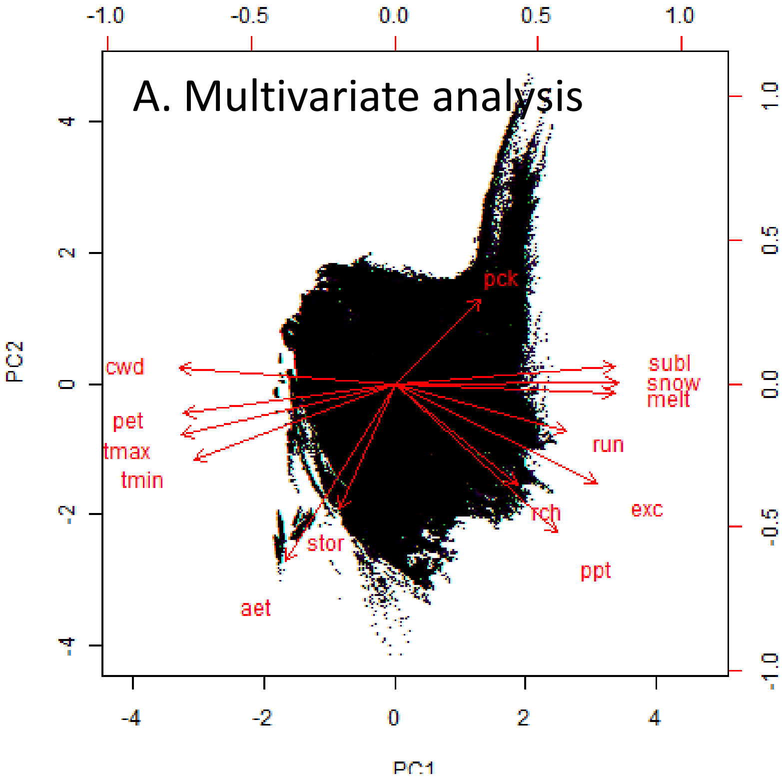
P(vegetation stress | climate change)

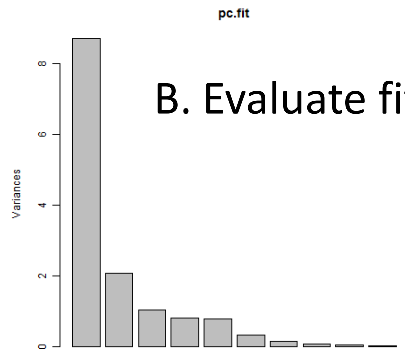
Sensitivity

P(vegetation change | climate change, fire)

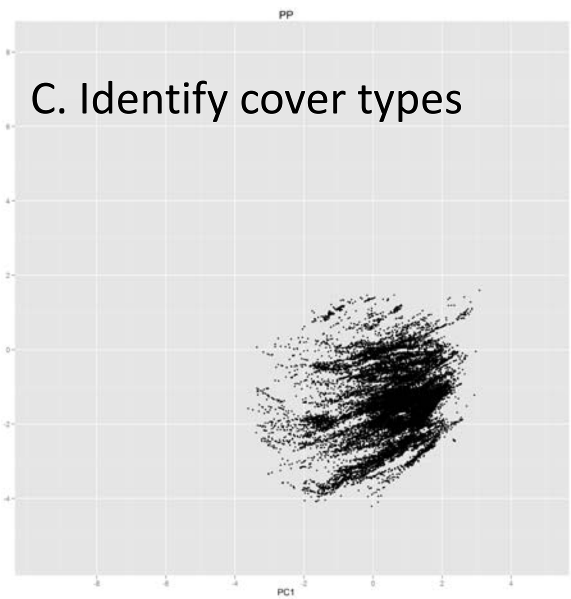
Sensitivity

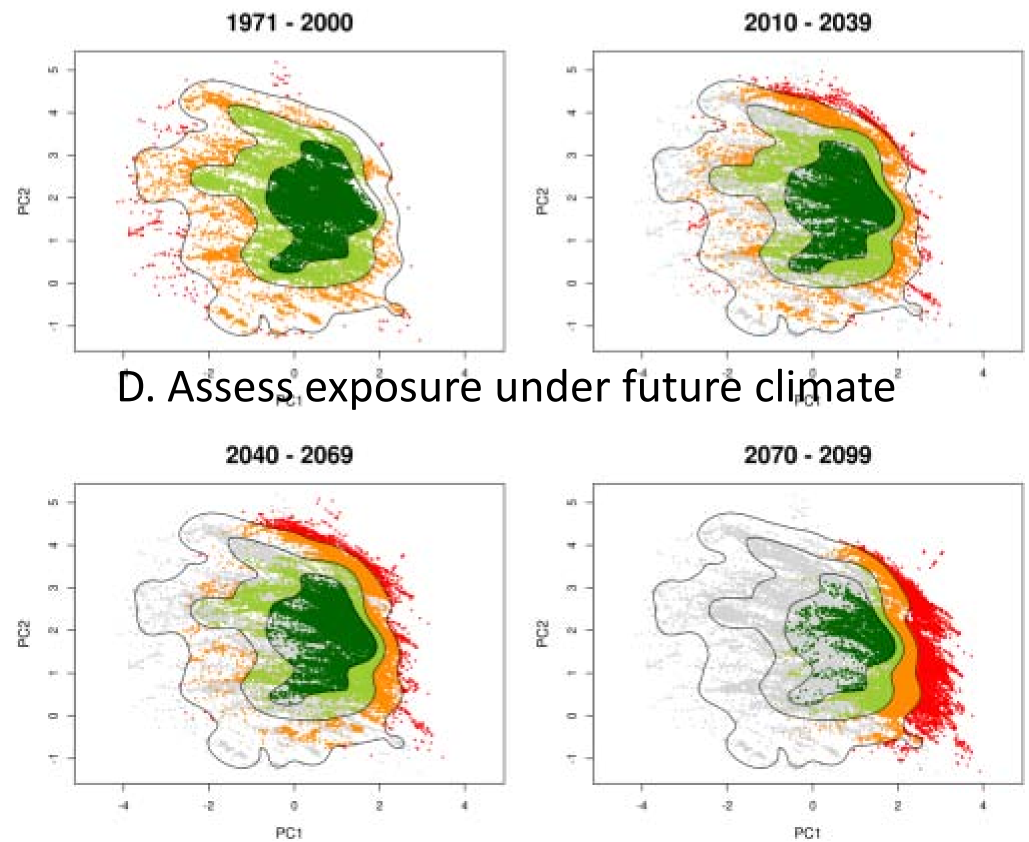
Vegetation Exposure to Climate Change

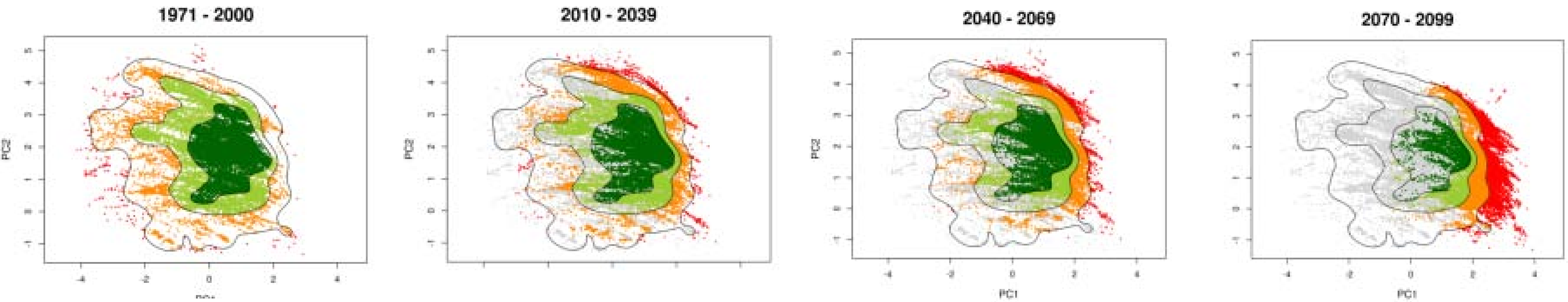




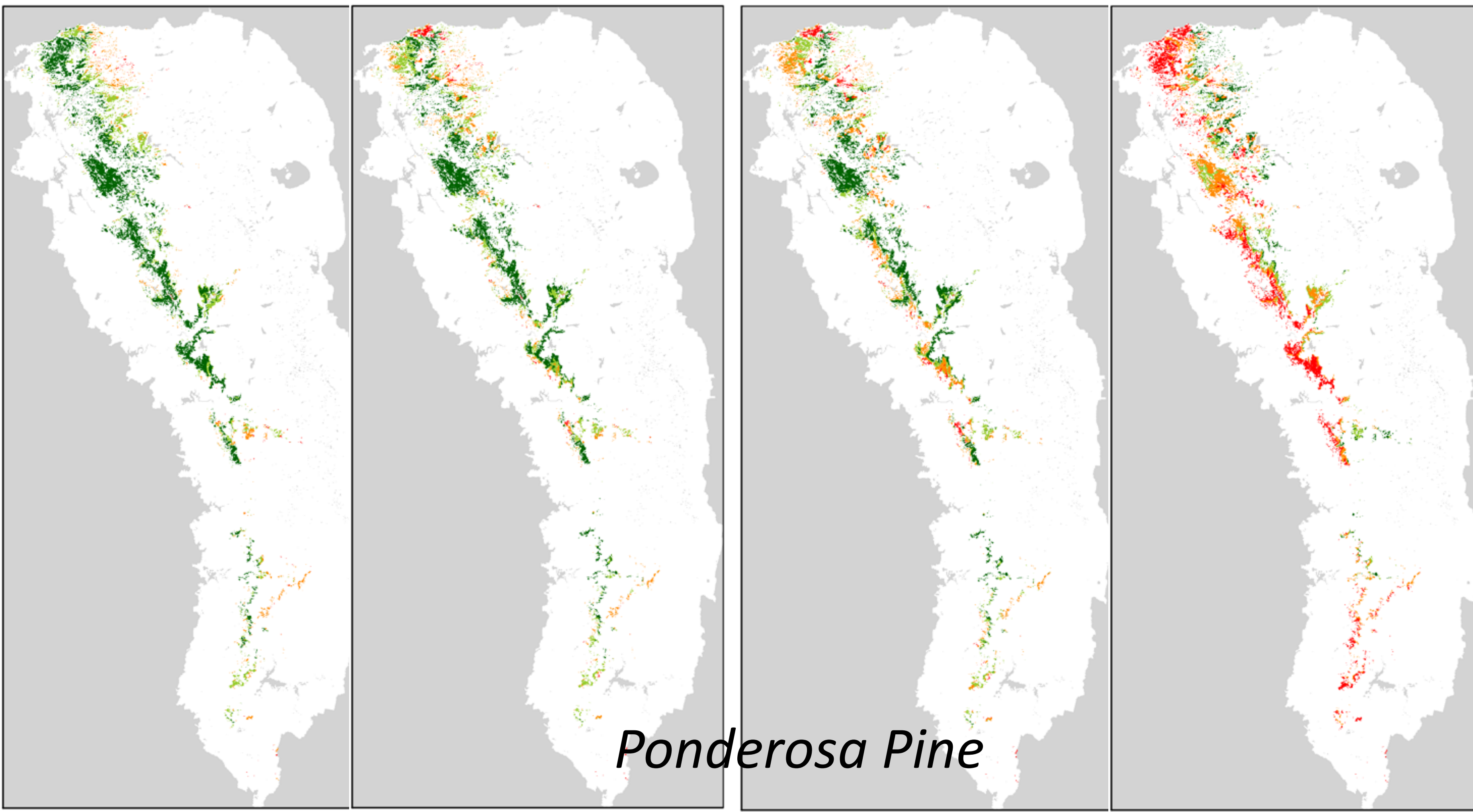
Central (<66%);
Marginal 67-90th,
Highly marginal (90-99th%), and
Outside (>99th%







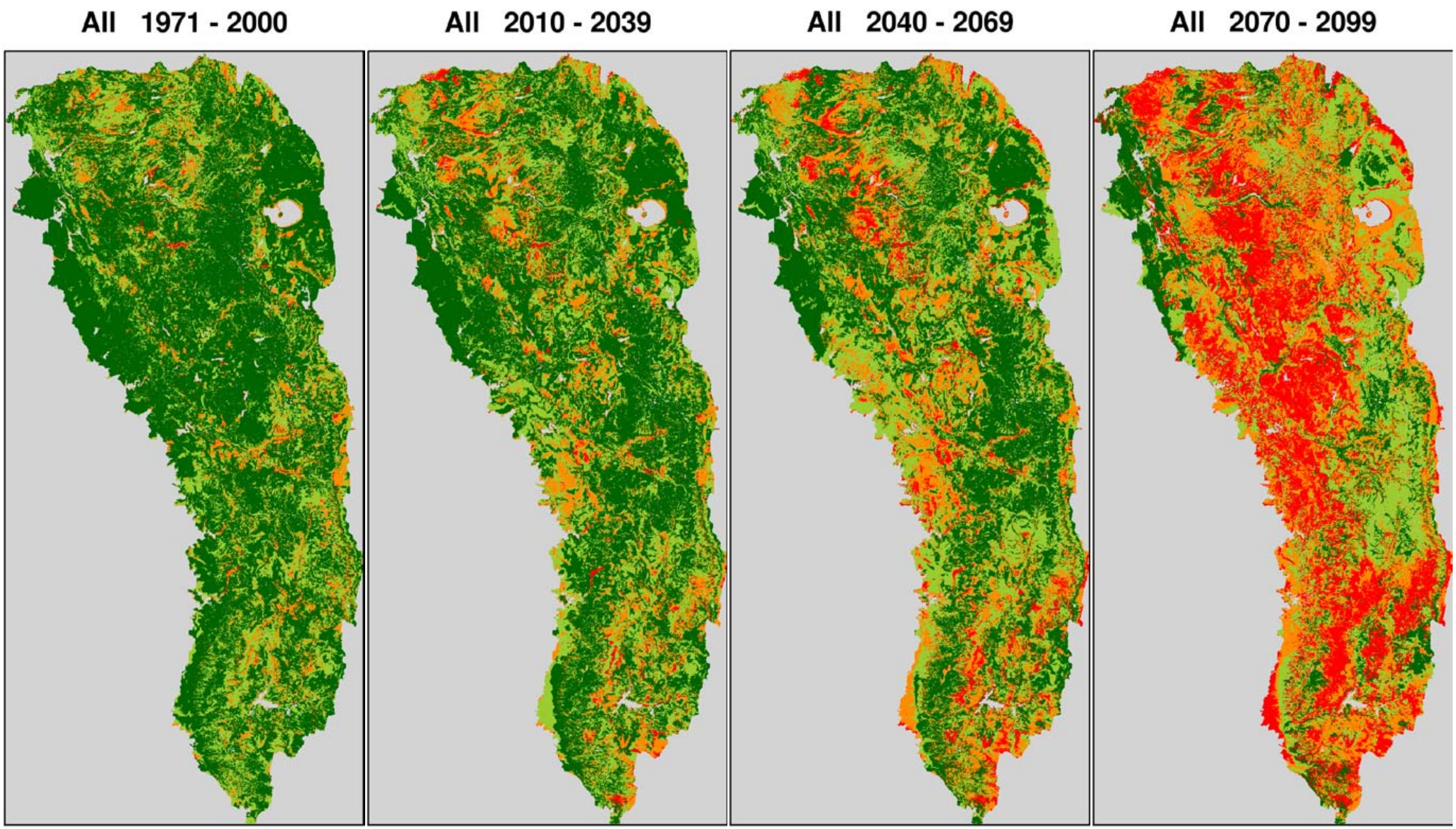
PP 1971 - 2000 **PP 2010 - 2039** **PP 2040 - 2069** **PP 2070 - 2099**



Ponderosa Pine

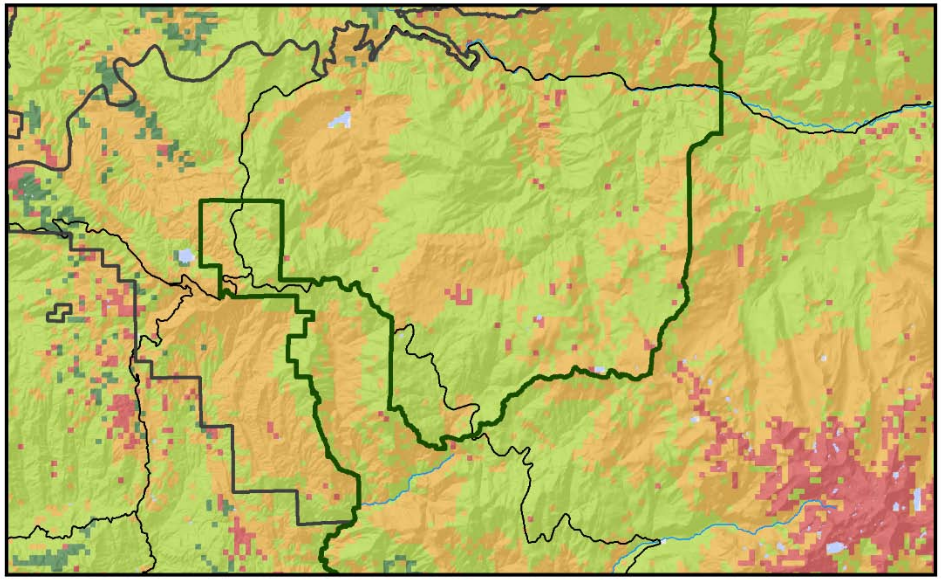
P(vegetation stress | climate change)

Dark green: secure
Light green: likely secure
Orange: moderately sensitive
Red: highly sensitive



Magnitude of change

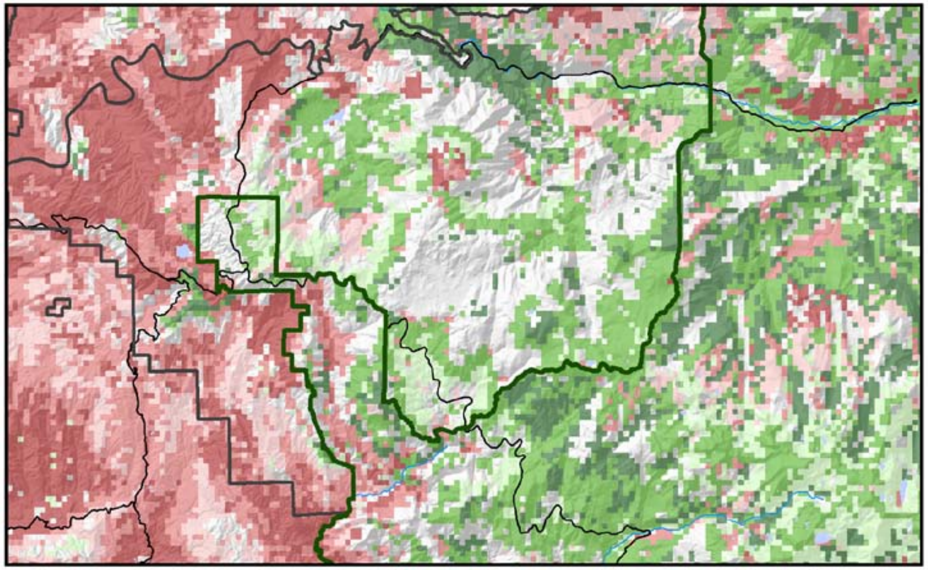
- Under future climate; how does each location intersect with the bioclimatic envelope of each of the 80 veg types (central, … marginal, outside).
- How different is each veg class from the current (conifer to conifer; conifer to hardwood; conifer to shrublands)
- Combine the two and get a weighted average; map.



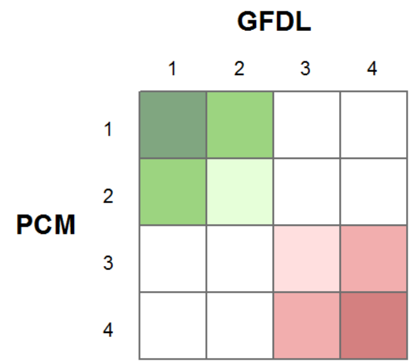
Hume Landscape; Magnitude of change; GFDL model; 2070-2099. Red and orange: dramatic changes such as conifer to shrublands.

Note red in lower right: granite, mostly

Sensitivity Analysis

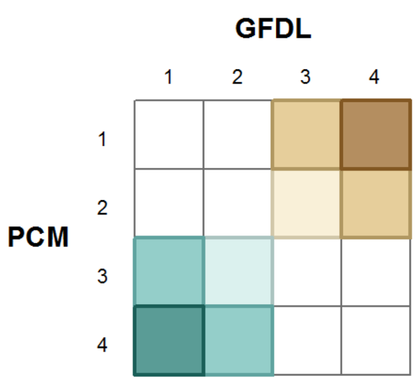


Model agreement

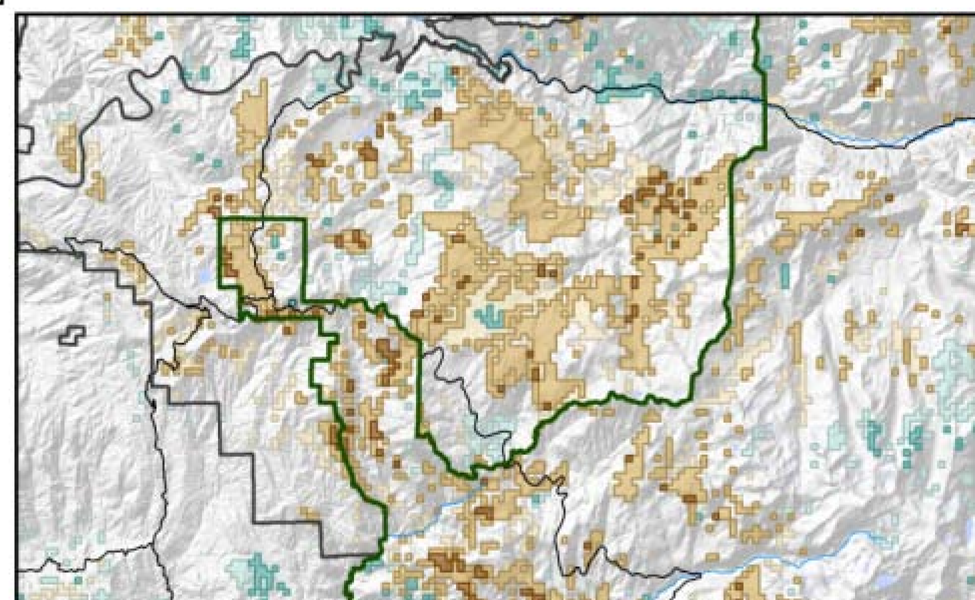


Green-secure
Red - exposed

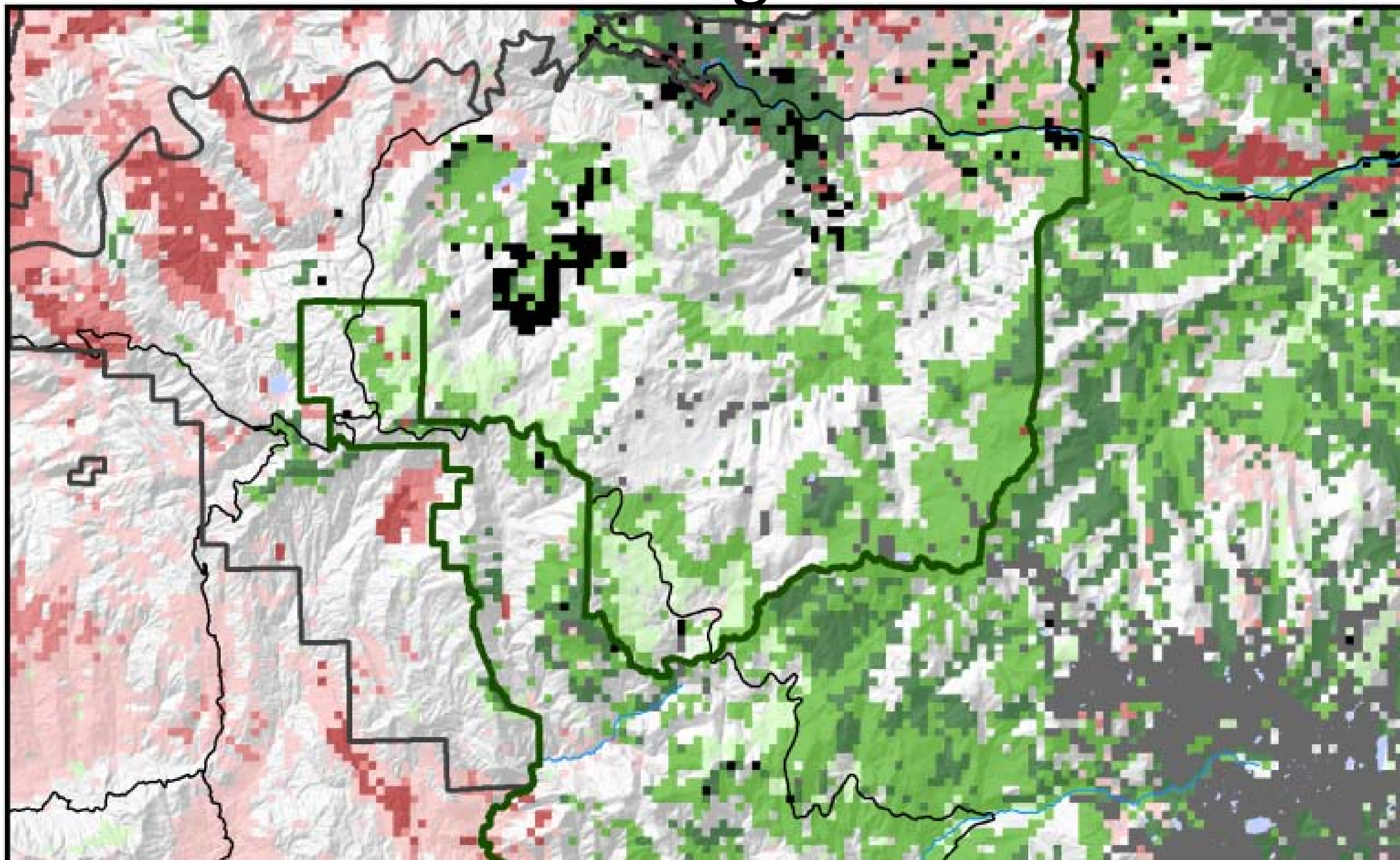
Brown-uncertain
Blue- uncertain



Model disagreement

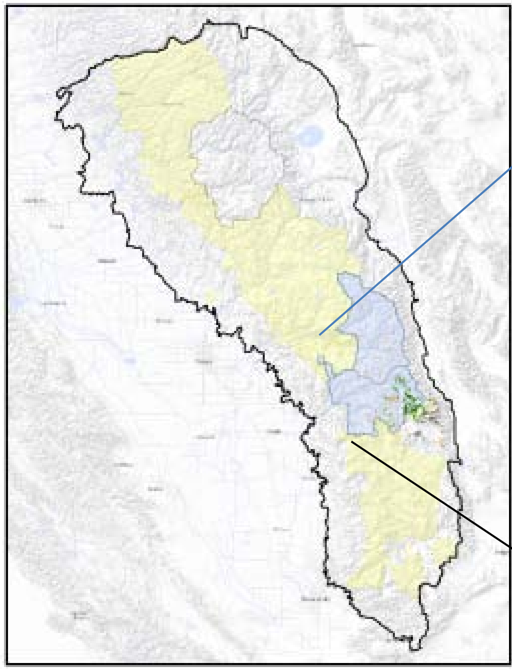


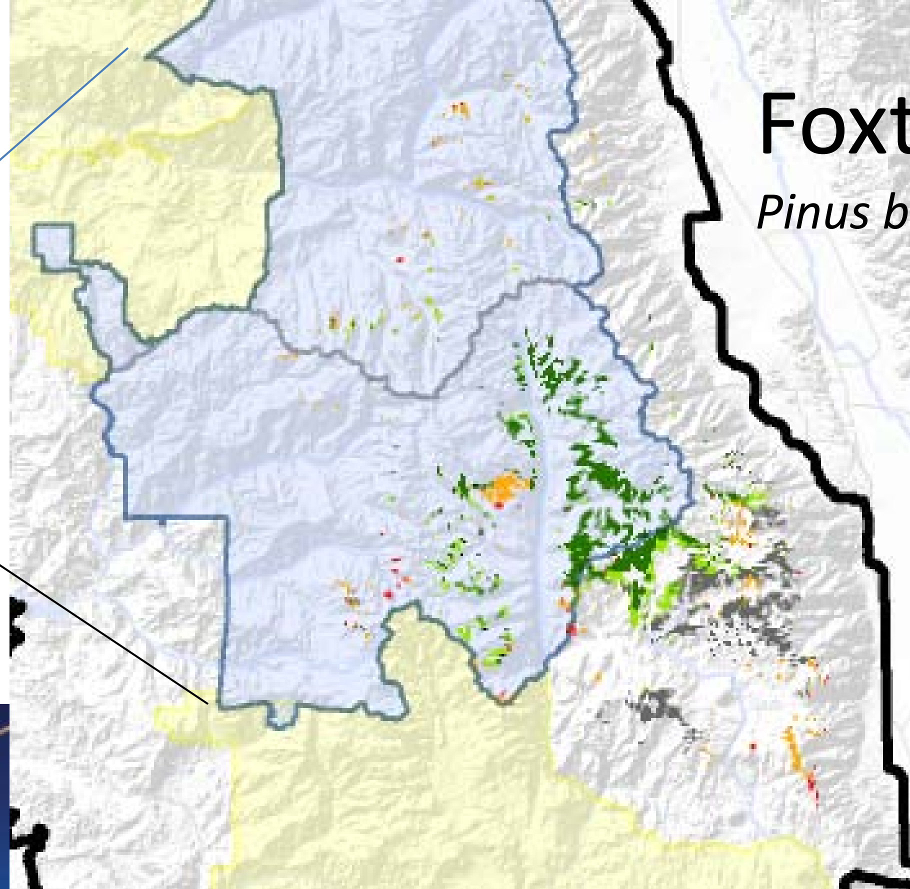
Early exposure / end-of-century refugia



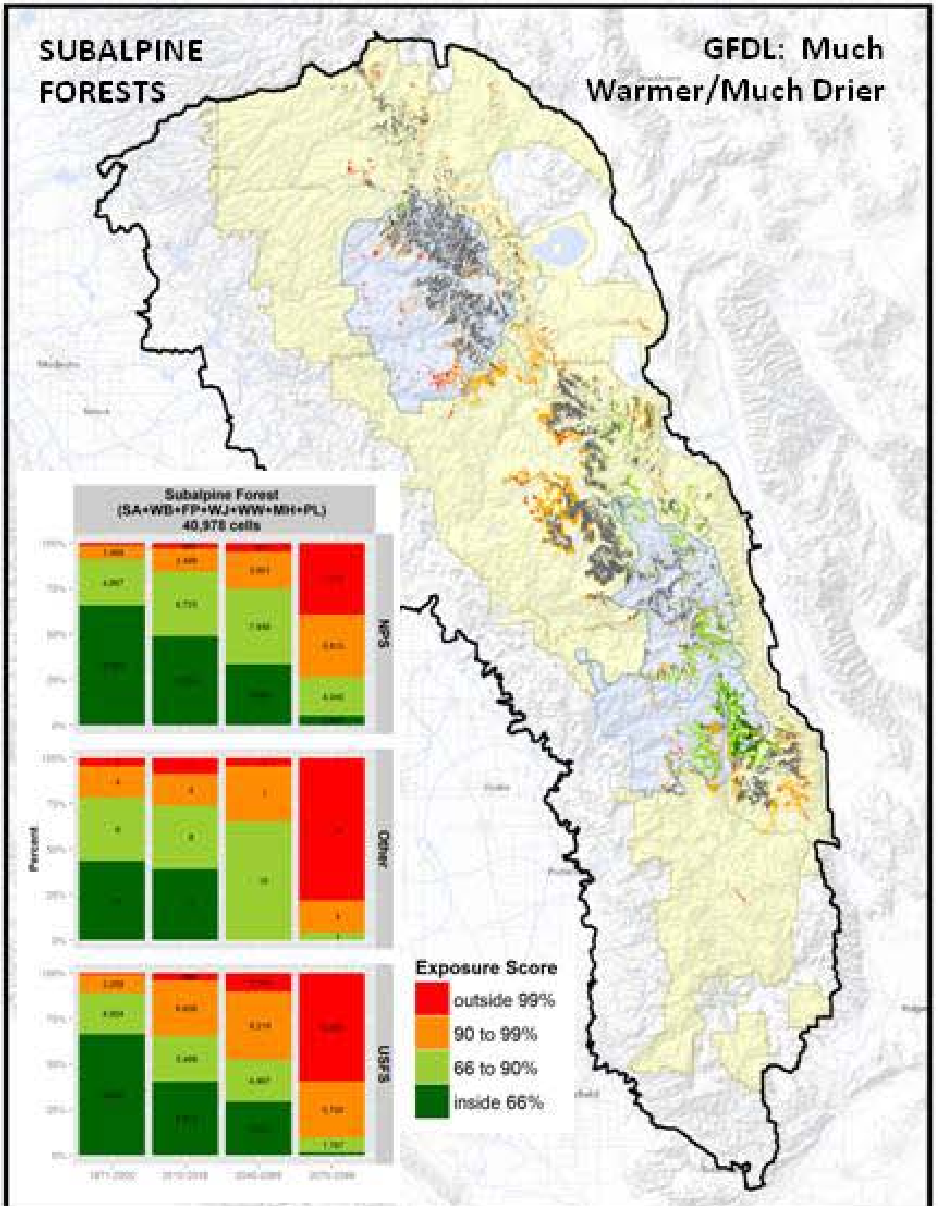
Foxtail Pine

Pinus balfouriana

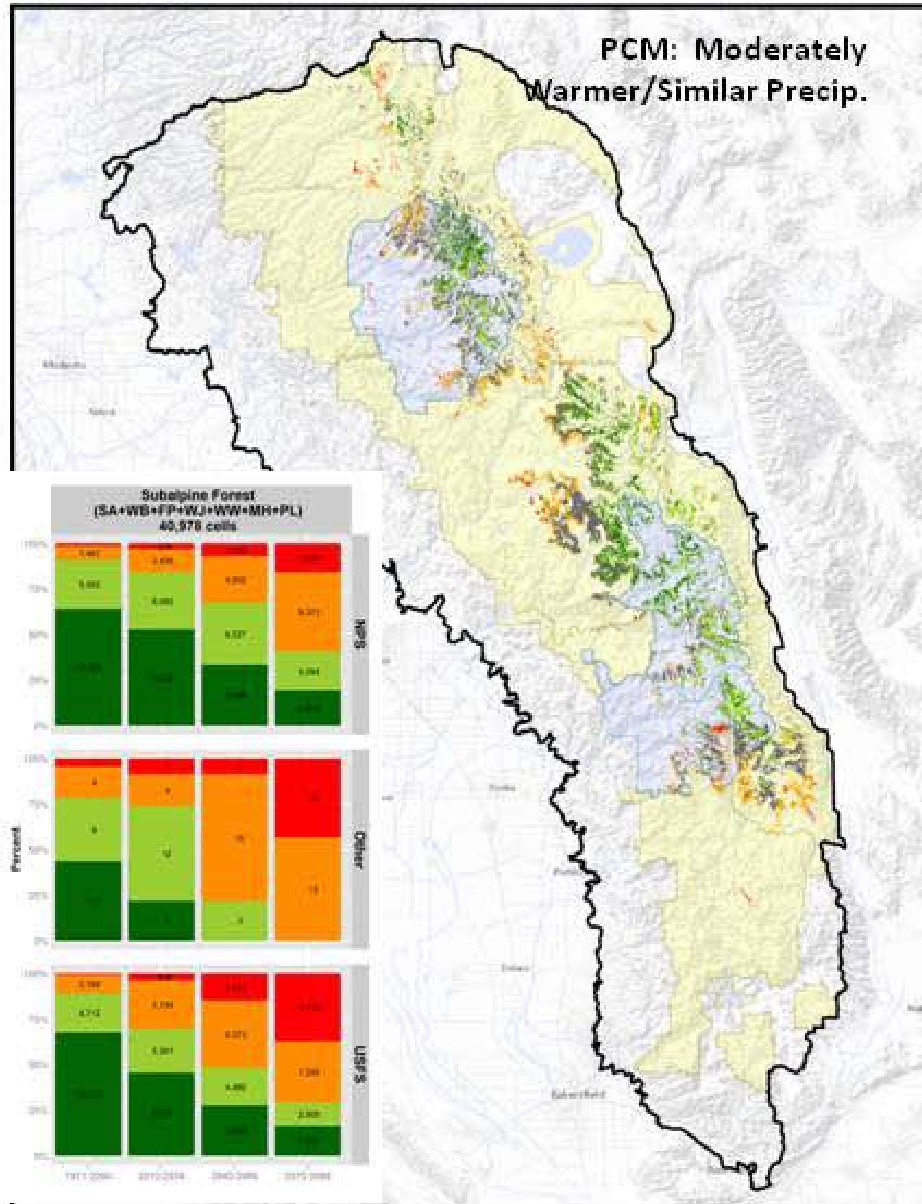




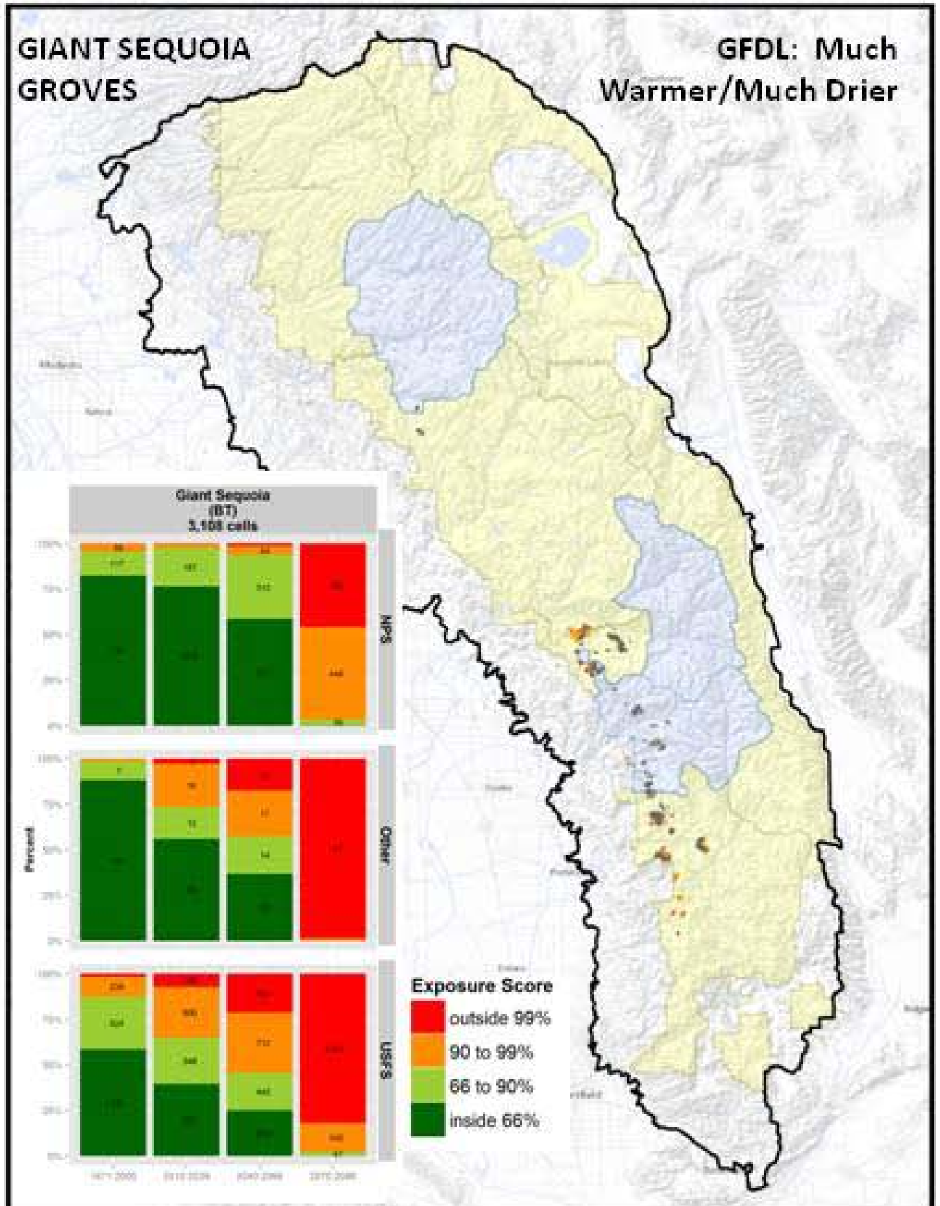
Most occurrences of *P. balfouriana* that appear secure through the 21st century are in the National Park, and not the US Forest Service land.

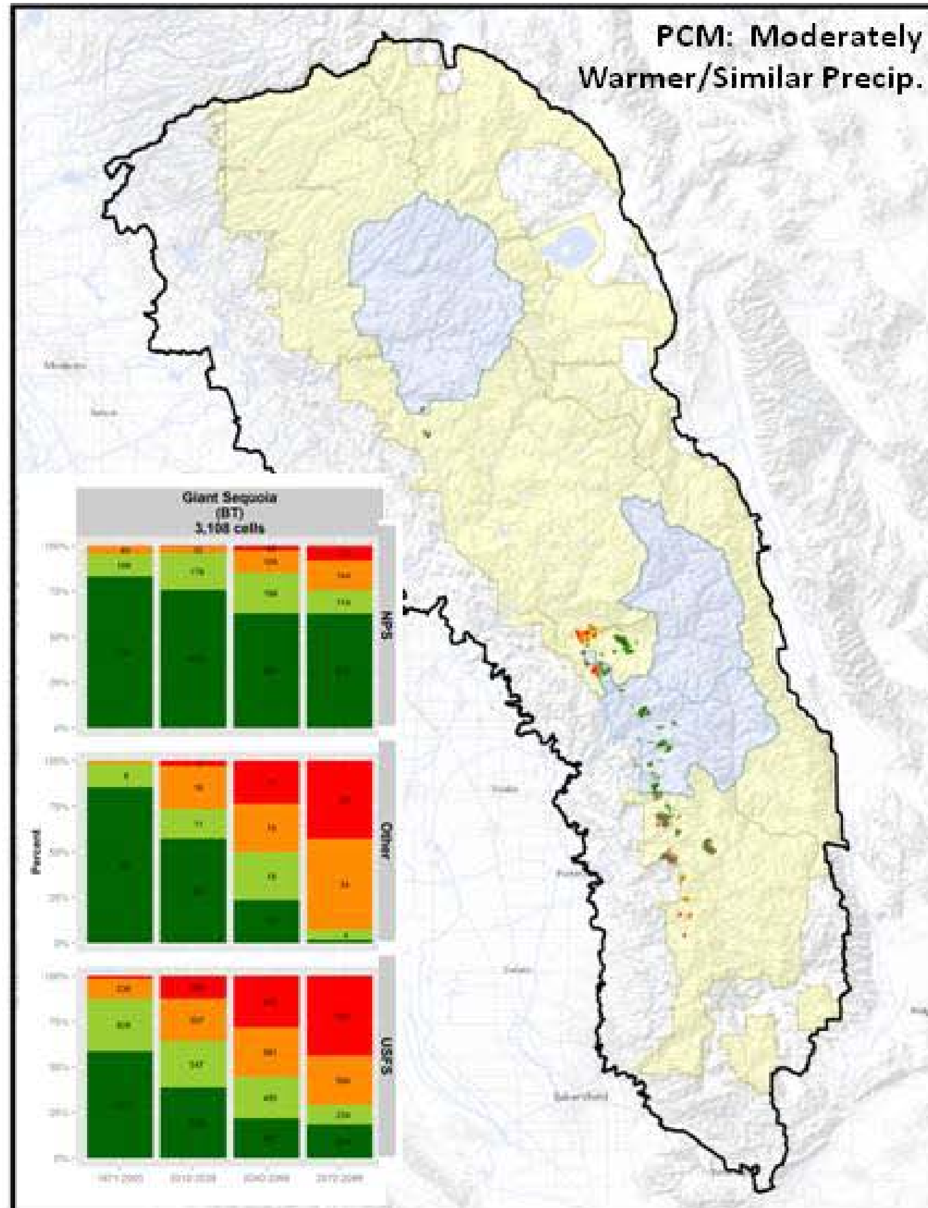


SUBALPINE FORESTS
GFDL: Much Warmer/Much Drier
Subalpine Forest
(SA+WB+FP+WJ+WW+MH+PL)
40,978 cells
NPS
Other
USFS
Percent
Exposure Score
outside 99%
90 to 99%
66 to 90%
inside 66%



PCM: Moderately Warmer/Similar Precip.
Subalpine Forest
(SA+WB+FP+WJ+WW+MH+PL)
40,978 cells
NPS
Other
USFS
Percent


GIANT SEQUOIA
GROVES
GFDL: Much
Warmer/Much Drier
Giant Sequoia
(BT)
3,108 cells
NPS
Other
USFS
Percent
Exposure Score
outside 99%
90 to 99%
66 to 90%
inside 66%


PCM: Moderately
Warmer/Similar Precip.
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USFS
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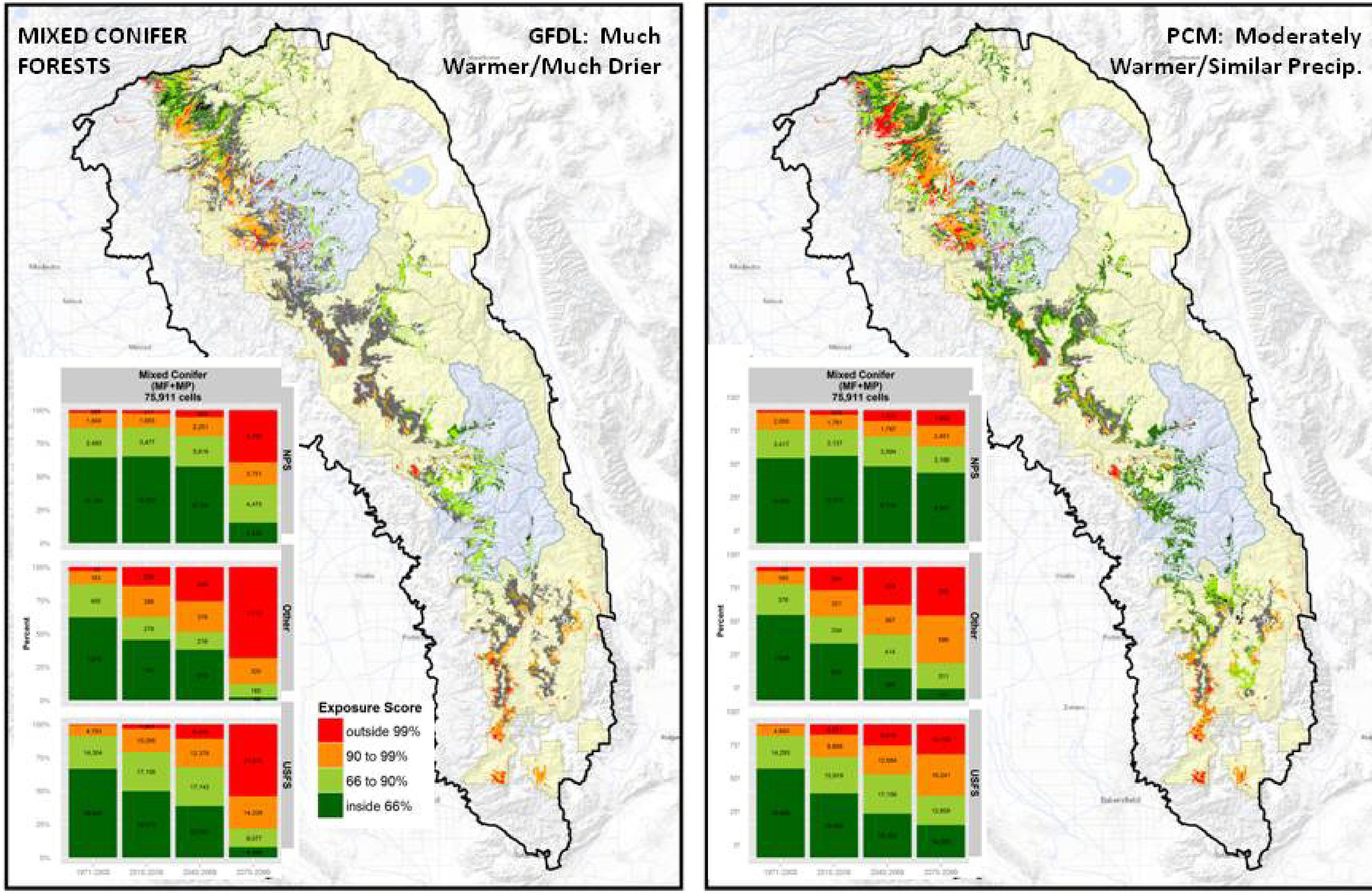
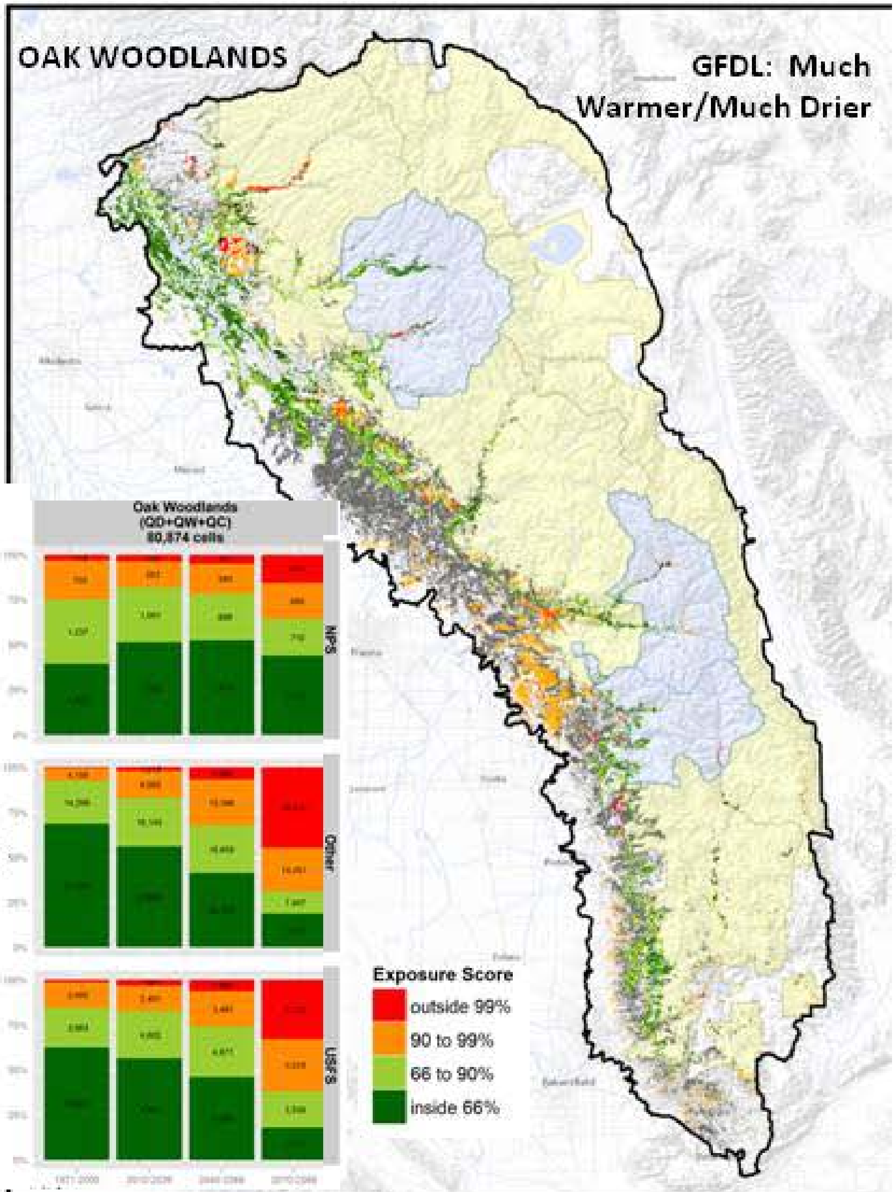
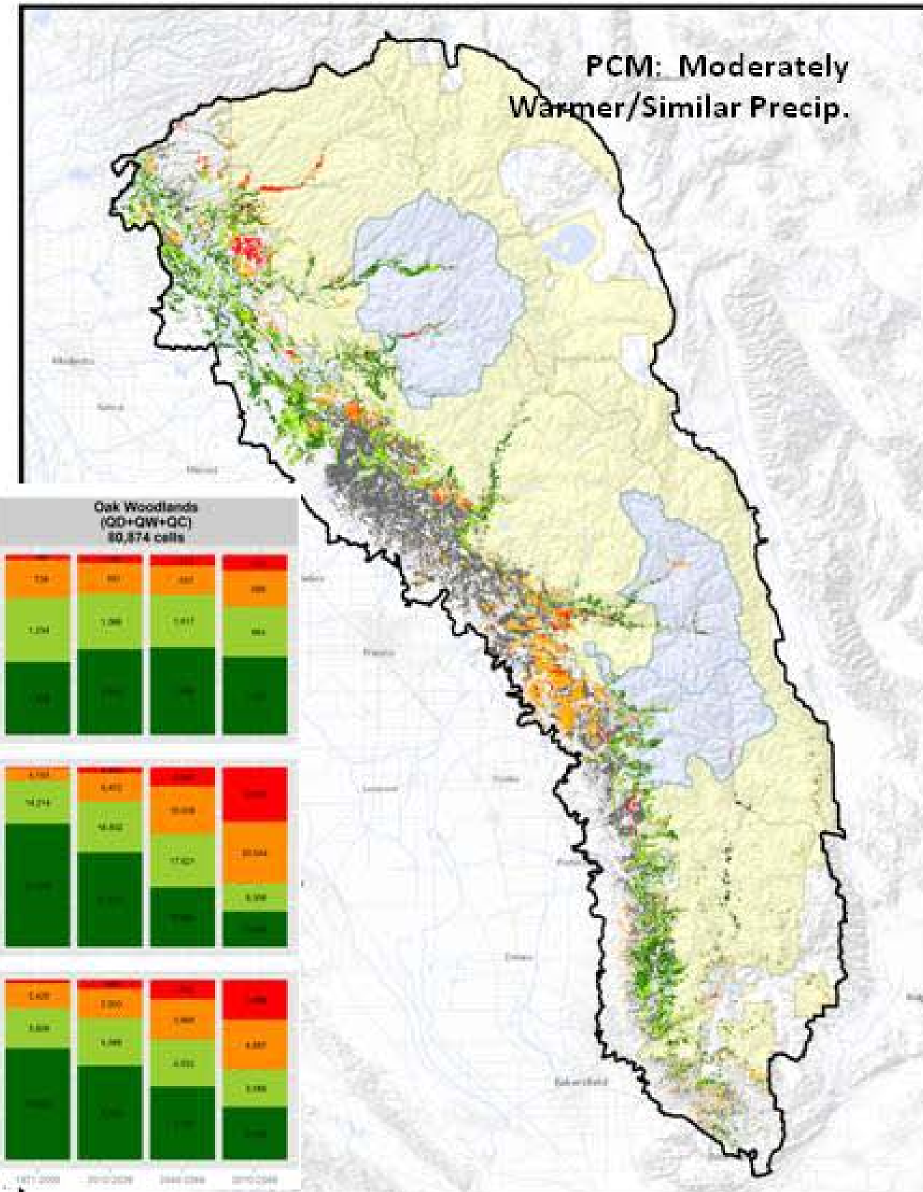


Figure 3. Two scenarios of future climate exposure for mixed conifer forests in the southern Sierra Nevada study area. Maps show grove area predicted to be at risk soonest (high exposure in 2010-2039) in red and orange; resilient longest (low exposure in 2070-2099) in dark and light green; and at risk later (high exposure by 2070-2099) in gray. Blue borders = NPS; yellow shading = USFS. Bar graphs show percent of study area falling within different climate exposure score categories over time (1971-2000; 2010-2039; 2040-2069; 2070-2099, across bottom) and for NPS, other, and USFS lands. Exposure score percentiles are based on projected future climate conditions compared to the baseline (1971-2000) climate envelope for mixed conifer forests, which include mixed conifer-fir and mixed conifer-pines CalVeg types. From Schwartz et al. In Prep.

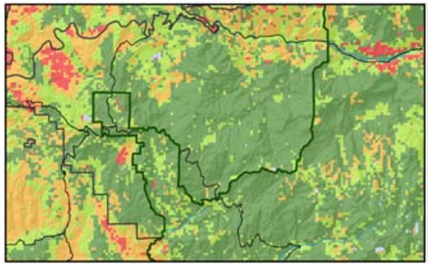

OAK WOODLANDS
GFDL: Much Warmer/Much Drier
Oak Woodlands
(QD+QW+QC)
80,874 cells
NPS
Other
USFS
Exposure Score
outside 99%
90 to 99%
66 to 90%
inside 66%


PCM: Moderately Warmer/Similar Precip.
Oak Woodlands
(QD+QW+QC)
80,874 cells

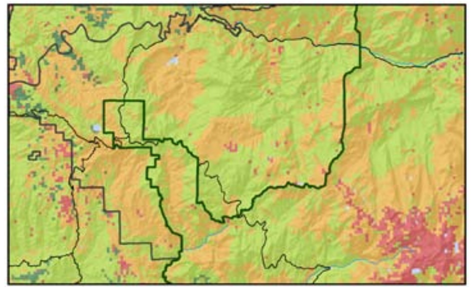
What do we do with this information?

- Adjust high level objectives
  - Restraint: If capacity limitation forces us to differentially value at risk resources, which ones do we let go?
  - Resilience/Resistance: For which elements do we try to manage fuels/fire to increase capacity to absorb climate change?
  - Realignment: Do we use fire management to realign ecosystems?
- Establish proximate management goals
  - Given a new set of objectives (values) where do we best deploy limited resources to:
    - increase resilience of valued elements (fortify)
    - Increase resistance of valued elements (delay change)
    - Foster orderly, but likely inevitable, change (re-align)
    - Prepare for the unexpected (big drought / fire years)

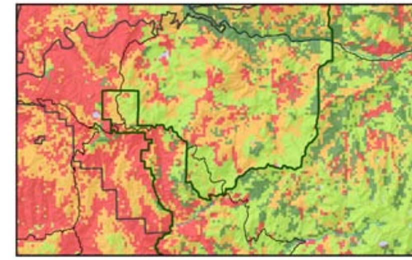
Near term exposure (red); 2010-2040; GFDL



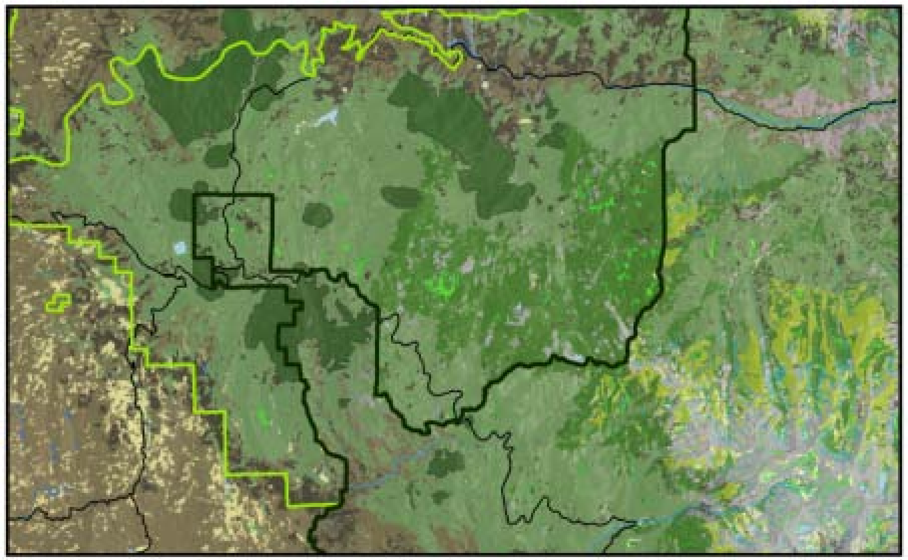
Expected magnitude of change (orange and red: major type conversion)



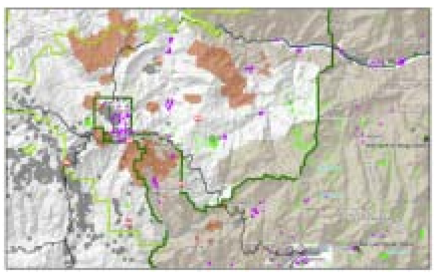
End of century refugia (green; 2070-2100; GFDL)



Hume, Veg map

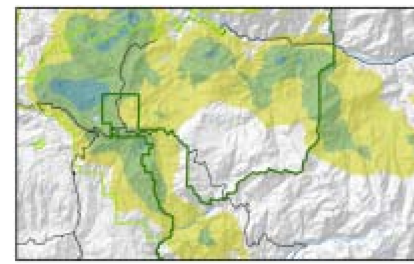


Cultural Values



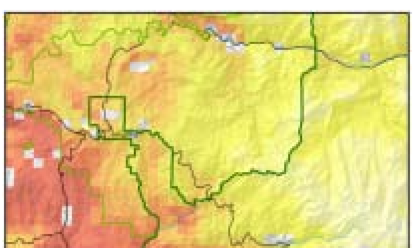
Paul Hardwick

Fisher habitat



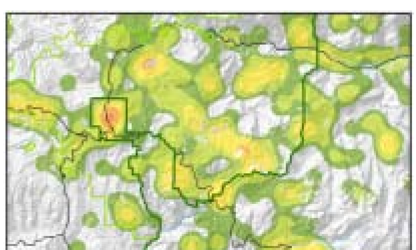
Wayne Spencer

Fire likelihood

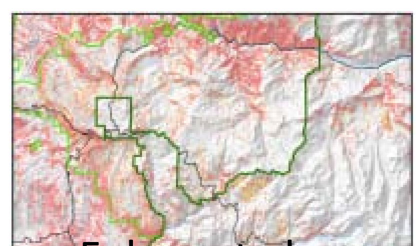


Max Moritz

Ignitions (#/time)

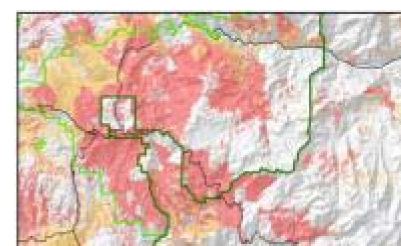


Flame length



Karen Folger et al

FRID



Interactive Planning Exercise

ECOSYSTEM MGMT: Fire Burn Out/
Big Problems Big Solutions

STATUS QUO:
Gradual Change/Anybody out there?

More human and/or lightning ignitions

Fire

Much warmer and drier

Available Moisture

Warmer and wetter

Ignitions

Fewer human and/or lightning ignitions

WATER WARS IGNITE:
Mega Mosaic/Riot & Revolution

MEGAFIRE LOOMS:
Fuel Build Up/Is Anyone Out There?

Support:

FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE

NATIONAL
PARK
SERVICE

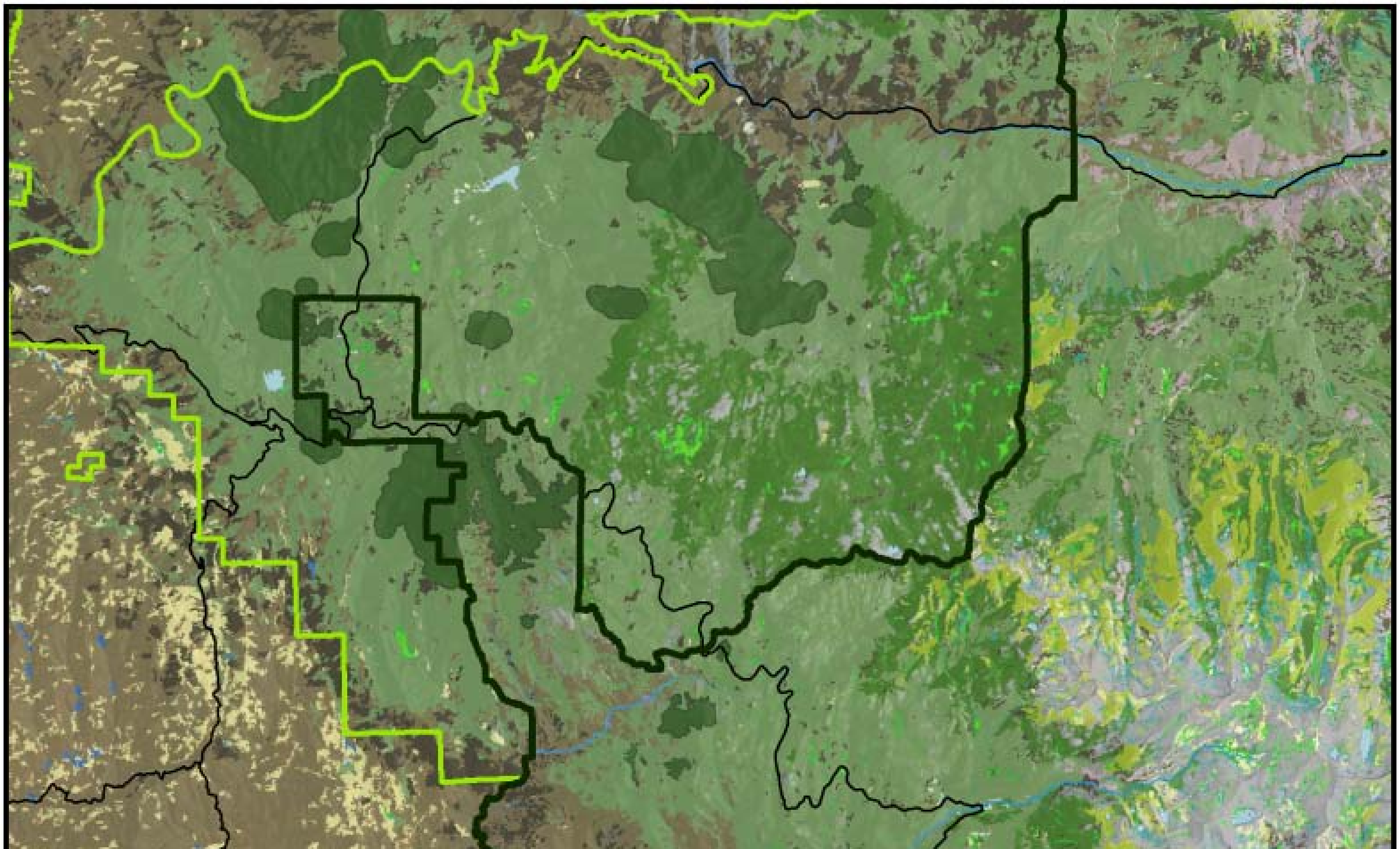
Thank You!

USGS

UCDAVIS
JOHN MUIR INSTITUTE
OF THE ENVIRONMENT

Planning a fire management strategy

- The Hume Landscape



P(Vegetation Change)/Climate Change

Vegetation Sensitivity

1. Multivariate analysis to capture bioclimatic space.
   - GFDL, PCM climate models; high emission scenario;
   - Basin Characterization Model (270 m climate downscale).
2. Contour scatter plots of points in current climate space to identify bioclimatic regions that are:
   - Central (<66%);
   - Marginal 67-90th,
   - Highly marginal (90-99th%), and
   - Outside (>99th%) the bioclimatic distribution of the type.
3. Plot PCA scores of projected future climate onto contours of current climate for all vegetation types.
4. Map onto the landscape