Webpage coming soon!!!
SWFireclime.org

Southwest FireCLiME

Landscape Impacts of Fire and Climate Change in the Southwest : A Science-Management Partnership

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AND THE WHOLE TEAM

NAU NORTHERN ARIZONA UNIVERSITY
School of Forestry

JOINT FIRE SCIENCE PROGRAM

Southwest FireCLiME

Team (Co-PIs)

- Andi Thode, NAU (PI)
- Anne Bradley, TNC
- Windy Bunn, NPS
- Zander Evans, FSG
- Don Falk, UA
- William Flatley, UCA

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Megan Friggens, RMRS

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Shaula Hedwall, USFWS

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Rachel Loehman, USGS

Jack Triepke, USFS

Craig Wilcox, USFS

Larissa Yocom, USU

USGS science for a changing world
Forest Stewards Guild
The Nature Conservancy — Protecting nature. Preserving life.
NAU Northern Arizona University School of Forestry
Forest Service U.S. Department of Agriculture
U.S. Fish & Wildlife Service
National Park Service
Rocky Mountain Research Station
The University of Arizona
University of Central Arkansas
UtahStateUniversity

Southwest FireCLiME

An experiment in co-production of science

1. Managers and scientists wrote the grant together
2. Managers and scientists were involved in every step of the project
3. Case studies of modeling and tools involved manager and scientist input and testing.
4. Final stage will test our fire-climate adaptation menu on a real USFS project.

Southwest FireCLiME

Goals

The goals of this project were to:

1. Evaluate how fire regimes may shift due to changing climate across Southwest landscapes
2. Model the potential ecological impact of those changes with treatments, and
3. Establish ways that managers may address these impacts.

The Phases

1. Science Synthesis
   - Coded Lit Review
   - Workshop September 2016
   - Annotated Bibliography
   - Paper on Climate and Fire in the Southwest
2. Vulnerability Analysis
   - VA Tool
   - GTR and webinars
   - Case Studies on the Lincoln National Forest, NM and in the Jemez Mountains, NM
3. Climate-Management Modeling
   - Webinars with Managers
   - Modeling Team of Managers and Scientists
   - Publication (Forests 2018, 9:192)
4. Fire-Climate Adaptation Menu
   - Manager and Scientist Development
   - Partnership with the Northern Institute of Climate Science (NIACS)
   - Testing of Menu on the Kaibab National Forest

Adaptation Process

Fire-Climate Adaptation Menu

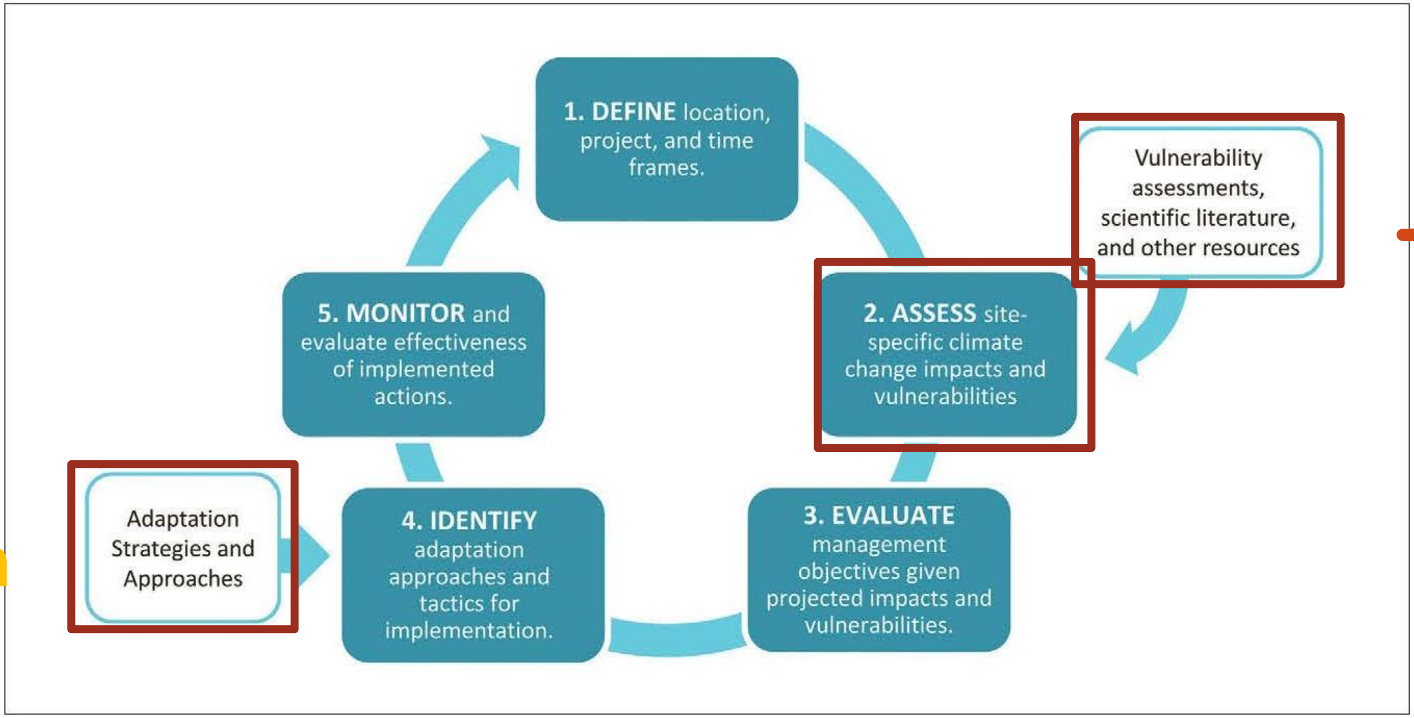


Figure 12.—An illustration of the adaptation process used to incorporate climate change as a management consideration and help ecosystems adapt to the anticipated effects of climate change. Additional resources provide information and tools that support the process.

Science Synthesis

Vulnerability Analysis

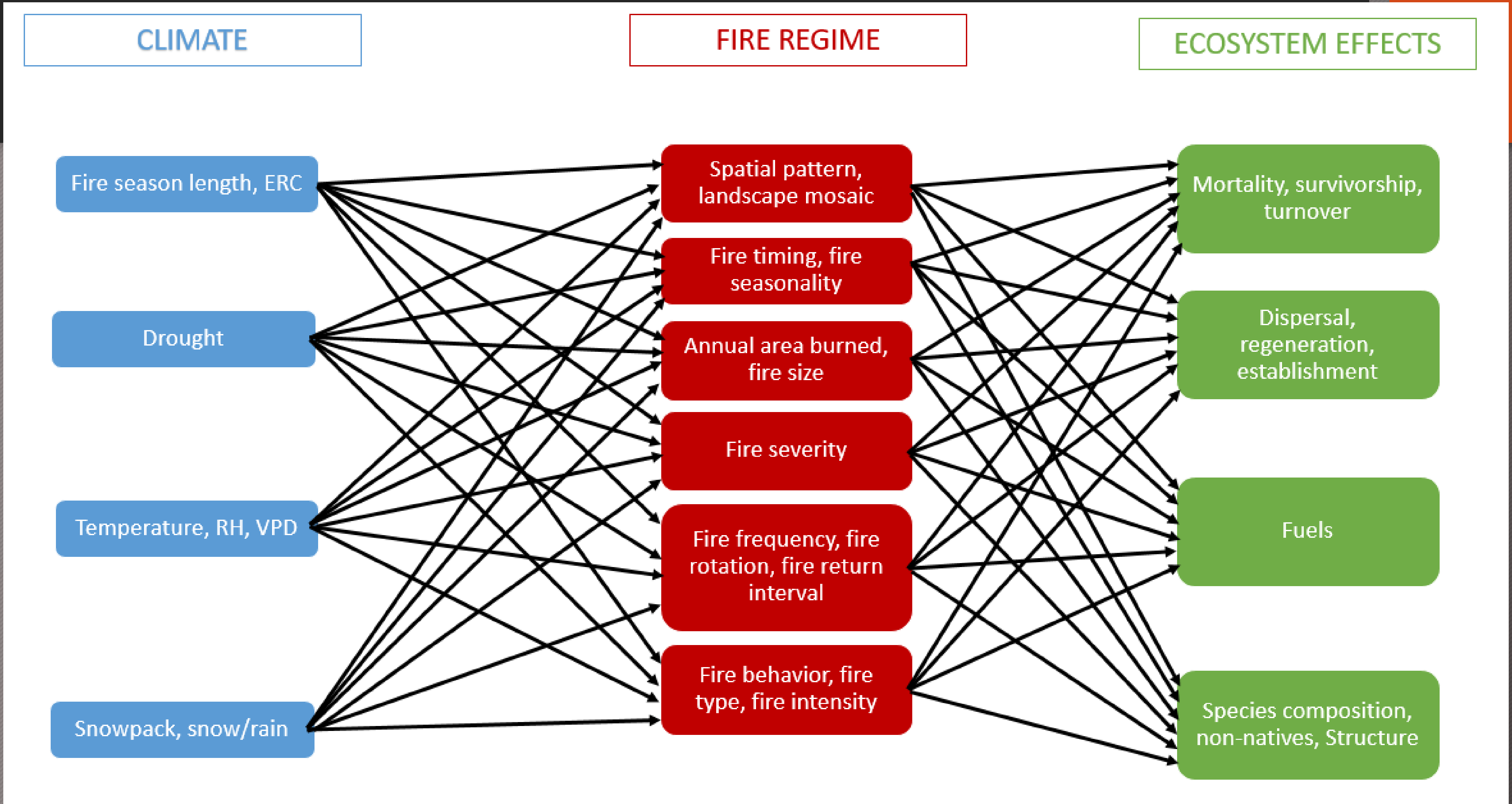
Modeling

From "Forest Adaptation Resources" GTR-NRS-87, Swanston et al., 2016

Phase 1: Science Synthesis

- Coded Lit Review
- Workshop September 2016
- Annotated Bibliography

Climate-Fire-Ecosystem Interactions



How does temperature, relative humidity, and vapor pressure deficit affect annual area burned and fire size?

Abatzoglou, J., & Kolden, C. (2013). Relationships between climate and macroscale area burned in the western United States. *International Journal of Wildland Fire, 22*(7), 1003–1020. https://doi.org/10.1071/WF13019

For the Southwest GACC specifically, temperature, precipitation, and drought indicators were strongly correlated to forested area burned. Unburned area within a fire perimeter did show a negative correlation to summer (June – Aug) temperature, however, the authors conclude that temperature is acting as an indirect proxy for fuel moisture stress and flammability. In general, biophysical variables that include a direct link to fuel moisture conditions performed better than any single individual variable, such as temperature or precipitation.

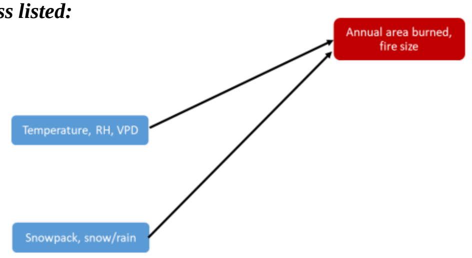
Cross listed:

- **Temperature, RH, and VPD on Fire timing, fire seasonality**
- **Temperature, RH, and VPD on Annual area burned, fire size**
- **Snowpack, snow/rain on Annual area burned, fire size**

Littell, J.S., McKenzie, D., Peterson, D.L., and Westerling, A.L. (2009). Climate and wildfire area burned in western U.S. ecoprovinces, 1916-2003. *Ecological Applications*, *19*(4), 1003–1021.

For the mountainous ecoprovince of Arizona and New Mexico, temperature during the year-of-the fire was related to area burned in these areas as well as annual (water year) PDSI.

Cross listed:



Westerling, A.L., Hidalgo, H.G., Cayan, D.R., Swetnam, T.W. (2006). Warming and earlier spring increase western U.S. forest wildfire activity. *Science*, 313(940), 14-26. https://doi.org/10.1126/science.1128834

Increasingly warm temperatures have significantly increased annual area burned by at least six and a half times between the time periods of 1970 to 1986 and 1987 to 2003. The author's suggest that as temperatures continue to warm, wildfires will become larger and more frequent.

Cross listed:

- **Fire season length on Fire timing, fire seasonality**
- **Temperature, RH, and VPD on Annual area burned, fire size**
- **Temperature, RH, VPD on Fire frequency, fire rotation, fire return interval**
- **Snowpack, snow/rain on Fire timing, fire seasonality**
- **Snowpack, snow/rain on Fire frequency, fire rotation, fire return interval**

Williams, A.P., Seager, R., Macalady, A.K., Berkelhammer, M., Crimmins, M.A., Swetnam, T.W., Trugman, A.T., Buenning, N., Noone, D., McDowell, N.G., Hryniw, N., Mora, C.I., Rahn, T. (2015). Correlations between components of the water balance and burned area reveal new insights for predicting forest fire area in the southwest United States. *International Journal of Wildland Fire*, 24(1), 14-26. http://dx.doi.org/10.1071/WF14023

March through August VPD, a measure of the ability of the atmosphere to extract moisture from surface vegetation, is more strongly correlated with area burned than temperature alone for the Southwest region.

Cross listed:

- **Temperature, RH, and VPD on Annual area burned, fire size**
- **Temperature, RH, VPD on Fire severity**

Phase 2: Vulnerability Analysis

- VA Tool
- GTR and Webinars
- Case Studies on the Lincoln National Forest, NM and in the Jemez Mountains, NM

Vulnerability Analysis

Exposure

Climate scenarios

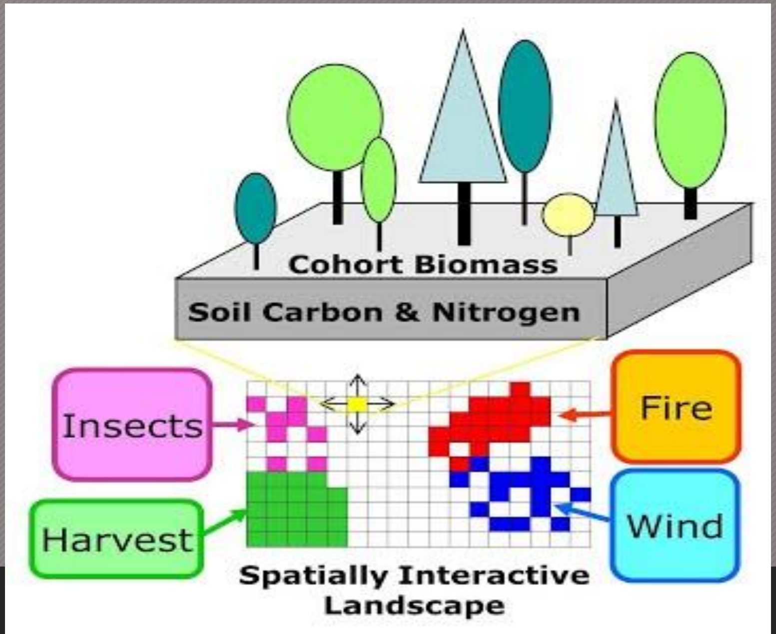
Sensitivity

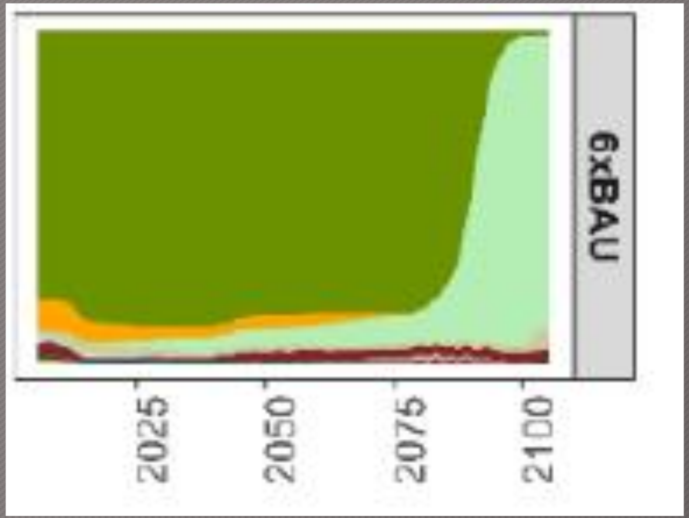
- Ecological components
- Fire regime components

Adaptive Capacity

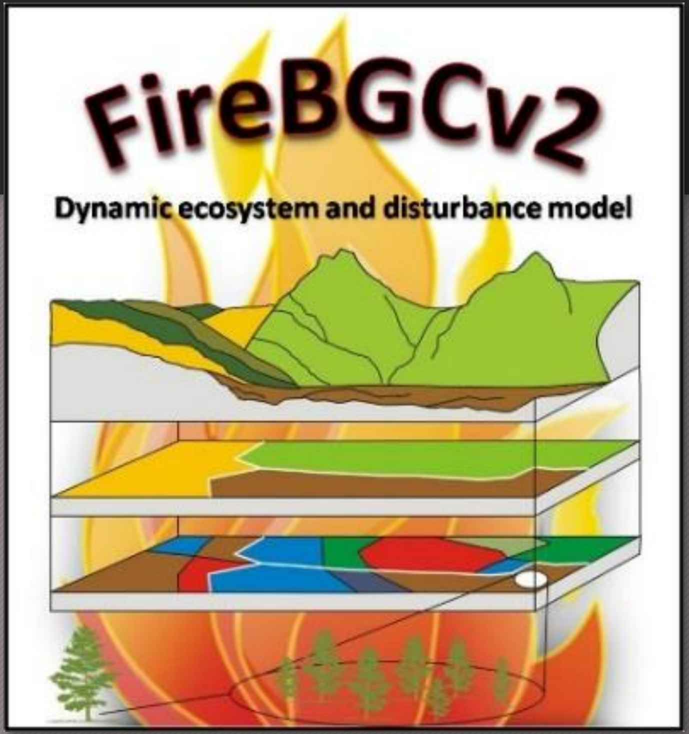
Identifying effective treatment

- Development of the SWFireCLIME Vulnerability Analysis Tool
  - RMRS-GTR-395
- Two Case Study Areas:
  - Lincoln National Forest
  - Jemez Mountains, NM





Phase 3: Modeling



- Webinars with Managers
- Modeling Team of Managers and Scientists
- Publication (Forests 2018, 9:192)
- Second publication in process

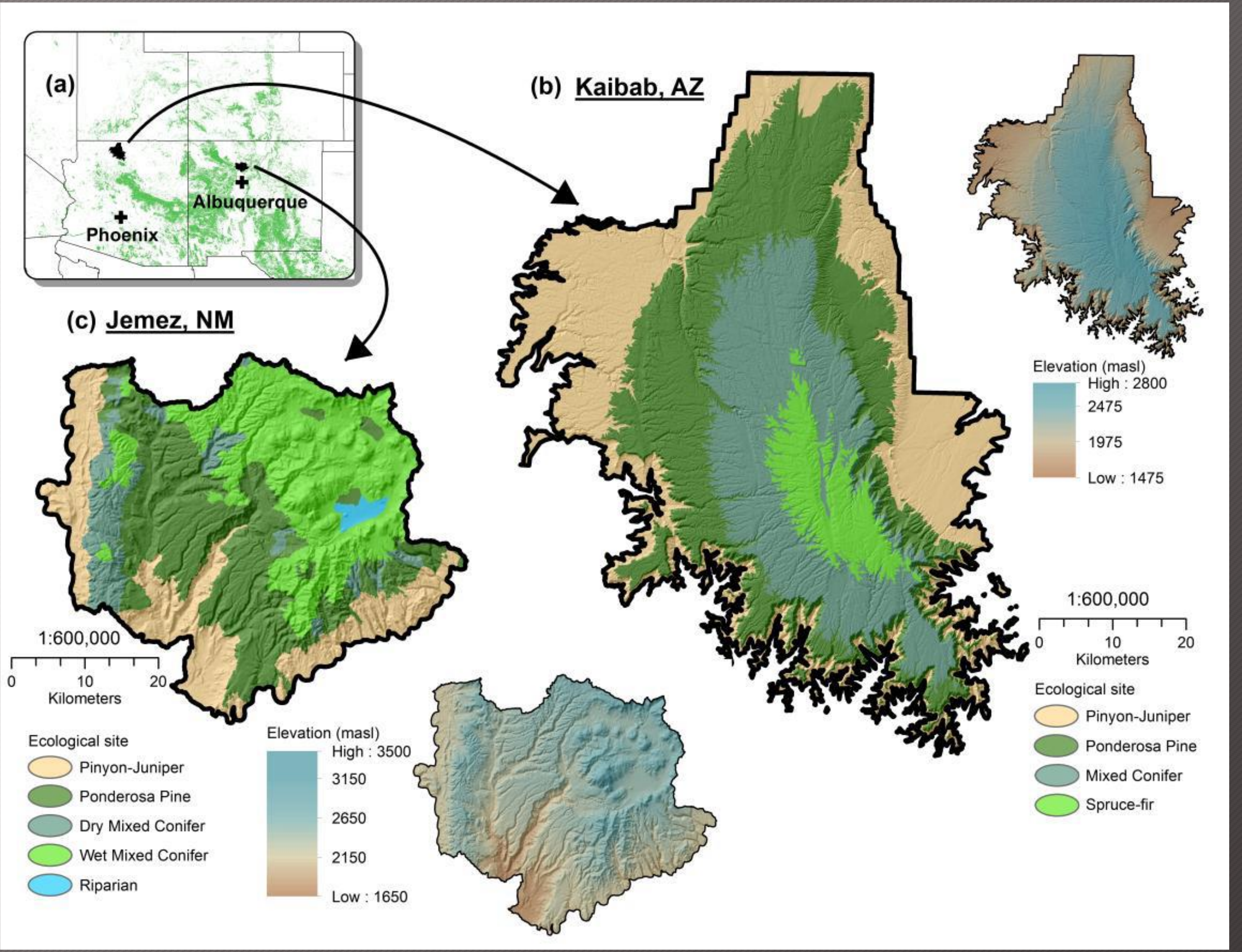
Modeling in the Jemez Mountains, NM and North Kaibab, AZ

Used two different models on two landscapes:

- FireBGCv2 for the Jemez Mountains, NM
- LANDIS-II for the North Kaibab, AZ

Scenarios are combinations of:

1. Management
2. Climate



Phase 4: Fire-Climate Adaptation Menu

- Manager and Scientist Development
- Partnership with the Northern Institute of Climate Science (NIACS)
- Testing of the Menu on the Kaibab National Forest

Climate Menu: Adaptation Strategies, Approaches and Tactics

NIACS
Northern Institute of Applied Climate Science

Box 10

Menu of Adaptation Strategies and Approaches

Strategy 1: Sustain fundamental ecological functions.

1.1. Reduce impacts to soils and nutrient cycling.
1.2. Maintain or restore hydrology.
1.3. Maintain or restore riparian areas.
1.4. Reduce competition for moisture, nutrients, and light.
1.5. Restore or maintain fire in fire-adapted ecosystems.

Strategy 2: Reduce the impact of biological stressors.

2.1. Maintain or improve the ability of forests to resist pests and pathogens.
2.2. Prevent the introduction and establishment of invasive plant species and remove existing invasive species.
2.3. Manage herbivory to promote regeneration of desired species.

Strategy 3: Reduce the risk and long-term impacts of severe disturbances.

3.1. Alter forest structure or composition to reduce risk or severity of wildfire.
3.2. Establish fuelbreaks to slow the spread of

Strategy 6: Increase ecosystem redundancy across the landscape.

6.1. Manage habitats over a range of sites and conditions.
6.2. Expand the boundaries of reserves to increase diversity.

Strategy 7: Promote landscape connectivity.

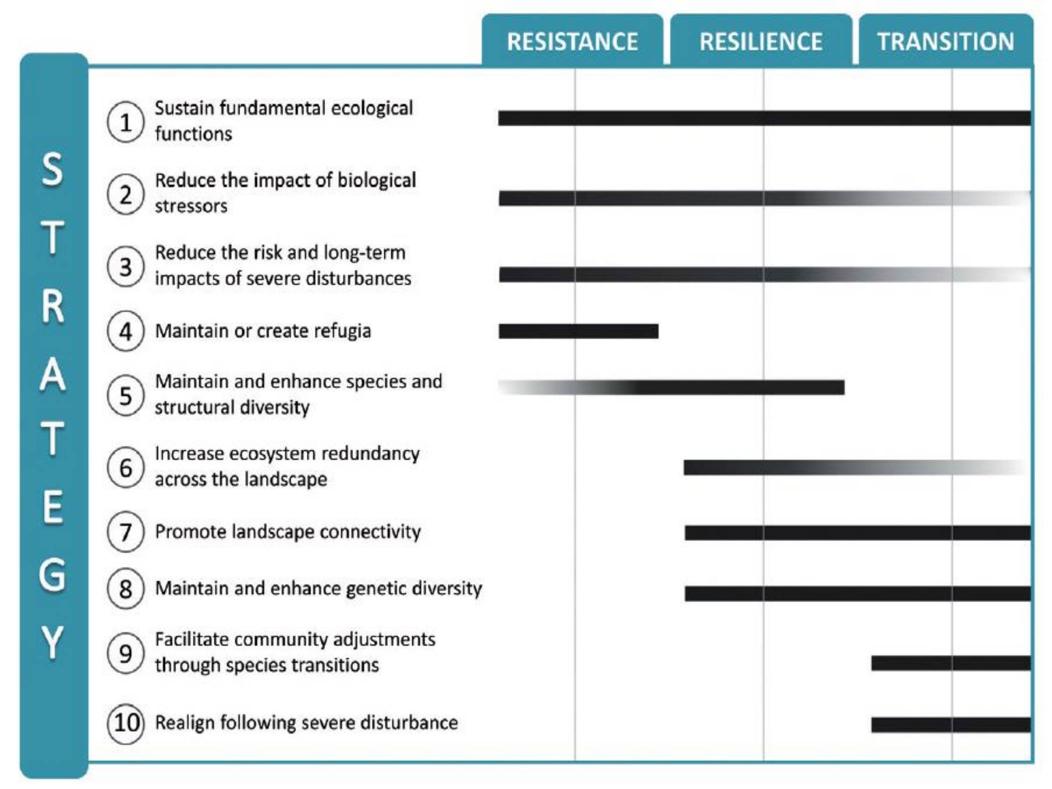
7.1. Reduce landscape fragmentation.
7.2. Maintain and create habitat corridors through reforestation or restoration.

Strategy 8: Maintain and enhance genetic diversity.

8.1. Use seeds, germplasm, and other genetic material from across a greater geographic range.
8.2. Favor existing genotypes that are better adapted to future conditions.

Strategy 9: Facilitate community adjustments through species transitions.

9.1. Favor or restore native species that are expected to be adapted to future conditions.
9.2. Establish or encourage new mixes of native species



Swanston et al., 2016, NRS-GTR-87-2

Eleven Draft Fire-Climate Strategies

Fire Adaptation Strategies and Approaches

Southwest FireCLiME

Strategy 1: Sustain fire as a fundamental ecological process

1.1. Restore or maintain fire in fire-adapted ecosystems
1.2. Develop fire use strategies in altered or novel ecosystems where fire can play a beneficial role
1.3. Protect fire-sensitive ecosystems from fire

Strategy 2: Reduce the effects of biotic and abiotic stressors on fire regimes

2.1. Prevent the establishment and spread of nonnative invasive species and remove existing populations
2.2. Maintain
2.3. Limit or se /or function

We need your input and edits!!!

Strategy 3: Reduce the risk of severe fire

3.1. Alter forest structure or composition to reduce risk or severity of wildfire
3.2. Establish fuel breaks to slow the spread of catastrophic wildfire
3.3. Manage fire-prone ecosystems to reduce uncharacteristically extreme fire behavior

Strategy 4: Reduce long-term effects of severe fire and promote post-fire recovery

4.1. Promote post-fire ecosystem recovery
4.2. Consider using fire effects as a tool to align vegetation communities with changing climate regimes
4.3. Promote habitat connectivity and increase ecosystem redundancy at the landscape scale

Acknowledgements (at least some of them)

- 60+ people attended our workshop on the fire linkages
- Managers from the North Kaibab District of the Kaibab National Forest, the Santa Fe National Forest and the Valles Caldera National Preserve helped in defining modeling management scenarios
- Managers from the Lincoln National Forest allowed us to run a case study of the VA tool with them.
- Alex Spannuth, Drew Leiendeker and Ariel Leonard from the Kaibab National Forest are working with us to help develop a fire-climate adaptation workshop for the KPERP project.
- Ariel Leonard with the Kaibab National Forest linked us to the NIACS group through review of our initial stabs at adaptation menus and comments on our annotated bibliography.

Funding

- Funded by the Joint Fire Science Program
- Project Number: 15-1-03-26

Burning Questions?

Photo: Mary Lata, Fire Ecologist